# Fieldwork sites in East Allendale, Northumberland

- **Geography**
  *River features and processes on the East Allen river.*

# Geography

## ORGANISATIONAL DETAILS

### Aim of fieldwork

River features and processes of the upper course

### Target Group

Key Stages 3 and 4 geography.

### Location

This fieldwork day is based around Allenheads on the upper reaches of the River East Allen. The three river sites identified are along a walk that begins just north of Dirt Pot, where there is a bridging point on the River East Allen (GR: NY851465). The walk then continues north along the River East Allen to Peasmeadows (GR: NY850472). The minor road is then followed to Hammershield (GR: NY848472), where the footpath is taken to Burnfoot (GR: NY849469) and then on to the starting point. The first river site is on the Middlehope Burn, a tributary of the River East Allen, above the footbridge (GR: NY851469). This site is the smallest of the river sites as it is a tributary but the site may be measured second for ease. The second site is at the start of the walk (GR: NY851465) above where the Middlehope Burn tributary enters. The third site is below where the Middlehope Burn tributary enters above the footbridge at Byerhope Bridge (GR: 851471).

### Practical Details

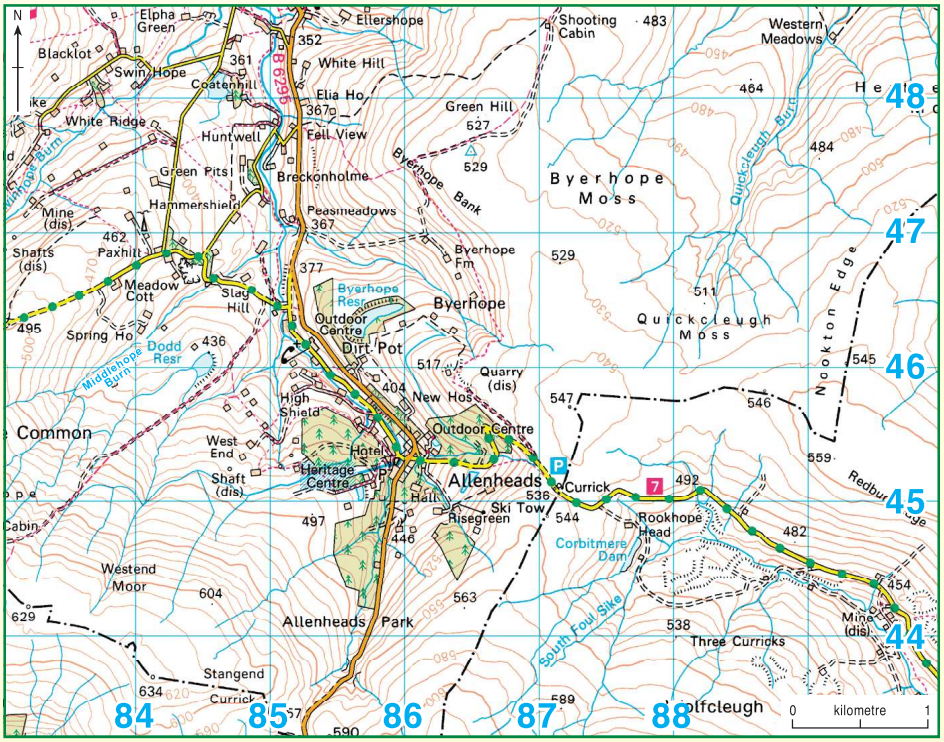
- Parking – There is free parking at bridging point at GR: NY851465, which is suitable for a coach. Parking for coaches is on the main road (GR: NY 905281).
- Toilet facilities – There are public toilets in Allenheads .
- Useful map – Ordnance Survey 1:25 000 Explorer OL31 North Pennines Teesdale and Weardale

### Safety Issues

- The fieldwork activities on the River East Allen will involve the students working in the river and the fieldwork should only be undertaken at low flow conditions.
- Refer to the Hazard Identification Sheet

# River Features and Processes on the River East Allen

## Fieldwork Outline - Teacher Resource Sheet



# HAZARDS IDENTIFICATION SHEET

The following notes will help teachers conduct their own risk assessments. This is not a risk assessment and teachers should follow guidelines from the Department of Children, Schools and Families.

| Hazard Identified | Risk and to whom | Control measures |
|---|---|---|
| Vehicles on the road | Students need to take care when getting off the mini-bus or coach as the lay-by is next to the road.<br>All students and staff. | Supervise students getting off the coach or minibus and gather in a safe place. |
| Uneven paths | Paths are uneven and may be slippery in wet weather. Students may slip and fall.<br>All students and staff. | Warn about conditions.<br>Walk in single file and have a leader and back marker to warn about approaching vehicles. |
| Working in rivers | Rocks in the river may be slippery and there is the risk of falling into the river.<br>All students and staff. | Warn about conditions. |
| Walk along the River East Allen | River bank is unfenced.<br>All students and staff. | Warn about river<br>Keep together as a group |
| Section of minor road | A short section of the walk is along a minor road with no footpath<br>All students and staff. | Warn about the road.<br>Keep together and walk in a disciplined manner on one side of the road. |

# INTRODUCING THE FIELDWORK

**Purpose and aims of the visit**

The main purpose of the fieldwork is to look at the features and processes that operate in the upper course of a river.

**The aims of the fieldwork are:**

- To look at the features of the upper course of the River East Allen
- To find out what controls the energy levels of the river.
- To find out how changes in energy affect the processes at work in the river.

**Background information**

The features of a river vary from source to mouth. The energy available for erosion, transportation and deposition varies with time and over the course of the river. Introduce river features and processes using Student Information Sheet 1.

Having introduced the aims of the fieldwork, set up hypotheses based upon the following:

- What factors influence how fast a river flows?

  Gradient?

  Amount of water in the river? (Discharge)

  Shape and efficiency of the channel? (Cross sectional area, hydraulic radius)
- Where will the river have most energy?
- Where does the river flow fastest?
- What processes will be dominant in different parts of the river?
- How does the material carried by the river change with the river's course?

  Size?

  Shape?

## *Introducing Fieldwork Methods*

Introduce the fieldwork methods needed to test the hypotheses. Use Student Information Sheet 2 to introduce the methods.

Use the O.S. extract to show the location of the river sites.

# UNDERTAKING THE FIELDWORK

River measurements are to be carried out on 3 sites. The first is a tributary to the East Allen called Middlehope Burn, the second is on the East Allen at the start of the walk and the third is at Byerhope Bridge. See O.S. map extract.

At each site the following measurements are carried out:

- Width
- 10 x depth recordings
- Wetted perimeter
- Float velocity – 10 x across the river
- Flow meter velocity – 10 x across the river
- Gradient
- Bed load test
- Suspended load test
- Measurement of the A-axis of 10 pebbles
- Measurement of the roundness of 10 pebbles
- Field sketch and description of the river features. The main features to observe are the 'v'-shaped valley, interlocking spurs, pools and riffles or areas of rapids.

All measurements can be recorded on Student Resource Sheet 1.

**Fieldwork equipment**

The following equipment will be required:

Clipboards

30m tapes

Metre rules

Float – boneo (biodegrades if left behind or eaten by sheep!) or orange

Stopwatch

Flow meter

Gun clinometer

Laminated board and spring balance

Pot for suspended sediment

Student Resource Sheet 1 – Recording Sheet.

## *FOLLOWING UP THE FIELDWORK*

Presenting and describing your results

**1. Processing the data**

Use Student Resource Sheet 2 to process the data collected in the field. Each group should use their own data. This will allow the students to see the change in the river's characteristics as they move from site 1 to 3 (i.e. as they move downstream).

**2. Cross sectional areas**

Using graph paper plot the cross sectional areas of the 3 river sites. Use these to describe the shape of the river channel. The shape can be related to the amount of water in touch with the bed and banks of the river and so the amount of friction produced. The channel shape with the least amount of water in contact with the bed and banks will be more efficient. Relate these cross sectional areas to the results for the hydraulic radius, which is a measure of the efficiency of the river.

**3. Field sketches**

Tidy the field sketches made and add the site description information to them.

**5. Describing your results**

For each of your results describe what they show.

**5. Analysing your results**

Use the data collected to accept or reject the hypotheses set up before the fieldwork. Explain what your results mean.

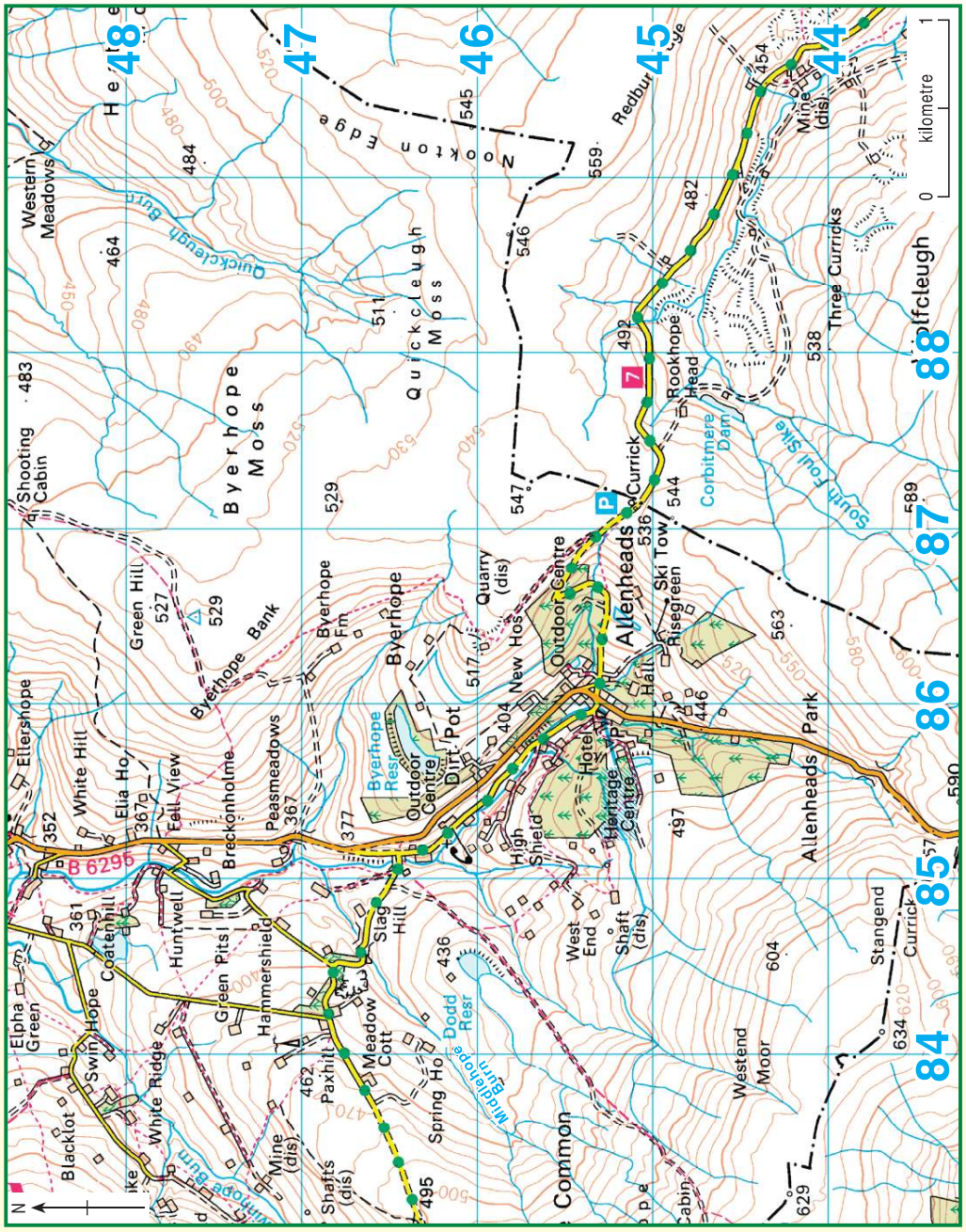
**6. Summarising your results**

From the results summarise the following:

- What are the controls on velocity and what are the relationships?
- Where does the river flow fastest and why?
- Where does the river have the most energy?
- What processes are most important at each site?
- How is this outcome reflected in the shape and size of the pebbles you measured?

## *ADDITIONAL WORK*

- Use a range of graphical techniques to present the results.
- Use Spearman's Rank Correlation Coefficient on the results to identify significant positive and negative correlations between the variables measured in the field.
- Use the measurements to calculate Manning's 'n' – a measure of the channel's roughness.
- Use the case study provided of the River Gaunless Flood Alleviation Scheme to look at the factors that affect flooding on a North Pennines river and a flood alleviation scheme that has been put in place.




*O.S. Map of Allenheads*



# Ordnance Survey Map Symbols

## ROADS AND PATHS

- M1 or A6 (M) — Motorway
- A35 — Dual carriageway
- A30 — Main road
- B3074 — Secondary road
- Narrow road with passing places
- Road under construction
- Road generally more than 4m wide
- Road generally less than 4m wide
- Other road, drive or track, fenced and unfenced
- Path

## RAILWAYS

- Multiple track
- Single track

## PUBLIC RIGHTS OF WAY

- Footpath
- Bridleway

## BOUNDARIES

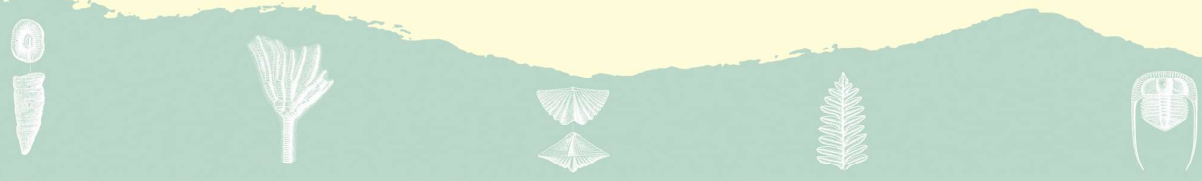
- National
- County (England)
- Civil Parish (CP)
- National Park boundary

## SELECTED TOURIST AND LEISURE INFORMATION

- P — Parking
- Information centre
- PC — Public convenience
- Telephone
- Campsite / caravan site
- Golf course or links
- Public house
- Walks
- Viewpoint
- Picnic site
- Country park

## GENERAL FEATURES

- \+ — Place of worship
- Building
- Bus or coach station
- Triangulation pillar
- Windmill
- BP/BS — Boundary post / stone
- CH — Clubhouse
- FB — Footbridge
- Mon — Monument
- PO — Post Office
- Pol Sta — Police station
- Sch — School
- TH — Town hall



# River Features and Processes on the River East Allen

## Student Information Sheet 1

## RIVER FEATURES

Rivers usually start on high land and flow to the sea. The start of a river is called the **source** and where it enters the sea is called the **mouth**.

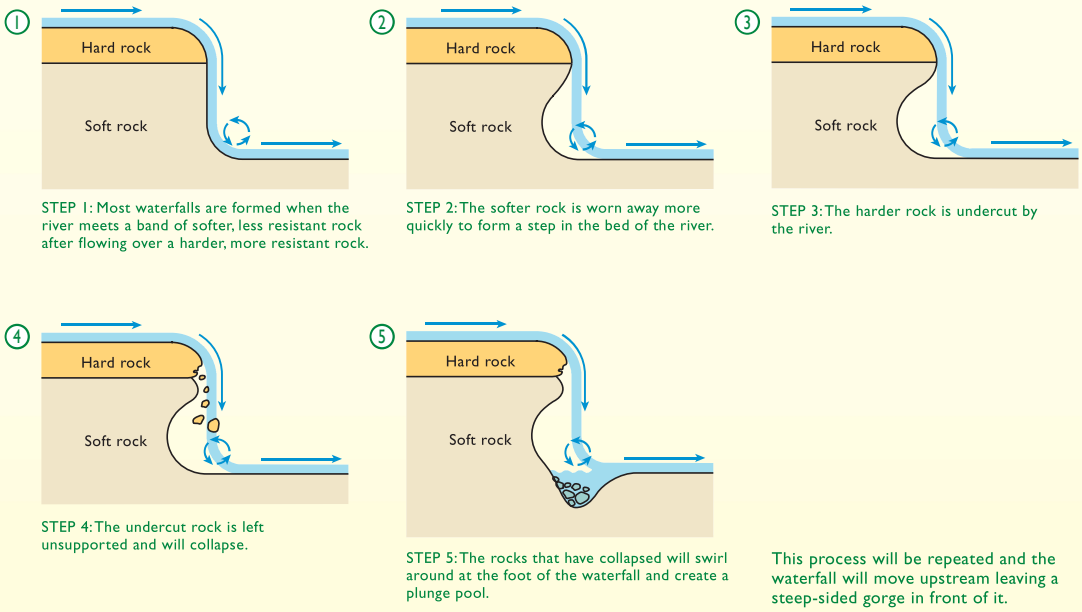
The main features of the upper course are features produced by erosion and include 'V' shaped valleys, interlocking spurs, waterfalls and rapids:

**'V' shaped valleys** – the energy of a river in its upper course is used to cut downwards, developing steep-sided, narrow valleys shaped like the letter 'V'.

**Interlocking spurs** – the river is forced to wind its way around protruding hills and outcrops of rock. The protruding outcrops are called interlocking spurs and restrict the view up and down the valley.

**Waterfalls** – most waterfalls are formed when the river meets a band of softer, less resistant rock after flowing over a relatively hard resistant rock. The softer rock is worn away more quickly and the harder rock is undercut. The undercut rock will be unsupported and will eventually collapse. The rocks that have collapsed, will be swirled around by the river at the foot of the waterfall and create a plunge pool. This process will be repeated and the waterfall will move upstream leaving a steep-sided gorge in front of it.

### How are waterfalls formed?




STEP 1: Most waterfalls are formed when the river meets a band of softer, less resistant rock after flowing over a harder, more resistant rock.

STEP 2: The softer rock is worn away more quickly to form a step in the bed of the river.

STEP 3: The harder rock is undercut by the river.

STEP 4: The undercut rock is left unsupported and will collapse.

STEP 5: The rocks that have collapsed will swirl around at the foot of the waterfall and create a plunge pool.

This process will be repeated and the waterfall will move upstream leaving a steep-sided gorge in front of it.

**Rapids** – these occur where the layers of hard and soft rock are narrow and so there is no break in slope like when a waterfall is formed. The wearing away of the less resistant rock makes the gradient steeper producing rapids or areas of fast flowing water. There are often sequences of fast and slow flowing water called pools and riffles.

The main features of the lower course are depositional and include, **flood plains**, **levees** and **deltas**. Meanders and ox-bow lakes are the result of both erosion and deposition. These features will not be seen, as our study will be concentrated on the upper course.

## *RIVER PROCESSES*

The river has three types of processes: erosion, transportation and deposition.

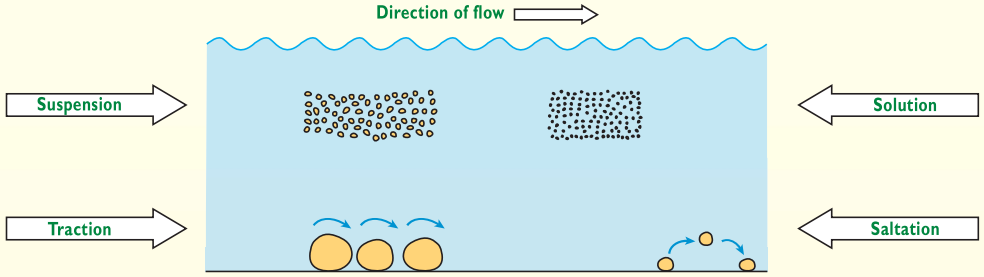
**Erosion** – The material carried by a river erodes the bed and banks. A river erodes by 4 different processes:

- **Attrition** – boulders and material moved by the river along its bed, collide and break up into smaller pieces. This is the main process of erosion in the river's upper course.
- **Corrasion or Abrasion** – material carried by the river in suspension (carried in the water) wears away the banks of the river. This is the main process of erosion in the lower course, as the material carried by the river is small enough to be transported in suspension.
- **Corrosion** – this where slightly acidic river water dissolves the bedrock when it is an alkali rock like limestone. This can occur at any point during the river's course.
- Hydraulic action **–** this where the force of the water in the river dislodges particles from the river's bed and banks.

**Transportation** – The river can transport material by 4 main processes: traction and saltation along its bed, suspension and solution within the river itself.

- **Traction** – this is the rolling of stones along the bed of the river and requires the most energy.
- **Saltation** – sand-sized particles bounce along the riverbed.
- **Suspension** – silt and clay-sized particles are carried within the water itself
- **Solution** – this is where minerals are dissolved in the water and are carried along. This method of transport requires the least energy.

### Transportation in a river




**Deposition** – this occurs when the river does not have enough energy to carry its load and the material is dropped onto the bed or banks of the river. The heaviest material is dropped or deposited first and may occur when the amount of water (or discharge) in the river is reduced or the velocity of the water decreases such as on the inside of a meander bend.

**The river's energy**

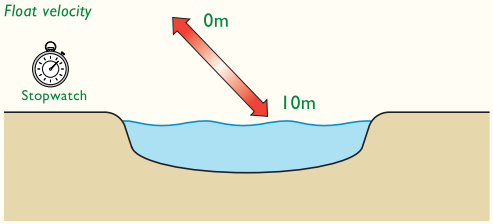
Energy levels in a river vary over time and over the course of a river. When energy levels are high the river can transport material and erode the bed and banks. If energy levels fall the river may not be able to transport, as much material and it will be deposited.

# River Features and Processes on the River East Allen

## *Student Information Sheet 2*

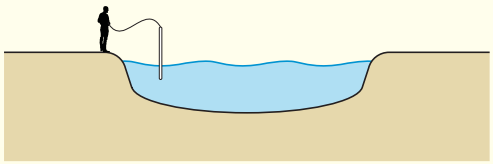
### 1. Velocity measurements

*Float velocity*



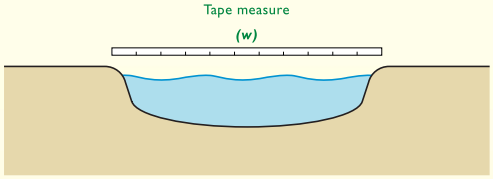

Record the time it takes for the float to travel 10m.
Repeat the exercise 10 times across the width of the river.

*Flow meter velocity*



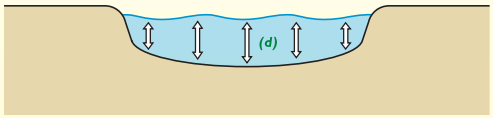
Place the flow meter in the river 2/3 up from the bottom or 1/3 down from the top.
Record the velocity 10 times across the stream.

### 2. Width



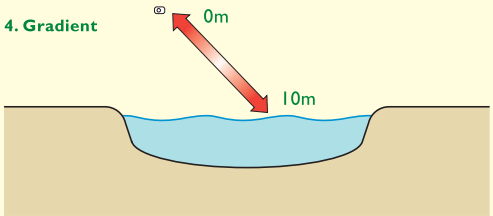

Measure the width of the stream from the surface of the water on one side to the surface of the water on the other side.

### 3. Depth (m)



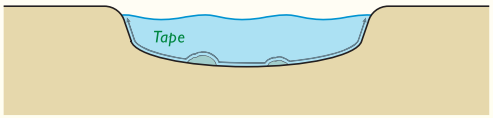

Take 10 depth measurements across the width of the river.

### 4. Gradient



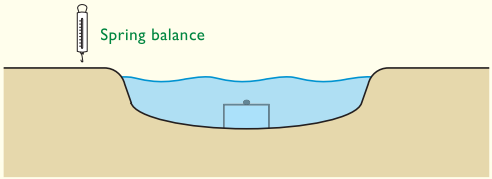

Use the gun clinometer over 10m. Site on the eyes of a person the same height as yourself and when the gun clinometer stops swinging, stop it and read the angle.

### 5. Wetted perimeter



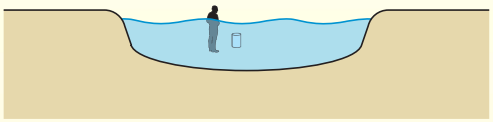

Measure the wetted perimeter from the surface of the water on one side, over every hump and bump on the river bed, to the surface of the water on the other side.

### 6. Bedload test




Weigh the pebble that gradually moves across the laminated board on the bed of the river.

### 7. Suspended load



Collect a sample of water from the middle of the river.

### 8. Size and shape of bedload


Record the length of the A-axis of 10 pebbles

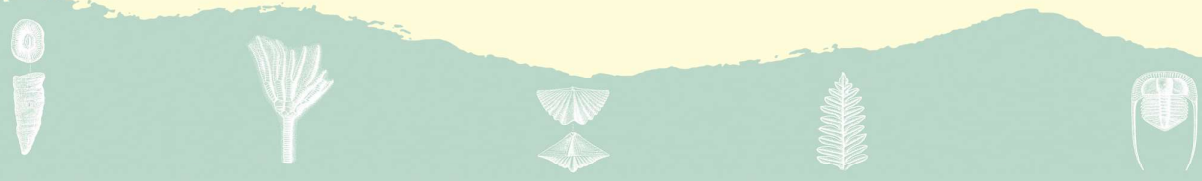
Record the roundness of 10 pebbles using the roundness chart

### 9. Site description

Fill in description on the recording sheet.

Describe the features of the upper course.

Draw a field sketch or take a photograph and label the main features.



# River Features and Processes on the River East Allen

*Student Resource Sheet 1*

## RIVER RECORDING SHEET

| Results | Site 1<br>*Name:* | Site 2<br>*Name:* | Site 3<br>*Name:* | Site 4<br>*Name:* |
|---|---|---|---|---|
| **Grid reference** | | | | |
| **Width (m)** | | | | |
| **Depth (cm)** | | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| **Wetted perimeter (m)** | | | | |
| **Float velocity (time taken to travel 10m)** | | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

| Results | Site 1<br>*Name:* | Site 2<br>*Name:* | Site 3<br>*Name:* | Site 4<br>*Name:* |
|---|---|---|---|---|
| **Float metre velocity (m/s)** | | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| **Gradient (degrees)** | | | | |
| **Mass of pebble that just moves across board (g)** | | | | |
| **Depth of sediment from suspended load (mm)** | | | | |
| **Length of A-axis (cm)** | | | | |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

| Results | Site 1<br>*Name:* | Site 2<br>*Name:* | Site 3<br>*Name:* | Site 4<br>*Name:* |
|---|---|---|---|---|
| **Bed load shape:** | | | | |
| No. Angular | | | | |
| No. Sub-angular | | | | |
| No. Sub-rounded | | | | |
| No. Rounded | | | | |
| **Site description:** | | | | |
| 1. Size of valley | | | | |
| 2. Steepness of valley | | | | |
| 3. Is the river large or small compared to the valley | | | | |

## Field Sketches

Site 1: _____

Site 1: _____

Site 1: _____

Site 1: _____

# River Features and Processes on the River East Allen

*Student Resource Sheet 2*

## RIVER ANALYSIS SHEET

| | **Site 1** *Name:* | **Site 2** *Name:* | **Site 3** *Name:* | **Site 4** *Name:* |
|---|---|---|---|---|
| **Width (m)** | | | | |
| **Mean depth (m)** (add 10 depth measurements together and divide by 10) | | | | |
| **Cross sectional area (CSA) ($m^2$)** (Width x mean depth) | | | | |
| **Mean float velocity (m/s)** (10 divided by the mean number of seconds) | | | | |
| **Mean flow meter velocity (m/s)** | | | | |
| **Discharge ($m^3/s$)** (CSA x flow meter velocity) | | | | |
| **Wetted perimeter (m)** | | | | |
| **Hydraulic radius - a measure of the efficiency of the stream** (CSA divided by wetted perimeter) | | | | |
| **Gradient (degrees)** | | | | |
| **Mass of pebble (g)** | | | | |
| **Bed load shape** | | | | |
| % Angular | | | | |
| % Sub-angular | | | | |
| % Sub-rounded | | | | |
| % Rounded | | | | |
| **Bed load size** (mean length of A-axis (mm) | | | | |
| **Depth of suspended sediment (mm)** | | | | |