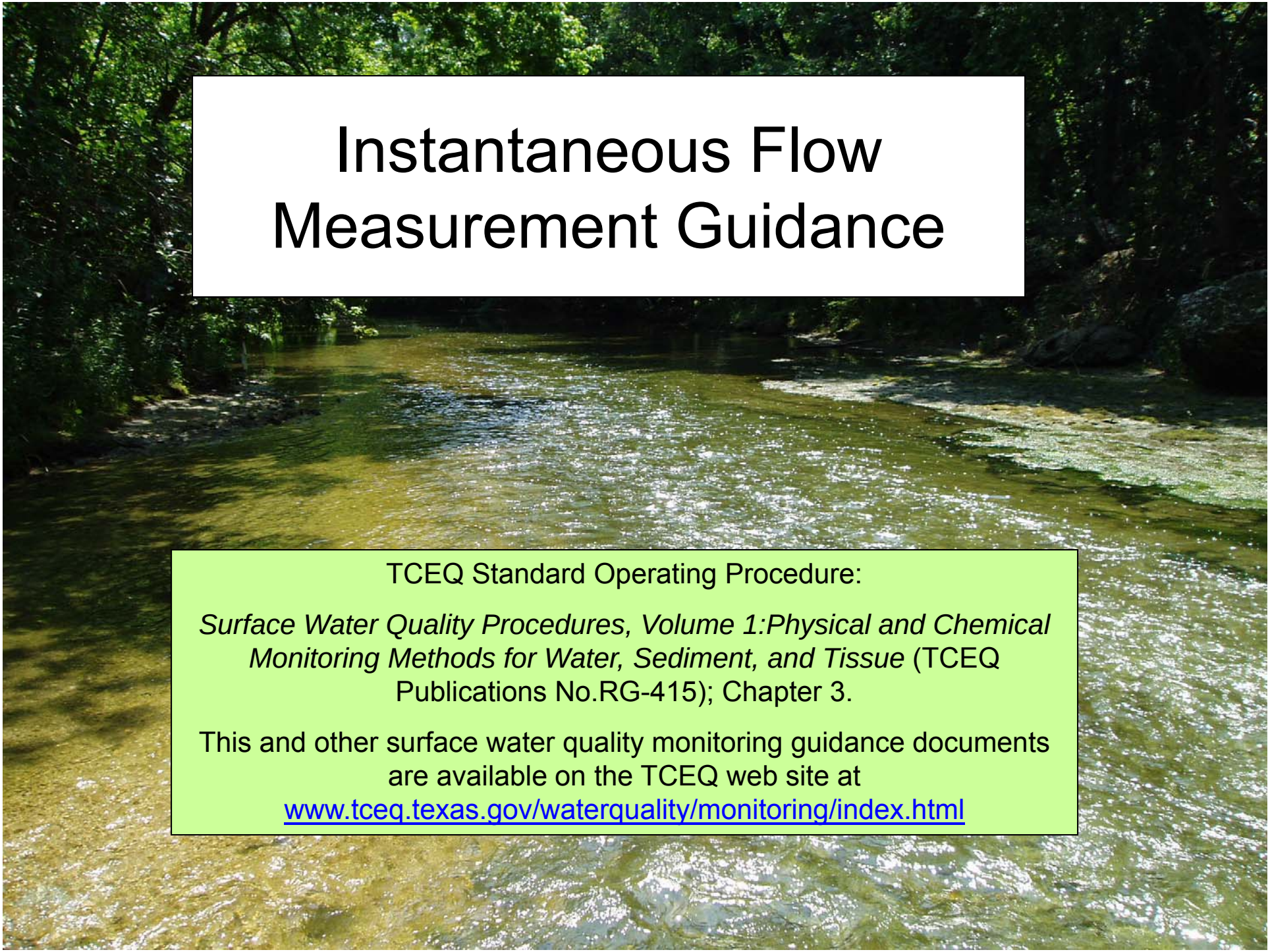
Measuring Instantaneous Stream Flow

Training Module 1

Monitoring & Assessment Section
Water Quality Planning Division
February 2013

TCEQ

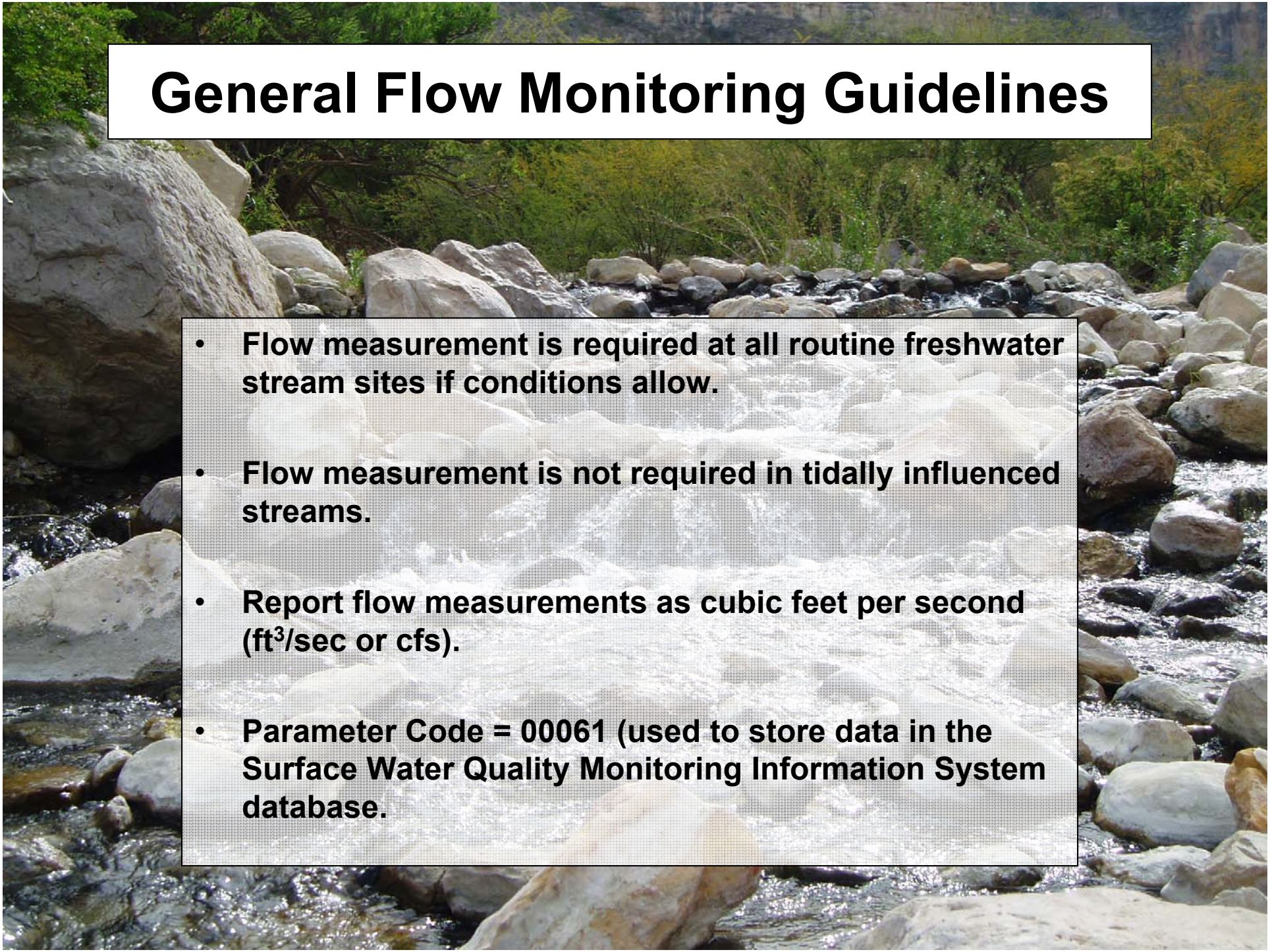


Instantaneous Flow Measurement Guidance

TCEQ Standard Operating Procedure:

Surface Water Quality Procedures, Volume 1:Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue (TCEQ Publications No.RG-415); Chapter 3.

This and other surface water quality monitoring guidance documents are available on the TCEQ web site at www.tceq.texas.gov/waterquality/monitoring/index.html



General Flow Monitoring Guidelines

- **Flow measurement is required at all routine freshwater stream sites if conditions allow.**
- **Flow measurement is not required in tidally influenced streams.**
- **Report flow measurements as cubic feet per second (ft^3/sec or cfs).**
- **Parameter Code = 00061 (used to store data in the Surface Water Quality Monitoring Information System database.**

Exceptions to Reporting Flow

Stations with no flow report as zero flow (WQ samples collected)

Dry - streambed containing no water

Unsafe conditions—high or flood flows

Flow Severity

Parameter Code 01351

- Record a flow severity value for each monitoring event on a freshwater stream or river.

- The six flow severity values are,

  1 = No Flow
  2 = Low Flow
  3 = Normal Flow
  4 = Flood Flow
  5 = High Flow
  6 = Dry

Note: There are no numerical flow guidelines associated with flow severity. This is an observational measurement highly dependent on the water body and the knowledge of monitoring personnel.

Flow Severity

1-No Flow

- Water bodies with water in isolated pools or long reaches with no detectable flow.
- In streams with no flow, report a flow value of 0.0 cfs and a flow severity of 1.

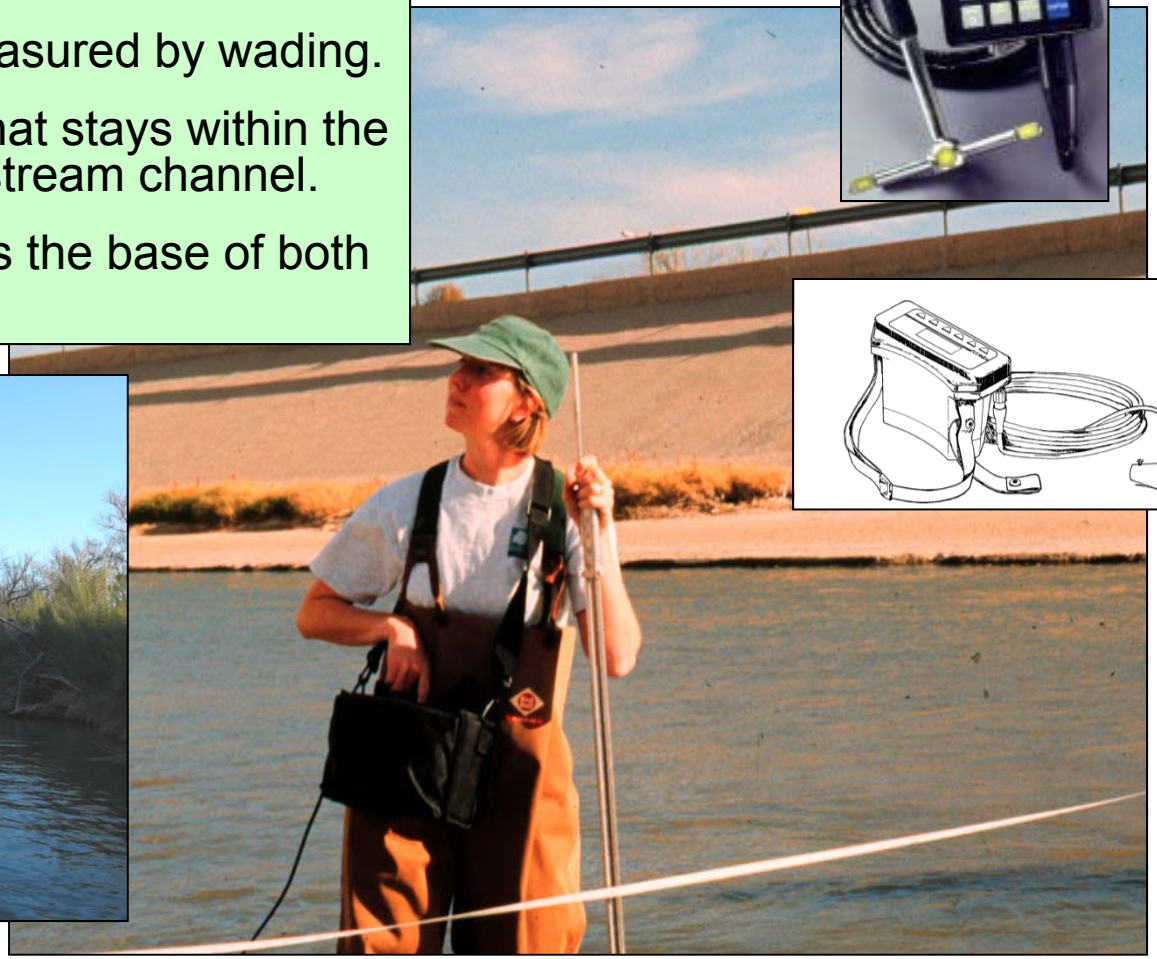
Flow Severity
2-Low Flow

- May be too shallow for flow measurement but flow can be detected.
- In streams with detectable flow but too shallow to measure, report a flow value of < 0.10 cfs.
- Flows might not fill the normal stream channel.
- Water would not reach the base of both banks.
- Portions of the stream channel might be dry.
- Flow might be confined to one side of the channel.

Flow Severity

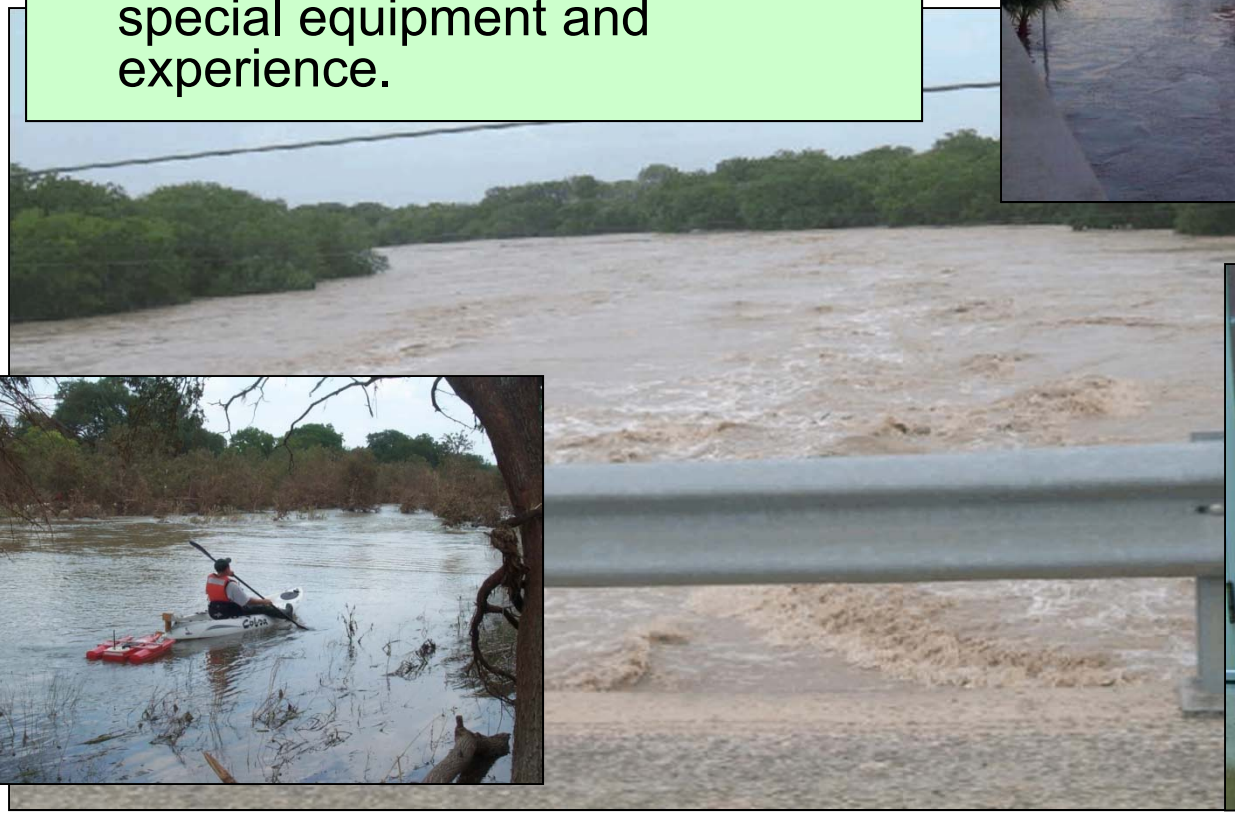
3-Normal Flow

- Dependent on particular water body.
- Flow can usually be measured by wading.
- Characterized by flow that stays within the confines of the normal stream channel.
- Water generally reaches the base of both banks.



Flow Severity
4-Flood Flow

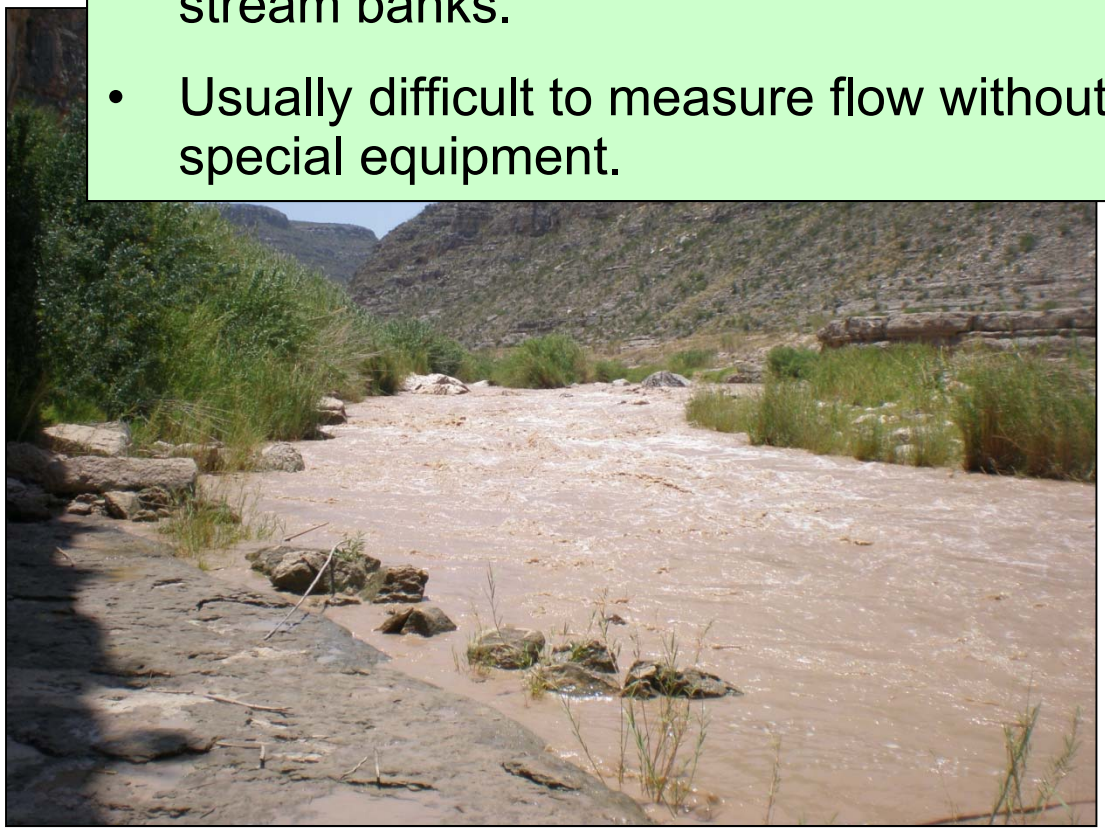
- Flow moves out of stream channel and on to the floodplain.
- Difficult to measure flow without special equipment and experience.



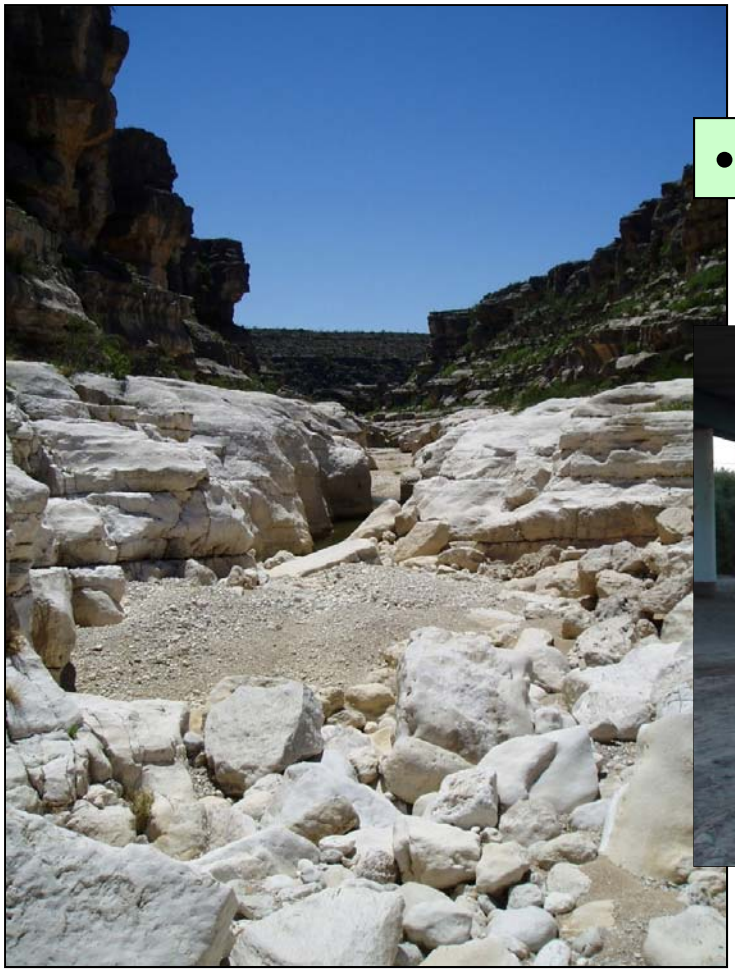
Flow Severity

5-High Flow

- Characterized by flow that leaves the normal stream channel but stays within stream banks.
- Usually difficult to measure flow without special equipment.



Flow Severity
6-Dry

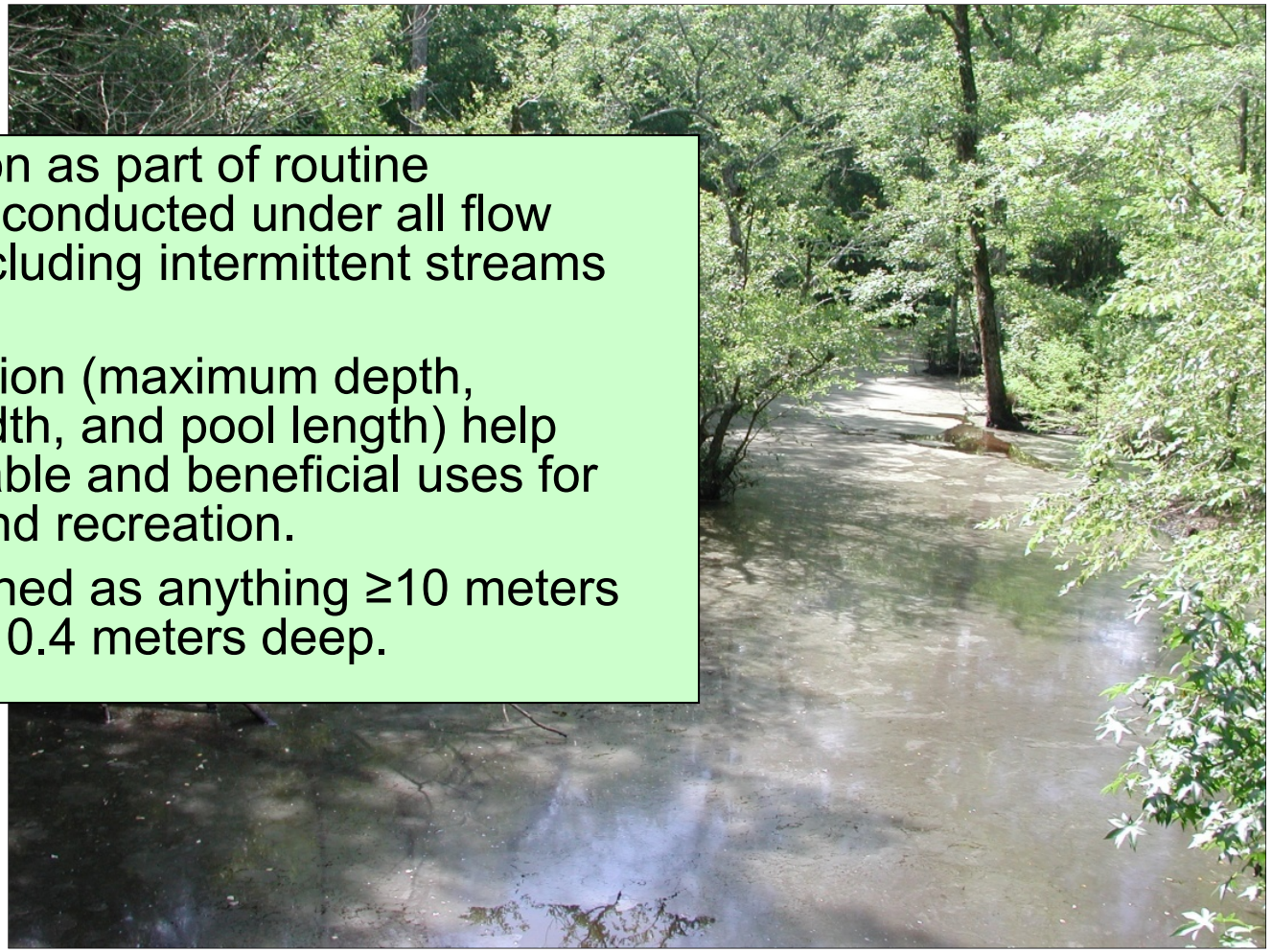


- Dry with no visible pools.

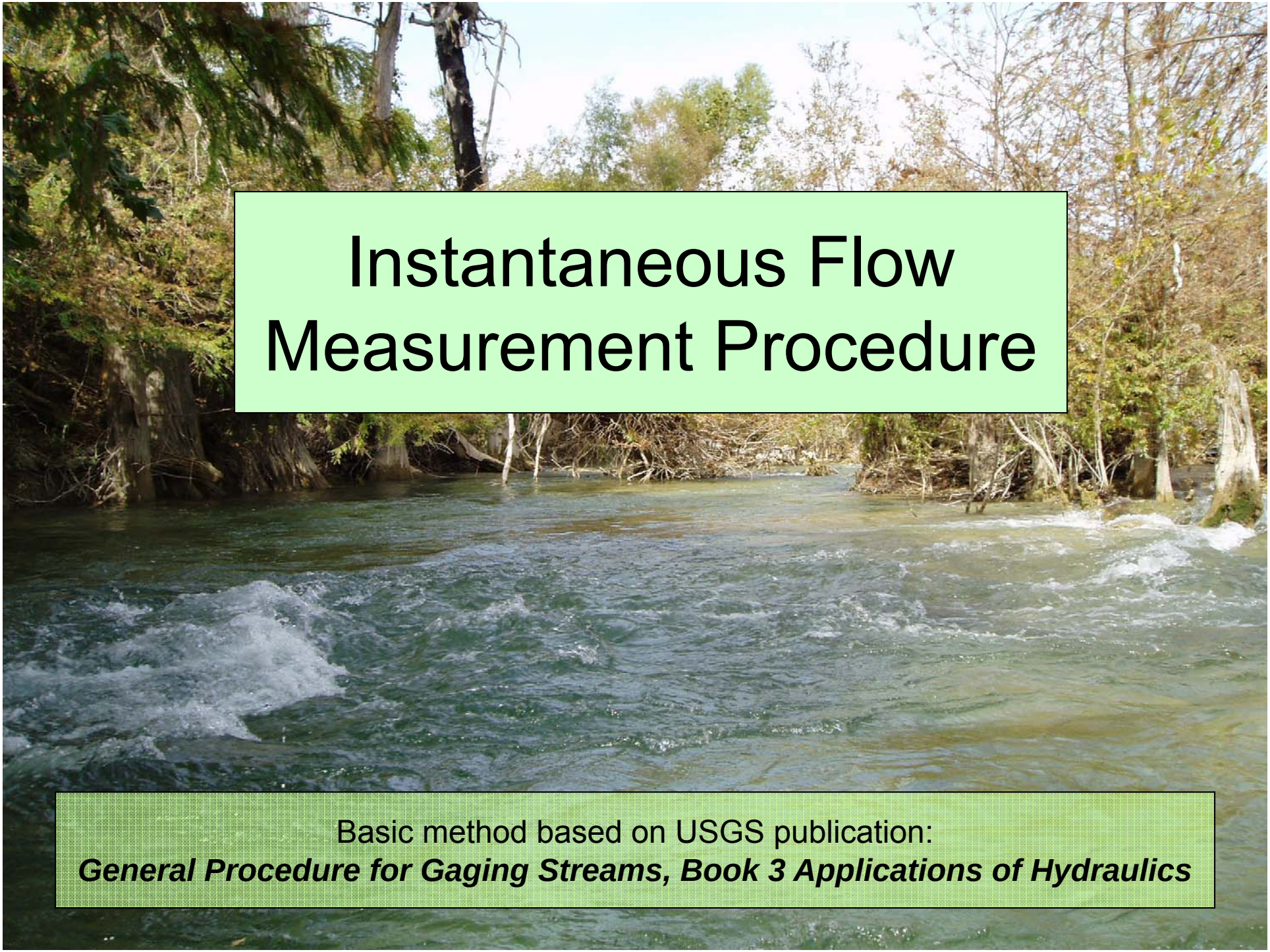
Flow Severity

1-No Flow

Pool Characteristics



- Data collection as part of routine monitoring is conducted under all flow conditions including intermittent streams with pools.
- Pool information (maximum depth, maximum width, and pool length) help define attainable and beneficial uses for aquatic life and recreation.
- A pool is defined as anything ≥10 meters long and ≥ to 0.4 meters deep.



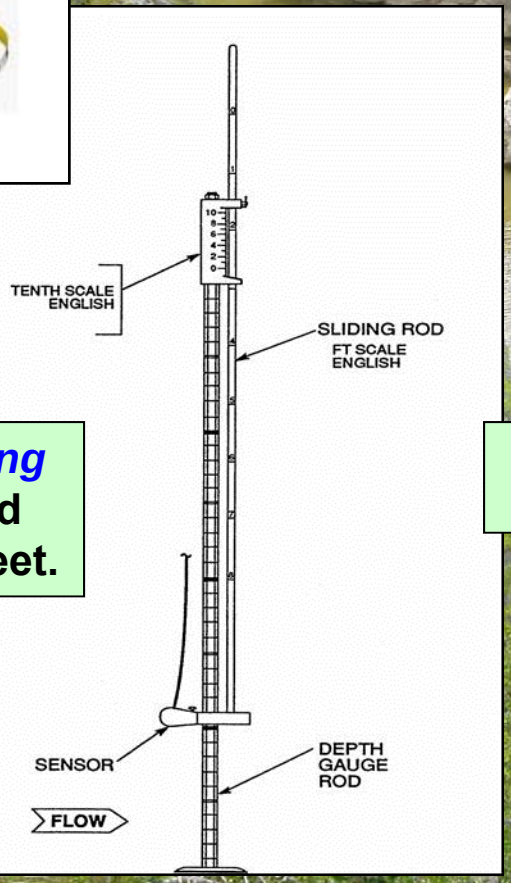
Instantaneous Flow Measurement Procedure

Basic method based on USGS publication:
General Procedure for Gaging Streams, Book 3 Applications of Hydraulics

Equipment

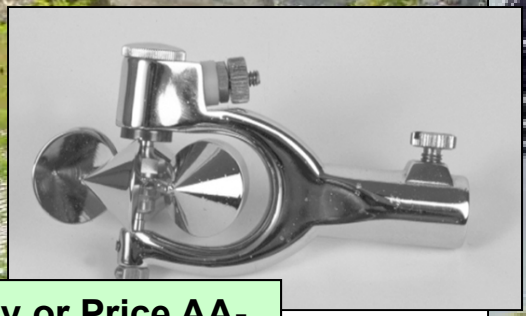
Three basic pieces of equipment are needed to measure instantaneous flow:

1. 100 ft *measuring tape* mark in 0.10 ft increments.



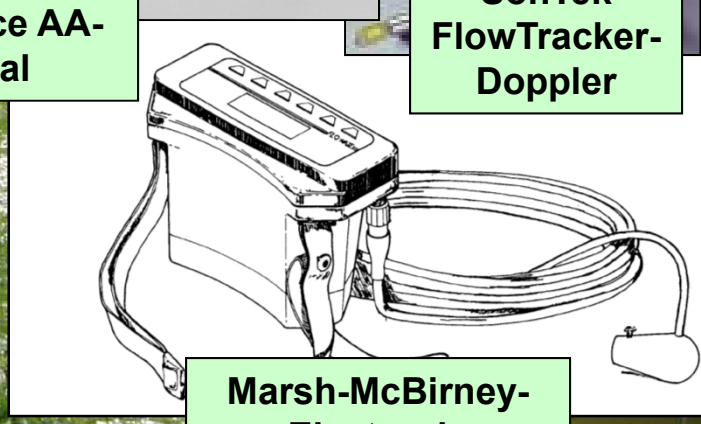
2. *Top setting wading* rod marked in feet.

3. Mechanical, electronic or Doppler *flow meter*.



Pygmy or Price AA-Mechanical

SonTek FlowTracker-Doppler



Marsh-McBirney-Electronic

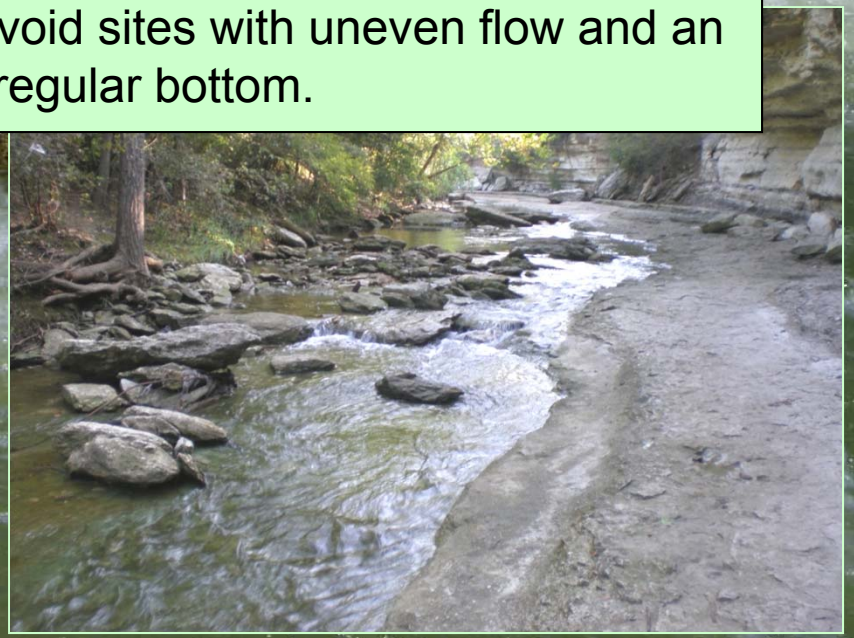
Selecting a Flow Measurement Site

The key to a successful flow measurement is *Site Selection*.

Avoid sites with back eddies and negative flows.

Select an even stream bed free of large rocks, protruding obstructions, or vegetation.

Avoid sites with uneven flow and an irregular bottom.



Selecting a Flow Measurement Site

Select a site with laminar flow

Laminar flow = threads of parallel velocity extending from bank to bank.

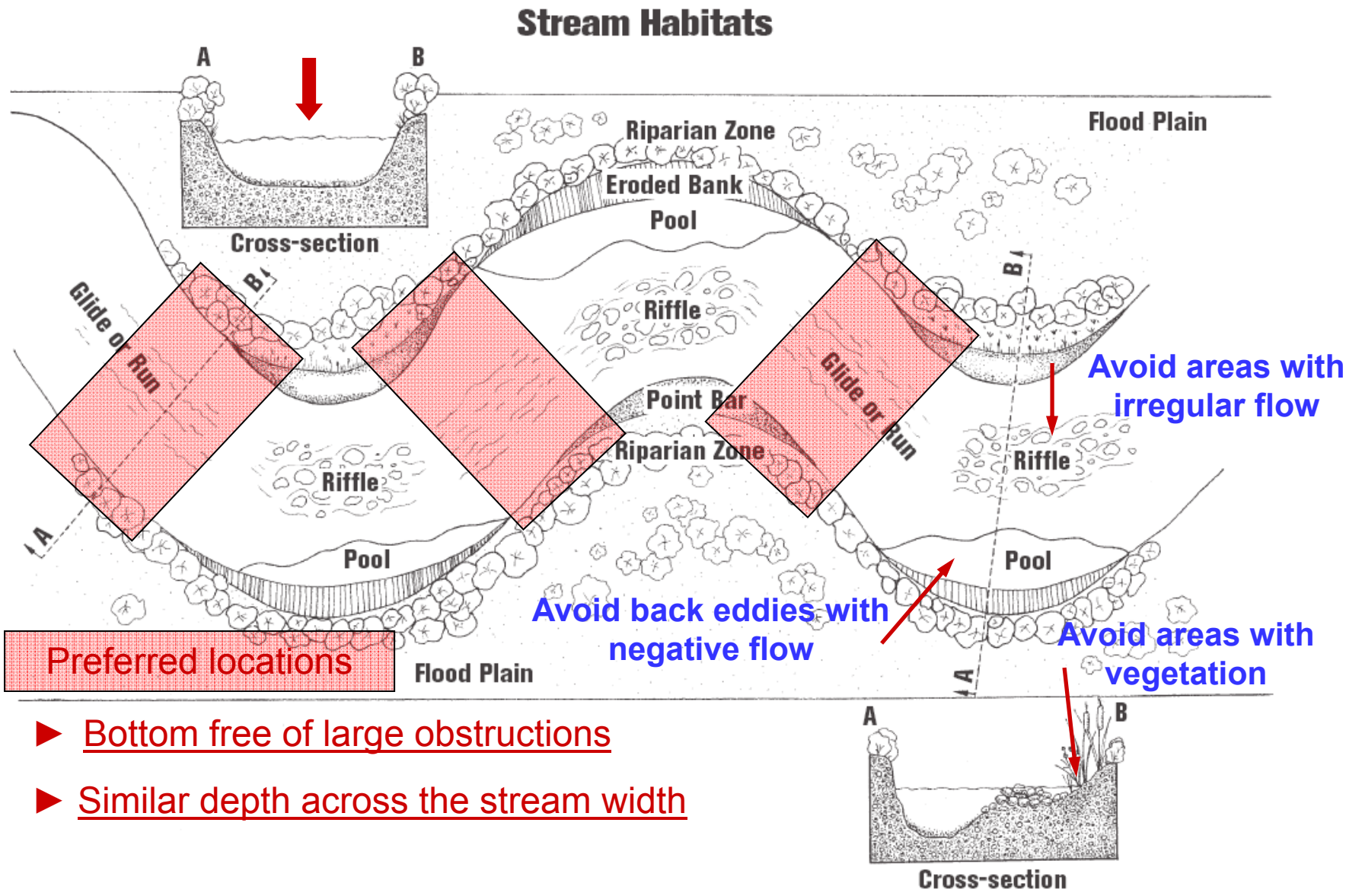
Laminar flow, no obstructions

Laminar flow, no obstructions

Avoid uneven flow with irregular bottom

Avoid instream obstructions

Where to Measure Flow



- Bottom free of large obstructions
- Similar depth across the stream width

Key Steps to Measuring Stream Flow

The key steps to measuring stream flow are,

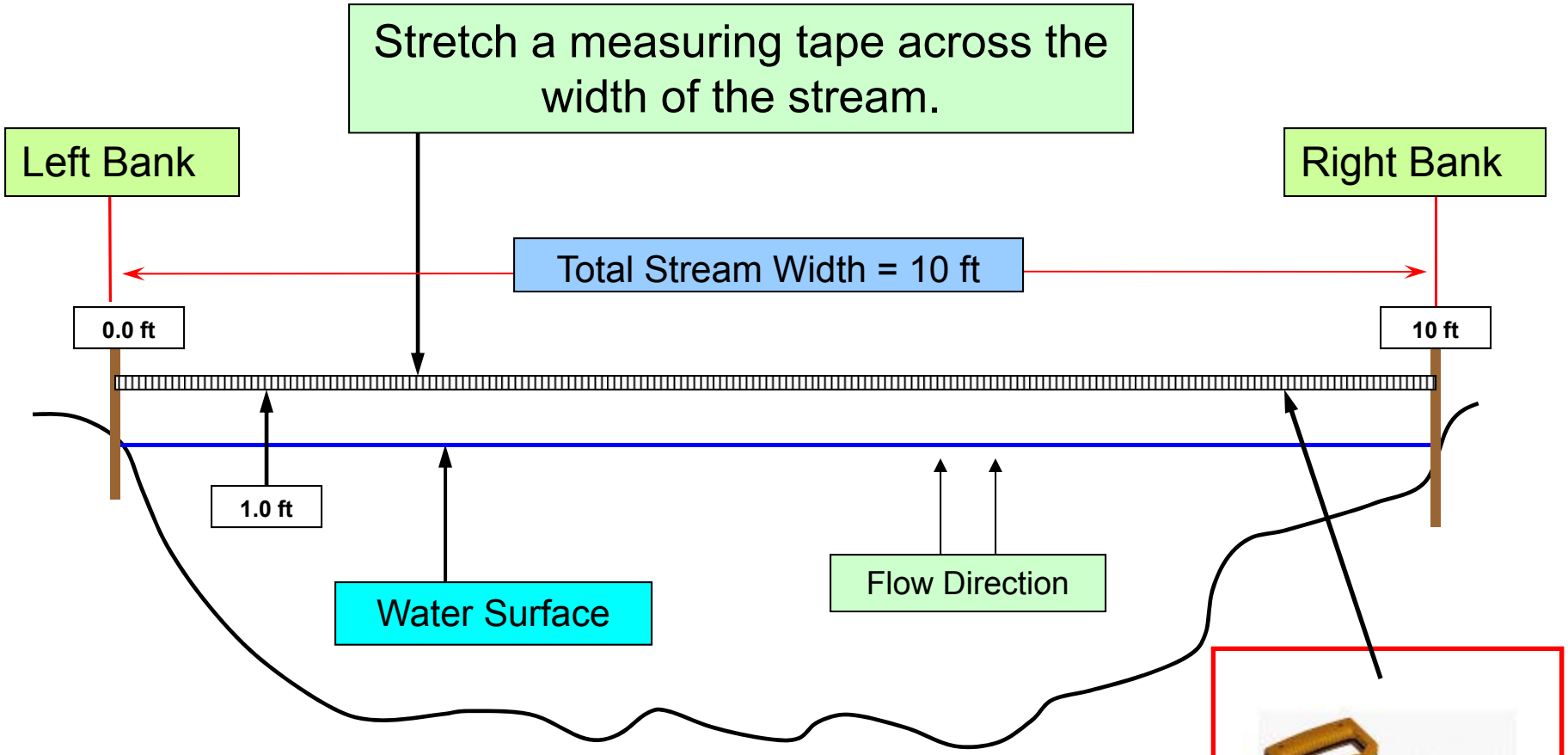
1. Select the flow measurement site.
2. Measure the total width of the stream.
3. Determine the # of cross sections.
4. Find the midpoint of the cross section.

At the midpoint of each cross section:

1. Measure the depth and record.
2. Set the flow sensor at the correct depth.
3. Measure the velocity and record.
4. After completing measurements at all cross sections, calculate flow.

These steps are detailed in this training module.

Measure the Total Stream Width



Left Bank/Right Bank Orientation is determined by facing downstream.

The tape is marked in 0.10 foot increments.

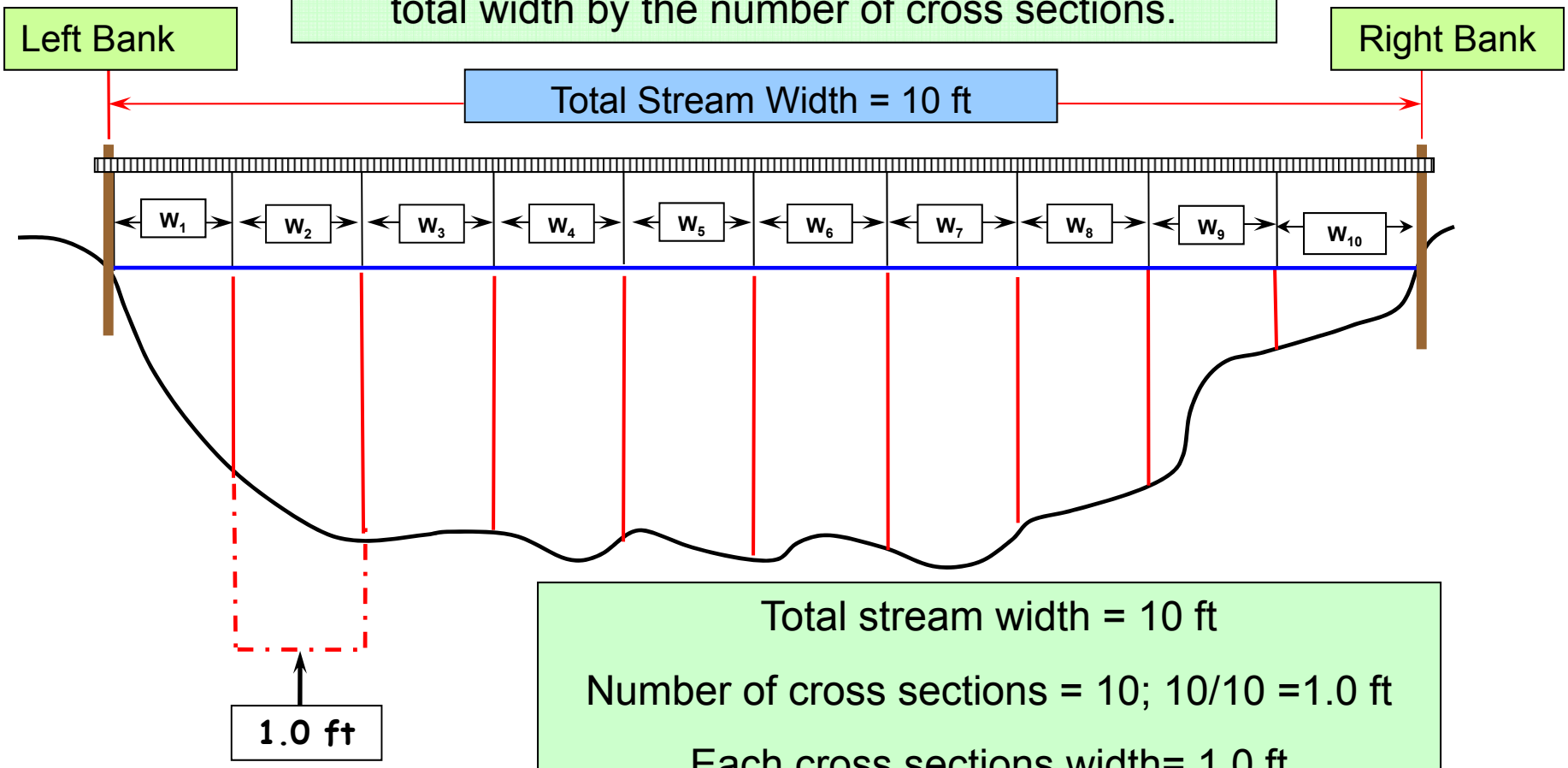
Determine Number of Cross Sections

- Sections should be of equal width
- *Stream width < 5 ft*
  - Cross section width 0.5 feet
- *Stream width > 5 ft but < 10 ft*

  - Minimum 10 cross sections
- *Stream width > 10 ft*
  - Preferred number of cross sections = 20 to 30

Establish the Cross Section Width

Establish cross section width by dividing the total width by the number of cross sections.



Total stream width = 10 ft

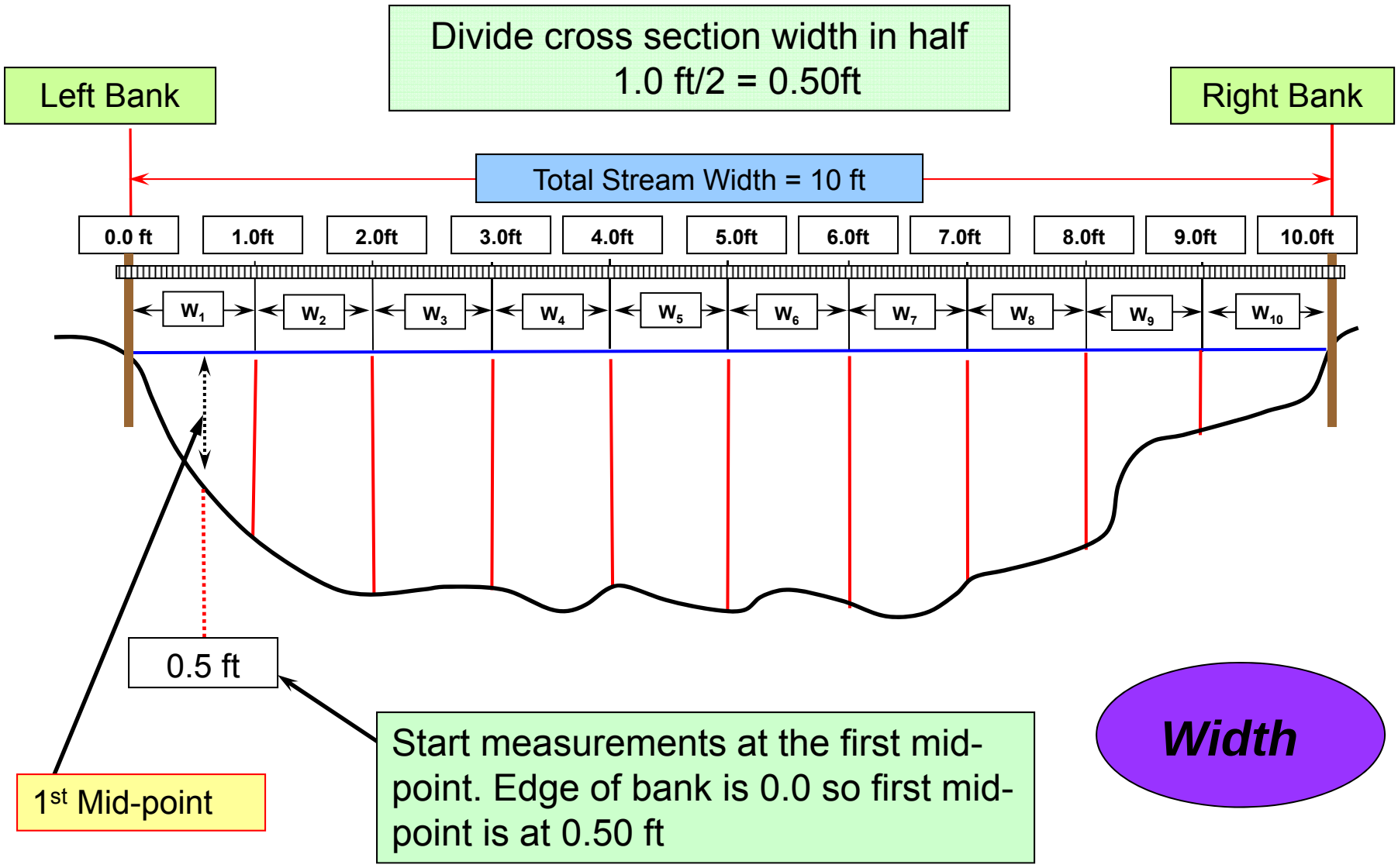
Number of cross sections = 10; 10/10 =1.0 ft

Each cross sections width= 1.0 ft

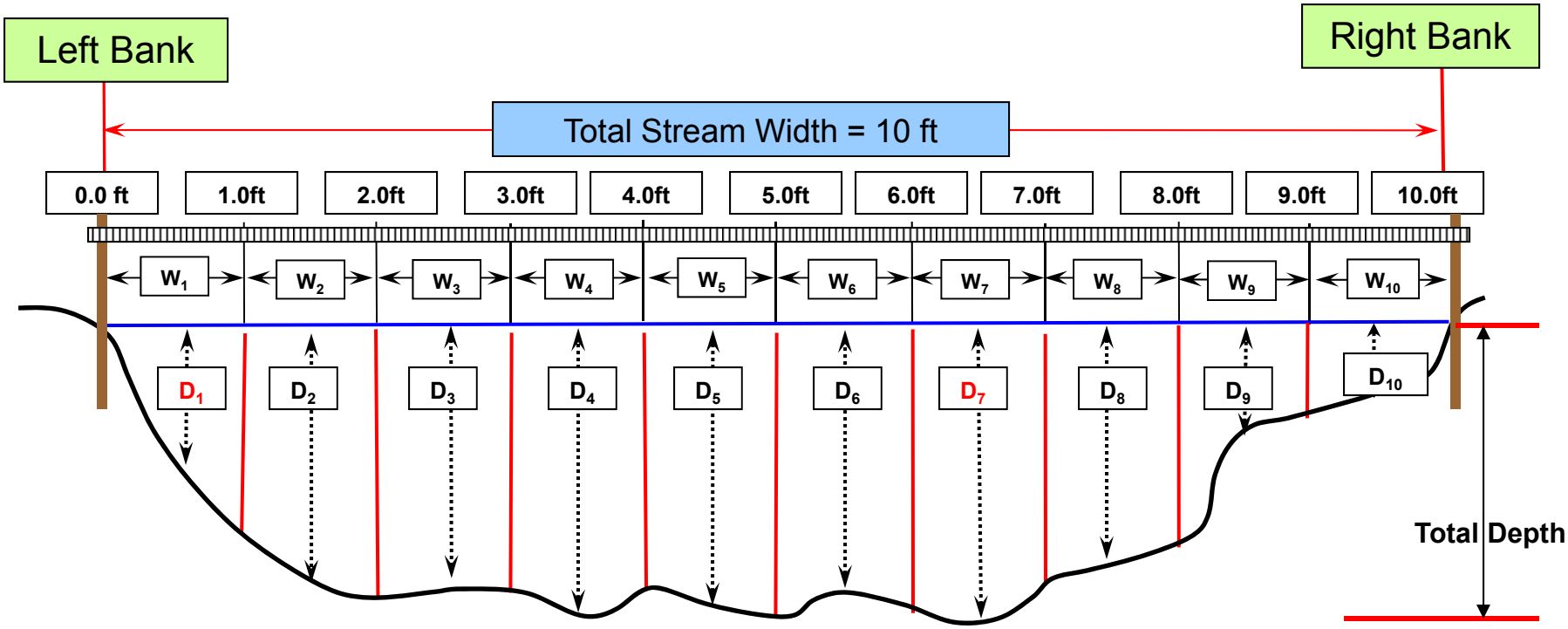
Stream width > 5 ft but ≤ 10 ft
Minimum 10 cross sections

Width

Find the Mid-point of the Cross Section



Measuring Depth

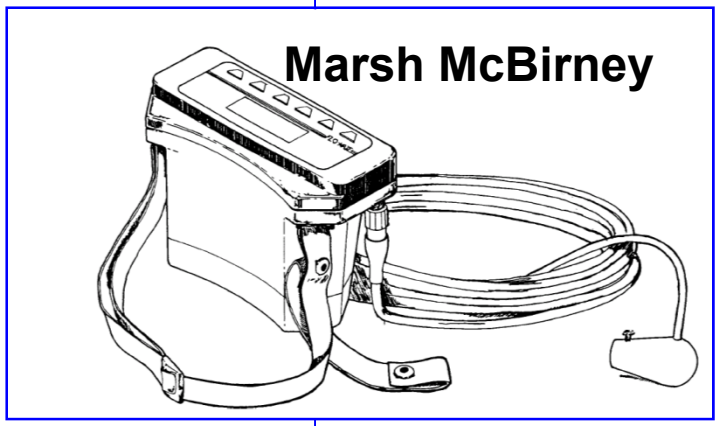


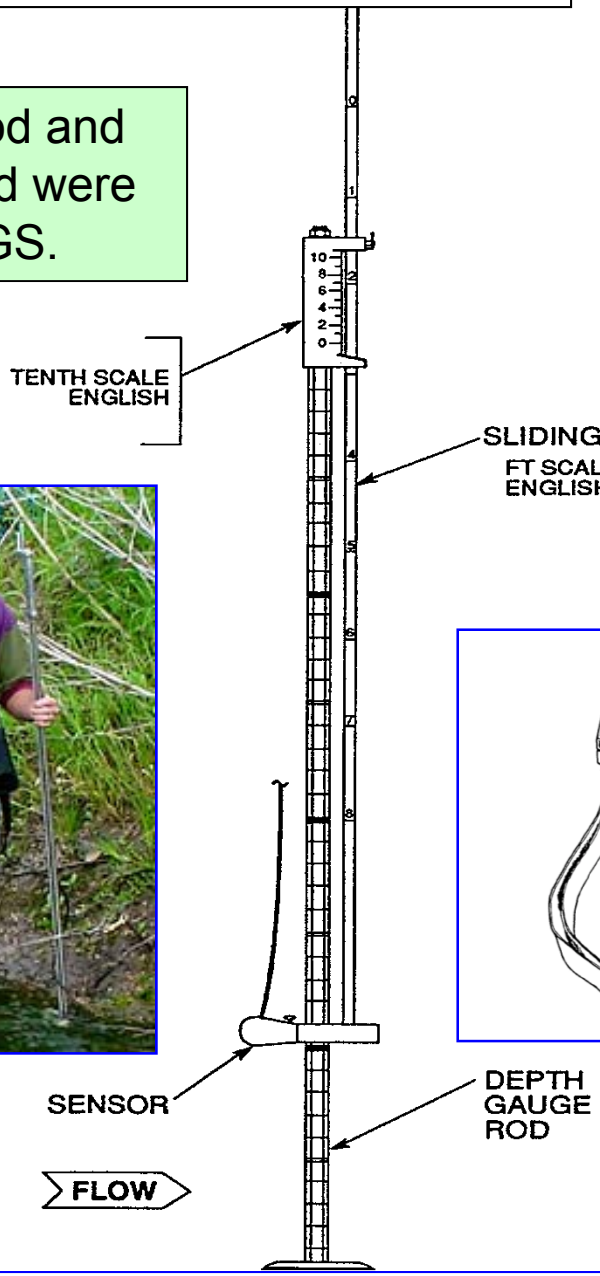
Measure depth at the midpoint of each cross section using a top setting wading rod.

Depth

Top-Setting Wading Rod

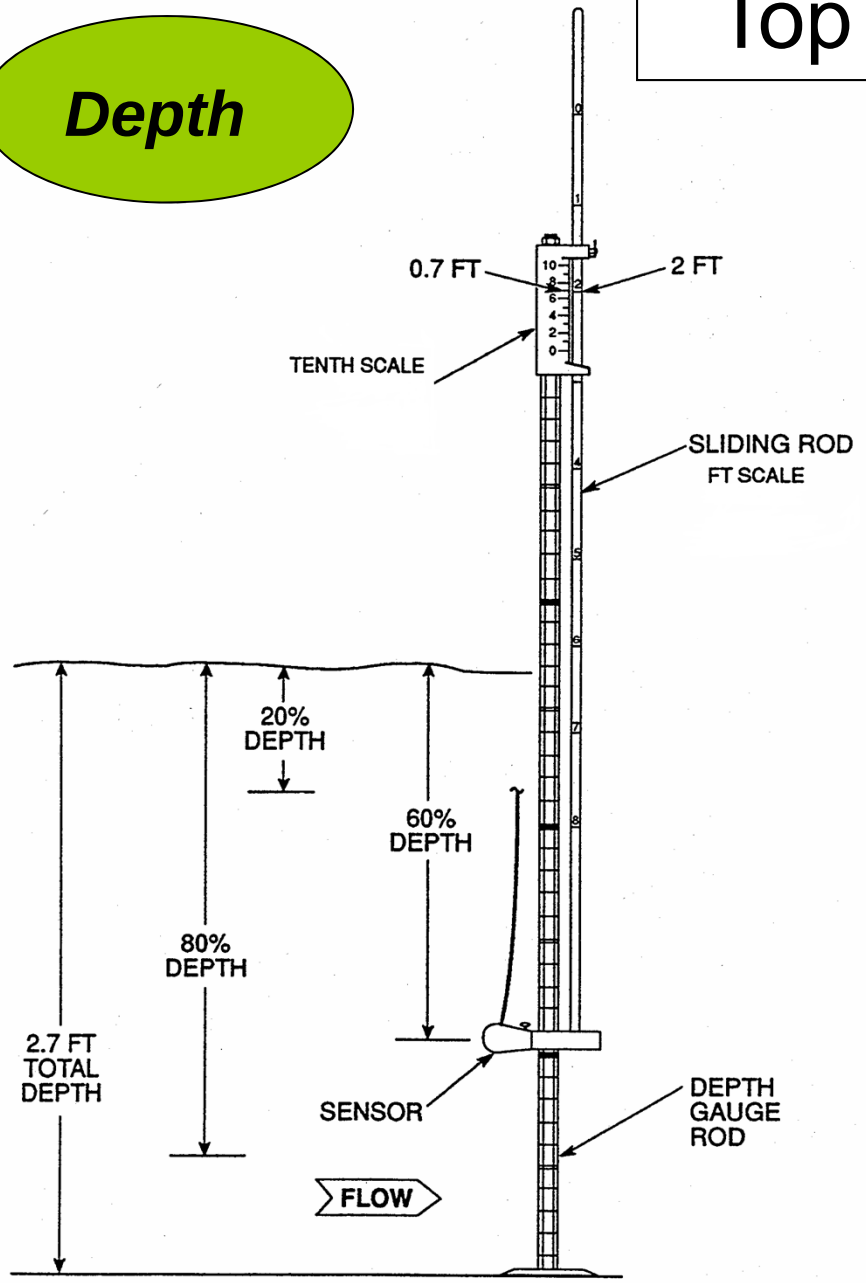
The top-setting wading rod and flow measurement method were developed by the USGS.





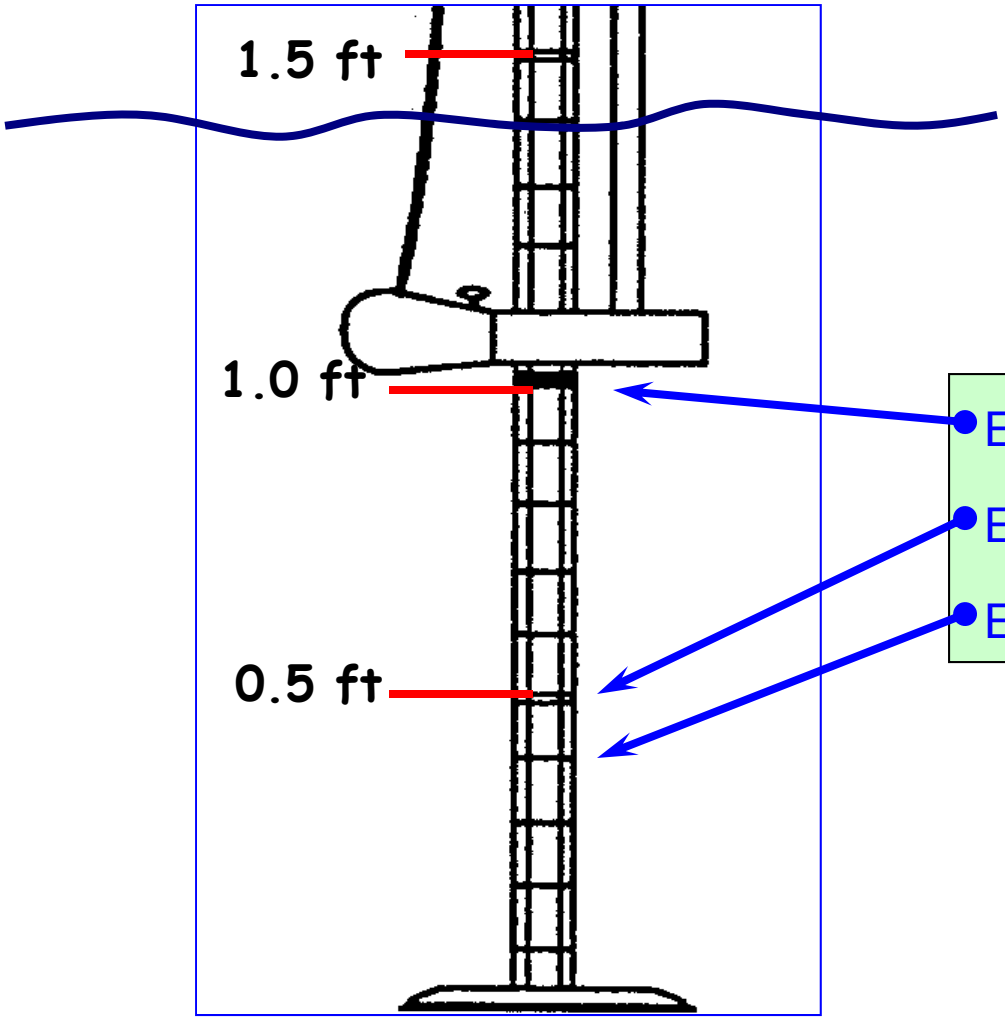
Top Setting Wading Rod

Depth



The top setting wading rod is designed to easily set the sensor 20, 60, and 80% of the total depth.

Measuring Depth



Water Depth at D_1= 1.4 ft

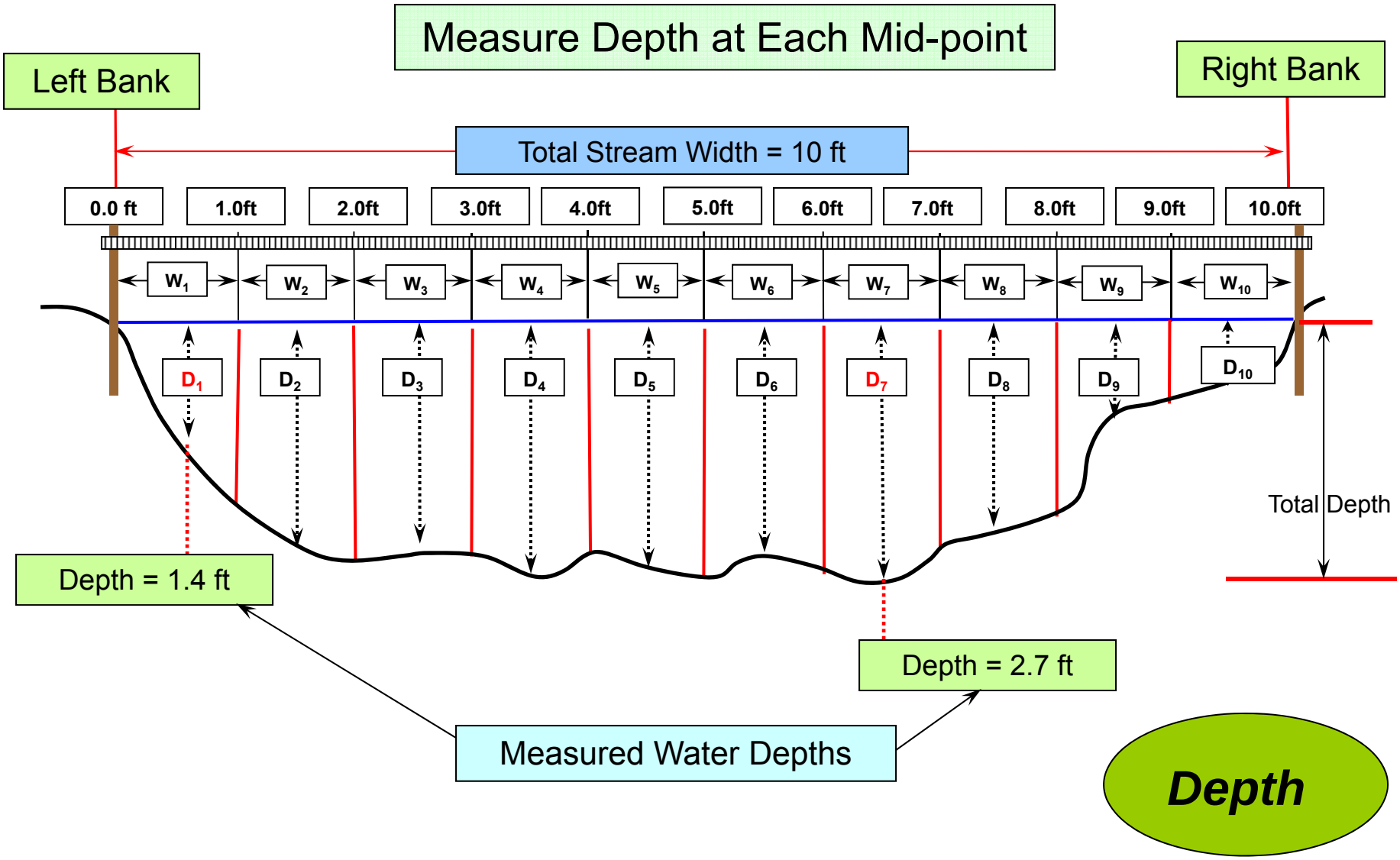
Each triple line = 1.0 ft

Each double line = 0.50 ft

Each single line = 0.10 ft

Depth

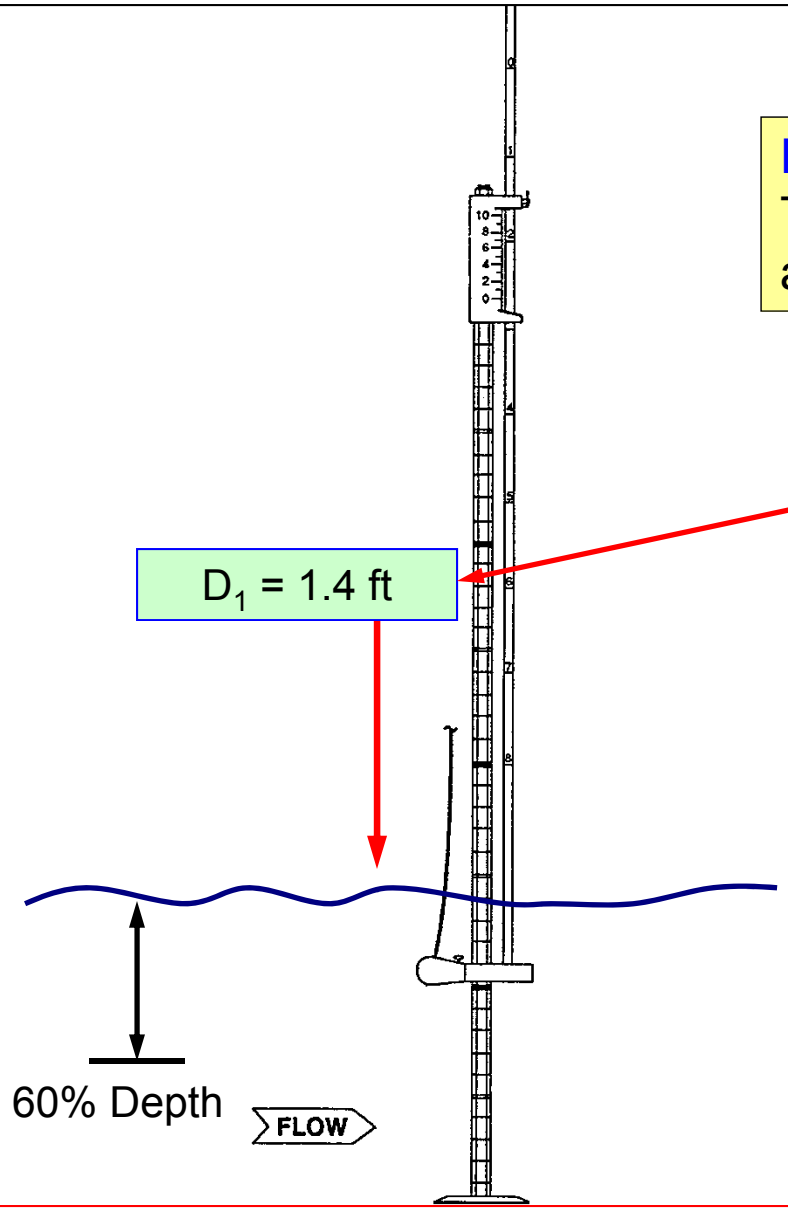
Measuring Depth

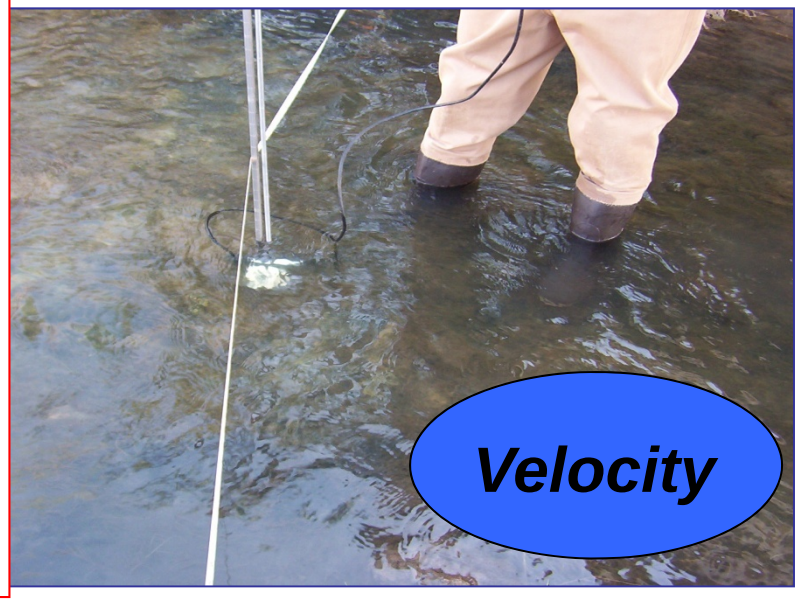


One-Point Velocity Measurement

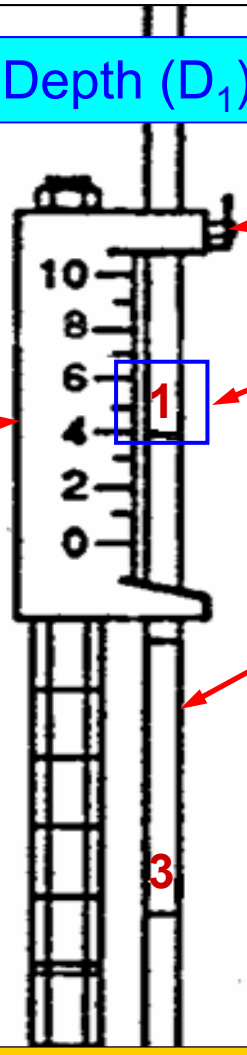
For depths < 2.5 ft—
Take one velocity measurement at 60% of total depth

Use the water depth, measured at each cross section, to set the flow sensor at the correct depth.





Setting the Sensor Depth-One Point



Water Depth (D_1)= 1.4 ft

Button that releases and holds the sliding rod.

Adjust the sliding rod so the "1" foot mark lines up with the "4" on the tenths scale.

1 ft

The *Sliding Rod* has lines marked in feet (0 to 8 ft)

This sets the sensor at 60% of the total depth

Velocity

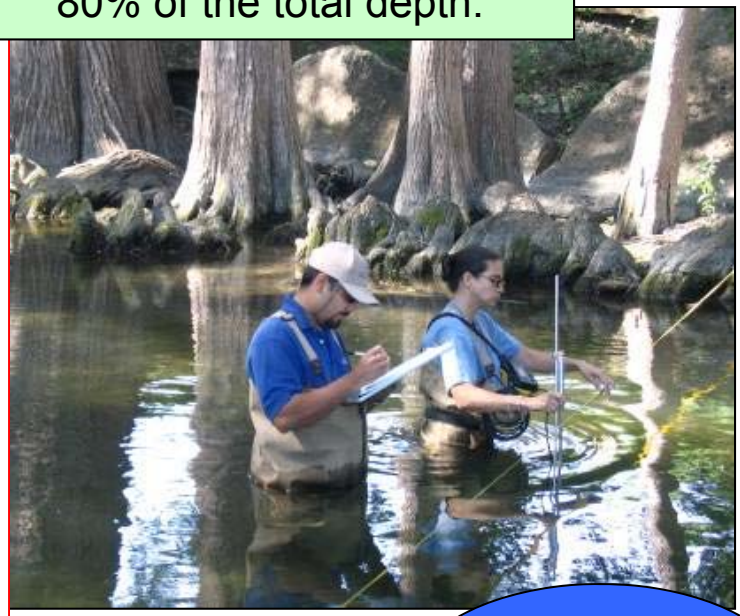
The velocity measured is used in the flow calculation for this cross section (V_1).

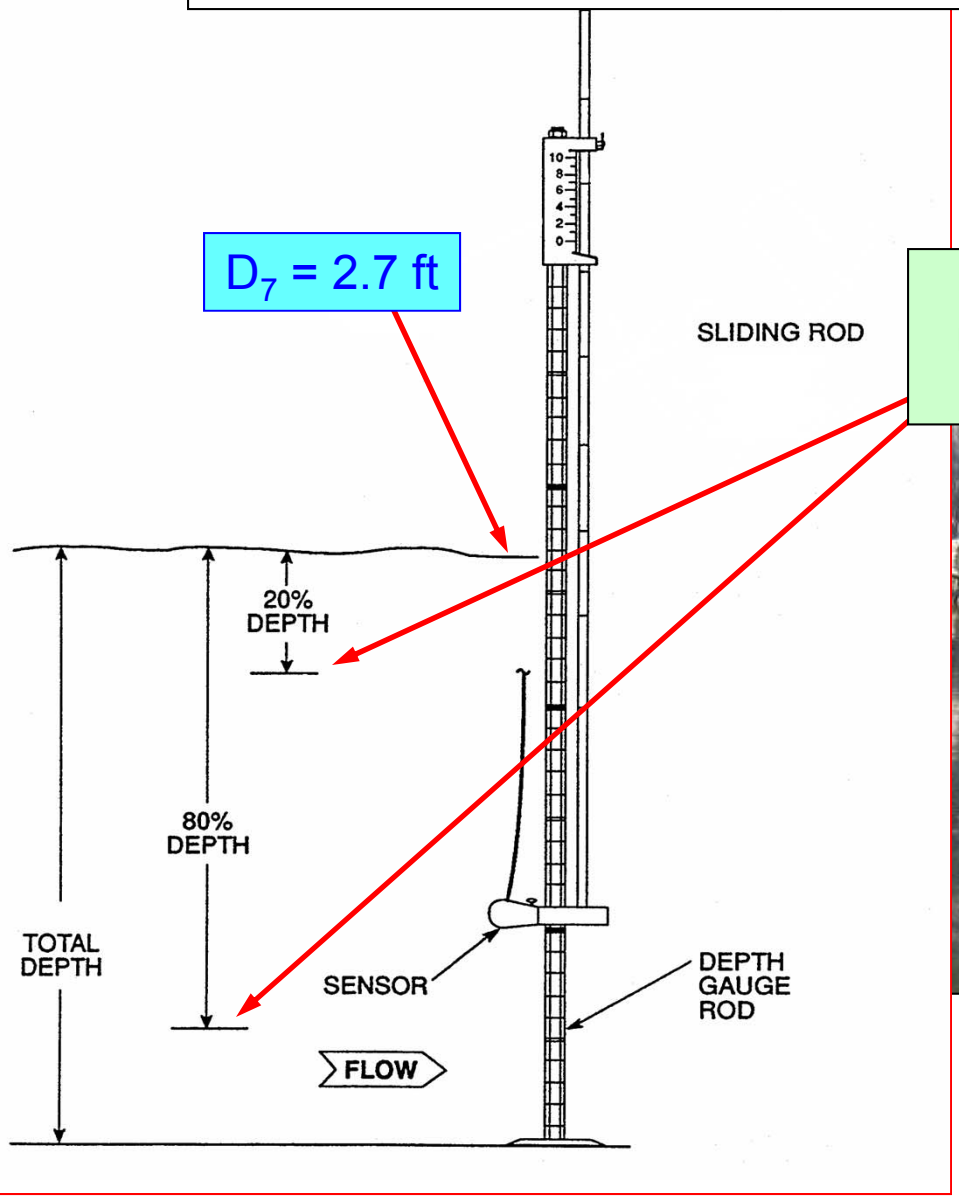
Two-Point Velocity Measurement

For Depths > 2.5 ft

D_7 = 2.7 ft

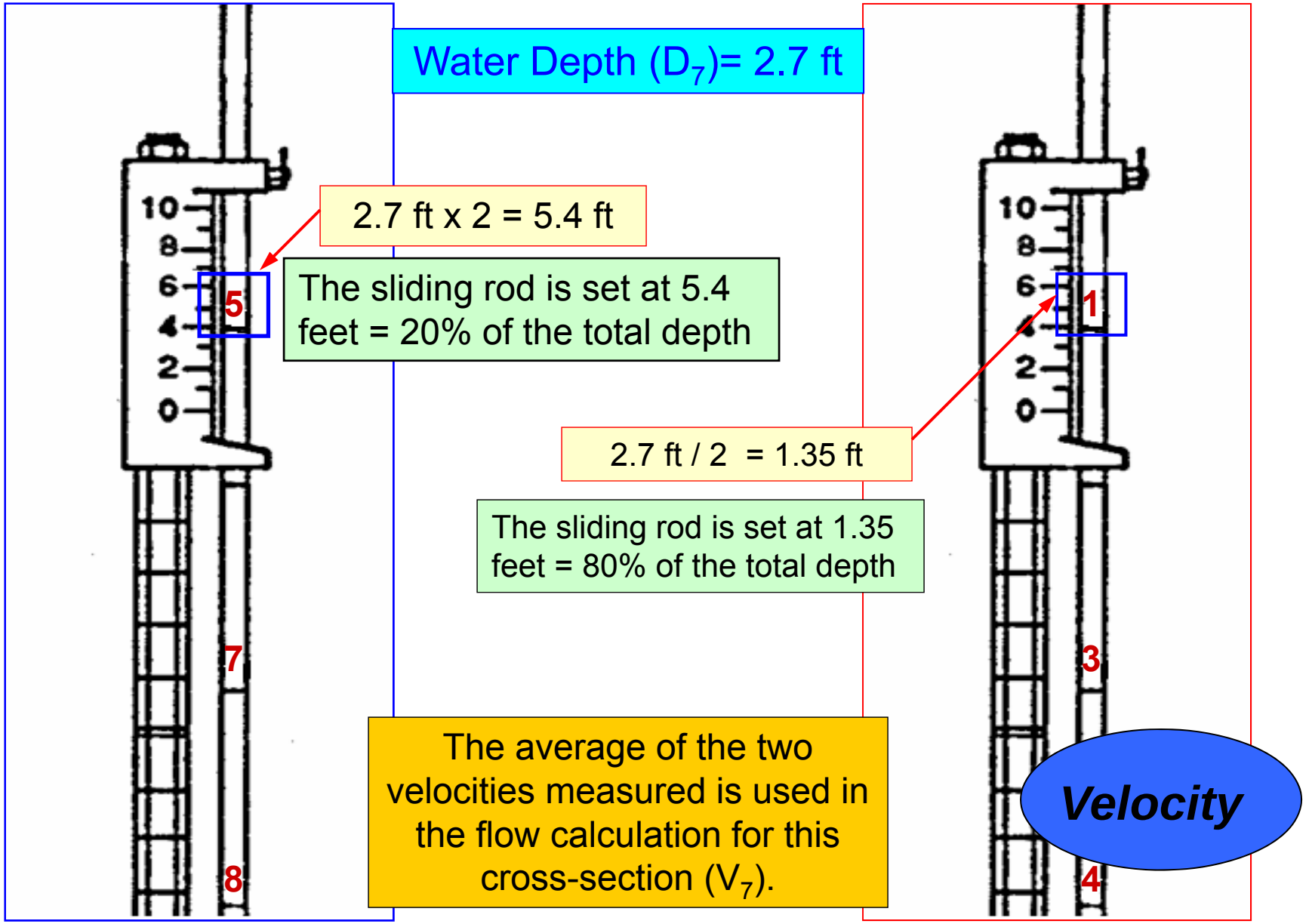
Take two velocity measurements at 20% and 80% of the total depth.



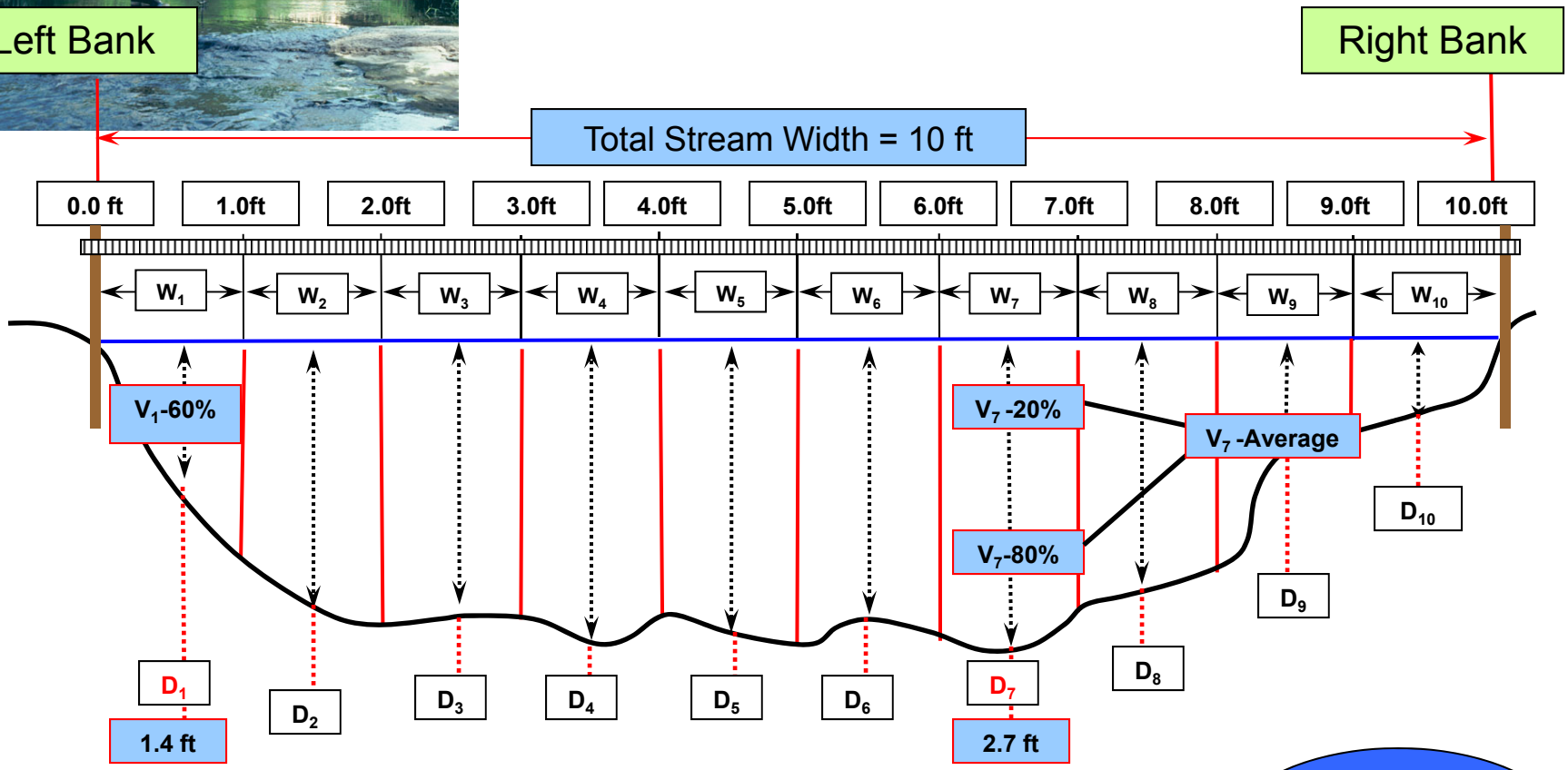


Velocity

Setting the Flow Sensor Depth-2 Points



Measuring Velocity



Eddies and backwater areas often produce negative flows. Record these values and include them in the final flow calculation.

Velocity

Flow Measurement Summary

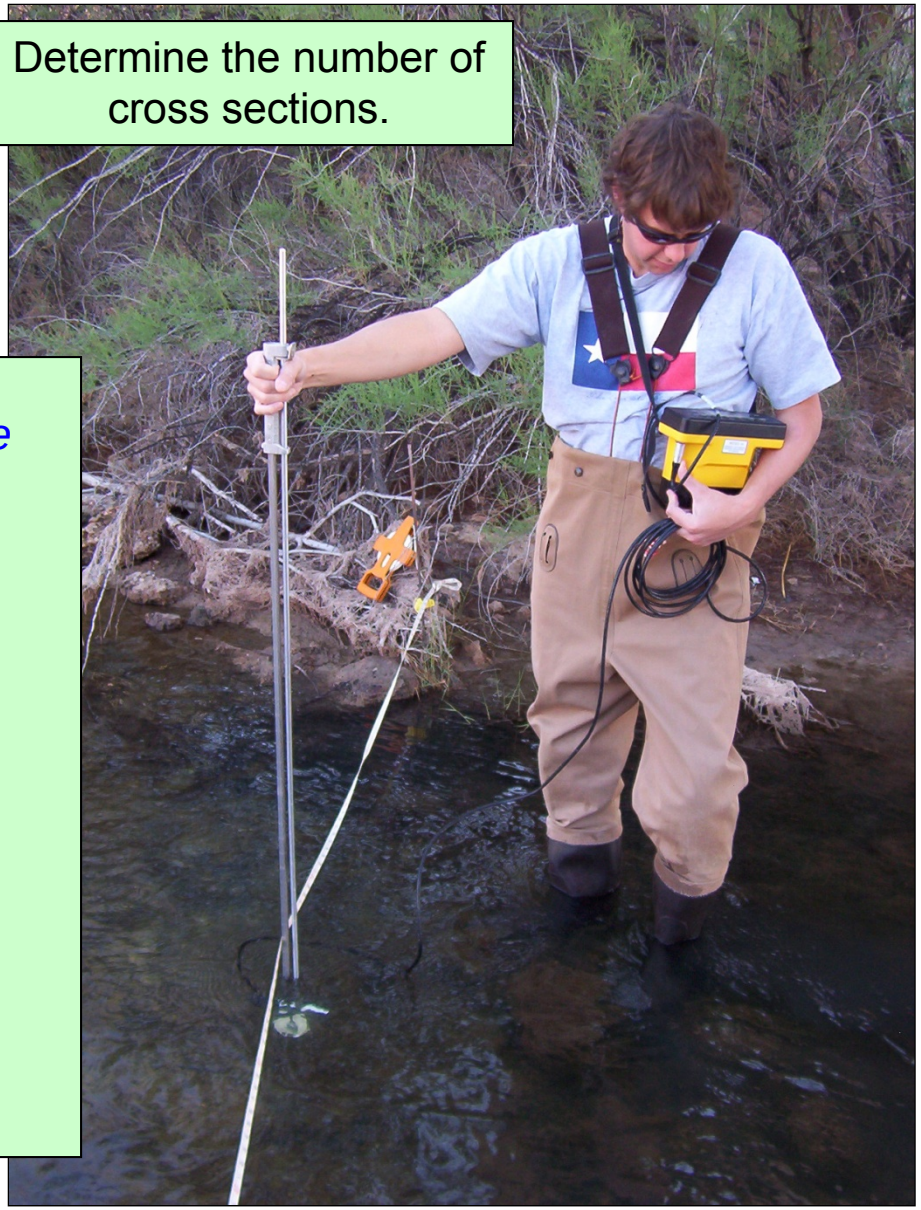
Using the measuring tape, determine the total stream width.

Determine the number of cross sections.

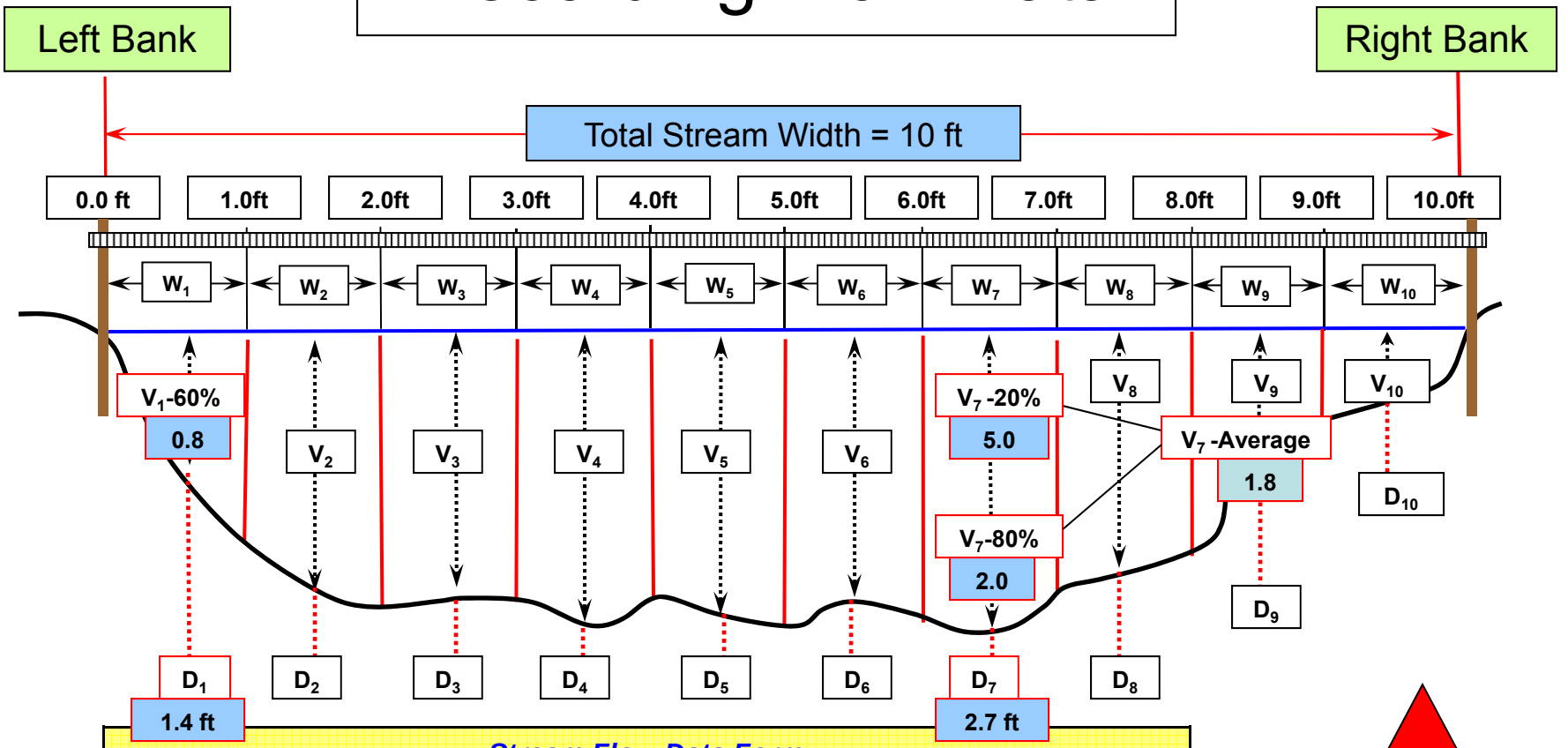
Find the mid-point of the first cross section.

Standing at least 1.5 ft downstream and to the side of the flow sensor, at midpoint of each cross section:

- Measure and record the depth using the wading rod.
- Position the flow sensor at the correct depth at the midpoint of the cross section.
- Allow the sensor to adjust to the current.
- Measure and record the velocity.



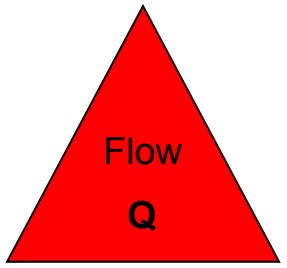
Recording Flow Data



Stream Flow Data Form

Stream Width = 10 ft; Cross Section Width (W) = 1.0 ft

Section Midpoint (ft)	Section Depth (D) (ft)	Sensor Depth	Velocity (V)		Discharge (Q) (ft^3/s) Q = (W)(D)(V)
			At Point (ft/sec)	Average (ft/sec)	



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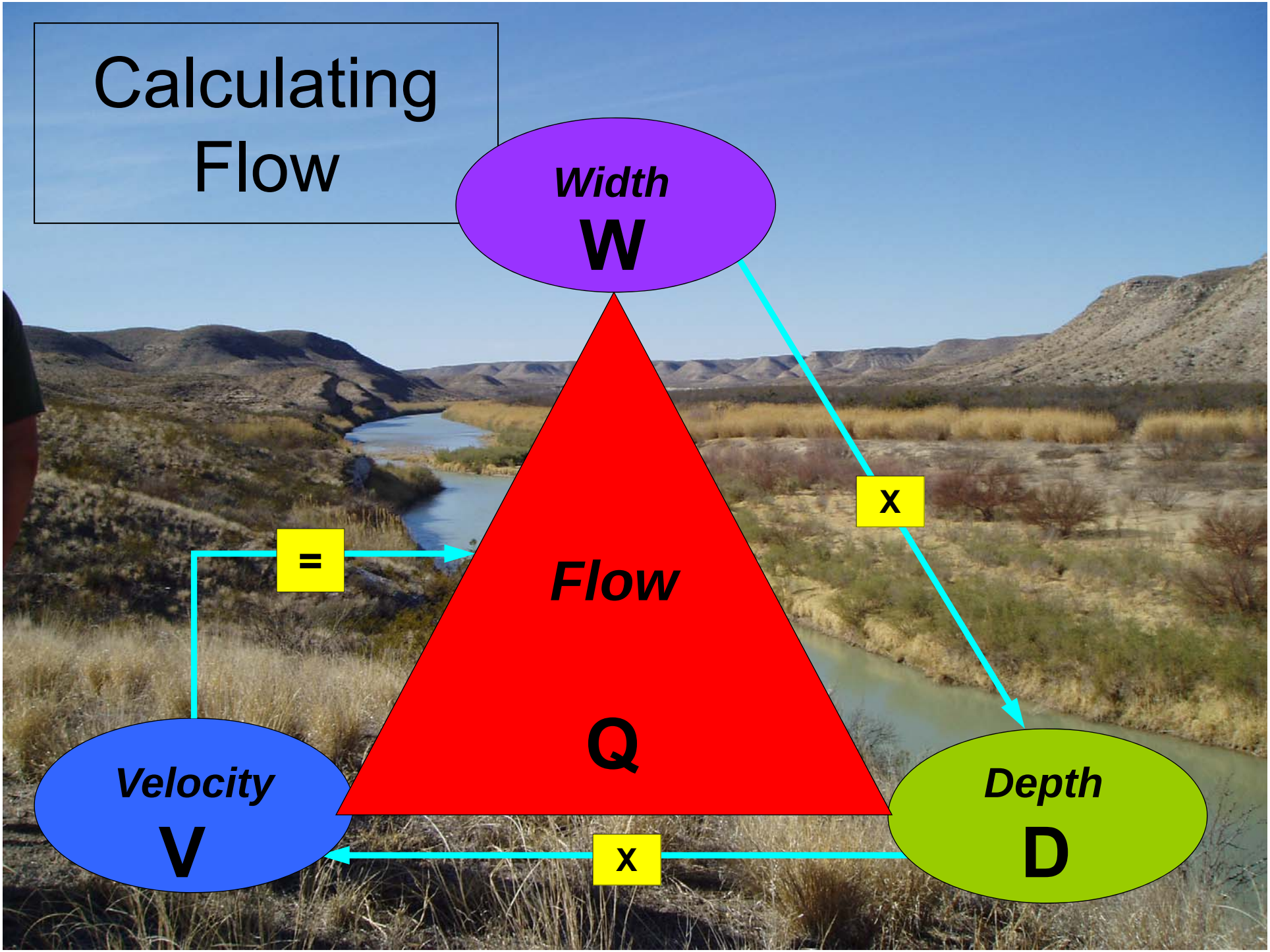
Recording Flow Data

Stream Width = 10 ft; Cross Section Width (W) = 1.0 ft					
Section Midpoint (ft)	Section Depth (D) (ft)	Sensor Depth	Velocity (V)		Discharge (Q) (ft^3/s) Q = (W)(D)(V)
			At Point (ft/sec)	Average (ft/sec)	
0.5	1.4	1.4		0.85	
1.5	2.0	2.0	60%	1.0	
2.5	1.9	1.9		1.3	
3.5	2.2	2.2		1.7	
4.5	2.1	2.1		1.8	
5.5	2.5	2.5	20%	1.8	
6.5	2.7	5.4	1.8	1.9	
		1.35	2.0		
7.5	1.7	1.7	80%	1.1	
8.5	1.0	1.0		0.75	
9.5	0.5	0.5		-0.45	

W_1 D_1 V_1

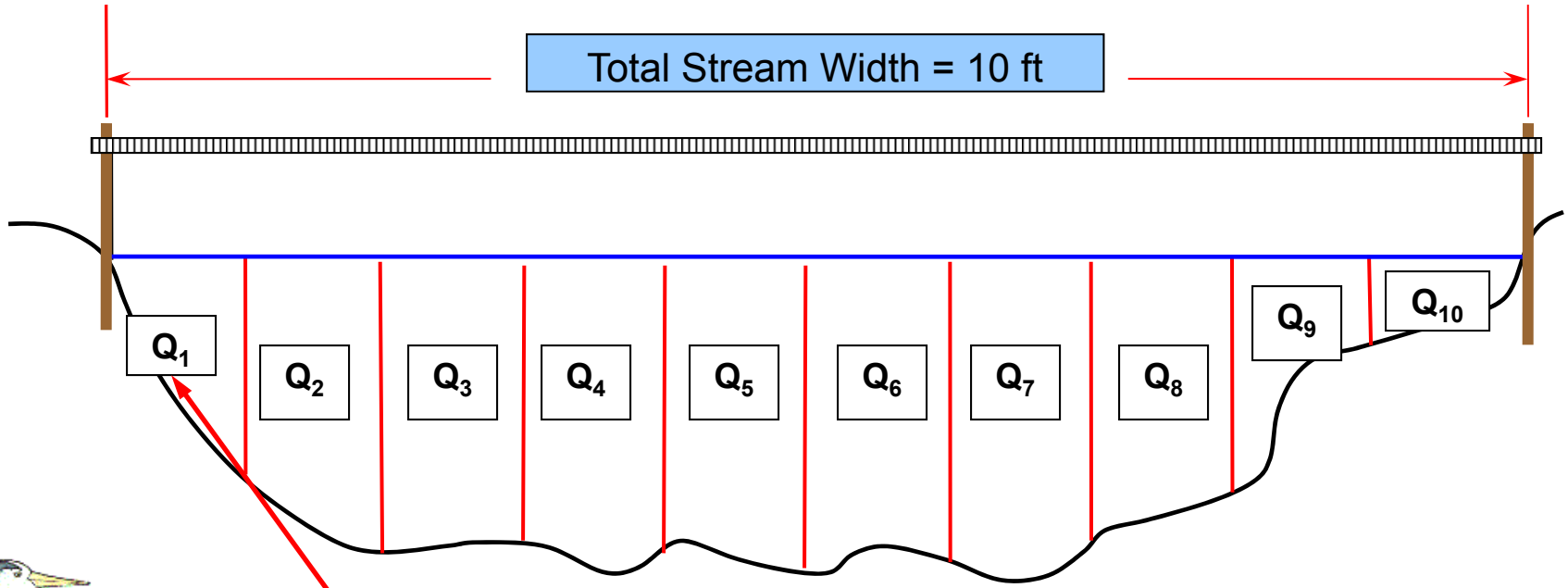
W_7 D_7 V_7

Record the depth and velocity for each mid-point.


Calculating Flow
Width
W
x
=
Flow
Q
Velocity
V
x
Depth
D

Calculating Flow

Flow is calculated using the width (W), depth (D), and velocity (V) measured at each cross section.



$W_1 \times D_1 \times V_1 = Q_1$

Calculating Flow

Stream Width = 10 ft; Cross Section Width (W) = 1.0 ft					
Section Midpoint (ft)	Section Depth (D) (ft)	Sensor Depth	Velocity (V)		Discharge (Q) (ft^3/s) Q = (W)(D)(V)
			At Point (ft/sec)	Average (ft/sec)	
0.5	1.4	1.4		0.85	1.19
1.5	2.0	2.0	60%	1.0	2.0
2.5	1.9	1.9		1.3	2.47
3.5	2.2	2.2		1.7	3.74
4.5	2.1	2.1		1.8	3.78
5.5	2.5	2.5	20%	1.8	4.5
6.5	2.7	5.4	1.8	1.9	5.13
		1.35	2.0		
7.5	1.7	1.7	80%	1.1	1.87
8.5	1.0	1.0		0.75	0.75
9.5	0.5	0.5		-0.45	-0.225

W_1 D_1 V_1

W_7 D_7 V_7

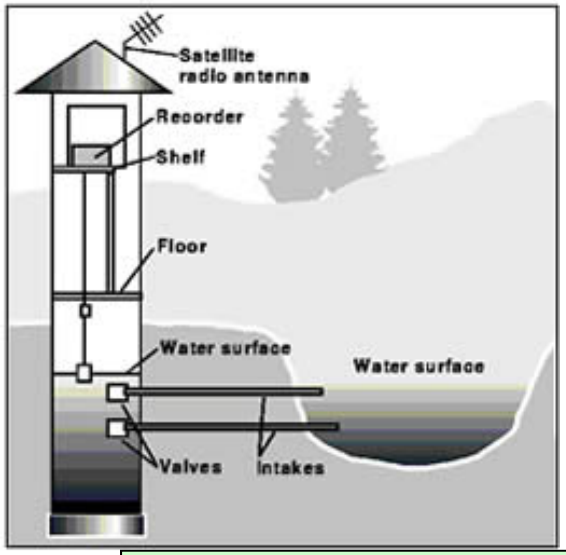
Sum the Qs

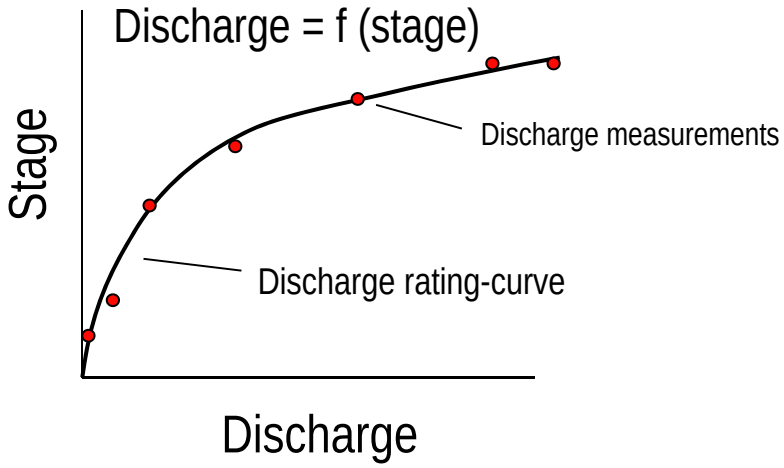
Q = 25.2 cfs

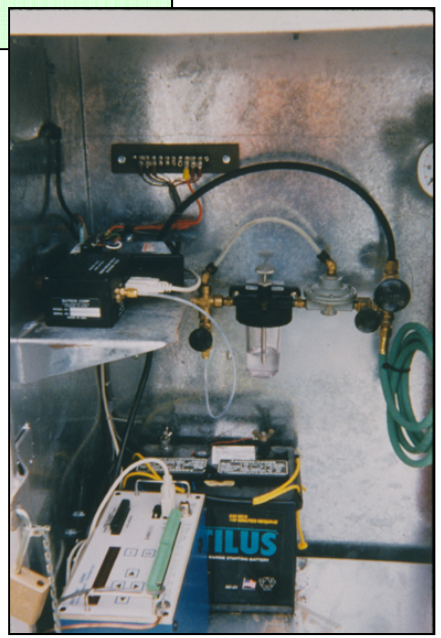
Note: Include negative values in the flow calculation.

Flow Gauging Stations

Gauged flow values may be reported with WQ data if collected within a 0.25 mile of a flow gauge site. This data can be used for a greater distance if there are no dischargers or tributaries between the flow gauge and monitoring site.





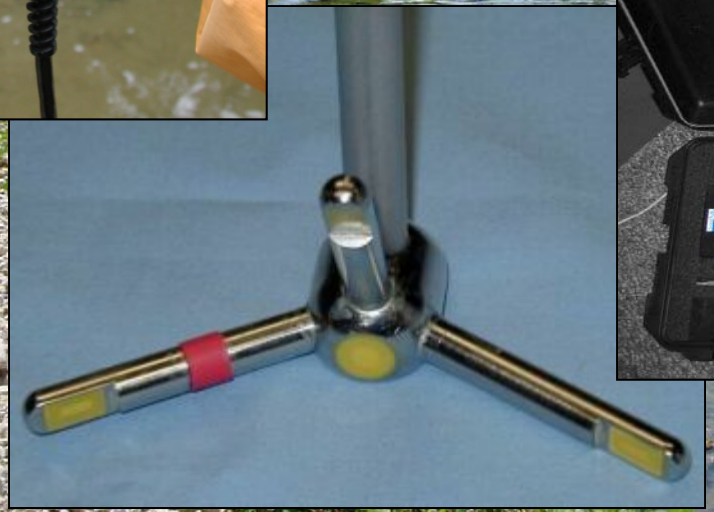


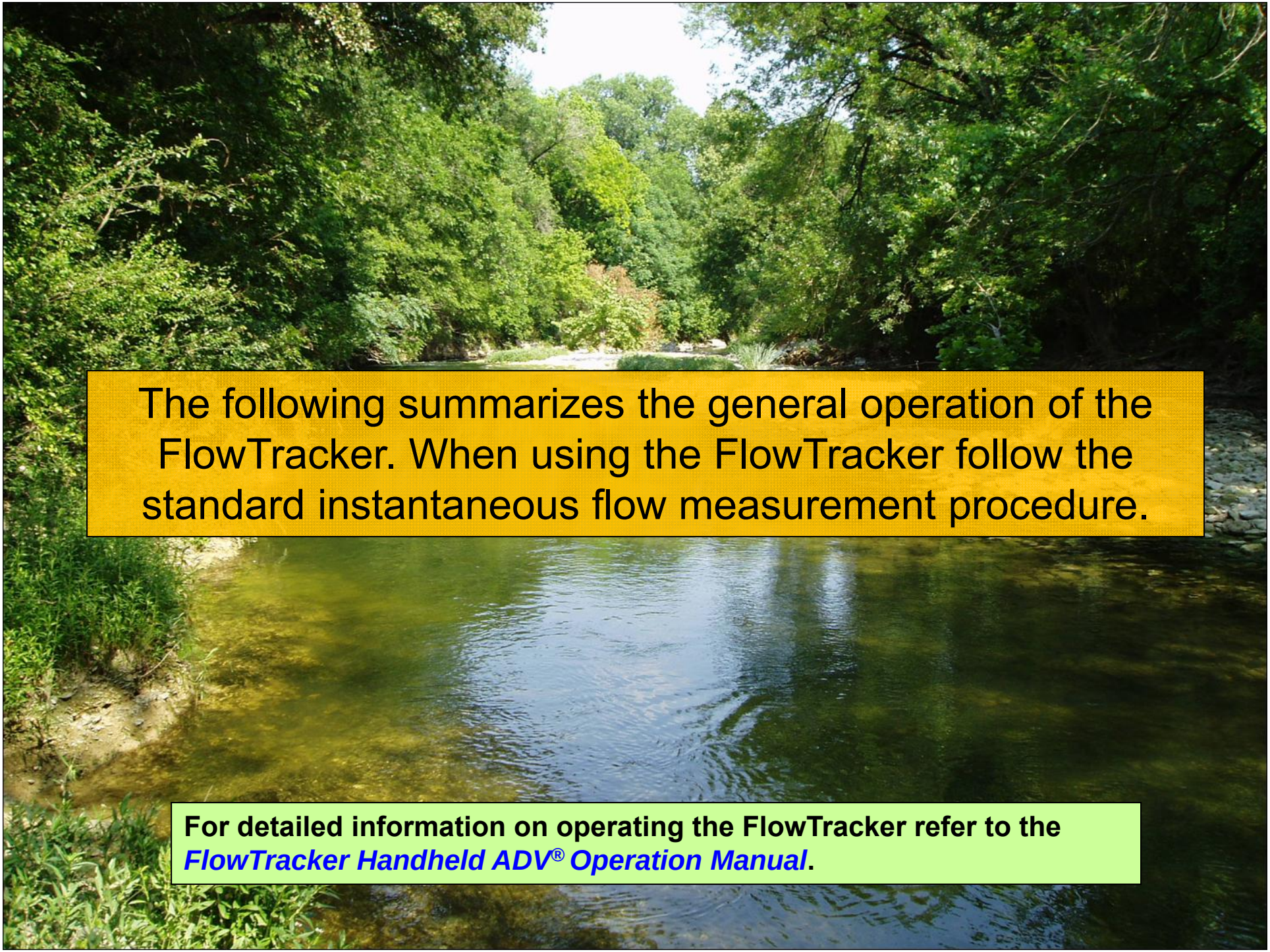
***Real-Time Flow Data on the Web*:**

USGS (statewide)— http://waterdata.usgs.gov/tx/nwis/rt

IBWC (Rio Grande Basin)— http://www.ibwc.state.gov/Water_Data/Reports/RG_Flow_data.html

FlowTracker Handheld Acoustic Doppler Velocimeter® (ADV)





The following summarizes the general operation of the FlowTracker. When using the FlowTracker follow the standard instantaneous flow measurement procedure.

For detailed information on operating the FlowTracker refer to the *FlowTracker Handheld ADV® Operation Manual*.

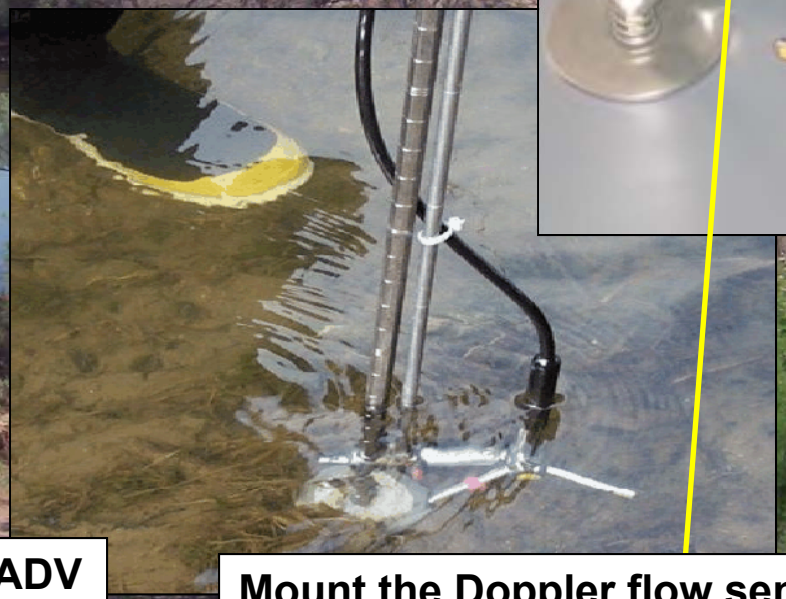
Flow Measurement Procedure

***As described in the instantaneous flow measurement procedure*:**

- **Select an appropriate flow measurement site.**
- **Stretch a tape across the width of the stream.**
- **Based on the total width determine the number of cross sections and the midpoint of the cross section.**
- **Using the top setting wading rod, measure the depth and set the flow sensor at the correct depth.**
- **Measure velocity.**
- **The main difference when using the FlowTracker- *no data recording or flow calculation in the field*.**

Mounting the FlowTracker on a Top-Setting Wading Rod

Mount the FlowTracker Handheld ADV on the top-setting wading rod.



Mount the Doppler flow sensor on the top-setting wading rod using the probe mount adaptor bracket.

FlowTracker Handheld ADV®

FlowTracker 3.0
2006/06/01 08:10:25
Press Enter
For Main Menu

Handheld Controller

LCD Screen

Keypad

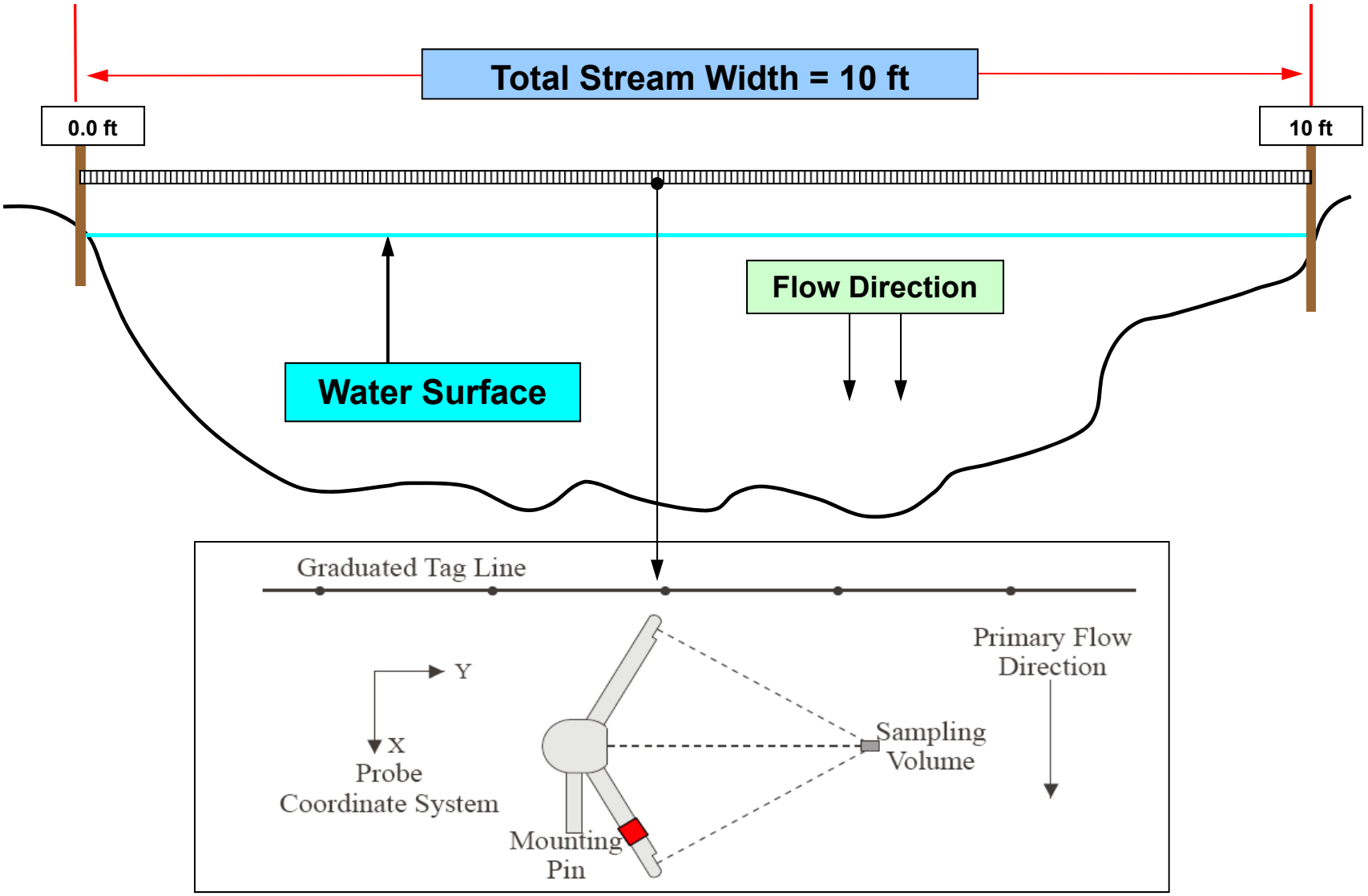
Probe Cable

FlowTracker Probe

External Power/ Communications Connector

The *FlowTracker* is operated using the *Handheld Controller.*

Positioning the FlowTracker Sensor



FlowTracker Keypad

The *FlowTracker* functions are accessed using the *Keypad*.

Firmware Version 3.0

On / Off	Back Light	Delete ←	Measure
Corr. Factor 1	Next Station 2	Set Loc. 2 3	Set Location ABC+
LEW / REW 4	Prev. Station 5	Set Meas Depth 6	Set Depth ABC-
Set Ice Depth 7	8	Toggle Method- 9	Toggle Method+
Abort 0	Calc. Disch. .	End Section -	ENTER

Firmware Version 3.1

⏻	💡	Delete ←	Measure
Corr. Factor 1	Next Station 2 ABC	Set Velocity 3 DEF	Set Location
LEW / REW 4 GHI	Previous Station 5 JKL	Set Meas Depth 6 MNO	Set Depth
Set Ice Depth 7 PQRS	QC Menu 8 TUV	Method - 9 WXYZ	Method +
Abort 0	Calculate Disch. .	End Section -	ENTER

Details on the key functions are located in Section 2.2-Keypad in the *FlowTracker Operations Manual*.

Getting Started

To turn FlowTracker *On*: Hold the *On/Off* key for 1 second; the system will open with the *Wake-up Screen*.

```
FlowTracker 3.0
2006/06/01  08:10:25
Press Enter
For Main Menu
```

Press *Enter* to display the *Main Menu*

```
Main Menu
1: Setup Parameters
2: System Functions
3: Start Data Run
```

Press 1 for Setup Parameters Menu

Press 2 for System Functions Menu

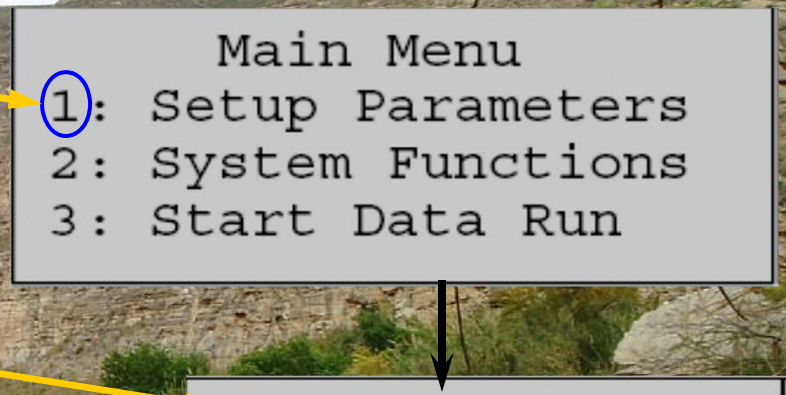
Press 3 to Start Data Run

Note: Always return to the *Main Menu* before turning the system off to ensure all data has been properly saved.

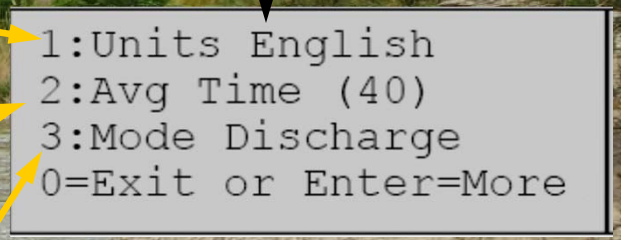
Rio Grande, Rio Grande Basin, Segment 2306

1:Setup Parameters Menu

From the *Main Menu*, press 1 to access the *Setup Parameters* menu.



Press 1 to set the units to *English* (flow is calculated as cubic feet per second or cfs).



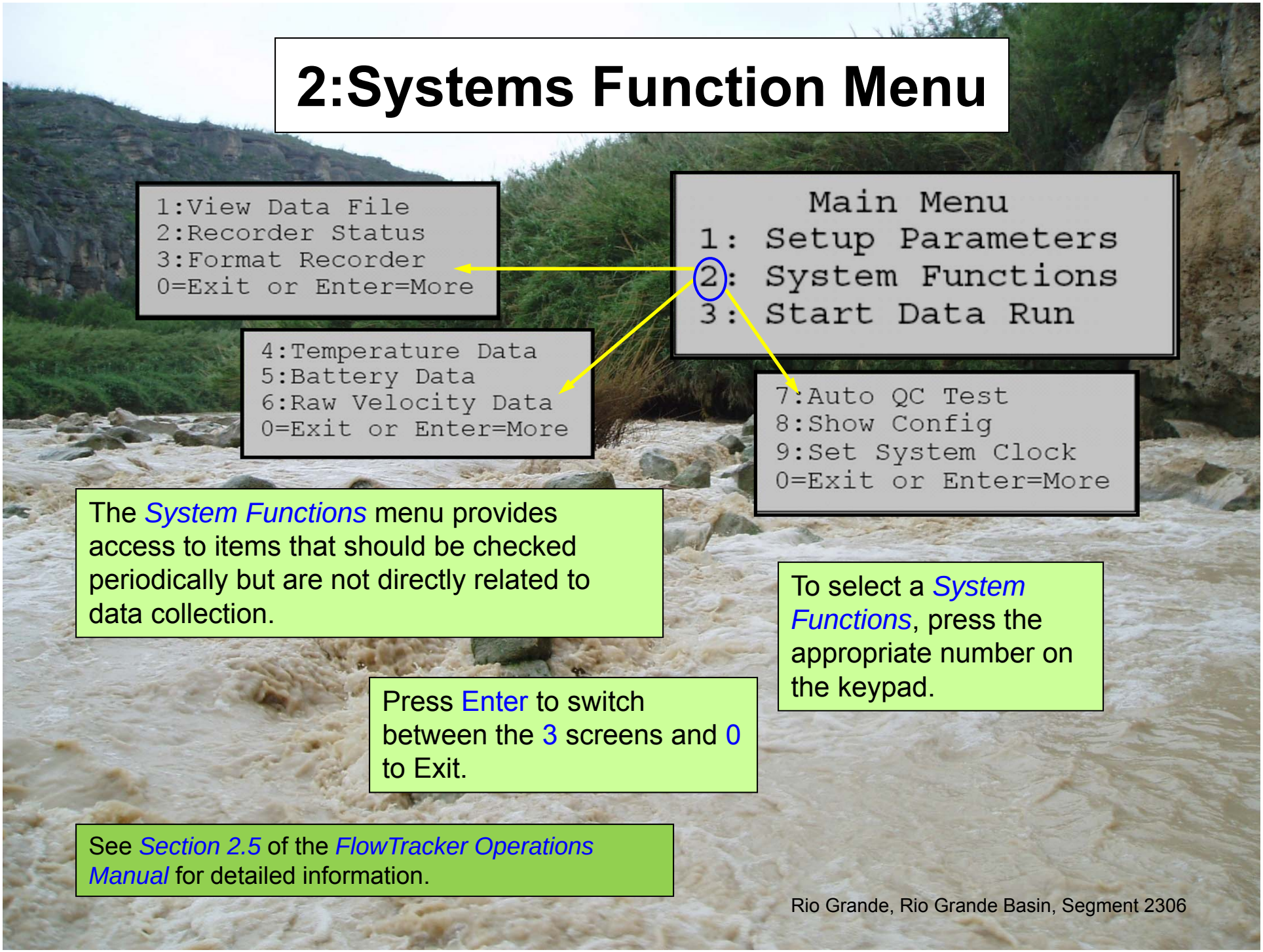
Press 2 to set the average time (Avg Time) to 40 seconds.

Press 3 to set the *Mode* to *Discharge*. The *Discharge* mode calculates flow the *General* mode does not.

The Setup Parameters are usually set up once and don't need to be adjusted with each use. See *Section 2.4* of the *FlowTracker Operations Manual* for detailed information.

Rio Grande, Rio Grande Basin, Segment 2306

2:Systems Function Menu



The *System Functions* menu provides access to items that should be checked periodically but are not directly related to data collection.

To select a *System Functions*, press the appropriate number on the keypad.

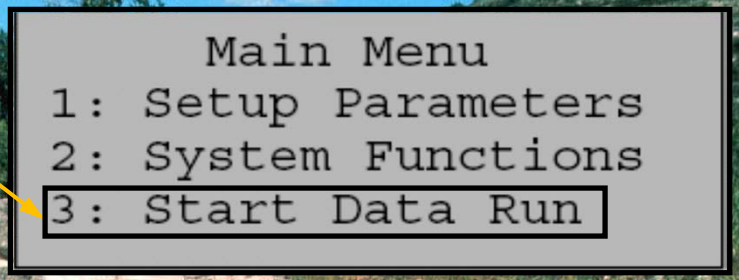
Press Enter to switch between the 3 screens and 0 to Exit.

See *Section 2.5* of the *FlowTracker Operations Manual* for detailed information.

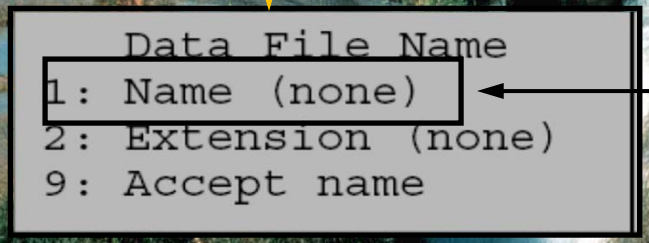
Rio Grande, Rio Grande Basin, Segment 2306

3: Start Data Run Menu

From Main Menu, press "3" to *Start Data Run*.

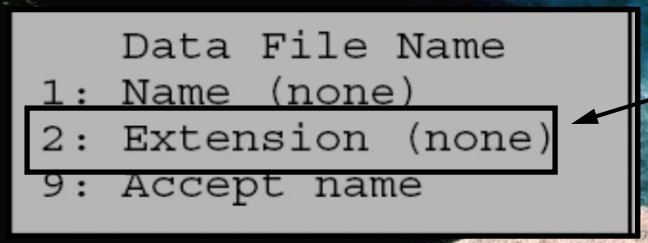


This will display the *Data File Name* menu.



Press 1 to enter a file name (required)

- File names have a maximum of 8 characters (letters or numbers).
- For example, use the Station ID and enter "17077" or "Site 17A"



If there is an existing file name, press 2 to add a file extension, a maximum of 3 characters.

Devils River, Rio Grande Basin, Segment 2309

Entering a Data File Name

Firmware Version 3.1

To enter a number, type the number on the key pad.

To enter a letter, e.g., for C press 2 four times: 2-A-B-C

Press Enter to complete the file name which will appear in parentheses on the screen.

```
    Data File Name
1: Name (none)
2: Extension (none)
9: Accept name
```

Press 9: Accept name when ready to start data collection.

See *Section 2.2* of the *FlowTracker Operations Manual* for detailed information.

Nueces River, Nueces River Basin

Start Data Collection

The next screen after pressing *9: Accept Name* will display the starting gauge information.

After entering the file name *Staff* and *Gauge Height* information will be displayed. These values are optional.

```
1: Staff Ht 0.00
4: Gauge Ht 0.00
7: Rated Q 0.00
Next Stn When Ready
```

On the keypad, Press *Next Station* to continue.

```
    Starting Edge
Loc 0.00    Dep 0.00
LEW         CF 1.00
  Next/Prev Stn Key
```

Starting Edge Screen

Continued on next slide

Set the Starting Edge

1. On the *Keypad*, Press *Set Location* key to set the Starting Edge of Water.

Starting Edge Screen

```
    Starting Edge
Loc 0.00    Dep 0.00
LEW         CF 1.00
  Next/Prev Stn Key
```

The Starting Edge of Water is usually *Loc 0.00* and will be *Station 0 (Stn 0).*

The Starting Edge of Water Depth is usually *Dep 0.00*

2. On the *Keypad*, Press *Set Depth* key to set the Starting Edge of Water Depth, *Dep*.

3. Specify the Starting Edge

Continued on next slide

See *Section 5* of the *FlowTracker Operations Manual* for detailed information.

Set the Starting Edge

Starting Edge Screen

```
    Starting Edge
Loc 0.00    Dep 0.00
LEW         CF 1.00
  Next/Prev Stn Key
```

To specify the Starting Edge of Water, Press *LEW/REW* on the keypad.

LEW = left edge of water

REW = right edge of water

When ready, Press *Next Station* to continue; the Starting Edge information is complete.

See *Section 5* of the *FlowTracker Operations Manual* for detailed information.

Continued on next slide

Medina River, San Antonio River Basin, Segment 1903

Station Information

The next screen after pressing ***Next Station*** will be the station information.

Station Information

```
Stn 1        Mthd .6D
Loc 0.00     Dep 0.00
MDep .6D
             Press Meas
```

Press ***Set Location*** to set the first station location ***(Loc 1, Stn 1)***. Loc 1 will be the midpoint of the first cross section.

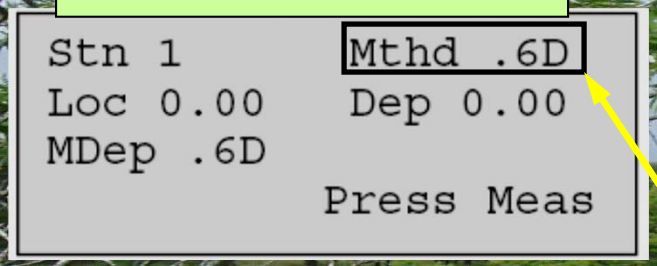
Measure the **depth** at Loc 1. Press ***Set Depth*** to set the water depth at Loc1.

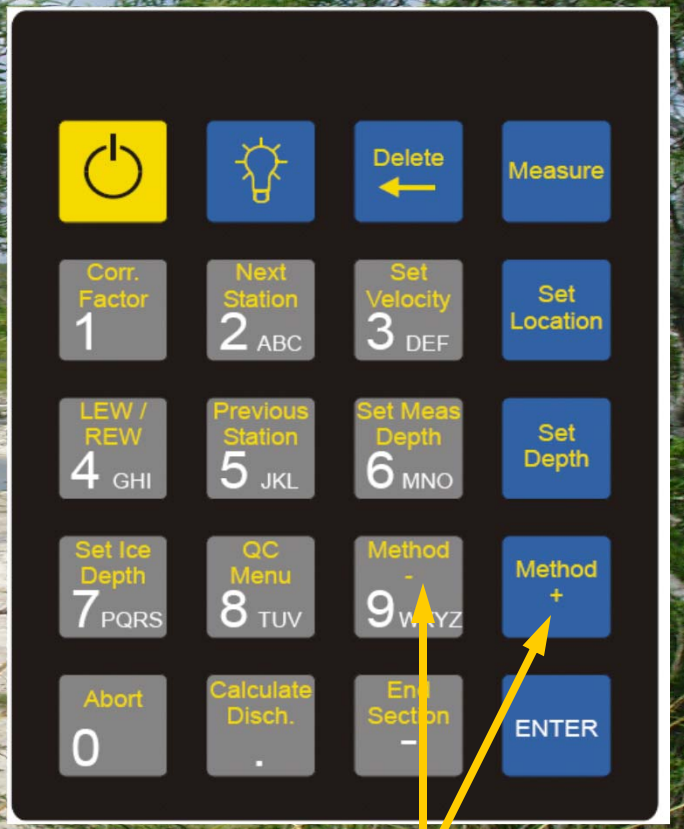
After pressing ***Set Depth***, select a method for determining velocity, ***Single Point*****-Mthd .6D** or***Two-Point*****-Mthd 2/8**.

Continued on next slide

Setting the Velocity Measurement Method

Station Information





The *Single Point Method*-Mthd .6D measures velocity at 60% of the total depth. Applies to depths < 2.5ft.

The *Two-Point Method*-Mthd 2/8 measures velocity at 20 and 80% of the total depth. Applies to depths > 2.5ft.

On the keypad, use the *Method+* or *Method-* keys to select the appropriate method. The method will appear on the Station Information Screen.

Continued on next slide

Measuring Velocity

Keep in mind:

The velocity measurement method will need to be switched between *Mthd .6D* and *Mthd 2/8* when the depth is > 2.5ft at other stations.

After the station information has been entered correctly, use the top setting wading rod to set the sensor to the correct depth.

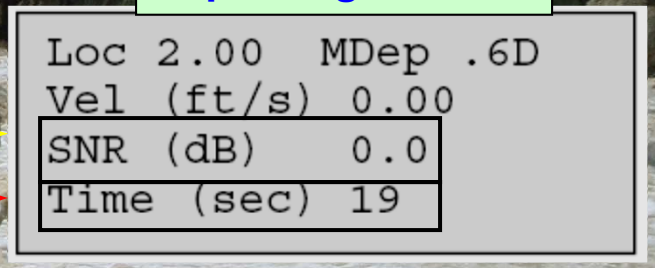
Press *Measure* to start data collection.

Continued on next slide

Velocity Measurement

While the velocity measurement is being made an updating screen shows the velocity and *Signal to Noise Ratio (SNR)* . For best operating conditions the *SNR* should be 10 decibels (dB), but must be > 4 dB.

Updating Screen



Velocity Average Time = 40 sec; total measurement time

Note: A low *SNR* indicates the lack of suspended material in the water. A low *SNR* can be improved by stirring the sediment upstream of the flow measurement point.

Continued on next slide

See Section 1.4 of the *FlowTracker Operations Manual* for detailed information.

Completing a Measurement

When the velocity measurement is complete, a *Summary Screen* appears.

Summary Screen

```
Vel 2.25    σV 0.04
Ang 5°      SNR 15.1
Spikes 0    Bnd BEST
1: Accept   2: Repeat
```

Review the QC Checks

- Flow Angle <20°
- SNR > 4.0 dB
- Boundary QC (Bnd) = Good or Best

If the *QC Checks* pass, press 1 to *Accept* the measurement.

If any of the QC Checks fail, press 2 to *Repeat* the measurement.

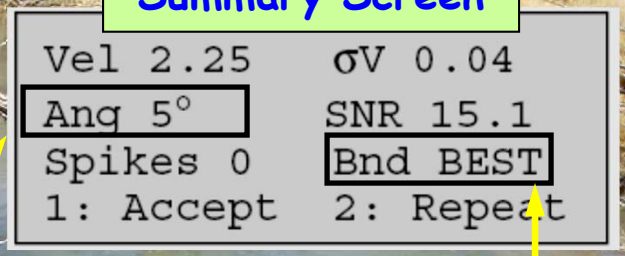
Continued on next slide

Additional Quality Control Checks

In addition to the SNR, there are two other important QC Checks that appear on the summary screen.

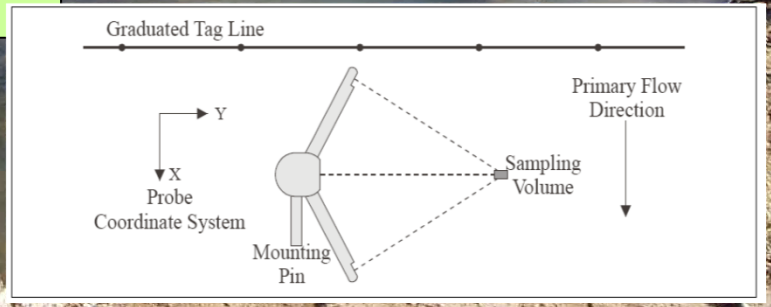
Flow Angle (Ang°) and Boundary QC (Bnd)

Summary Screen



***Boundary QC*: An indicator of interference from underwater objects.**

***Flow Angle*: Correct positioning of the flow sensor-perpendicular to the measuring tape. Zero degrees = perpendicular; Angles < 20° are okay.**



See Section 1.4 of the *FlowTracker Operations Manual* for detailed information on QC Checks.

Next Station

Location, depth, and method data for the ***Next Station*** are predicted based on the pervious station.

At the second location, ***Loc2/Stn2***, the width is changed so that the rest of the measurements are done at the cross section width. This change is made after finishing ***Loc1/Stn1***.

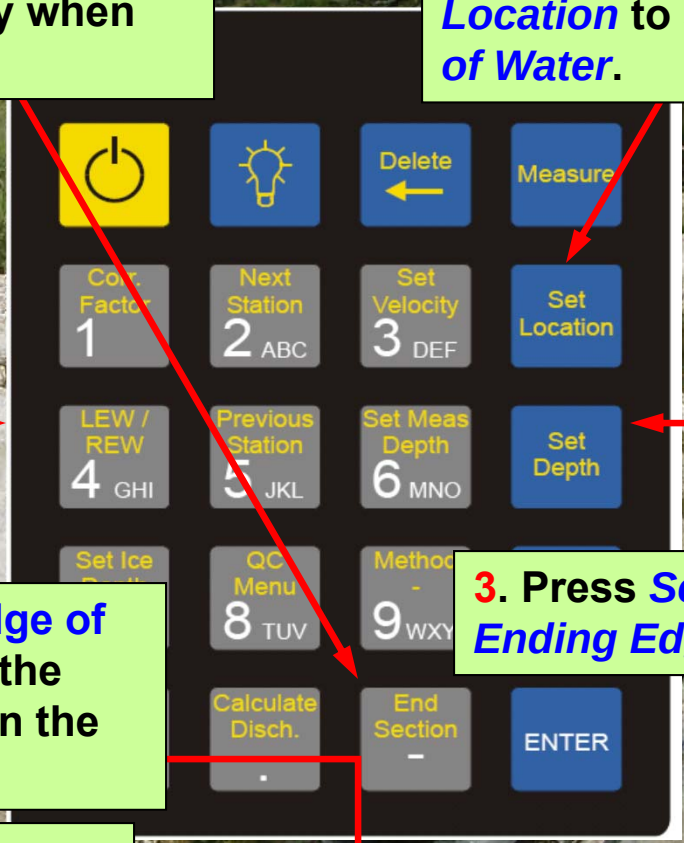
At ***Loc 2/Stn 2***, press ***Set Location*** and enter the cross section width.

For example, the cross section width is 1.0 ft and the midpoint is 0.5 ft. Set Loc2/Stn2 at 1.5 ft. When this measurement is accepted the FlowTracker will automatically start using 1.0 ft widths for the rest of the measurements.

Ending Edge Information

1. Press the *End Section* key when all stations are complete.

2. On the keypad Press *Set Location* to set the *Ending Edge of Water*.



3. Press *Set Depth* to set the *Ending Edge of Water Depth*.

4. To specify the Ending Edge of Water, Press *LEW/REW* on the *Keypad*. This will depend on the starting edge of water.

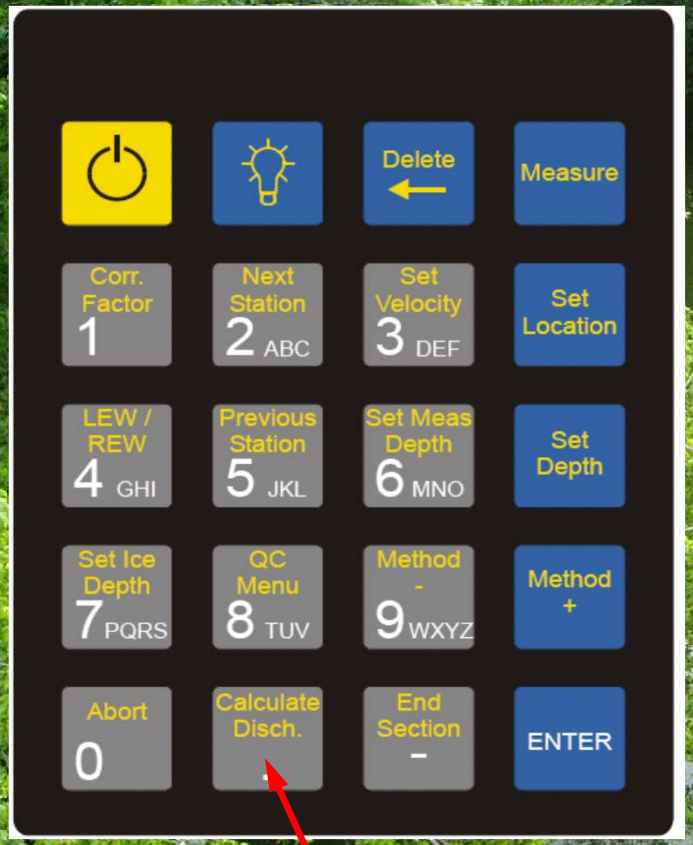
LEW = left edge of water

REW = right edge of water

Continued on next slide

See *Section 5* of the *FlowTracker Operations Manual* for detailed information.

Calculating Flow




```
File: SITE100.002
Mode: DISCHARGE
2002/06/20  10:02:03
9=Exit or Enter=More
```

```
File: SITE100.002
TotalQ: 15.653 cfs
RatedQ: 16.200 cfs
9=Exit or Enter=More
```

```
Num Stations 27
Mean V 1.43 ft/s
Max V  2.21 ft/s
9=Exit or Enter=More
```

```
Width 23.0 ft
Area 47.3 ft^2
Max Depth 2.50 ft
9=Exit or Enter=More
```

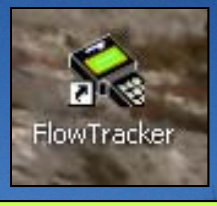
```
Mean SNR 16.5 dB
Mean σV 0.05 ft/s
Boundary BEST
9=Exit or Enter=More
```

After calculating flow five screens are available. Use *Enter* to move between the screens.

Press *Calc Disch* to complete the flow calculation.

When done, to turn the FlowTracker off: Hold the On/Off key for 3 second

Downloading FlowTracker Data



Desktop Icon

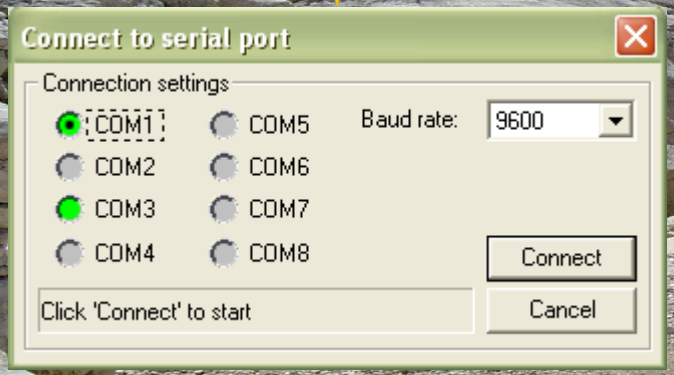
Connect the power/communications cable from the FlowTracker to PC COM1

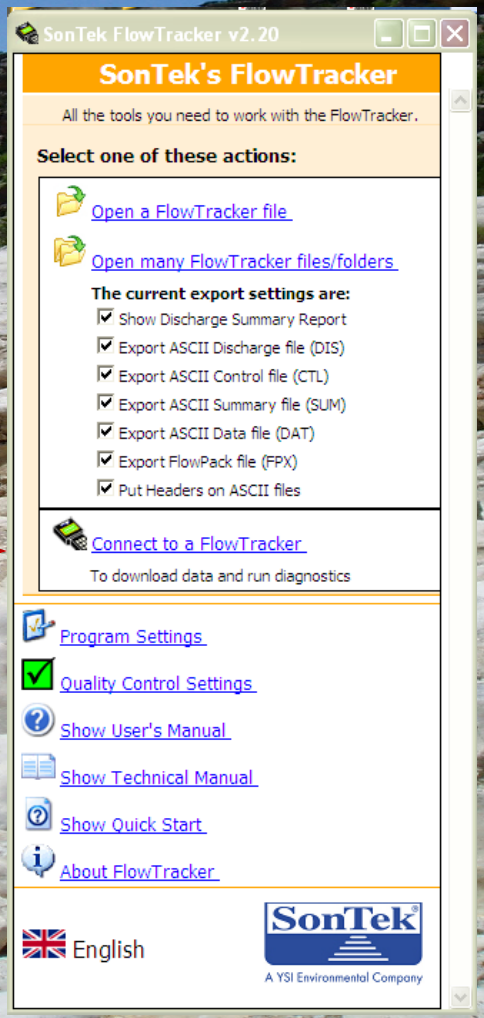
To run the FlowTracker software, click on the *desktop icon*

or

Click *Start* | *Programs* | *SonTek Software* | *FlowTracker*

Click *Connect to a FlowTracker*





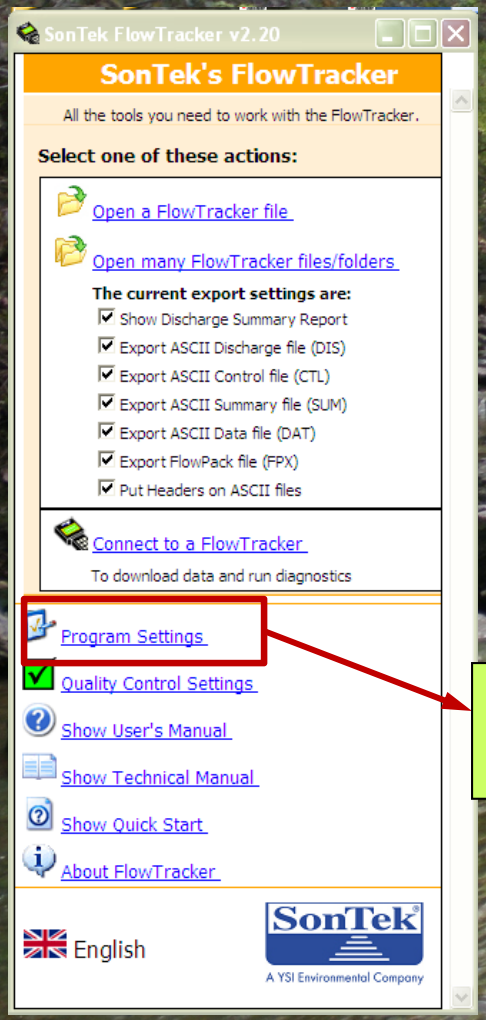
***Note*: When the connection is established the FlowTracker keypad will display *Flow Tracker Under External Control*.**

***Note*: FlowTracker does not have to be turned on but batteries must be installed.**

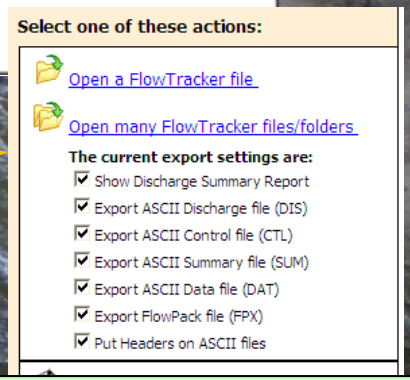
Continued on next slide

Data Display and Export

Data Export: Exports binary FlowTracker files to ASCII text format files that can be read in programs such as Word, Notepad and other text editors.



Click *Program Settings* to specify units, the output file directory, and the output type

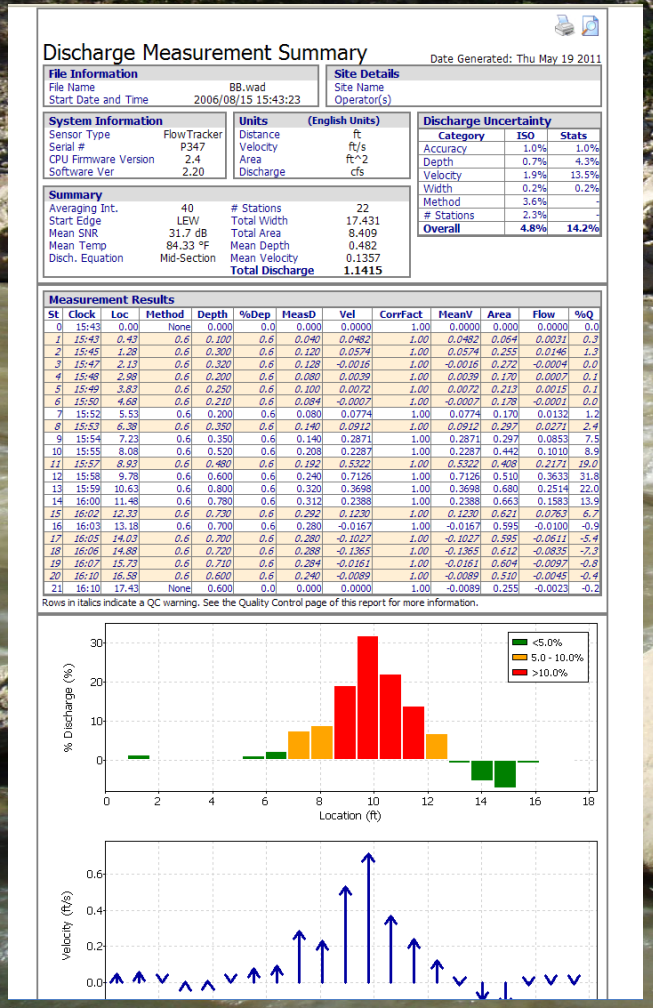


Output File Options

Section 6.3 —FlowTracker Technical Manual

FlowTracker Discharge Data

See *Section 6* of the *FlowTracker Operations Manual* for detailed information on downloading (*Section 6.3*) and exporting FlowTracker data (*Section 6.5*).



Discharge Measurement Summary

Date Generated: Thu May 19 2011

File Information		Site Details	
File Name	BB.wad	Site Name	
Start Date and Time	2006/08/15 15:43:23	Operator(s)	

System Information		Units	(English Units)
Sensor Type	FlowTracker	Distance	ft
Serial #	P347	Velocity	ft/s
CPU Firmware Version	2.4	Area	ft^2
Software Ver	2.20	Discharge	cfs

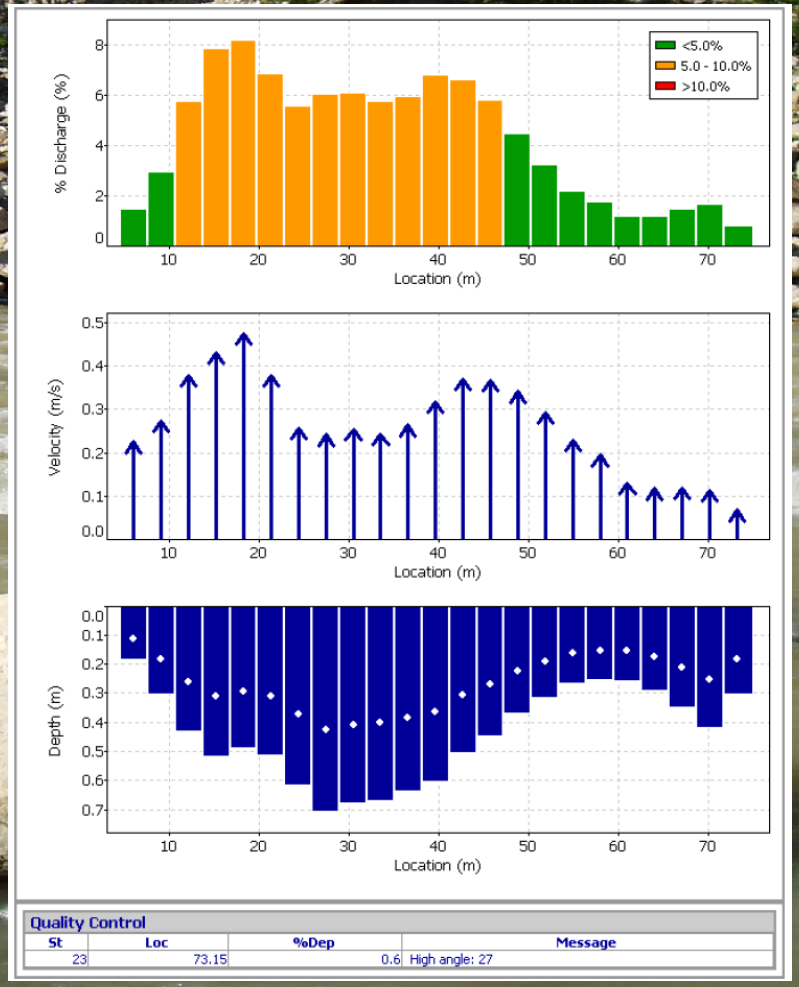
Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.7%	4.3%
Velocity	1.9%	13.5%
Width	0.2%	0.2%
Method	3.6%	-
# Stations	2.3%	-
Overall	**4.8%**	**14.2%**

Summary			
Averaging Int.	40	# Stations	22
Start Edge	LEW	Total Width	17.431
Mean SNR	31.7 dB	Total Area	8.409
Mean Temp	84.33 °F	Mean Depth	0.482
Disch. Equation	Mid-Section	Mean Velocity	0.1357
		Total Discharge	**1.1415**

Measurement Results

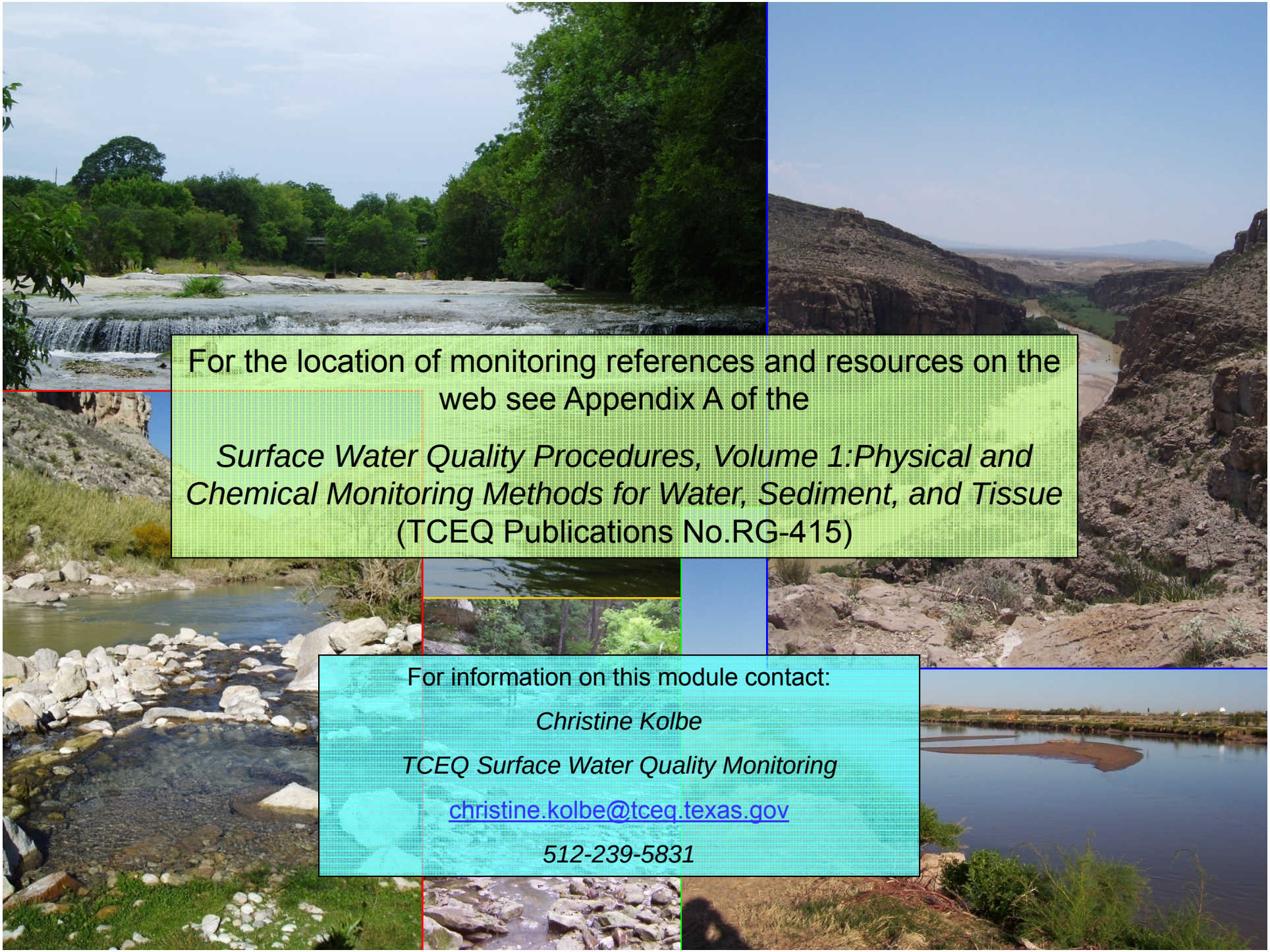
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	15:43	0.00	None	0.000	0.0	0.000	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	*15:43*	*0.43*	*0.6*	*0.100*	*0.6*	*0.040*	*0.0482*	*1.00*	*0.0482*	*0.064*	*0.0031*	*0.3*
2	*15:45*	*1.28*	*0.6*	*0.300*	*0.6*	*0.120*	*0.0574*	*1.00*	*0.0574*	*0.255*	*0.0146*	*1.3*
3	*15:47*	*2.13*	*0.6*	*0.320*	*0.6*	*0.128*	*-0.0016*	*1.00*	*-0.0016*	*0.272*	*-0.0004*	*0.0*
4	*15:48*	*2.98*	*0.6*	*0.200*	*0.6*	*0.080*	*0.0039*	*1.00*	*0.0039*	*0.170*	*0.0007*	*0.1*
5	*15:49*	*3.83*	*0.6*	*0.250*	*0.6*	*0.100*	*0.0072*	*1.00*	*0.0072*	*0.213*	*0.0015*	*0.1*
6	*15:50*	*4.68*	*0.6*	*0.210*	*0.6*	*0.084*	*-0.0007*	*1.00*	*-0.0007*	*0.178*	*-0.0001*	*0.0*
7	15:52	5.53	0.6	0.200	0.6	0.080	0.0774	1.00	0.0774	0.170	0.0132	1.2
8	*15:53*	*6.38*	*0.6*	*0.350*	*0.6*	*0.140*	*0.0912*	*1.00*	*0.0912*	*0.297*	*0.0271*	*2.4*
9	15:54	7.23	0.6	0.350	0.6	0.140	0.2871	1.00	0.2871	0.297	0.0853	7.5
10	15:55	8.08	0.6	0.520	0.6	0.208	0.2287	1.00	0.2287	0.442	0.1010	8.9
11	*15:57*	*8.93*	*0.6*	*0.480*	*0.6*	*0.192*	*0.5322*	*1.00*	*0.5322*	*0.408*	*0.2171*	*19.0*
12	15:58	9.78	0.6	0.600	0.6	0.240	0.7126	1.00	0.7126	0.510	0.3633	31.8
13	15:59	10.63	0.6	0.800	0.6	0.320	0.3698	1.00	0.3698	0.680	0.2514	22.0
14	16:00	11.48	0.6	0.780	0.6	0.312	0.2388	1.00	0.2388	0.663	0.1583	13.9
15	*16:02*	*12.33*	*0.6*	*0.730*	*0.6*	*0.292*	*0.1230*	*1.00*	*0.1230*	*0.621*	*0.0763*	*6.7*
16	16:03	13.18	0.6	0.700	0.6	0.280	-0.0167	1.00	-0.0167	0.595	-0.0100	-0.9
17	*16:05*	*14.03*	*0.6*	*0.700*	*0.6*	*0.280*	*-0.1027*	*1.00*	*-0.1027*	*0.595*	*-0.0611*	*-5.4*
18	*16:06*	*14.88*	*0.6*	*0.720*	*0.6*	*0.288*	*-0.1365*	*1.00*	*-0.1365*	*0.612*	*-0.0835*	*-7.3*
19	*16:07*	*15.73*	*0.6*	*0.710*	*0.6*	*0.284*	*-0.0161*	*1.00*	*-0.0161*	*0.604*	*-0.0097*	*-0.8*
20	*16:10*	*16.58*	*0.6*	*0.600*	*0.6*	*0.240*	*-0.0089*	*1.00*	*-0.0089*	*0.510*	*-0.0045*	*-0.4*
21	16:10	17.43	None	0.600	0.0	0.000	0.0000	1.00	-0.0089	0.255	-0.0023	-0.2

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.



Quality Control

St	Loc	%Dep	Message
23	73.15	0.6	High angle: 27



For the location of monitoring references and resources on the web see Appendix A of the

Surface Water Quality Procedures, Volume 1:Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue (TCEQ Publications No.RG-415)

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