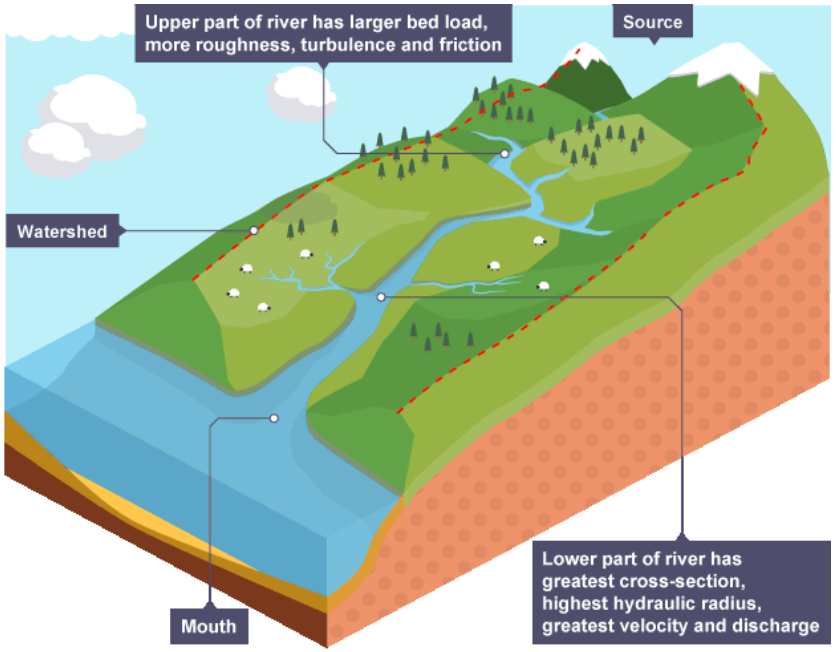
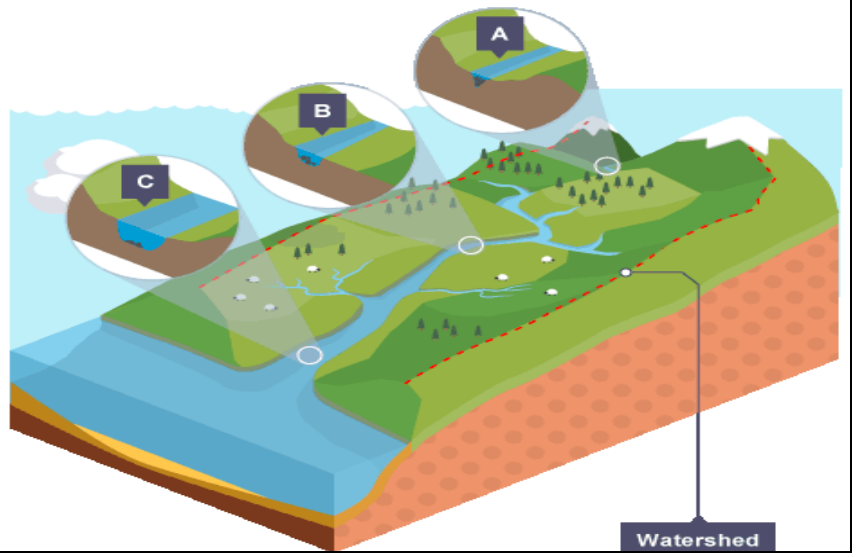
Physical landscapes in the UK: River landscapes of the UK

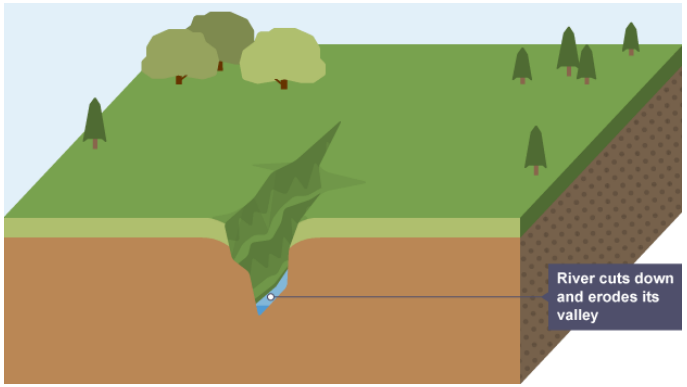
	Covered in class?	☺	😐	☹	Revision undertaken
River landscapes of the UK					
I can define what a river is.					
I can describe the long profile of a river.					
I can describe the cross profile of a river.					
I can name and explain the processes of **erosion**: 1. Hydraulic action. 2. Abrasion. 3. Attrition. 4. Solution.					
I can name and explain the processes of **transportation:** 1. Traction. 2. Saltation. 3. Suspension. 4. Solution.					
I can explain the process of **deposition**:					
I can explain the formation of interlocking spurs.					
I can explain the formation of waterfalls and gorges.					
I can explain the formation of meanders and ox-bow lakes.					
I can explain the formation of levees.					
I can explain the formation of floodplains.					
I can explain the formation of estuaries.					
I can identify the major landforms of erosion and deposition along the River Tees.					
I can state reasons why human factors increase flood risk.					
I can state reasons why physical factors increase flood risk.					
I can explain the costs and benefits of the following hard engineering management strategies: 1. Dams and reservoirs. 2. River straightening. 3. Embankments. 4. Flood relief channels.					
I can explain the costs and benefits of the following soft engineering management strategies: 1. Flood warnings and preparation. 2. Flood plain zoning. 1. Afforestation. 2. River restoration.					
I can explain why the flood management scheme was needed on the River Calder.					
I can explain why the management strategy used on the River Calder.					
I can explain the social effects of the management scheme.					
I can explain the economic effects of the management scheme.					
I can explain the environmental effects of the management scheme.					
I can identify fluvial features of deposition and erosion from photographs and sketches.					

1. What are river processes?	2. What are the features of river erosion and deposition?	3. What is the long-profile and cross-profile of a river?
• A **river** is a large freshwater stream of water flowing in a channel to the sea. • **Erosion:** The wearing away and removal of material by a moving force, such as a river. • **Transportation:** The process by which a river carries its load. • **Deposition:** When a river loses energy and so drops the sediment and rocks (the load) it is carrying. • **Vertical erosion:** Erosion which takes place downwards, deepening the river. • **Lateral erosion:** Erosion which wears away the side of the riverbanks, widening the river. • **Hydraulic action:** The sheer force of the water causing the bed and banks of the river to erode. • **Abrasion:** The process of rocks scraping and wearing away the banks and bed of the river. • **Attrition:** The process of rocks hitting against each other and becoming smaller, smoother and rounder. • **Solution:** The acids in the water cause erosion. • **Traction:** Larger stones and rocks get rolled along the riverbed. • **Saltation:** Small pebbles and rocks are bounced along the riverbed. • **Suspension:** Fine, light particles are carried in the flow of the river. • **Solution:** Minerals dissolved in the river and carried in solution.	**Rivers can be split into 3 distinct sections – upper course, middle course and lower course.** **Upper course = Vertical erosion** is the dominant process and leads to the formation of distinct landforms. • **V-Shaped Valleys:** A narrow, steep-sided valley formed as a result of vertical erosion by a stream or river. • **Interlocking spurs:** ridges of high ground that project into V-shaped valleys. They occur on alternative sides of a valley and interlink like the teeth of a zip fastener. • **Waterfalls:** Occur as water drops from a height when a river or stream flows over a steep drop. **Middle course – lateral erosion and deposition** leads to the formation of distinct landforms. • **Meander:** A bend in the river. • **Ox-bow Lake:** A curved lake formed from a bend in a river where the main stream has cut across the narrow neck and no longer flows around the loop of the bend. **Lower course - deposition** leads to the formation of distinct landforms. • **Floodplains:** The relatively flat areas of land that form the valley floor each side of the river channel, which are sometimes flooded. • **Levees:** Embankments of sediment running along the banks of a river. • **Estuaries:** Tidal mouth of a river where it meets the sea. Wide banks of deposited mud are exposed at low tide.	**Long Profile:**  **Cross-Profile:** 

4. How are erosional landforms formed?

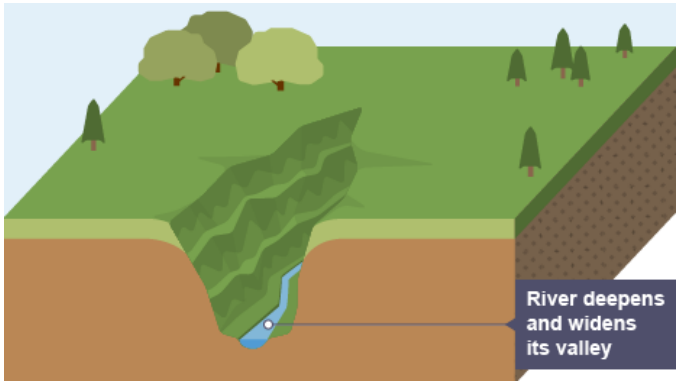
V-Shaped Valleys:

A V-shaped valley is a valley with steep sides and a narrow valley floor.

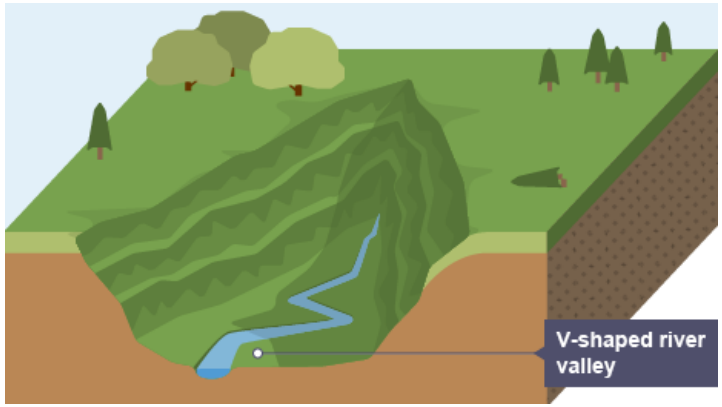


How do V-shaped valleys form?

Firstly, as a river transports its load, erosive processes occur (mainly **hydraulic action** and **abrasion**) and **vertical erosion** takes place. **This** creates steep-sided banks.



Next, because the banks are left unsupported, they eventually collapse.



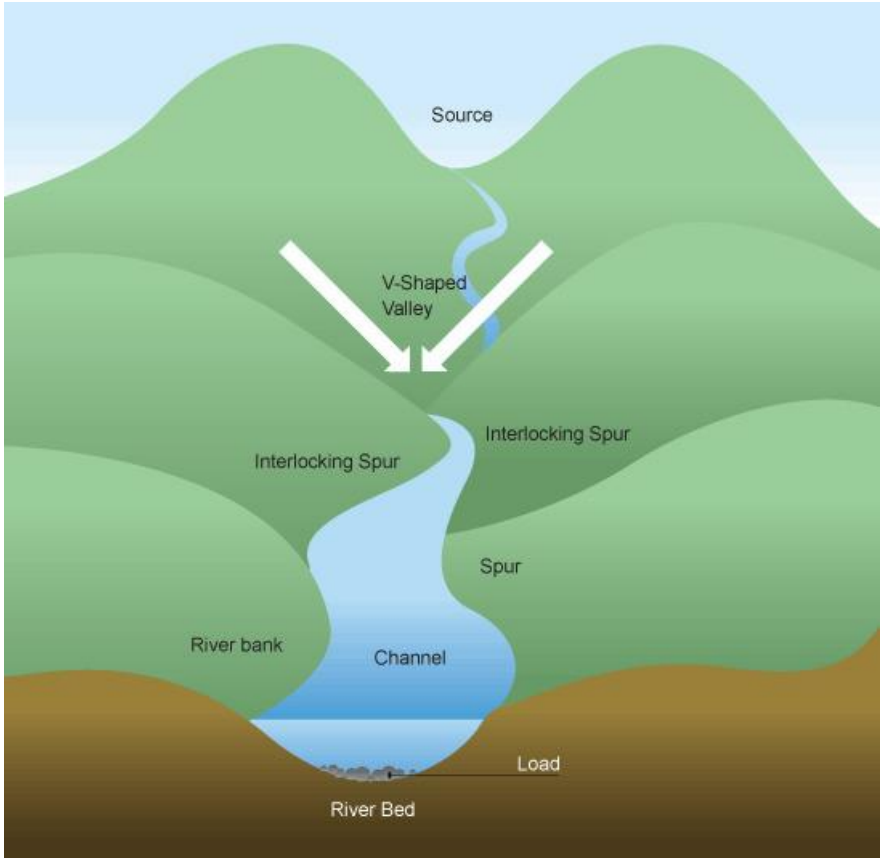
Finally, a valley is left behind which is known as a V-shaped valley.

Interlocking spurs:

An interlocking spur are hard bands of rock sticking out into the river valley.

How do interlocking spurs form?

Firstly, as a river transports its load, **abrasion** and **vertical erosion** takes place on the river bed.
Next, steep banks are formed which lack support and so collapse, leaving behind a V-shaped valley.
Then, the river begins to wind round the high hillsides, eroding the softer rock quicker than the harder rock.
Finally, this causes the hillsides to stick out and interlock, creating interlocking spurs.



5. How are erosional landforms formed?

Waterfalls and gorges

A waterfall is a part of a river where water flows over a vertical drop. A gorge is the narrow valley left behind as a waterfall retreats.

How are waterfalls and gorges formed?

Firstly, in the upper course, a river flows over hard and soft rock.
Then, as soft rock erodes quicker than the hard rock, often by hydraulic action, creating plunge pool which undercuts the hard rock.
Next, the hard rock now overhangs and is left unsupported, so it collapses.
Then, the rocks fall into the plunge pool and act to erode the plunge pool further by abrasion.
Finally, over time, the sequence of processes repeats, and more erosion and undercutting causes further collapse. The waterfall retreats upstream, leaving a **steep-sided gorge**.

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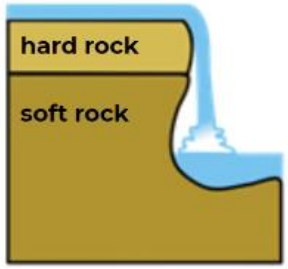

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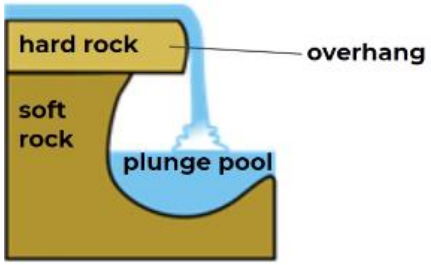

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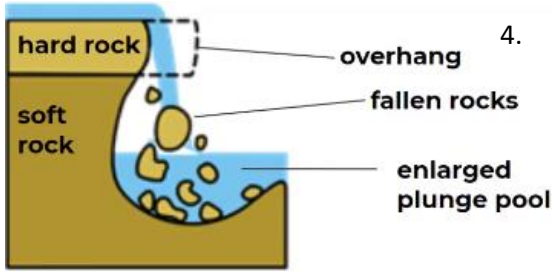

Overhang

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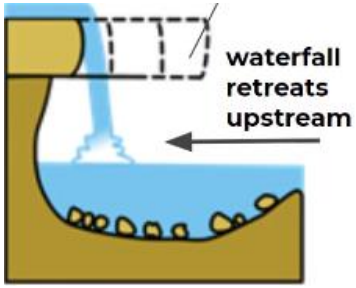


6. How are erosional and depositional landforms formed?

Meanders and Ox-bow lakes

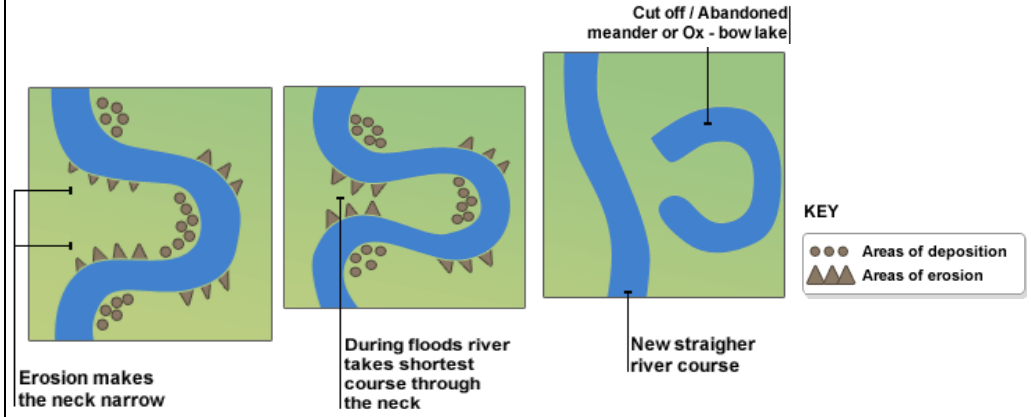
Meanders are bends in a river. An oxbow lake is a curved lake left behind when a river migrates.

How are meanders formed?

Firstly, water flows faster on the outside of the bend, so erosion occurs through processes like abrasion.
Next, a river cliff is created on the outside bend.
Then, velocity is slower on inside bend, so deposition occurs, creating a slip-off slope.
Then, this continues over time, making the meander more sinuous.
Finally, the river migrates across the valley through lateral erosion.

Ox-bow lakes

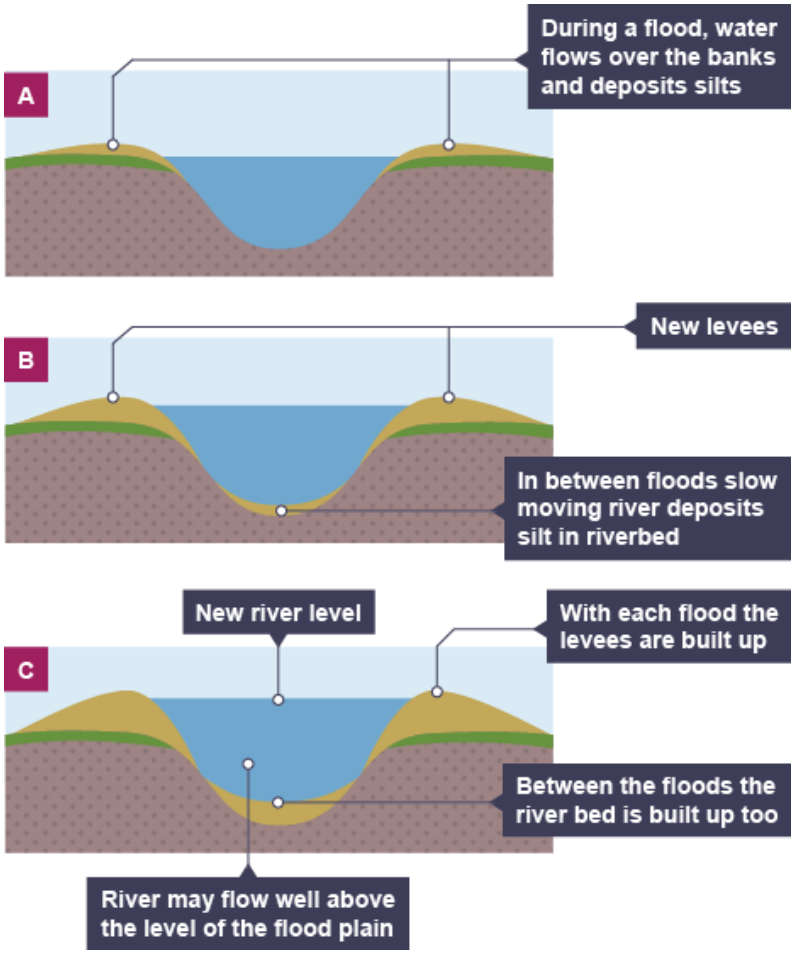
Firstly, the meander loop becomes very large and only a narrow strip of land separates the river channel.
Next, continued lateral erosion causes the neck of the meander to become increasingly narrow.
Then, the river floods so the main water flow cuts straight across the neck of the meander which breaks and a new straighter river channel is created.
Finally, the loop of the meander does not receive river water and deposition cuts off the loop from the new main straighter river channel creating an Ox-bow lake.



7. How are depositional landforms formed?

Levees

A levee is a raised embankment found at side of a river on a flood plain.

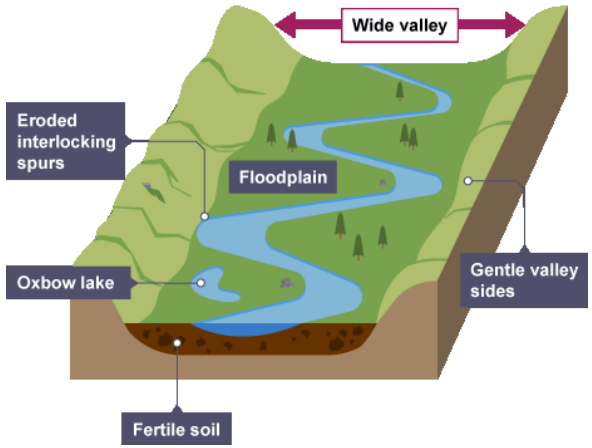


How do levees form?

Firstly, when a river bursts its banks, friction with the land reduces velocity and causes deposition.
Next, heavy sediment is deposited first, closest to the river.
Then, the size of the sediment then becomes progressively smaller with increased distance from the river.
Finally, with each flood, the banks of the river are built up higher.

Floodplains

Due to lateral erosion in the lower course, the river will now have a wide, flat area either side of the river channel.



How are floodplains formed?

Firstly, when the river floods, material (alluvium) being carried by the river is deposited (as the river loses its speed and energy to transport material).
Next, over time, this process continues and the floodplain becomes slightly higher each time as more fertile deposits of alluvium are deposited.
This makes floodplains a good place for agriculture.

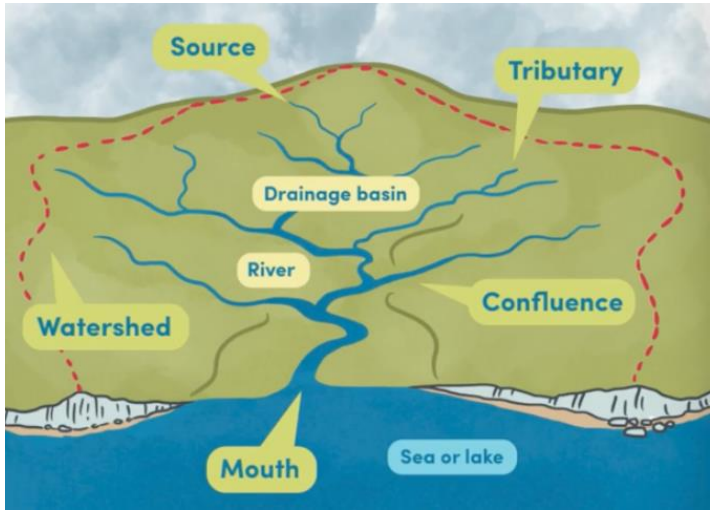
Estuaries

Estuaries are found at the mouth of a river where the water is tidal, so water levels rise and fall.

How do estuaries form?

Firstly, during a high tide, the sea moves up the river, which slows the river and therefore energy is lost meaning sediment is deposited.
Next, at low tide, these deposits are seen where they form mudflats.
Finally, over time, these can develop into mudflats.

8. The features of a river drainage basin



Source: The start of a river, usually in upland areas.

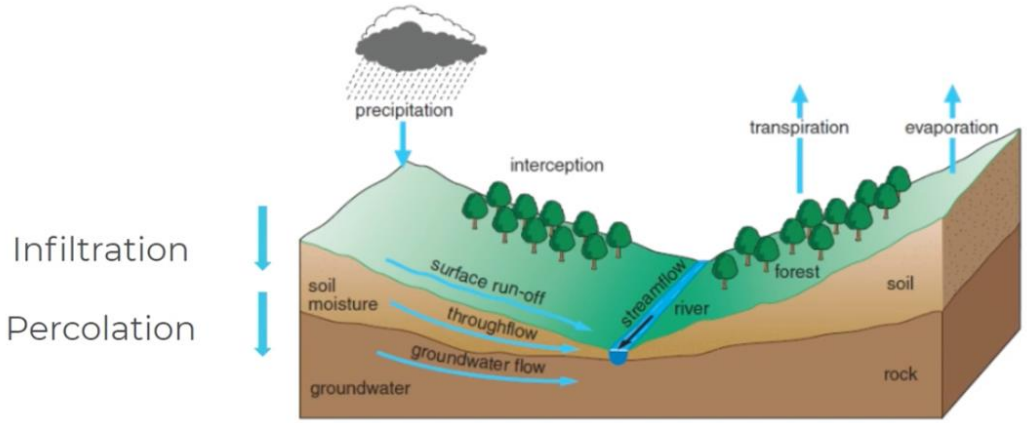
Tributary: A small river which joins a larger one.

Confluence: The point at which two or more rivers meet.

Mouth: Where the river enters the sea or a lake.

Watershed: The invisible line dividing different drainage basins.

9. The drainage basin system



The drainage basin system has **inputs, outputs, stores, flows and a boundary** (The (invisible) dividing line between drainage basins).

Inputs (water in):
Precipitation: Rain, snow, sleet and hail entering the drainage basin.

Outputs (water out):
Transpiration: Evaporation of water from plants.
Evaporation: Water changing state, from a liquid to a gas (water vapour).
River Discharge: The volume of water flowing in a river per second. Flows out of the drainage basin at the mouth.

Stores (water building up):
Soil Moisture: Water stored in the soil.
Interception: When precipitation lands on vegetation. It may drip down and land on the land surface.
Vegetation storage: Water stored in vegetation eg. Inside trees and plants.
Surface Storage: Water stored in a drainage basin on the surface e.g., puddles.
Channel storage: Water stored in the river channel.
Ground Water: Water stored in permeable rock (rocks that allow water to flow through it).

Flows (water moving):
Infiltration: Water seeping from the surface into the soil.
Percolation: Water seeping from the soil into permeable rock.
Streamflow: Water flowing in the river channel.
Surface runoff: Water flowing over the land.
Groundwater flow: Water flowing through permeable rock.
Through flow: Water flowing downhill through soil.

10. Factors that increase flood risk

Flooding occurs when a river bursts its banks and overflows onto the surrounding land. There are many factors which can cause a flood. These are either human or physical factors.

Physical Factors causing flooding

1. Precipitation

A) Prolonged rainfall

If it rains for a long period of time, the soil becomes **saturated** (its holding as much water or moisture as can be absorbed) → This means that more rainfall cannot be absorbed so infiltration is reduced → This increases surface runoff → This increases river discharge → This therefore increases the flood risk.

B) Intense, sudden rainfall

Due to the rainfall happening so suddenly, infiltration does not happen fast enough → This causes surface runoff to increase as infiltration does not take place. → This increases river discharge → This therefore increases flood risk.

2. Geology

Permeable rocks **allow** water to pass through the pores and cracks of the rocks, whereas **impermeable** rocks **do not.**

If the valley is made up of impermeable geology, surface runoff is increased as the water cannot infiltrate or percolate through the rock → This increases the river discharge → This therefore increases the flood risk.

3. Relief

Steep valley sides means infiltration will not happen fast enough, as the water will run off into the river more quickly → This means that surface run off will be increased → This will increase river discharge and therefore increase the flood risk.

- Low-lying flat land can also be at risk of flooding as the gradient is not steep enough to remove the flood water. Infiltration does not take place; surface run-off also decreases and therefore the water is left on the land.

Human Factors causing flooding

1. Urbanisation

When an area surrounding a river is built on, the surfaces and buildings are made from impermeable materials, such as concrete and tarmac → This reduces infiltration as water cannot flow through these materials → This increases surface runoff → This means that river discharge is increased → This therefore means the flood risk is increased.

Drains and sewers which are found in urbanised areas also take water directly to the river which increases flood risk.

2. Deforestation

- Trees and plants intercept precipitation which reduces flood risk as surface runoff is decreased, and therefore so is river discharge.
- However, humans are removing trees (**deforestation**) from the surrounding area of the river which reduces interception, vegetation storage and transpiration → This increases the amount of precipitation that reaches the surface → This means that surface runoff increases → This causes river discharge to increase → Therefore, flood risk increases.

11. What are the engineering strategies to defend the environment against flooding? (Hard engineering)

There are two forms of engineering strategies that are used to defend the environment against natural processes. These are called **hard engineering** and **soft engineering** strategies.

These strategies are needed to protect the environment, to protect homes and businesses and to stop disruption.

Hard engineering strategies:
This includes using **man-made** (artificial) structures to defend against natural processes.
The aim is to control the flow of rivers and reduce flooding (and its impacts).
Each strategy has positives and negatives.

1. Dams and reservoirs
- A dam is a concrete barrier built across a river channel.
- A reservoir is an artificial lake behind the dam.
- River discharge is released from the reservoir, in a controlled way, reducing flood risk.

\+ Hydroelectric power (electricity generated by the movement of water) can be generated as water is released.
\+ Tourism to reservoirs is popular.
\+ Forestry provides jobs and new habitats.
\- Farmland is less fertile downstream.
\- Expensive to build.
\- Floods settlements and land.

2. Channel straightening
- Meanders are removed from the channel.
- The channel is made wider, deeper and straighter.
- This allows river discharge to flow away from the area more quickly, meaning the risk of flooding is reduced.

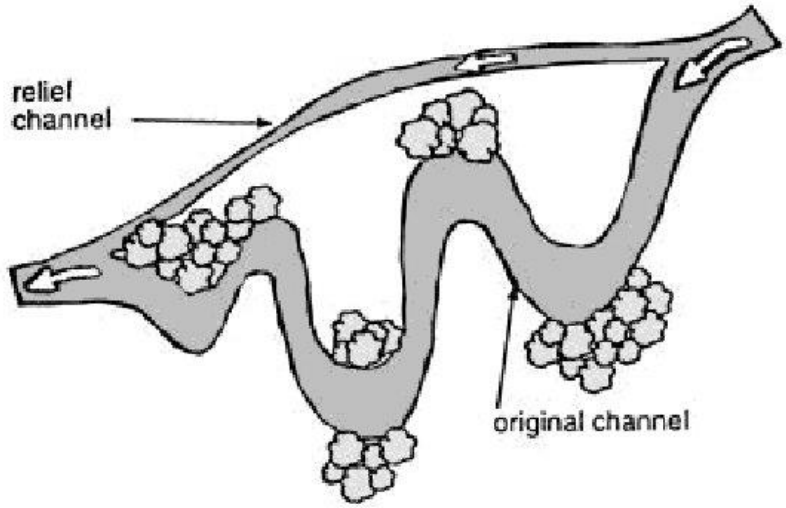
\+ New habitats can be created to make the channel look natural.
\+ Reduction in insurance costs for nearby houses and businesses.
\+ More water can be held in the channel.
\+ It can be used to reduce flood risk in built-up areas.
\+ Improved navigation – boats can use the rivers easier.
\- Flooding and erosion may still happen.
\- Can be expensive.
\- Damage to habitats in order to create the channel.

3. Embankments
- Raising the banks of a river means that it can hold more water.

\+ Cheap with a one-off cost.
\+ Allows for flood water to be contained within the river.
\- Looks unnatural.
\- Water speeds up can increase flood risk downstream.

4. Flood relief channels
- The floodwater flows into the relief channel.
- From here, it is taken either to an area where it can be absorbed or re-enters the river further down its course.

\+ Removes access water from the river channel to reduce flooding.
\- Expensive to build.
\- If water levels continue to rise, the relief channel may also flood.



12. What are the engineering strategies to defend the environment against flooding? (Soft engineering)

Soft engineering strategies:
This includes using **schemes designed to reduce the effects of flooding by working with natural processes and our knowledge of river systems.**

Soft engineering strategies are cheaper, better for the environment and easier to maintain, but not as effective.

1. Flood warnings and preparation

- The Environment Agency will issue flood warnings, based on weather data.
- Warnings are given through the media (newspapers, TV, radio, the internet), which gives people time to prepare for evacuations and movement of possessions, and adding sandbags or flood boards to properties.
- Modifications to buildings can be made prior to a flood event.
- Action plans can be drawn up in advance of a flood, in preparation.

\+ Flood warnings give people extra time to prepare, which reduces the overall effect of the flood + People can move belongings, add sandbags and prepare for evacuations, which will reduce insurance claims.

\+ Issuing warnings is a low-cost way to reduce the effects of flooding.

\+ Issuing warnings makes people feel secure and in control.

\- Flood warnings and preparation does not actually prevent a flood, which leaves homes and businesses at risk.

\- Not everyone has access to the internet to receive the warnings.

\- People do not always act on the warnings issued.

2. Flood plain zoning

- Floodplain zoning is where the land use in a river valley is planned carefully to reduce the effects of flooding.
- High value properties and land use are located furthest away from the river channel; parks and animal grazing are located closest to the river channel.

\+ The risk of a flood is reduced because there are less impermeable surfaces. This means that rainwater will enter the river channel more slowly.

\+ If there are no properties near the river channel, there will be less damage and loss of life if a flood occurs.

\+ There could be an increase in green space.

\- Many urban areas have already built on the 'at risk' zones, and therefore it would not be feasible to change this.

\- There is a housing shortage in the UK and so not being able to build in certain areas would add pressure to this.

\- Building elsewhere may put Greenfield sites at risk of development.

3. Afforestation (planting trees)

- Trees intercept rainfall.
- Trees also undertake transpiration.
- Trees also store water.
- If we plant more trees, less rainwater will reach the river channel.
- This reduces the chance of the river reaching bank full capacity and flooding.

\+ Soil erosion is reduced as tree roots bind the soil. This prevents soil being washed into the river, reducing its capacity.

\+ Increase in natural habitats.

\+ Trees absorb carbon dioxide, helping to mitigate against climate change.

\- Less farmland will be available as the trees will be planted on the land.

\- Trees take time to grow so the impact of the strategy may be delayed.

\- Less land is available for building homes and businesses.

4. River Restoration

- Restoring a river channel back to its natural state, having been managed by hard engineering in the past.
- This allows the floodplain to flood naturally.
- This is designed to reduce flooding downstream, which may have been created by channel straightening.

\+ A restored river requires less maintenance, reducing costs.

\+ New habitats are created, with increased biodiversity.

\+ Tourism to the area may increase, creating jobs and increasing income.

\- Restoring a river can be very expensive.

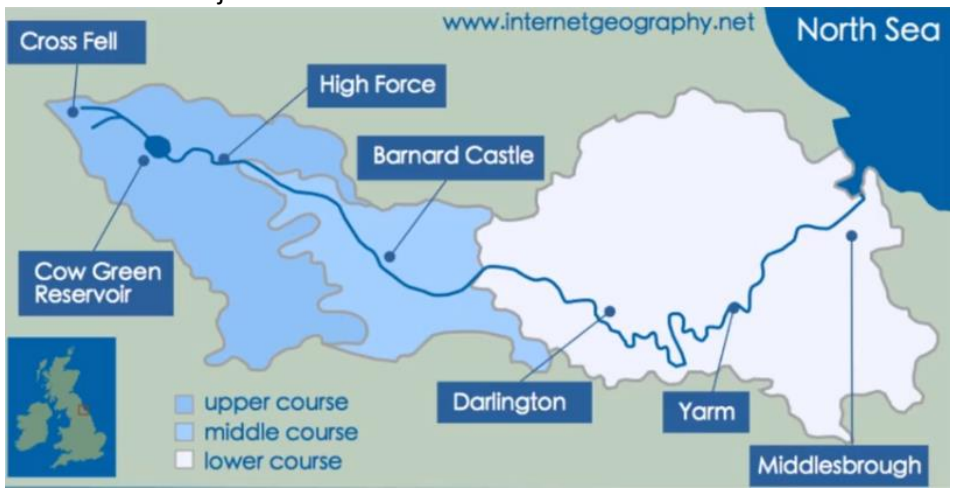
\- There may be an increase in localised flooding, putting some properties at risk.

\- There may be a loss of agricultural land as the river channel naturally meanders.

13. Landform Case Study: The River Tees

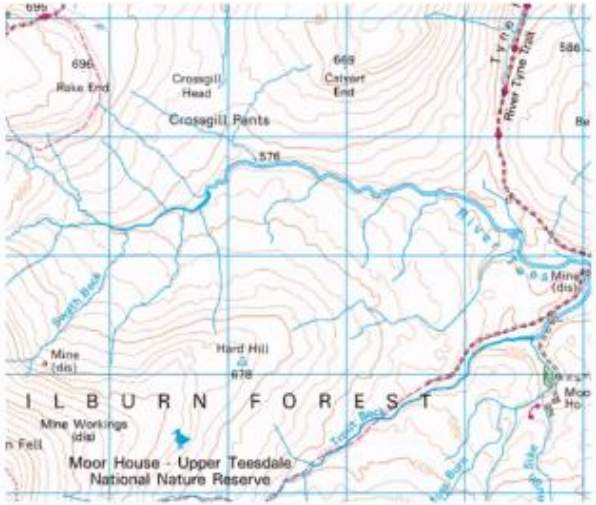
Where is The River Tees?

- The River Tees is located in the **north of England.**
- The source is located in the Pennines at Cross Fell and flows east to its mouth where the river joins the North Sea.



The Upper Course:

- The upper course has hard impermeable rocks. Vertical erosion has formed a V-shaped valley. **High Force** is an example of a **waterfall** found here. It is the UK's largest at 21 metres high. An area of hard rock (Whinstone) is located above a layer of soft rock (sandstone and shale).
- On an OS map:
- Contour lines are very close together which shows the gradient is very steep.
- There are many small tributaries.
- There are V-shaped valleys identified by the contour lines.



The Middle Course:

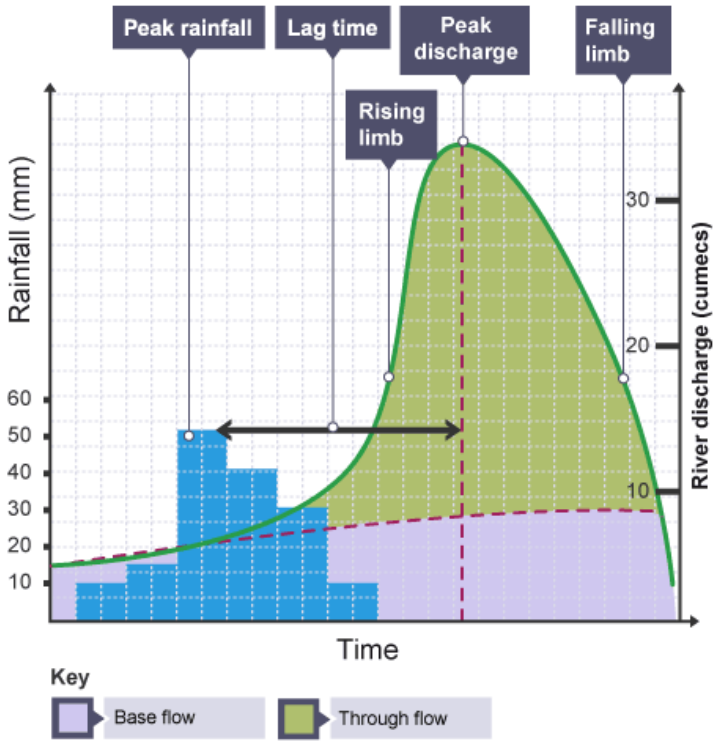
- As the River Tees starts to erode sideways (lateral erosion), **meanders** are formed.
- There can be identified in the middle course of the river **near Barnard Castle**.

The Lower Course:

- **Near Yarm**, the meanders in the lower course are much longer, and **oxbow lakes** have formed.
- There are also **levees** which have formed when the river has flooded.
- The River Tees has a very large estuary with mudflats and sandbanks which support wildlife in the area.

14. What is a hydrograph?

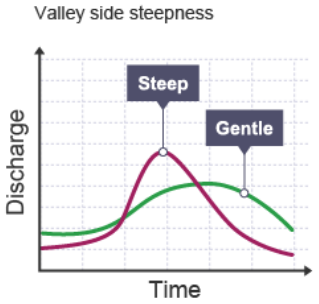
- A **hydrograph** shows how a river responds to a period of rainfall.
- The vertical axis measures rainfall (mm) and discharge (cubic metres per second).
- The horizontal axis measures time (usually hours or days).
- The bars represent rainfall and the line graph shows discharge.
- **Peak rainfall:** The maximum amount of rainfall measures in millimetres (the highest bar).
- **Peak discharge:** The maximum amount of water held in the river channel (the top of the line graph).
- **Lag time:** The time difference between peak rainfall and peak discharge. There is a delay because not all rainfall falls directly into the channel, it will either flow over the surface (**surface runoff**) or underground (**groundwater flow**).
- **Rising limb:** This shows the increasing discharge on the hydrograph; the steeper the line, the faster the rainwater is reaching the river channel.
- **Falling limb:** This shows the return of discharge to normal/base flow on a hydrograph.
- **Base flow:** This is the normal discharge of the river.

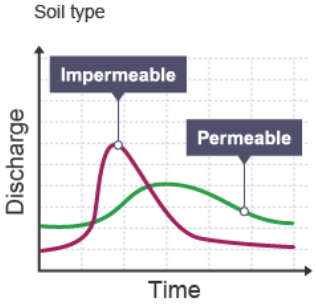


- The lag time on a hydrograph can be short or long dependent on the characteristics of the drainage basin:

1. Relief of the drainage basin:

- Steeper valleys will reduce infiltration and increase surface runoff.
- Rainwater will therefore reach the river channel faster, which **reduces** the **lag time.**
- This will create a **steeper rising limb** and a **higher peak discharge**.





2. Geology of the drainage basin

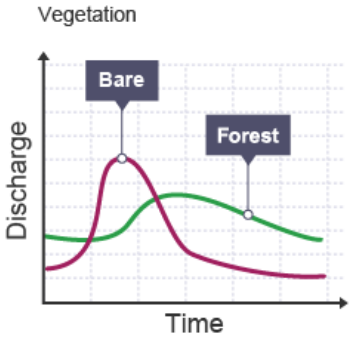
- Impermeable soils and rock will reduce infiltration/percolation and increase surface runoff.
- This means that the rainwater will reach the river channel faster, therefore reducing the lag time.
- This will create a steeper rising limb and a higher peak discharge.

3. Urbanisation of the drainage basin

- Increasing buildings and roads increases impermeable surfaces.
- This means that infiltration will decrease and surface runoff will increase.
- Therefore, rainwater will teach the river channel faster, reducing the lag time.
- This means there will be a steep rising limb and a higher peak discharge.

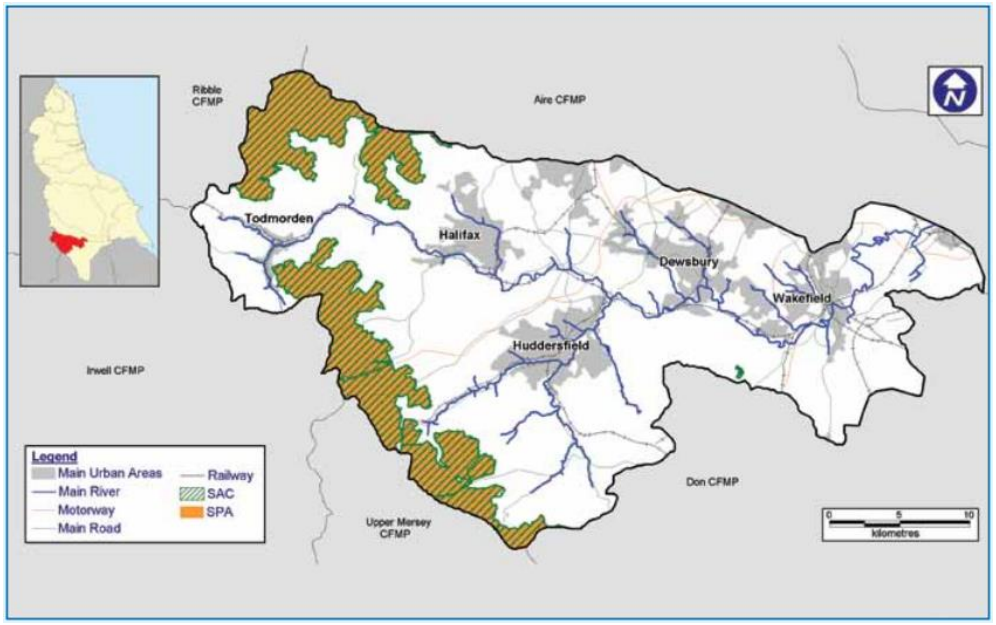
4. Deforestation in the drainage basin

- Removing trees reduces interception and transpiration.
- This means that surface runoff increases as more rainwater reaches the surface.
- This means that rainwater will reach the river channel faster and therefore reducing the lag time.
- This will create a steeper rising limb and a higher peak discharge.



15. Flood Management Scheme: The River Calder

Where is the River Calder?



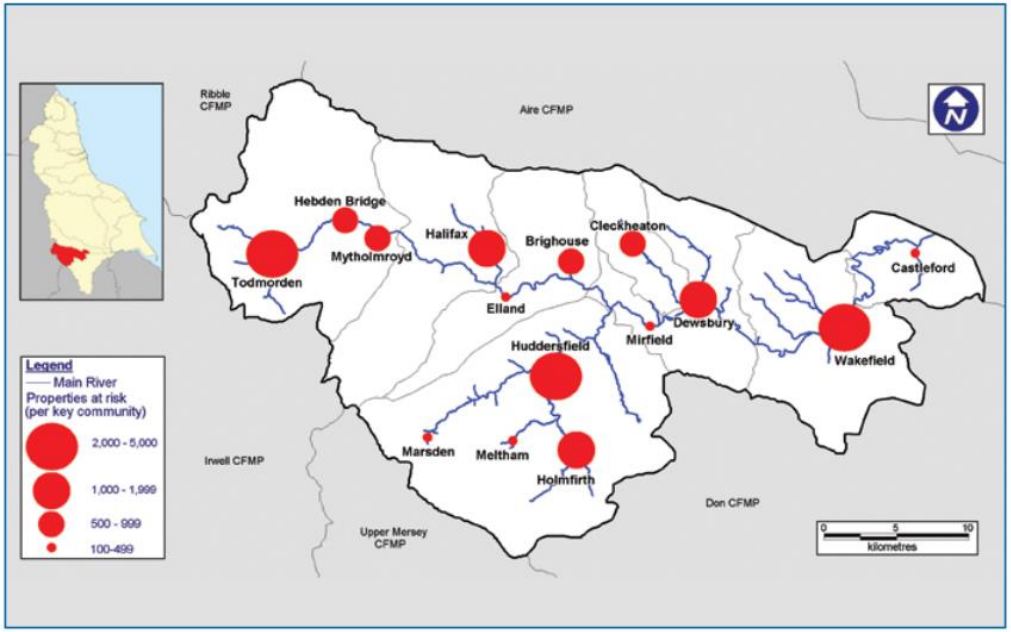
- The River Calder is located in **Calderdale, West Yorkshire.**
- The River Calder flows for **72km** starting at the source from 400 metres above sea level at **Heald Moor near Todmorden**, to its confluence with the **River Aire near Castleford.**
- The upper course of the river is steep with many tributaries.
- The lower course of the river is gentle, and an important agricultural floodplain where the river meanders.

Key Facts about the catchment area:

- There is a long history of flooding.
- Nearly **77,000** people live in this area.
- Major concentrations of population are found in Huddersfield, Dewsbury, Halifax, Todmorden, and Wakefield where there are many important transport routes, hospitals, and emergency services.
- There are also environmentally important sites – the South Pennine Moors have conversation areas for wildlife and Sites of Special Scientific Interest (SSSI).

The current flood risk

- The most damaging floods occurred in **July 2007** when over 1,700 properties were flooded.
- Currently, those living in Hebden Bridge, Elland, Huddersfield, Dewsbury and Wakefield have the highest urban flood risk.
- Almost 21,000 properties have a 1% chance of flooding every year if there were no defences in place (see below):



16. Flood Management Scheme: The River Calder

The protection of Calderdale

- To protect over 1,600 homes and businesses across Calderdale, the government has committed a total of over £50 million for flood defences.

1. Strengthening defences:

- Continued construction of the Mytholmroyd flood alleviation scheme.
- Hebden Bridge flood alleviation scheme.
- Flood reduction schemes in Sowerby Bridge, Halifax, Elland.

2. Natural Flood Management

- Tree planting at Hebden Bridge, peat and heath restoration, creating woodland and construction of leaky dams

3. Maintenance

- Support landowners to understand their roles and responsibilities to maintain watercourses.
- Annual maintenance meetings.
- Community-led channel maintenance.
- River channels being maintained – removal of blockages.

4. Community resilience

- Annual flood emergency day in Calderdale to practice flood plans.
- Increased number of flood warden groups.

5. Existing water assets

- Yorkshire Water reservoirs to provide flood storage areas.
- Investigate changes to the operation of canals to reduce the risk of flooding.

What have they already done?

- Repaired flood defences.
- Cleared all high-risk channel blockages.
- Commenced the clearance of vegetation in the river channel at Mytholmroyd.

To help the local community and wildlife:

- Repair and maintain rights of way to prevent them from flooding and becoming eroded.
- Carry out a programme of tree planting, bog restoration and leaky dams to slow surface runoff, which will in turn reduce river discharge.
- Develop and implement a strategy for managing invasive plant species along watercourses.
- ‘Save some space for a rainy day’ project – work with communities to store and slow water in their gardens.

Preparation for home and business owners:

- Have a flood action plan – know what you would want to move to safety during a flood.
- Check insurance cover.
- Know how to turn off gas, electricity and water mains supplies.
- Prepare a flood kit of essentials and keep it handy.
- Ensuring the 17,500 households are familiar with the flood warning codes and know what they mean.

FLOOD ALERT
FLOODING IS POSSIBLE. BE PREPARED.

FLOOD WARNING
FLOODING IS EXPECTED. IMMEDIATE ACTION REQUIRED.

SEVERE FLOOD WARNING
SEVERE FLOODING. DANGER TO LIFE.