



GEOPACKS

A MAP MARKETING COMPANY

MFP126-S Advanced Stream Flowmeter OPERATION MANUAL



River Lyd at Brat Tor, Dartmoor.

Geopacks Flowmeter

Be Aware – Be Safe

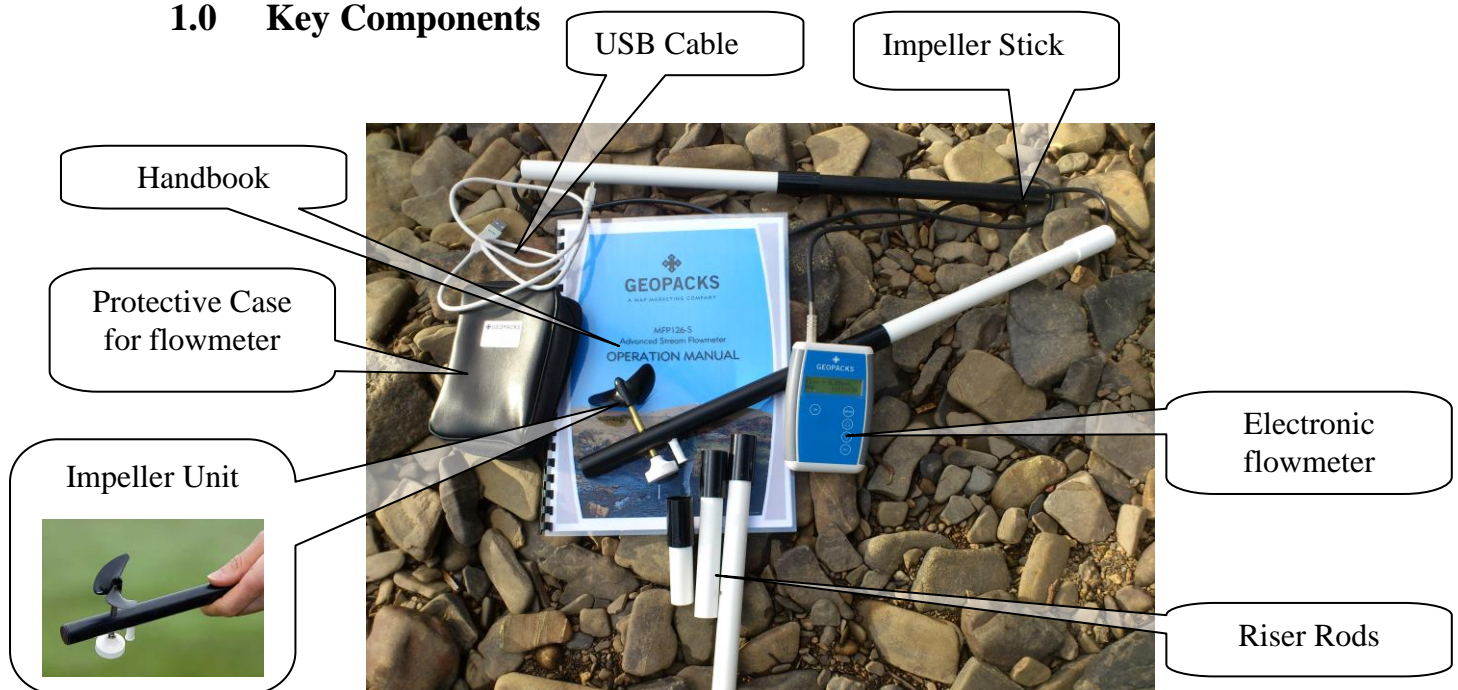
Fieldwork Safety when working in streams or rivers

There are a number of things to consider when carrying out work in streams or rivers.

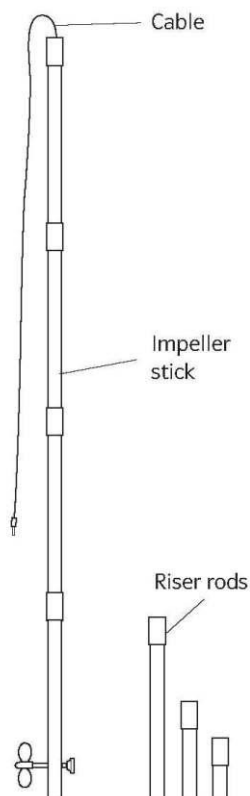
1. **CHECK THE WEATHER FORECAST** before you go out on fieldwork. In heavy rain rivers can rise quickly and what was a gentle trickle can become a torrent in a short space of time. Fast moving water which is higher than knee-deep can easily take you off your feet, especially if working on an uneven, or rocky river bed.
2. **WEAR THE RIGHT CLOTHING** for the day. If you get wet (see 4 below too) then you will get cold. Cold is unpleasant and uncomfortable at best and a life threatening at worst (hypothermia). Always make sure you take enough clothing even in summer. You'll be surprised how quickly you can get cold if you are wet, even on a summers day.
3. **NEVER WORK ALONE** and always let someone else know **WHERE** you are working and your **EXPECTED TIME OF RETURN**.
4. Moving water is powerful, and the banks of rivers may be undercut. **CHECK THE STABILITY OF THE BANKS** before you start working on the channel so you don't fall in before you've even started!
5. River beds can be very rough, or have a bed-load of boulders which can easily move underfoot. **CHECK THE CHANNEL IS SAFE** before stepping in to it. I remember nearly taking my eye out when I walked into the branch of a tree. Water can appear deceptively shallow at times. Check how deep it is before stepping into the channel.



1.0 Key Components



1.1 Impeller Stick




The impeller stick is used for measuring water velocity and consists of:

- An IMPELLER and coupled SENSOR in which a switch opens and closes as the impeller is rotated by the flow of water
- Four 250 mm long tube sections which slot together to make a 1m stick
- Three “riser rods” which when slotted singly or in combination, allow the impeller to be elevated above the stream bed at fixed heights – 250mm, 125 mm and 75 mm or combinations of these up to a maximum of 450mm.
- A 1m long cable which connects to a flowmeter
- A USB cable which connects the flowmeter unit to a laptop or PC to allow data transfer. Data is stored as a CSV(comma-separated-values) file which can be used without modification in Excel, Word etc.

1.2 Geopacks Advanced Flowmeter Setup

Before using the flowmeter you need to:


- Assemble the stream flow impeller (see page 2)
- Insert the jack plug from the flow impeller into the socket.
- Set up the meter with the date, time and the units which you wish to use for measuring (metres/sec or mph). Although not always necessary this action adds the date and time to your data file so you can track it later.
- Initiate motion of the sensor in the water
- Switch the instrument  - the ON button also brings the flowmeter out of sleep mode (see page 7)





1.3 How to set up the flowmeter

1. Remove the plastic tag from the battery compartment. The unit will display...


*Flowmeter 3
Geopacks 2011*

2. To start the meter press the  key. This will allow you to set the date and/or time for data logging purposes

3. The meter will show a menu as follows \Rightarrow




Use the  or  arrow keys to scroll through the menu options

Set Time
Set Date
Set Units
Set Logging
Finish



4. The meter defaults to metres/sec as the units of measurement so if data logging is not required then press the  arrow will display “FINISH”



and pressing the  button will start the meter running.

Setting the TIME

5. Press the  or  arrow keys until **Set Time** is displayed then press 




The display will now show **00:00:00** and should be set as a 24hour clock

With the cursor under the tens of hours digit use the  or  keys to obtain the correct tens of hours and then confirm with




The cursor will then move to the hours column. Repeat for units of hours, tens and units of minutes then press  **Set Time** and scroll  to FINISH.

You do not need to set seconds, these will be automatically set to zero when you exit the menu system using the FINISH option.

Setting the DATE




6. Press the  or  arrow keys until **Set Date** is displayed then press 

The display will now show **Year? 2000**




With the cursor under the tens of years digit use the  or  keys to obtain the correct tens of years and then confirm with 

 will also move the cursor to the desired location. Repeat for units of years and confirm.

When the year has been set the display will show **Month? Jan**

Use the  or  keys to select the required month and confirm with 




The display will now show **Day? 01**

With the cursor under the tens of days digit use the  or  keys to obtain the correct tens of days and then confirm with 




The cursor will then move to the **days units** column.

Setting the RECORDING UNITS




7. The meter defaults to metres per second (m/s) on power up.

Press the  or  arrow keys until **Set Units** is displayed then press 


The display will now show **Units are
m/s**



Use the  or  key to toggle between **m/s** and **mph** and confirm with 

Setting up LOGGING

To set up LOGGING press the  or  arrow keys until **Set Logging** is displayed then press 


The display will now show **Manual Log?**




The meter will show a menu as follows 

Use the  or  arrow keys to scroll through the menu options

Manual Log?
Auto Log?
Logging Off?
New Data?
Clear Data?




How these options work:

- a. Manual Log** – the flowmeter will store the reading whenever the  button is pressed during normal operation. The reading is stored in a file called Flowdata.csv which is accessible via the USB connection to a laptop or PC.




To set up Manual Logging press the  or  arrow keys until **Manual Log** is selected then press 

The display will now show **Set Logging**

b. Auto Log – the flowmeter will store the reading at a programmed interval set by the user. The reading is stored in a file called Flowdata.csv which is accessible via the USB connection to a laptop or PC. *Note - removing the batteries without the meter being connected to a USB device will wipe any recorded data.*

To set up Auto Logging press the  or  arrow keys until **Auto Log?** is selected then press 

The display will now show **Log Interval**
00 mins

The cursor will be under the tens-of-units digit. Use the  or  buttons to select the required tens of minutes. Confirm with 


The display will now show **Set Logging**

c. New Data – The logged data is stored as a “comma separated values file”. New Data simply starts a new line in the data file by inserting a Carriage Return (CR LF) to start a new line in the file for the new data.

To set up New Data press the  or  arrow keys until **New Data?** is selected then press 




The display will now show **Set Logging?**

d. Clear Data – Clear Data deletes ALL the data from the Flowdata.csv file and sets the logging ‘file pointer’ back to zero. Be careful using this option.

To Clear Data press the  or  arrow keys until **Clear Data?** is selected then press 

The display will now show **Set Logging?**

e. Logging Off – turns off all logging.

To set Logging Off press the  or  arrow keys until **Logging Off?** is selected then press 

The display will now show **Set Logging?**

Finish setting up the Flowmeter

To complete the setup process and start the meter running select Finish using the



or



arrow keys until **Finish?** is selected then press




The display will now show... **Flow = x.xx m/s**
MAN 10:34:01

...or something similar

The units displayed (m/s or mph) will reflect those selected. The logging mode will show MAN or AUTO, or remain blank if no logging is selected.

Sleep Mode

If the Flowmeter detects no input for a period of 2 minutes the display will go blank and the meter will go to sleep to conserve power.

Pressing the  button will restore operation. All settings and data are retained.

USB Operation

To retrieve the logged data from the Flowmeter plug the mini USB cable (supplied) into the Flowmeter and a suitable PC or Laptop.

The meter will display...

USB Detected
Connect?

To connect to the computer press the  button. To disconnect remove the cable.

The Flowmeter appears on the computer as a very small flash drive named *Flowmeter*. The drive contains a read-only file named Flowdata.csv which contains the data for export to Excel (or any other application capable of using CSV files). If you are saving data from multiple meters onto a single PC then consider renaming each Flowmeter.CSV file once it is downloaded to the PC before downloading the file from the new meter. Each meter will use the same file name for its CSV file so be careful not to overwrite one file with another. **No attempt should be made to write to, delete, or format the flowmeter from a PC** or all functions could be lost.

The Flowmeter can store just over 100 readings. After this the data needs to be downloaded and the CLEAR DATA option used to ready the meter for new logging.

During logging an asterisk flashes on the display next to the MAN or AUTO indicators to show that data has been recorded. If there is no more space for data then the asterisk will NOT flash indicating no available space.

Battery Condition

The battery is tested at the point of waking up. A flashing “B” on the display indicates a low battery. Data is retained even when the battery is too low to operate the meter but it’s not stored for ever. When connected to a PC via the USB the power to the meter comes from the PC so it can be a convenient way to change the battery without loss of setup information.

2.0 Operating Instructions

2.1 Impeller Stick with the Flowmeter

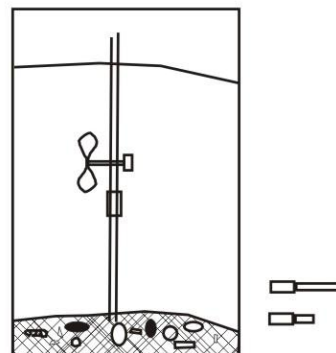
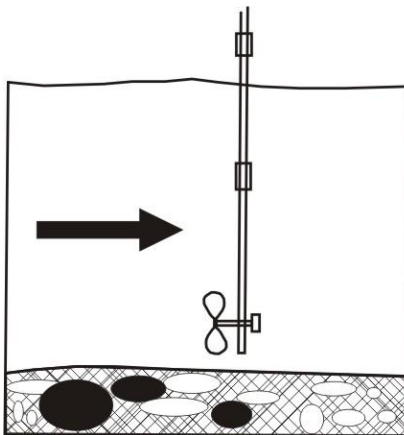



Slot the rods of the IMPELLER unit together and point the impeller up into the flow of moving water at the required depth (Figure 1a).


Use one or more of the three “riser” rods to elevate the impeller off the stream bed if necessary (figure 1b).

Figure 1a Impeller Stick in the flow

Figure 1b Using Riser Rods







When the impeller is turning at the correct depth (which will depend on the purpose of your measurements), press the “SEL” button. 

The Flowmeter will either record the velocity of the water at that point in time if set to MANUAL or start the timed recordings if set to AUTO LOG. To end an AUTO LOG session press  and FINISH

When Manual logging, a ❖ symbol will appear in the display when the button is pressed to acknowledge that data has been written to the data file. When Auto Logging, the same symbol will flash on briefly at every logging interval to show that readings are being taken.

To ensure that it is clear which record is which if you are logging it to a data file (see above) it may be convenient to select “New Data” each time you move on to a new recording location. That will ensure that when you download the data you have each location (no matter how many readings) on one line when viewed in the data file.

To set “New Data” press the  button (“Finish” will display) then press  to get to Set Logging. Use the  button to select “New Data” then  to confirm.

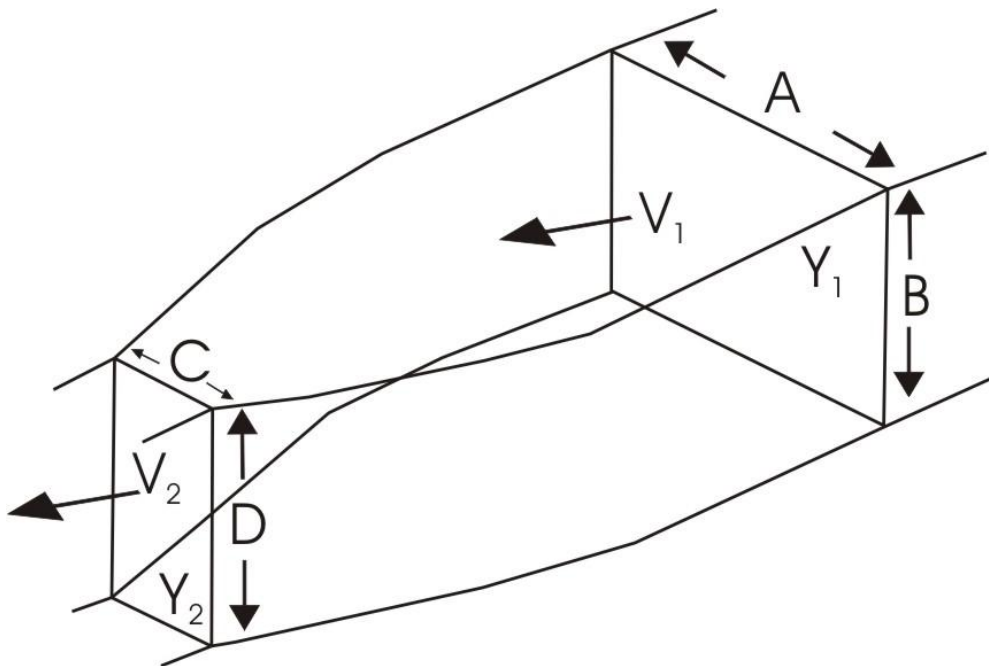
In order to have a clear record of which readings are taken at which location, river depth etc we recommend using the field observation chart included in the Appendix. See Section 4 on page 12 for further fieldwork information.

3.0 Stream Flow Velocity

3.1 Theoretical Background

A moving fluid exhibits certain important features. The flow velocity of a fluid depends upon the cross-sectional area of the flow, the roughness of the surfaces it is passing over (friction) and upon the quantity of fluid, which passes through that area in unit time. This is known as the DISCHARGE and illustrates the 'Principle of the Continuity of MASS'.

Figure 2: River Cross-sections and Flow Velocity



In the river channel depicted in Figure 2 the volume of water, which passes through section Y₁ in a second, is the DISCHARGE (Q) and will be given by:

$$Q = a \cdot b \cdot V_1$$

and similarly at section Y₂

$$Q = c \cdot d \cdot V_2$$

In these equations, a and c are the widths and b and d are the depths of the channel at the two sections, and V₁ and V₂ are the flow velocities. Since the same DISCHARGE (Q) passes through both of the sections then flow velocity relates to the difference between a . b and c . d (the cross-sectional area) ; i.e. if the channel becomes either narrower or shallower then the flow velocity increases and vice versa.

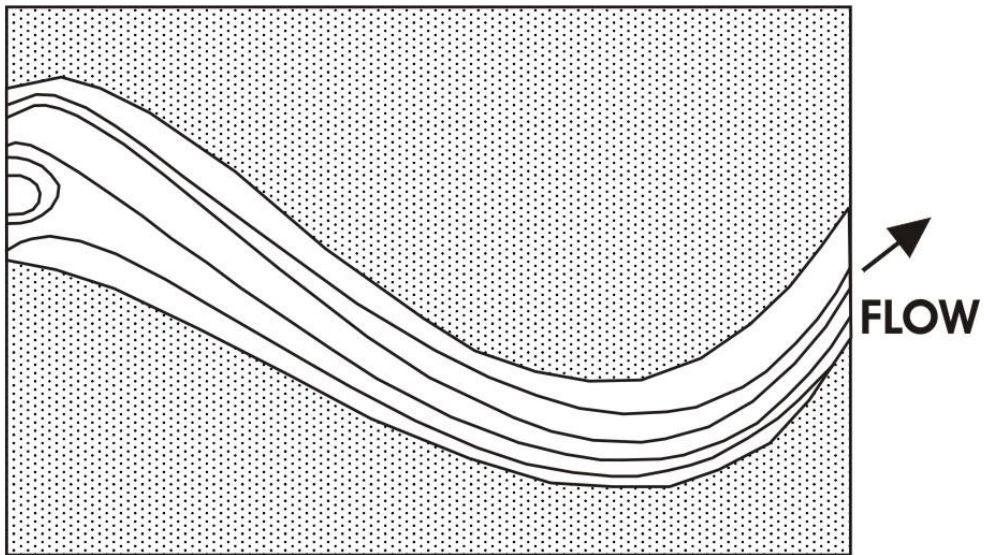
This principle explains many of the variations in the river channel morphology and in flow velocity. It is therefore important that this principle be understood by anyone undertaking serious fieldwork measurements in rivers. This could be demonstrated by measuring channel cross-sectional area discharge at a number of different sections along a short stretch of river.

3.2 Describing Flows

To understand the flow characteristics within streams of moving water it is sometimes helpful to consider the flow in the form of **STREAM LINES** or **VECTOR LINES**.

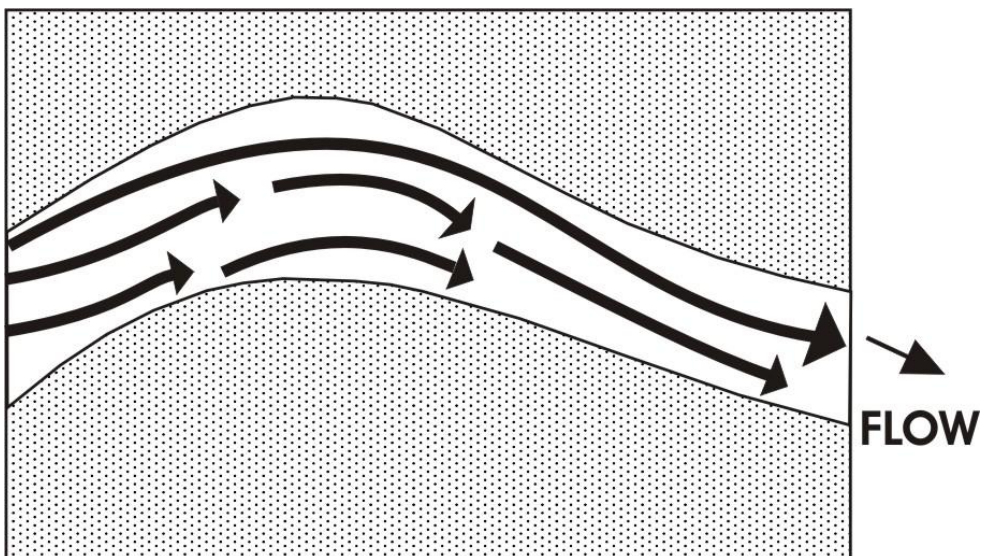
Figure 3 shows how Stream Lines depict possible paths of a single fluid particle.

Figure 3 Stream Lines in a flow around a meander



Vector Lines represent both the flow direction and velocity. The longer and broader the line the greater the flow velocity. Vector lines convey useful information about the stream flow characteristics.

Figure 4 Vector Lines in a flow around meander

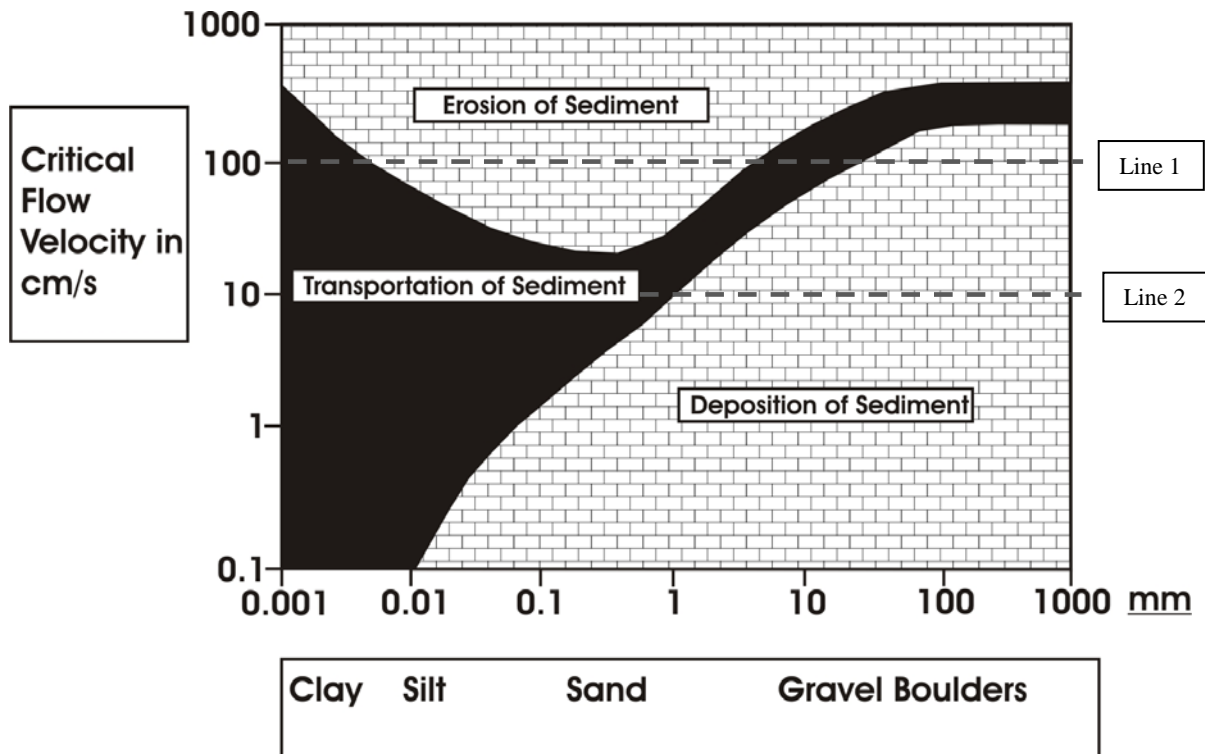


In this diagram the short thin arrows represent the slower areas of the stream and the long, thick lines the regions of faster flow.

3.3 Sediment Transport

The amount of sediment and maximum particle size that can be transported by moving water is related to the flow velocity. Therefore, measurements of velocity obtained using the flowmeter can be used to determine the maximum size of sediment particles, which may be transported by the flow (Figure 5).

Figure 5 Erosion Velocities for Water



The chart, which is referred to as the “Hjulstrom Curve”, has been derived from a mass of accumulated observed data, shows that for a given flow velocity there are a range of behavioural possibilities for sediment particles lying on the bed, or entrained within the flow, of a stream. For example, at a measured flow velocity of 100 cm/s (1 m/s) silt and sand (through not compacted clay) will be eroded from the stream bed and transported downstream (see Line 1). At the same velocity, all sediment particles finer than 1mm, which were already in motion, will continue in motion. Where the stream velocity falls below 10 cm/s (0.1 m/s), due to, say, a widening of the channel, sediment particles greater than 1mm diameter will be deposited (see Line 2).

Thus, a stream flowmeter can be a valuable observation tool when used in sediment transportation studies. Observed flow velocities can be traced on the graph and the corresponding maximum particle size which can be transported at the velocity (the competence of the river), can be determined.

4.0 Studying Streams – Some fieldwork suggestions

4.1 Recording Stream Velocity

Equipment Needed:

Geopacks stream flowmeter

Measuring tape

Ranging pole

Clipboard and pen

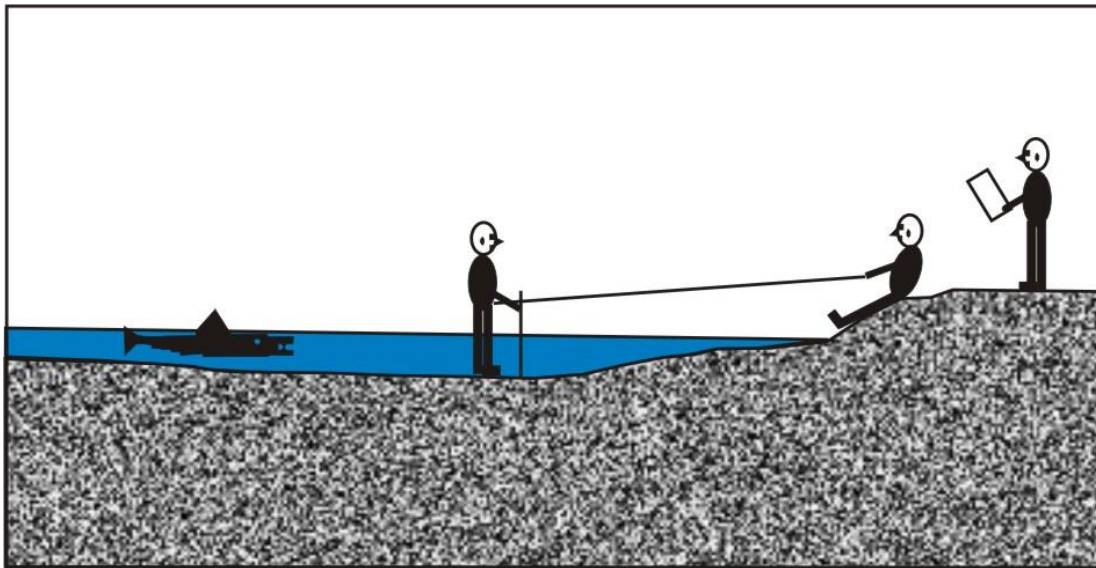
Field observation chart

Watch

Working in groups of two or three, students make rapid progress provided they work efficiently, know their objectives and have thoroughly prepared the ground. For example, one student works in, or above the stream with the meter while a second student uses a watch to note the time (and date) of the velocity recording. A third member of the group records the data, such as notes on the site, distance from the bank from which the measurements are being taken, also the depth of reading, recording time, and possibly, as a backup-plan to be on the safe side, the velocity.

Measurements of the distance from the banks and the position of the meter in the stream are vital. For systematic collection of stream velocity data, the position of the meter readings should always be recorded with reference to one bank – DISTANCE OUT. For example, in larger channels, where stretching a tape across is impractical, this may be determined by attaching a tape to the waist or belt of the student working in the stream with the meter. By standing on the bank, and holding the tape out horizontally across the channel one person can determine the position of the meter from the bank.

Figure 6 – Measuring “Distance Out” using tape attached to student’s belt



In smaller channels it may be more convenient to stretch the tape measure across the channel horizontally from the bank to bank. The ends of the tape can be attached to ranging poles on the bank or secured with heavy stones at each end.

Figure 7 Measuring “Distance Out” using tape secured at each end



Depth of measurement (DISTANCE DOWN) can easily be measured if the flowmeter tubes are simply calibrated beforehand using tape or water-resistant paint or ink, or more accurately, by taping a meter ruler to them. In estimating water depth please note that each section of the flowmeter stem is 250 mm long. Total water depth from surface to bed (sometimes called the WET READING) can be measured with the impeller stick if less than 1M. It is useful to have an elastic band or some other device on the impeller stick which can be moved up and down the stem to the water level. This allows a reasonably accurate estimate of depth to be made visually. Alternatively, if calculating the position of 0.6 of the depth (see section 4.3) for mean water column velocity measurement, the band can be moved to the appropriate position along the stem.

4.2 Plotting the Channel Cross-Section

This is essential for meaningful stream velocity recording. A plan or “map” of the stream cross-section at each point where measurements are to be made forms the basis for recording observations.



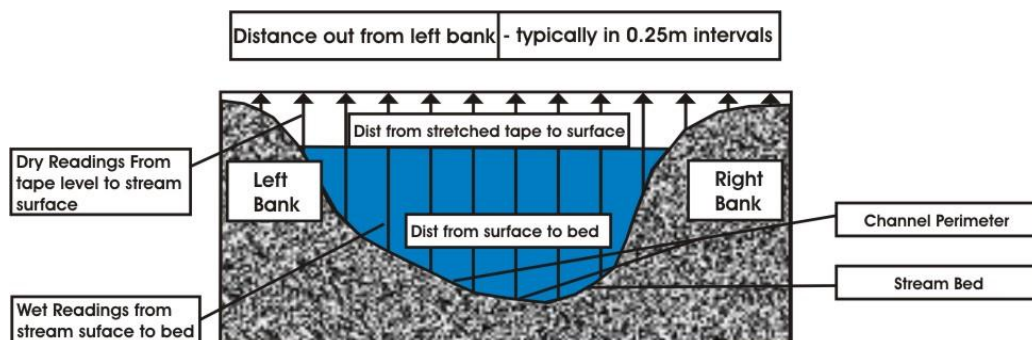
One method of measuring and plotting the channel form is by stretching a tape measure across the channel as described above. Depths can be measured vertically down from the tautly stretched tape to the stream bed.

Distance from Bank	Dry Reading	Wet Reading	Total
0m	0 cm	0cm	0cm
0.25m	14 cm	3cm	17cm
0.50m	14 cm	15cm	29cm
0.75m	14 cm	22cm	36cm
1.00m	14 cm	31cm	45cm
1.25m	14 cm	35cm	49cm
1.50m	14 cm	38cm	52cm
1.75m			

Measurements of channel widths and depths are then recorded using data sheet provided. At regular intervals along the tape, two measurements should be noted. Firstly, the distance from the tape to the ground or water surface known as the DRY READING. Secondly, the WET READING should be recorded. This is the depth of the water at each point.

This depth can be measured using the calibrated stem of the flowmeter, but more accurately by using a meter rule. The greater the number of measurements taken at each cross-section, the more accurate the representation of the channel, however, the closer the readings are together the longer it will take. In small channels, which are less than say 2 metres wide, a horizontal interval of 10cms would be workable. However, in a larger channel, maybe 5 or 6 metres across an interval of 20 or 25cms would give sufficient accuracy.

Figure 8 – Measuring & Plotting the Channel Cross-Section



4.3 Calculating Stream Discharge

In section 3.1 it was demonstrated (Figure 2) that:

$$\text{DISCHARGE (Q)} = \text{Cross-Sectional Area} \times \text{Flow Velocity}$$

So, if the cross section area of a channel was 1 m^2 and the rate of flow was measured at 1 m/s , then the Discharge Q would be $1 \text{ m}^3/\text{s}$ (1 cumec). If, after heavy rain the channel area increased to 2 m^2 and the flow velocity to 1.5 m/s then the discharge (Q) would be $3 \text{ m}^3/\text{s}$ or 3 cumec. Discharge is an important variable, unfortunately, it's not always easy to measure.

Figure 9a Semi-Circular Channel

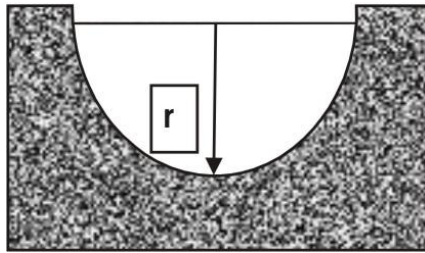
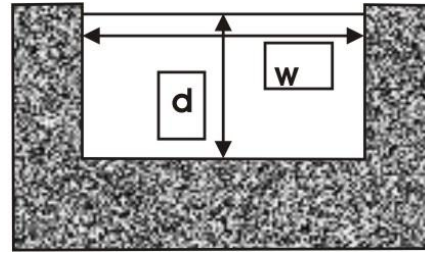


Figure 9b Rectangular Channel



Calculating discharge in the case of either the semi-circular channel (Figure 9a) or the rectangular channel (Figure 9b) is relatively simple.

In the semi-circular channel, if we take:

Radius of Channel (r)	=	1 m
Cross-sectional area (Δ)	=	$\pi^2) 2 = 1.57\text{m}^2$
Mean Velocity (V)	=	1 m/s
Discharge (Q)	=	$\Delta \times V = 1.57 \text{ m}^3/\text{s}$

Similarly, in the rectangular channel, if the:

Depth (d)	=	1 m
Width (w)	=	1.5 m
Cross-sectional area (Δ)	=	1.5m^2
Mean Velocity (V)	=	1 m/s
Discharge (Q)	=	$\Delta \times V = 1.57 \text{ m}^3/\text{s}$

In a real-life situation, however, the channel geometry will be far from regular. However, there is a “work around” which allows fairly accurate estimates to be made of these channel variables with a minimum of calculation. Try this...

Measured

Width	= as measured (in metres)
Wet Readings	= as measured (use metres – convert from cms if necessary)
Velocity	= as measured (metres per second)

Calculated

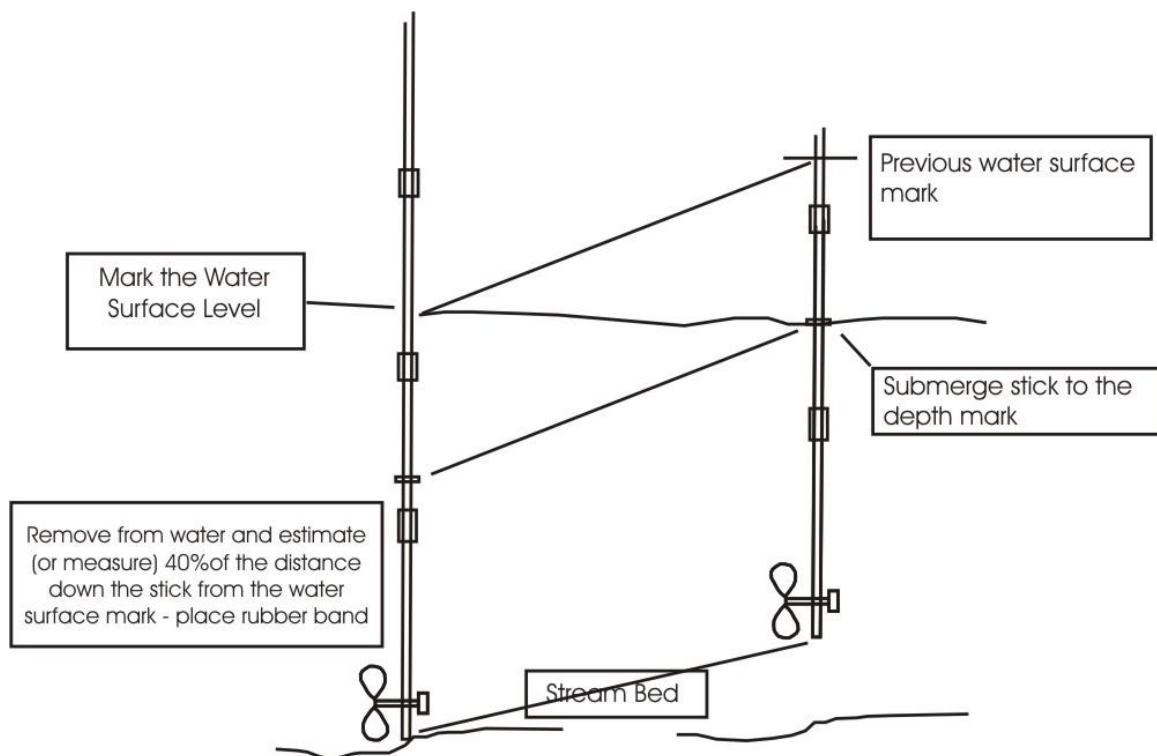
Mean Depth	= the mean average of all wet readings taken (in metres)
Cross Sectional Area	= Width * Mean Depth (metres ²)
Wetted Perimeter	= Width + (2 * Mean Depth)
Hydraulic Radius	= Cross Sectional Area / Wetted Perimeter (metres)
Discharge	= Cross Sectional Area * Velocity (metres ³ per second)

Unfortunately, there remains the problem of measuring the flow velocity in the channel. Because of friction with the bed and banks (the WETTED PERIMETER) and because of internal turbulence, stream velocity varies from point to point. Large numbers of observations under controlled conditions suggest that in water depths of less than 0.6m, a reliable average velocity can be recorded at a point, which is **0.6 of the depth of the water below the surface**. At this depth the faster surface flow is averaged out against the slower bed flow and this figure is an acceptable EMPIRICAL GUIDELINE (i.e. one derived from observation and experiment under a variety of circumstances).

A quick way of finding 0.6 of the depth requires a special piece of equipment – a rubber band!
Follow this simple procedure:

- Step 1 rest impeller base on stream bed.
- Step 2 mark the water surface level with finger and thumb.
- Step 3 removestick from the water keeping water surface mark.
- Step 4 visually estimate (or measure) 0.4 of the distance down the stick between the water surface mark and the base.
- Step 5 place a mark (e.g. rubber band) at this point.
- Step 6 submerge the impeller stick to this point on the stem.
- Step 7 the impeller will be approximately at the 0.6 of the depth from the surface down.

Figure 11 Finding 0.6 of the depth



But the problems aren't over yet! In the semi-circular and rectangular channel sections shown in Figures 9a and 9b, an impeller placed in the centre of the channel at 0.6 of the depth, would give a reasonable average flow velocity. In the real-life section shown in figure 10b, the channel

geometry is much less regular. Where should the mean velocity be measured? The most likely choice would probably be in the vicinity of the label letter “A”
 Thus, if the flow velocity (V) at this point was recorded as being 1 m/s and with a cross-sectional area of 1.45 m² then the DISCHARGE (Q) would be 1.45 m³ / s

To do the job properly however, it would be necessary to make a series of average flow velocity measurements, and this would require the channel cross-section to be subdivided into a series of columns like those in Figure 12.

Figure 12 Constructing Water Columns in a Stream Cross-Section

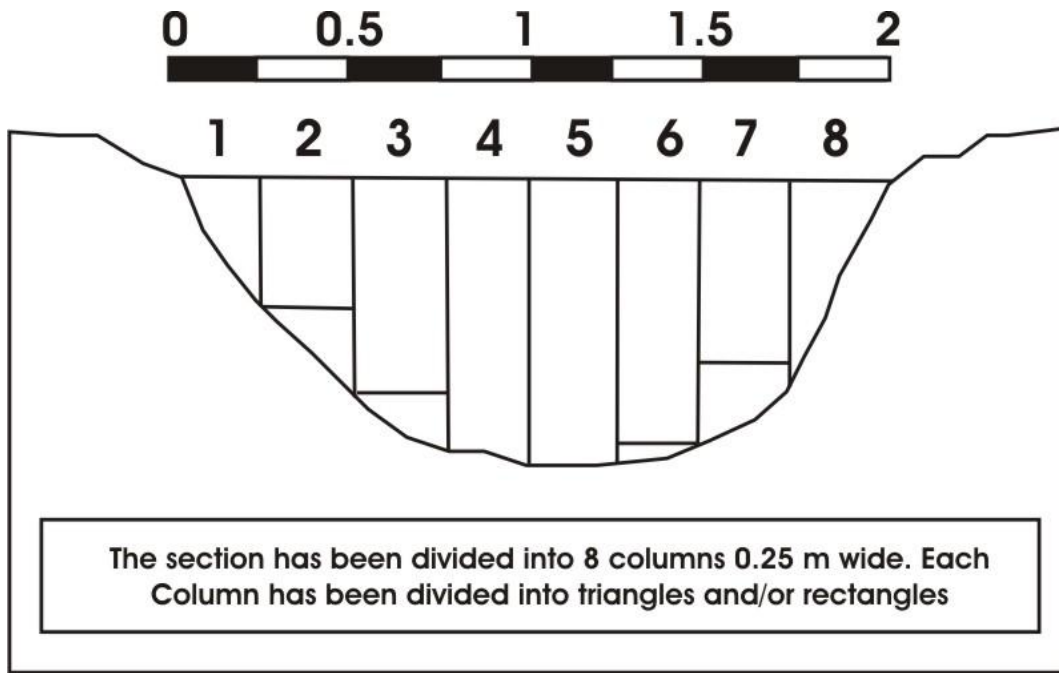


Figure 12 shows a stream cross-section which is 2 m wide. The section has been subdivided into columns (WATER COLUMNS) 0.25 m wide. According to the geometry of the channel, each column consists of a triangle and/or a rectangle. The area of each column has been calculated using the techniques described earlier and using the scale provided on the diagram. At an appropriate point within each column, the flow velocity would be measured with an impeller. A set of hypothetical velocities and the area measurements are displayed in Table 1, along with the calculations necessary to determine DISCHARGE (Q).

Table 1 Table of Measurements and Calculations for the Cross-Section

	Col.1	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8	Cols 1-8	
Area 1	0.00	0.07	0.12	0.22	0.23	0.19	0.13	0.00	0.96	
Area 2	0.07	0.06	0.03	0.00	0.00	0.02	0.02	0.11	0.31	
Area 1+2	0.07	0.13	0.15	0.22	0.23	0.21	0.15	0.11	1.27	Cross-Section area (M ²)
V	0.05	0.60	0.90	1.10	1.00	0.50	0.40	0.10	0.58	Mean Velocity (M/S)
Q	0.00	0.08	0.14	0.24	0.23	0.10	0.06	0.01	0.86	Discharge (M/S ³)

In the Table, Area 1 refers to rectangles and Area 2 to triangles

From the table:

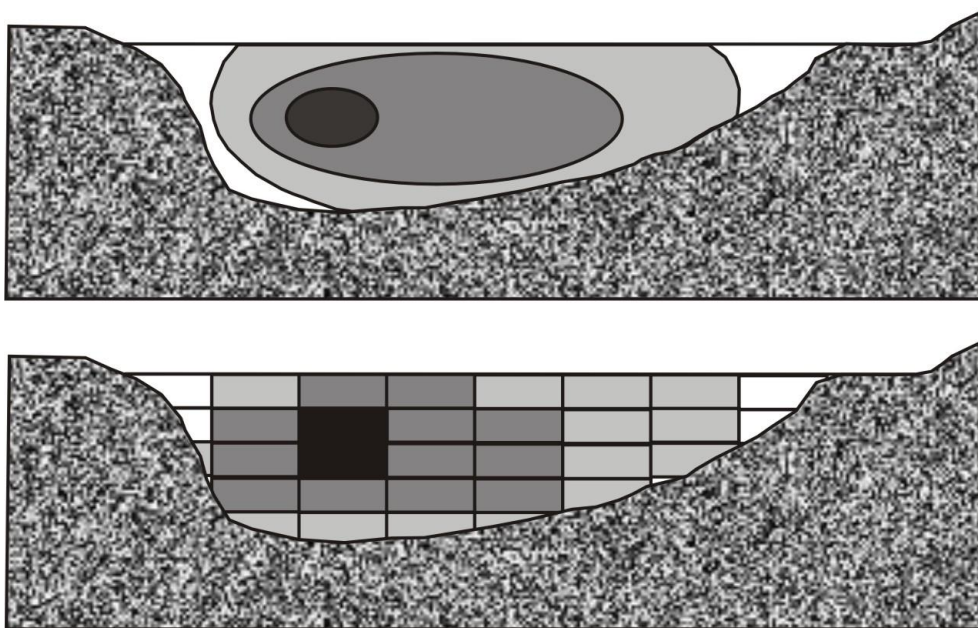
The total cross-sectional area has been calculated as	1.27 m ²
The mean flow velocity through the section is	0.58 m/s
The total discharge (Q) through the section is	0.86 m ³ /s

These procedures ensure that the best possible results are obtained from fieldwork. Once the hard work of surveying the channel section has been done, the profile can be used repeatedly under varying circumstances (e.g. before and after heavy rain) though adjustments for changes in depth and in-channel geometry due to erosion and deposition must be made. The exact position of the cross-section(s) must be fixed by inserting discrete stakes into the river banks.

4.4 Plotting Flow Patterns within a Stream

Using the cross-section channel profile(s) constructed for discharge measurements (or survey some new sections), it is possible to collect data to illustrate the internal flow characteristics of channelled flow. There are a number of techniques, most common being the construction of **ISOVELS** or **CHOROPLETHS**. Isovels are lines joining points of equal velocity and Choropleths involve shaded areas of like and unlike velocity.

Figure 13 Showing internal flow patterns – Isovels (above) & Choropleths (below)



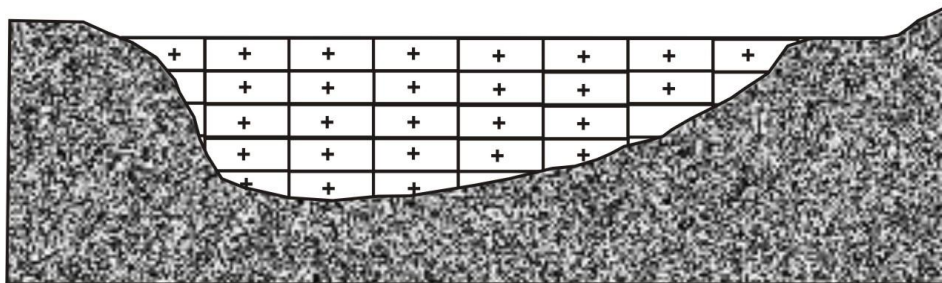
Key: dark shades = high velocity; light shades = low velocity

The isovels and choropleths represent lines and areas of equal velocity respectively. The highest velocity occurs usually in the centre of the channel near to the surface, while it is often lower nearer the bed and banks (Figure 13). However, the pattern displayed by the isovels and choropleths also reflects the shape of the channel i.e. its width, depth and symmetry (Figure 13). The spacing of the isovels and choropleths represents the velocity gradient.

Both methods can be effective in showing internal flow patterns. The degree of refinement depends on the number of readings which are taken – the more the better. Three values must be collected at each point – distance out from one or other bank; depth; and velocity at that point.

The stream cross-section must be surveyed as meticulously as for the calculation of discharge and readings are collected systematically in a transect across the stream channel. Instead of taking just one velocity reading 0.6 of the depth, a number of readings are taken at regular points within the water column.

Figure 14 Data collection grid for Isovel and Choropleth Construction



In Figure 14, the “+” signs indicate the midpoint of each “cell” in the grid. Typically a grid would consist of cells 0.25 m wide and 0.125 m deep. The size is determined by the size and scale of the channel and degree of accuracy required.

Table 2 Stream Velocity Data collected in Cells

Stream Velocity in m/s								
Depth	Col.1	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8
to 0.125	0.00	0.06	0.12	0.11	0.07	0.05	0.05	0.00
to 0.25	0.00	0.09	0.17	0.10	0.10	0.05	0.06	
to 0.375	0.05	0.11	0.16	0.10	0.10	0.10	0.04	
to 0.5	0.00	0.09	0.12	0.09	0.08	0.04		
to 0.625		0.06	0.07	0.06	0.06			

Cells are 0.25 wide and 1.25m deep

The data shown in this grid are ideally suited to constructing choropleths. For a representative and refined Isovel construction, at least twice as many velocity readings would be required (typically in a grid with 0.1 by 0.1 m cells).

Geopacks publishes a computer software package called “*River Channel Analysis*” which not only plots choropleths from fieldwork data but also draws channel cross-sections and calculates discharge among a wide range of other functions. For details see Appendix III.

5.0 Calibration

Before shipment the impeller unit has been carefully calibrated under laboratory conditions. The formulae and graphs from what we call the Calibration Data which was essential for users of the earlier Flowmeters. The latest Flowmeter has the relevant calibration data built into electronics so that direct velocity data is generated in m/s or mph as selected.

5.1 Pre –shipment Impeller Stick Calibration

The impeller sticks have been calibrated in a flume where flow velocities can be strictly controlled by combined variations in discharge, gradient and weir height adjustments. Flow rate was monitored by a miniature Nixon electronic flowmeter and an Ott flowmeter. The formula required to convert counts per minute (C) recorded by the Flowmeter to water velocity (V) in m/s is:

$$\text{Water Velocity (V) m/s} = (0.000854C) + 0.05$$

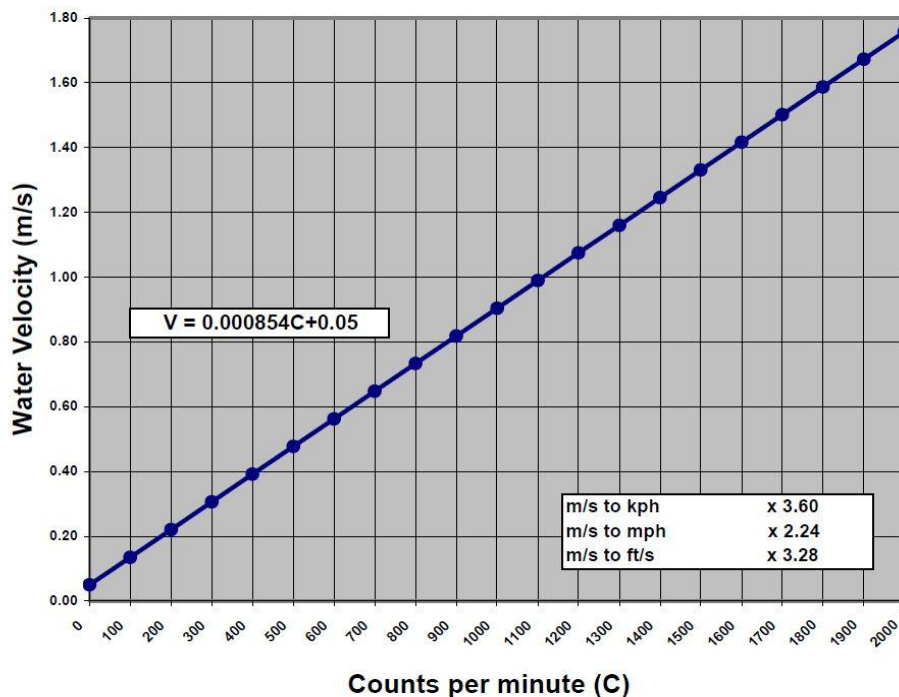
Alternative units can be calculated using the following conversion factors:

m/s to kph	x	3.60
m/s to mph	x	2.24
m/s to ft/s	x	3.28

Values in this manual are given in metres per second (m/s).

The chart below (Figure 15) shows the relationship between revolutions of the impellor and calculated velocity displayed on the meter. This is for information only.

Figure 15 Calibration Chart showing the relationship between revolutions of the impellor and Water Velocity



Appendix I

CARE OF YOUR FLOWMETER

Check your equipment before you start work.

BEFORE leaving for fieldwork check your equipment as follows:

Switch on the meter by plugging the impeller jack-plug into the socket then use the ON switch to activate the meter.

If nothing is displayed, check the batteries are correctly fitted. Batteries are accessed in the flowmeter by carefully removing the sliding panel on the back of the unit (take care not to lose the cover). Fit new batteries if necessary: always carry spares (Two by “AA” – average life several months depending on how often the meter is used). The battery is tested at the point of waking up. A flashing “B” on the display indicates a low battery, if you are out in the field and the “B” starts flashing then simply remove the batteries and put them straight back in again which will reset the charge chip and give several hours extra life. However removing the batteries will wipe any saved data unless the meter is connected to a USB device whilst the batteries are removed.

Although your flowmeter has been designed for use by fieldwork parties under a wide range of conditions and is reasonably robust, it can be damaged by rough treatment or immersion in water. Should the meter be immersed in water, REMOVE the batteries IMMEDIATELY; the flow meter can be left open to dry in a warm room, do not attempt to open the meter compartment. Just remove the batteries, leave the battery panel off and leave it to dry slowly. In case of a serious dunking then, after removing the batteries, wipe dry with a towel and cover the meter entirely with dry rice and leave for 24 hours. The rice will absorb any moisture, discard the rice and replace the batteries.

Should the flowmeter (impeller stick and/or meter) be damaged or otherwise malfunction we can repair/replace damaged parts at a very reasonable cost and will also provide repairs under guarantee where appropriate.

Please telephone Geopacks on 0843 2160 456 and speak to customer services or email us on service@geopacks.com **before** returning the meter to the address below:

GEOPACKS
Unit 4A, Hatherleigh Industrial Estate
Holsworthy Road
Hatherleigh
Devon, EX20 3LP

We can also customise your Flowmeter for any special requirements.

After each field session we recommend that the flowstick and impeller are rinsed in clean water and allowed to dry before being stored back in the carry case. Also, the batteries should be removed if the equipment is not being used for any length of time.

YOUR FLOWMETER IS GUARANTEED AGAINST DEFECTS IN MATERIALS AND WORKMANSHIP FOR 12 MONTHS FROM THE DATE OF PURCHASE.

Appendix II

Field Observation Sheet

Keep a log of your readings by river depth and distance from bank. Use this sheet to keep a track of the different sets of data that your meter will log so that you can use it in conjunction with the .csv file when back in the classroom.

Enclosed – 1 laminated sheet – please photocopy as required.

Field Trip Date

Reading Location

Student Names

Obs number	Location number	Distance from bank	Channel depth	Obs number	Location number	Distance from bank	Channel depth
1				51			
2				52			
3				53			
4				54			
5				55			
6				56			
7				57			
8				58			
9				59			
10				60			
11				61			
12				62			
13				63			
14				64			
15				65			
16				66			
17				67			
18				68			
19				69			
20				70			
21				71			
22				72			
23				73			
24				74			
25				75			
26				76			
27				77			
28				78			
29				79			
30				80			
31				81			
32				82			
33				83			
34				84			
35				85			
36				86			
37				87			
38				88			
39				89			
40				90			
41				91			
42				92			
43				93			
44				94			
45				95			
46				96			
47				97			
48				98			
49				99			
50				100			

Appendix III

Resources

Geopacks manufacture and distribute a wide range of products associated with the flowmeter discussed in this manual. We have measuring tapes, stop watches, ranging poles, a wide range of other survey equipment as well as the more specialized items described below.

Of particular interest are the following products – but be sure to ask for our full Geopacks catalogue. If you don't already have a copy, our address and telephone number given in Appendix I.

DVDs:

“Studying Rivers, a Practical Approach” – a 60 minute compilation for teachers and students. Practical guidance in using the flowmeter to test simple hypotheses moving on to develop skills in plotting internal flow characteristics and undertake full scale discharge measurements. Based on fieldwork in South Wales but incorporating background material from other locations especially the Colorado Plateau area of the American South West.

DVD Format; Geopacks order code ZDVD11

“Studying Sediment in Motion, a Practical Approach” – 45 minutes of instruction and demonstration on how to measure sediment transportation in streams and in moving air using flowmeter/anemometers. Filmed on location in South Wales, the video aims at students in the 13 to 18-age range of the UK education system (KS3 through GCSE to A level) through a series of staged experiments. Laboratory follow-up to fieldwork is especially emphasised in this compilation.

DVD Format; Geopacks order code ZDVD10

Computer Software:

“Geopacks River Form & Channel Analysis” by Rick Cope. The Essential software tool for guiding, processing, presenting the fruits of your river based field studies. “Channel Analysis” has been written for Windows by Rick Cope, a geography teacher well known for his expertise in field studies. This is available in single user, 2 – 10 users, or 11+ users – see the Geopacks Software section on www.geopacks.com for further details.

Some illustrations from “Channel Analysis” showing some of the opportunities it offers appear on the following pages.

Using “Geopacks River Form & Channel Analysis”

Ash Ghyll Beck - Field Data

File Data Profile Notebook Help

Site number 4 Number of readings 15

Cell contents .00

No.	Location	Dry	Wet	Total
1	.00	0	.00	.00
2	.25	12.00	3.00	15.00
3	.50	12.00	6.00	18.00
4	.75	12.00	23.00	35.00
5	1.00	12.00	45.00	57.00
6	1.25	12.00	34.00	46.00
7	1.50	12.00	33.00	45.00
8	1.75	12.00	45.00	57.00
9	2.00	12.00	39.00	51.00
10	2.25	12.00	31.00	43.00
11	2.50	12.00	22.00	34.00
12	2.75	12.00	11.00	23.00
13	3.00	12.00	15.00	27.00
14	3.25	12.00	5.00	17.00
15	3.50	.00	.00	.00

<Enter> key will repeat previous dry column reading

When depth data is gathered at regular intervals across the channel it is entered into a spreadsheet which works along the lines of a simplified version of Excel.

Location is Distance from the starting bank in metres

Dry is the distance from the tape to the surface of the water in cms

Wet is the depth of the water in cms at that point

Having entered this information, the cross-profile of the channel, the water as measured with the

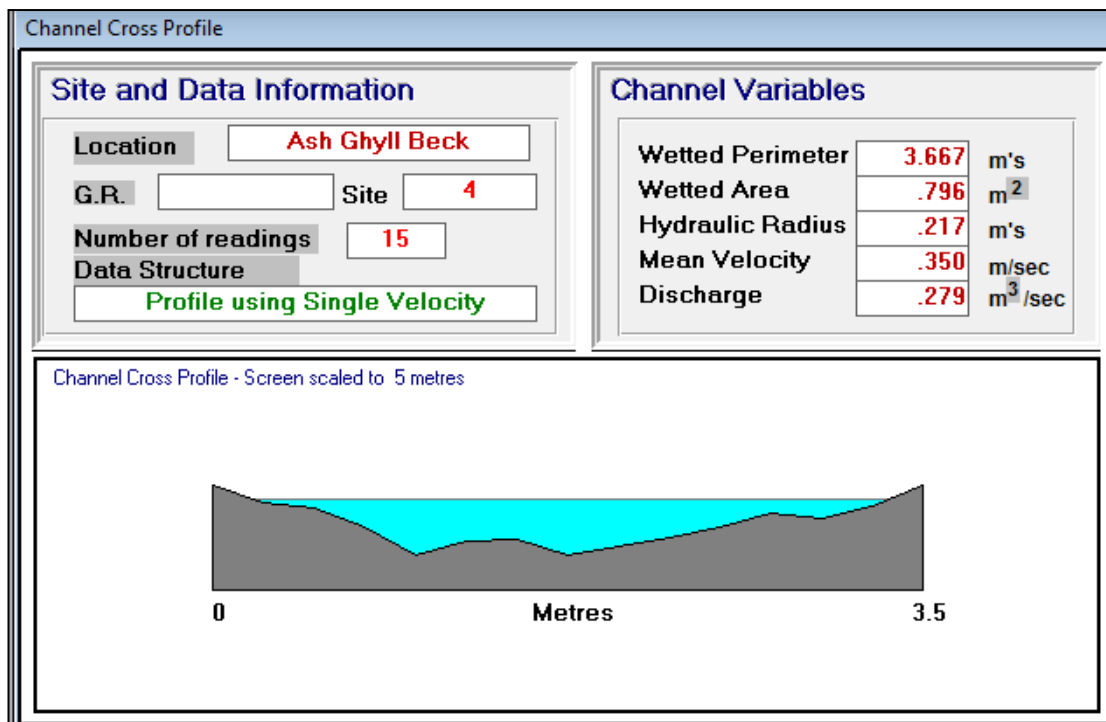
Velocity

Mean Velocity 0.35 m/s/sec

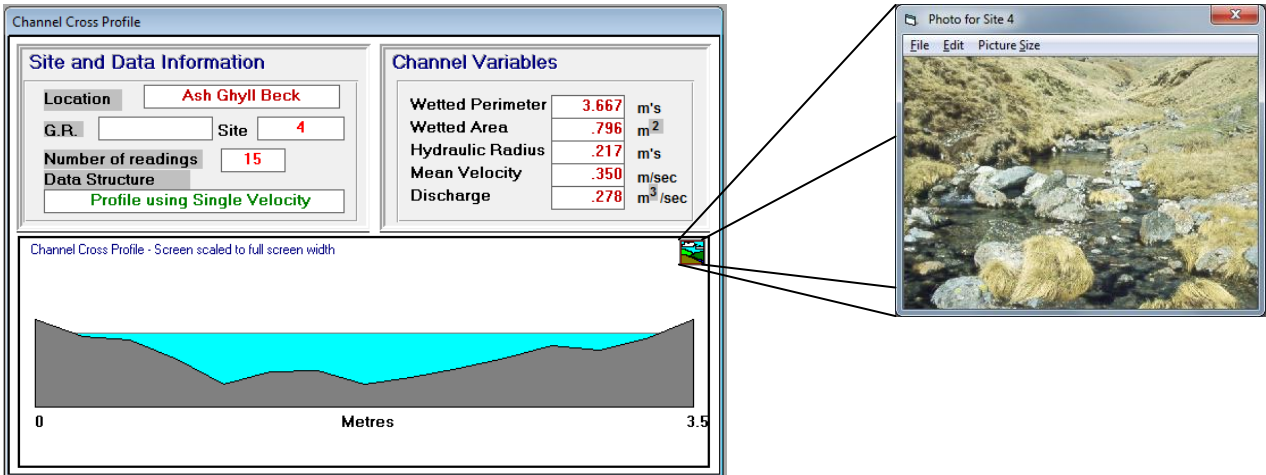
Display Profile Close

which is used to construct simply add the velocity of Geopacks Flowmeter.

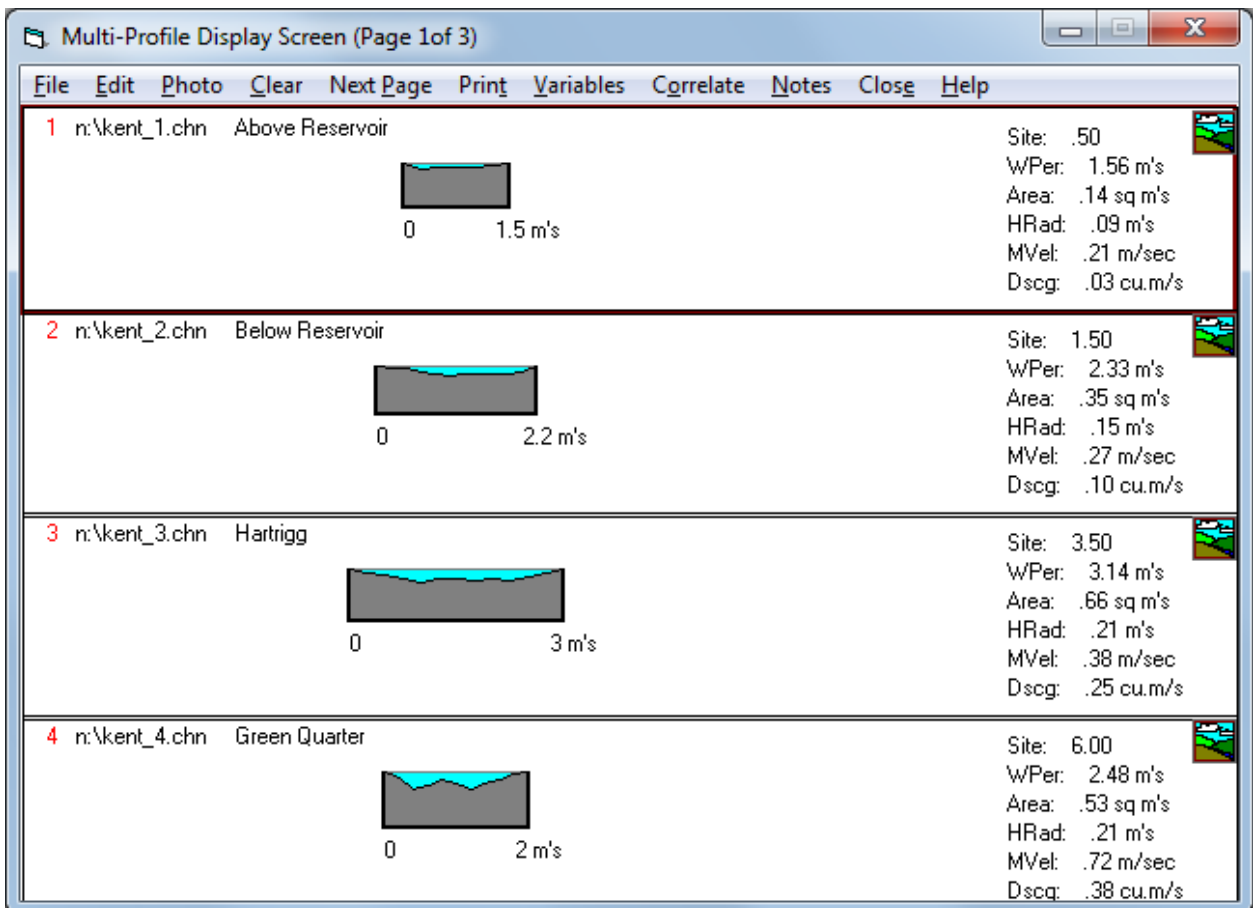
Channel Analysis will then display the completed Cross Section together with calculated Channel Variables.



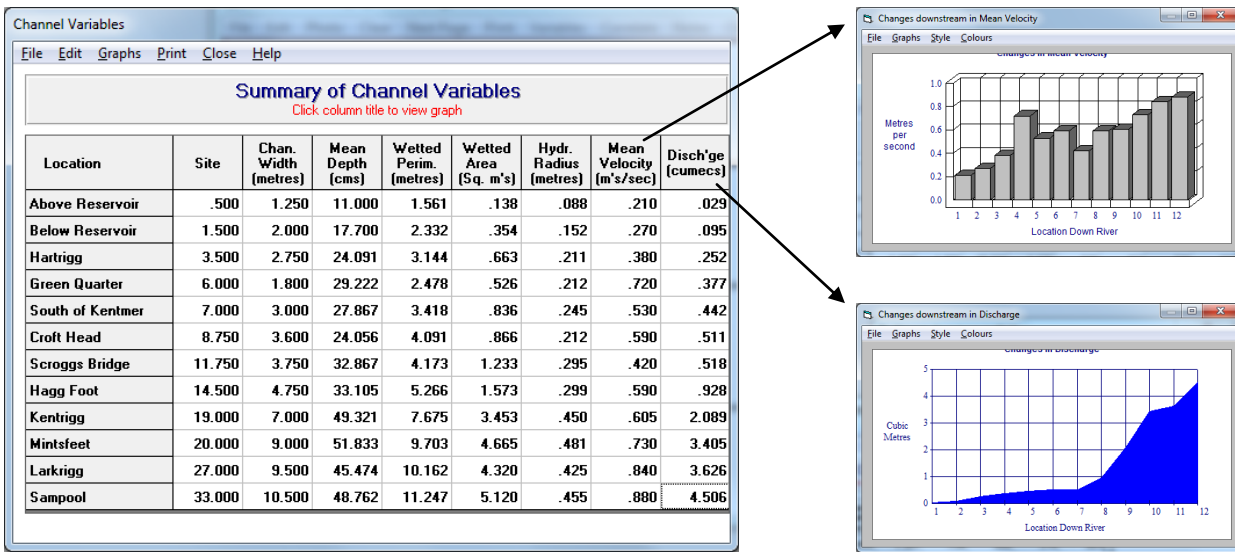
When on fieldwork most people make use of technology, such as digital cameras, or the camera facility on a mobile phone, to record events or locations. It is possible to combine these images with the cross-section and velocity data to give a more complete record of the location in its geographical setting.



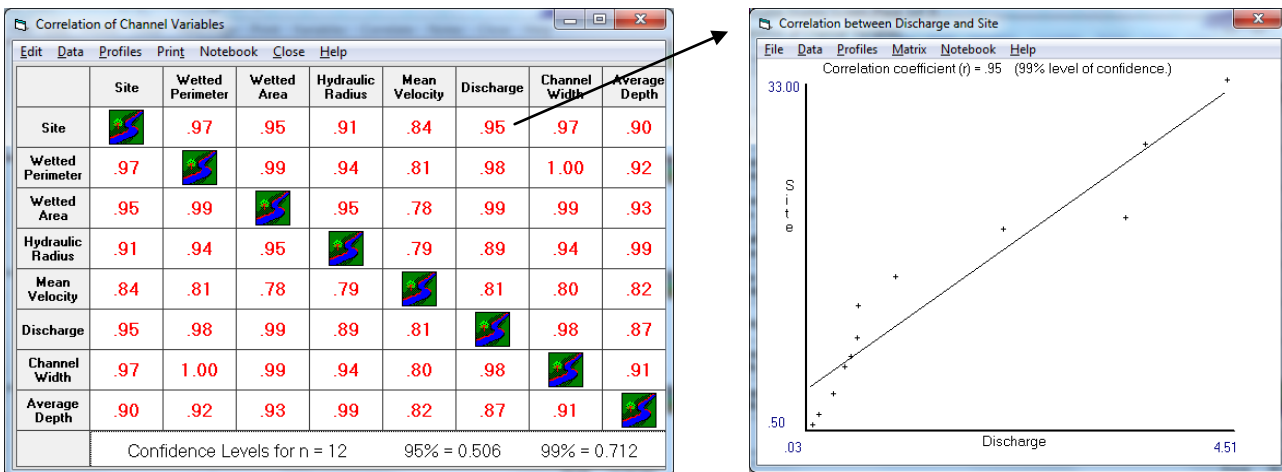
It is often desirable to be able to compare changes in size, shape and capacity of the channel at different locations. Channel Analysis does this in the form of a “Multi Profile” display which allows the user to view up to 12 cross sections at a time (in 3 panels of 4 profiles). As with the single profile, any photo which is associated with that location is imported with the data (see photo icon).



From this data it is possible to draw conclusions about the changes which may take place from one part of a river to another. These patterns, for any of the “channel variables”, can be displayed in the form of tables and associated charts.



If a pattern appears to exist then it is useful to see whether it is by chance or if there is a statistically significant relationship between the variables. To do this geographers often use a technique called “correlation”. Channel Analysis does this with the press of a button and will display a “correlation matrix” covering all variables, and scatter-graphs if two variables require closer scrutiny.



For more details about Channel Analysis (and other related fieldwork software packages) contact Geopacks on 0843 2160 456 or visit the website on www.geopacks.com