

# NATURAL FLOOD MANAGEMENT MEASURES

A PRACTICAL GUIDE FOR FARMERS





Image © Val Corbett



Funded by:



This guide has been developed to provide simple, clear information on natural flood management measures for landowners and farmers in the North West. The guide has been put together by a group of organisations within the Cumbria Strategic Flood Partnership and Catchment Based Approach Partnerships.

This document is based on the publication 'Natural Flood Management Measures – a practical guide for farmers (2017),' which was specifically requested by the farmers and land managers of the Yorkshire Dales National Park, and compiled by the Yorkshire Dales National Park Authority, Yorkshire Dales Rivers Trust and North Yorkshire County Council, with support from Natural England and the Environment Agency. Sincere thanks go to these partners for giving permissions to reproduce much of their work in this guide.

All information contained in this publication - including links to websites and further reading - is believed to be correct at the time of going to press.



# INTRODUCTION

Flooding is a natural process but it can have devastating consequences for people and property. With climate change science predicting an increase in occurrence and severity of high rainfall events, we need to change the way we think about managing flood risk.

Our modern landscape has been shaped by centuries of human impact and is less able to cope with high rainfall than it once was. Fewer trees, compacted soils and drained wetlands result in more water travelling more quickly to the valley bottoms where straightened river channels funnel water towards towns as fast as possible. When this water reaches towns and is squeezed under bridges and between walls, there is not enough room, especially in areas with development on the natural floodplain. This is when damaging floods occur, putting people and property at risk. The fast-moving water also carries sediment and gravel washed off the hills which gets deposited downstream, often causing issues for infrastructure.

Traditionally, flood defences in the U.K. have included large-scale, hard engineering in and around towns; flood banks and small scale engineering for rural communities and farmland; and coastal engineering. There is increasing interest nationally in how the management of the wider landscape can reduce the risk of flooding to towns and villages by slowing the speed of water coming off the hills and temporarily storing water in areas where it will not cause damage. This is known as Natural Flood Management (NFM). Natural Flood Management techniques can be used alongside more traditional methods to reduce reliance on engineered defences and make our catchments more resilient.

Simple techniques could have a significant effect on reducing flood risk without sacrificing production levels or greatly altering land management practices. These measures can also be beneficial to agricultural businesses by reducing the damaging effects of high rainfall events to farms such as soil loss, track erosion or inundation of buildings.

A number of case studies and research projects have shown Natural Flood Management to be effective when carried out in small catchments above a community at flood risk. A large scale of intervention is required to make a significant difference but it is the combined network, rather than individual features, that provides flood mitigation.



Image © Val Corbett

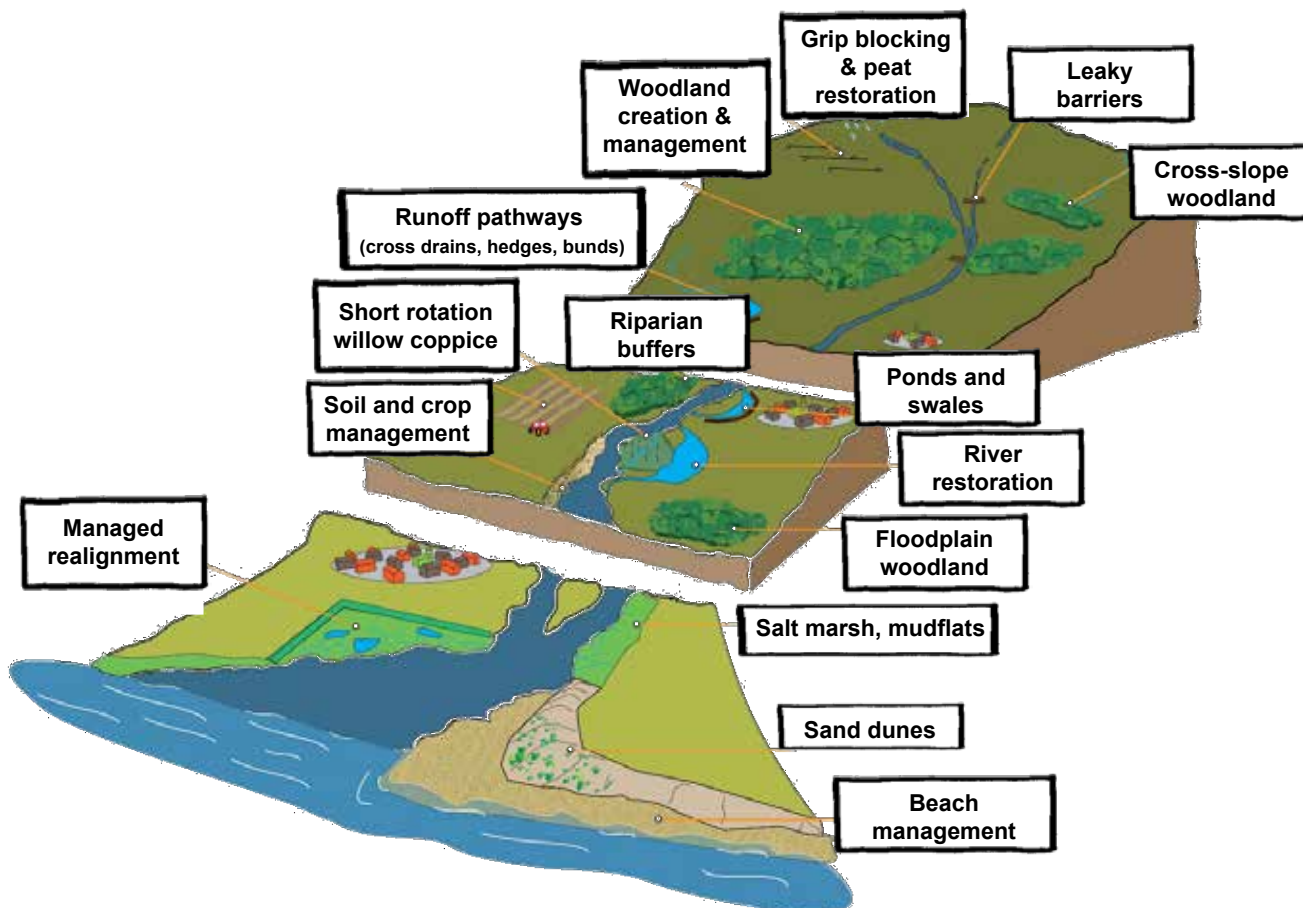
# WHAT IS NATURAL FLOOD MANAGEMENT?

Natural flood management involves implementing measures to restore or mimic natural functions of rivers, floodplains and the wider catchment, to store water in the landscape and slow the rate at which water runs off the landscape into rivers. Natural flood management takes many different forms and different terminology such as 'working with natural processes', green engineering, sustainable land management or runoff attenuation are also used to describe the techniques used.

Every farm will have features that, with some enhancement, could play a role in natural flood management. NFM techniques rely on one, or a combination, of the following underlying mechanisms:

<b>1</b>	<b>Slowing water</b> by increasing resistance to its flow - for example, by planting hedgerows and trees, blocking grips on moorland, installing woody debris dams or creating buffer strips.
<b>2</b>	<b>Storing water</b> by creating and maintaining capacity in bunds, ponds, ditches, swales or floodplains so they fill during rainfall events and empty slowly over 12 to 24 hours.
<b>3</b>	<b>Increasing soil infiltration:</b> Improving soil structure can increase the depth that water is absorbed to, significantly increasing the volume of water that can be stored in the soil. This will make saturation less likely, potentially reducing surface runoff.
<b>4</b>	<b>Intercepting rainfall:</b> Vegetation, especially tree leaves, intercept rainfall so it doesn't reach the ground. Water is then evaporated from the leaves, reducing the volume of flood water. Trees can reduce the amount of water reaching the ground by 25 – 45 % for conifers and 10 – 25 % for broadleaves <sup>1</sup> .

<sup>1</sup> Calder I.R, Reid I., Nisbet T.R. and Green J.C. (2003) Impact of lowland forests in England on water resources: Application of the Hydrological Land Use Change (HYLUC) model. Water Resources Research 39, 1319



Source: Environment Agency 2017

## ADDITIONAL BENEFITS

Natural flood management structures should be designed so that they do not significantly impact on farming and are typically small in size. Many of these measures are likely to provide additional benefits to farm businesses and to the general public.

### Benefits for land managers

- ✓ Reduced flood risk to productive farmland and farm buildings;
- ✓ Improved soil fertility and reductions in soil loss, pesticide and fertiliser runoff;
- ✓ Reduced effects of drought as healthy soils retain water for longer in dry periods;
- ✓ Improved drainage of waterlogged areas preventing prolonged inundation of farmland;
- ✓ Bankside fencing reduces risk of waterborne disease and lameness in stock;
- ✓ Hedges and tree planting can provide shelter and shade for stock;
- ✓ Reduced erosion of tracks and river banks;
- ✓ Reduced need for gravel management;
- ✓ Potential for income generation for the landowner (from commercial woodlands and short rotation willow coppice).

### Benefits for the wider landscape and community:

- ✓ Improved water quality and pollution removal;
- ✓ Improved habitat for wildlife;
- ✓ Economic benefits from higher landscape quality, including tourism and recreation;
- ✓ Some of these measures, such as woodland creation and restoration of blanket bog habitat, absorb carbon from the atmosphere and store it in the landscape, thus contributing to climate regulation.

### The evidence

The Environment Agency have produced an evidence base which summarises current research on the effectiveness of NFM techniques, provides a series of one page summaries and a range of case studies about each technique. This information is available on the Environment Agency's website:

**[www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk](http://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk)**

There is a lot of ongoing monitoring and research of NFM techniques to help us better understand the processes and potential benefits.

# USING THE GUIDE

The implementation of NFM measures can vary in terms of complexity, cost, and the benefits provided. This guide provides advice on the range of NFM measures available and key information for landowners and farmers considering which measures might be appropriate for their land. Information is also provided on the potential sources of grant funding available to help support the work.



Soil aerator. Image © Eden Rivers Trust

## Intervention

The various measures have been grouped into three different levels of intervention:

### LEVEL 1

Measures requiring minimum or no consultation with authorities such as the County Council or Environment Agency. These measures are usually low cost and simple to install, but can still be extremely effective.

### LEVEL 2

Measures requiring a certain level of consultation and possibly consent of authorities (see consents section on page 32). These measures are a mix of low to medium cost and may need contractors' help to install them.

### LEVEL 3

Measures that are targeted to certain locations within the catchment and may require design, planning permission and consents from authorities. In most cases advice from professional water management consultants will be required. These measures are usually high cost and need contractors to install them.

Each measure is described in terms of its flood management effectiveness, its benefit to agricultural businesses, any considerations that are required, and its overall cost. Set-up and maintenance costs have been colour-coded, with the definition provided below. These costs categories are intended to be approximate guidance and are not definitive. Costs will vary depending on the scale of implementation.

## Set-up costs

### LOW

Land manager can implement system with minimal advice, equipment or specialist material.

### MEDIUM

Requires some raw materials, specialist equipment, and/or expert involvement

### HIGH

Requires significant raw materials, specialist equipment, or expert involvement

## Maintenance costs

### LOW

Mostly involves routine inspections and low-grade management, which can be undertaken by the land manager.

### MEDIUM

Expert advice or equipment required to be brought in occasionally (e.g. ~ 10 yrs)

### HIGH

Expert advice or equipment required to be brought in frequently (e.g. < 5 yrs)

## HELP US KEEP TRACK

Please keep us updated. If you choose to implement a Natural Flood Management technique on your land, please contact your local Rivers Trust and let them know:

- which intervention was implemented;
- the location, size and number of interventions implemented; and
- the date of construction.

This will help us monitor the use of Natural Flood Management in our area, and enable us to evaluate their success. See page 33 for Rivers Trust contact details.



# SOIL MANAGEMENT





Loweswater farmer group discussing their shared sward lifter equipment during a demonstration event. Image © West Cumbria Rivers Trust









Soil compaction is when soil is squashed into an impermeable layer. This can occur due to high livestock densities and the movement of farm machinery, with certain soil types being more susceptible to compaction. Soil compaction often occurs around gateways and water troughs due to frequent use.

Soil compaction reduces the amount of water that can infiltrate into the soil, increasing the rate and volume of water flowing across the surface. Runoff from compacted soils is 50-60% higher than on aerated healthy soils (Agriculture and Horticulture Development Board, 2016).

Soil compaction can be detrimental to grass and root growth, reducing the ability of grass to pick up nutrients and water from the soil. It creates conditions for waterlogging and poaching and increases the risk of soil and nutrient loss through runoff.

Reducing the compaction of soils by aerating, subsoiling or sward lifting can help to alleviate flooding and improving land drainage.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Managing soil compaction is one of the most effective techniques farmers can use to reduce overland flow.</li> <li>■ It can help to increase the amount of water held in the soil over a wide area.</li> <li>■ It improves connectivity with groundwater by promoting strong root growth.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Improved movement of air and nutrients through the soil profile.</li> <li>■ Promotes strong root growth and more efficient crop growth. Improved fertiliser uptake so less fertiliser input needed.</li> <li>■ Reduced soil loss and poaching.</li> <li>■ Increased number of available grazing days (waterlogged soils stay colder for longer).</li> <li>■ Enhanced heat and drought stress tolerance.</li> <li>■ Easier access through reduction of waterlogged, muddy areas.</li> <li>■ Improved water quality by reducing runoff and soil loss into streams.</li> </ul>

<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ Look out for signs of waterlogging including water pooling on the surface, slimy topsoils and algae growth, boggy soils and yellowing of crops and pasture.</li> <li>■ Dig a hole up to 40 cm deep to look at soil condition and depth of compaction in topsoil and subsoil.</li> <li>■ Undertake soil tests to identify pH – add lime if pH is below 6. This encourages separation of soil particles from one another, creating air pockets.</li> <li>■ Mechanically aerate soils using spiked aerators, subsoiler or sward lifter, depending on depth of compaction.</li> <li>■ Managing crop and livestock rotation can be ways of reducing compaction, while also improving soil fertility and yield.</li> <li>■ Avoid using heavy machinery on wet soils to further protect from compaction.</li> <li>■ Consider re-seeding or overseeding using deep rooting plant species – for example, festulolium and clovers for grassland.</li> </ul>				
<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Sub-surface and surface historic features can be damaged by mechanical treatment – particularly where these operations have not been carried out before.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="background-color: #4CAF50; color: white; padding: 5px; text-align: center;"><b>LOW</b></p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Any field below the moorland line, particularly where water is seen to flow across the surface in high rainfall events</li> <li>■ Fields used for winter grazing.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">SET UP</td> <td style="background-color: #4CAF50; color: white; padding: 5px; text-align: center;"><b>LOW</b></td> </tr> <tr> <td style="padding: 5px;">MAINTENANCE</td> <td style="background-color: #4CAF50; color: white; padding: 5px; text-align: center;"><b>LOW</b></td> </tr> </table>	SET UP	<b>LOW</b>	MAINTENANCE	<b>LOW</b>
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<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Contact your local Rivers Trust who may be able to assist with contractor costs or machinery.</li> <li>■ Countryside Stewardship contains a range of options to reduce soil compaction. Contact Natural England for advice.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consents will generally not be required for work to reduce soil compaction. Use of sward lifters and subsoilers requires consultation with County Council or National Park historic environment teams.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/equipment-to-disrupt-tramlines-in-arable-areas-rp31">www.gov.uk/countryside-stewardship-grants/equipment-to-disrupt-tramlines-in-arable-areas-rp31</a>              (only available under higher tier).              Soil management  <a href="http://www.ahdb.org.uk/greatsoils">www.ahdb.org.uk/greatsoils</a>  <a href="http://www.gov.uk/guidance/soil-management-standards-for-farmers">www.gov.uk/guidance/soil-management-standards-for-farmers</a>  <a href="http://www.nfuonline.com/cross-sector/environment/soil/assessing-and-addressing-soil-compaction">www.nfuonline.com/cross-sector/environment/soil/assessing-and-addressing-soil-compaction</a></p>				




# WINTER COVER CROPS










Inter row sowing of grass in maize to help slow the flow and keep soil in place over winter. © Natural England.

Winter cover crops are non-cash crops grown on land that would otherwise be left bare over the winter.

Cover crops protect and improve the soil in between periods of regular crop production. Cover crops reduce winter runoff and soil loss whilst improving soil quality.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>Winter cover crops help to reduce overland flow by increasing infiltration.</li> <li>They slow runoff by increasing land roughness</li> <li>Reduced runoff results in less soil and sediment entering watercourses.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>Prevents soil erosion and reduces nutrient losses via runoff and leaching.</li> <li>Careful choice of cover crops can help fix nitrogen in the soil and thereby reduce fertiliser costs.</li> <li>Using deep rooting plants consistently over the years will improve the soil structure and nutrient content, thereby enhancing soil health and improving crop yields.</li> <li>Reduces the need for herbicides and other pesticides.</li> <li>Conserves soil moisture reducing the effects of drought.</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>Sow any plant that has the ability to grow throughout the winter. You can use phacelia, vetch, ryegrass, grazing rye, barley and mustard, or a mix of these depending on local conditions and needs.</li> <li>Leaving crop residues throughout winter can also act to protect the soil surface and increase infiltration.</li> <li>Do not destroy until immediately before establishment of following spring crop.</li> </ul>

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>Using cover crops may require altering the arable rotation away from winter drilling towards spring.</li> <li>Cover crops can be used repeatedly as part of an arable rotation's long-term strategy.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p><b>LOW</b></p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>Works well on arable or temporary grassland adjacent to watercourses, particularly on sloping fields.</li> <li>Where water is seen to flow across the surface in high rainfall events.</li> <li>Land vulnerable to nitrate leaching.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td><b>LOW</b></td> </tr> <tr> <td>MAINTENANCE</td> <td><b>LOW</b></td> </tr> </table>	SET UP	<b>LOW</b>	MAINTENANCE	<b>LOW</b>
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<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>Certain types of cover crop can be funded through the Countryside Stewardship scheme for mid and higher tier providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>Consents are unlikely to be required for work to establish cover crops.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship:  <a href="http://www.gov.uk/countryside-stewardship-grants/winter-cover-crops-sw6">www.gov.uk/countryside-stewardship-grants/winter-cover-crops-sw6</a>          Basic Payment Scheme (BPS) guidelines:  <a href="http://www.gov.uk/guidance/bps-2018">www.gov.uk/guidance/bps-2018</a></p> <p><b>COVER CROPS</b></p> <ul style="list-style-type: none"> <li><a href="http://www.cfeonline.org.uk/5-winter-cover-crops">www.cfeonline.org.uk/5-winter-cover-crops</a></li> <li><a href="https://cereals.ahdb.org.uk/media/655816/is41-opportunities-for-cover-crops-in-conventional-arable-rotations.pdf">https://cereals.ahdb.org.uk/media/655816/is41-opportunities-for-cover-crops-in-conventional-arable-rotations.pdf</a></li> </ul>				






# CROSS DRAINS IN FARM TRACKS










Cross drain to divert run-off from a farm track. © West Cumbria Rivers Trust.

Tracks provide a significant transport pathway for water and sediment. This creates problems with erosion of the track and deposition of sediment on farmland, roads or in watercourses. Tracks are costly to repair but are essential to the farm.

A cross drain is a system to collect runoff and divert water off a track or path. If the water carries a lot of sediment it should be diverted into a sediment trap for the sediment to settle out. Otherwise water can be diverted into areas of vegetation which will slow down the flow and allow infiltration.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Cross drains divert the main pathway of water, reducing the volume and velocity of runoff.</li> <li>■ Reduced soil and sediment entering watercourses, particularly when used with a sediment trap.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Farm tracks suffer from less erosion.</li> <li>■ Sediment caught in traps can be re-used on the track, saving time and money.</li> <li>■ Cross drains potentially reduce water issues at the end of the track and can prevent sediment being washed onto grassland.</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ The size of the cross drain will depend on local conditions. Small drains are typically d0.1 x w0.1 m, constructed of concrete, wood, metal or clay pipe. For heavy rainfall, d0.2 x w0.2m drains will be more effective.</li> </ul>

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Works on steep slopes or where runoff volume is high, a number of cross drains will be required, located at specific intervals along the track.</li> <li>■ They can be linked with swales and sediment traps alongside the track to encourage sediment to drop out of the water. This also prevents sediment being washed onto grassland.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p><b>LOW</b></p> <p>Cross drains should be inspected, cleaned out, or reshaped to original capacity after each major storm.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Tracks on steep hillsides, adjacent to yards or roads, or within close proximity of a watercourse.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td><b>LOW</b></td> </tr> <tr> <td>MAINTENANCE</td> <td><b>LOW</b></td> </tr> </table>	SET UP	<b>LOW</b>	MAINTENANCE	<b>LOW</b>
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<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Cross drains can be funded through the Countryside Stewardship scheme for mid and higher tier providing the land is eligible.</li> <li>■ Local Rivers Trusts in their project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ If work to a track is within 8 m of main river or on the floodplain of a main river the work must be registered with the Environment Agency as an exemption. This is free of charge. Consents are not required for works close to an ordinary watercourse (see Consents and Permissions section to check whether this applies).</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Contact your local Natural England Catchment Sensitive Farming Officer for advice.  <a href="http://www.gov.uk/countryside-stewardship-grants/cross-drains-rp5">www.gov.uk/countryside-stewardship-grants/cross-drains-rp5</a></p>				

# CREATING BUFFER STRIPS AND RIPARIAN TREE PLANTING



Bankside fencing and tree planting on Cam beck, River Ribble. © Woodland Trust.

Creating strips of vegetation within a field can provide a physical barrier that slows the flow of overland runoff, increases infiltration and prevents soil, sediment and nutrient loss from fields. Riparian buffer strips are next to watercourses whereas in-field buffer strips are found adjacent to field boundaries and across fields.

Buffer strips can contain long grasses, trees and shrubs. This vegetation increases the surface 'roughness' and slows down runoff.

Buffer strips often require fencing to prevent livestock from accessing both the buffer strip and the watercourse itself. Alternative drinking sources, such as gravity fed drinking troughs, solar pumps or pasture pumps can be used in combination with buffer strips to provide livestock with access to water.

## NATURAL FLOOD MANAGEMENT PURPOSE



- Vegetation in the buffer strip increases the roughness of the land surface, which slows runoff.
- Vegetation increases and rainfall interception.
- Reduce loss of soil and sediment into watercourses.
- Bankside trees stabilise the banks of watercourses, helping prevent erosion and siltation from bank material.
- Bankside trees shade rivers, keeping them cool for aquatic wildlife and more resilient to climate change.

## AGRICULTURAL BENEFITS









- Stabilise the banks of watercourses reducing erosion.
- Reduce frequency of ditch management through decreased rates of siltation and weed development.
- Enhance crop management operations by straightening irregular field edges.
- Provide habitat for beneficial insects including pollinators and predators of pests.
- Reduce effects of spray drift.
- Provide shelter and shade for livestock.
- Reduce risk of livestock acquiring waterborne diseases.
- Buffer strips trap and filter runoff, preventing loss of fertilisers, sediment and pesticides to watercourses, helping to meet cross compliance rules.
- Evidence suggests that the increase in soil moisture and climatic control provided by buffer strips aids in field grass growth.


## METHODS



- Riparian buffer strips should be a minimum of 6 m wide for maximum effect, and may require fencing to exclude livestock from the river banks.
- The in-field buffer strips should be at least 2m wide. By building a small mound along the in-field buffer strip, a beetle bank can be created, further benefiting the wildlife and encouraging natural predators of crop-eating insects.
- Planting native tree species within the buffer strip increases benefits for NFM and wildlife. Avoid planting tall growing species; shrubs such as hawthorn and hazel interspersed with alder, willow and birch would be more beneficial for slowing runoff and stabilising riverbanks.
- Maintenance of field buffer strips will depend on the land use, but fertilisers and manures should not be used.

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ If the strip is to be fenced from grazing, with the fence line more than 3 m from the middle of the river, there may be reductions in eligible land area under the Basic Rural Payments Scheme and/or implications for field boundary changes.</li> <li>■ Fencing of watercourses may require installation of alternative water access for livestock (such as gravity fed drinking troughs, solar pumps or pasture pumps) and can impact livestock movements through fields.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p><b>LOW</b></p> <p>Dependent on need for replacement/repair of fencing after flood events. To minimise this, fences in flood prone areas should be in 50 m sections and line wire where possible.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Throughout the catchment, adjacent to rivers, and especially on grazed land next to streams and ditches that suffer from high sediment loads.</li> <li>■ In-field strips on arable land at risk from soil erosion. This option works well alongside other run-off incepting options, such as contour bunds and hedgerows.</li> </ul>				
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<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Countryside Stewardship scheme contains a range of buffer strip, grass margin, and riparian management strip options for mid and higher tier providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> <li>■ Local Rivers Trusts may assist with riparian fencing cost in their project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consents are unlikely to be required for work to establish buffer strips.</li> <li>■ Fencing can be erected alongside a river without an environmental permit providing that the fencing is post and rail or post and wire. If wire is used it must be strands or at least 100 mm spaced mesh.</li> </ul>				

**ADDITIONAL INFORMATION**



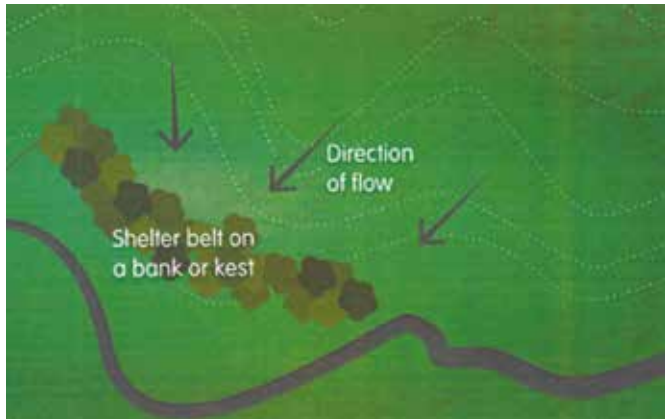
Countryside Stewardship:  
[www.gov.uk/countryside-stewardship-grants](http://www.gov.uk/countryside-stewardship-grants)  
 Basic Payment Scheme (BPS)  
[www.gov.uk/government/collections/basic-payment-scheme](http://www.gov.uk/government/collections/basic-payment-scheme)  
 Grass buffer strips and beetle banks  
[www.cfeonline.org.uk/1-grass-buffer-strips-next-to-a-watercourse-or-pond](http://www.cfeonline.org.uk/1-grass-buffer-strips-next-to-a-watercourse-or-pond)  
[www.swarmhub.co.uk/index.php?dlrid=3991](http://www.swarmhub.co.uk/index.php?dlrid=3991)  
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[www.rspb.org.uk/Images/Beetle%20banks\\_tcm9-133200.pdf](http://www.rspb.org.uk/Images/Beetle%20banks_tcm9-133200.pdf)



Riparian fencing and tree planting on the River Ehen in West Cumbria © West Cumbria Rivers Trust



# CROSS SLOPE TREE PLANTING




Cross slope planting and shelter belts to slow the flow, reduce runoff and aid soil infiltration. © Forestry Commission

Planting trees within farmland can be beneficial for reducing flood risk, for wildlife and for the farm business. Tree planting doesn't have to mean taking land out of production, even small scale tree planting can be beneficial when well-sited. Cross slope planting and riparian planting are particularly beneficial.




Trees reduce flood risk by: intercepting rainfall (catching rain water on their leaves from which it then evaporates); increasing surface roughness which slows overland runoff; and increasing infiltration rates via their roots. Trees planted along contours across a slope intercept the flow of water as it runs downhill and increase infiltration, storing water and nutrients in the soil.

They have a wide range of other benefits including stabilising river banks, providing shelter for livestock, reducing soil loss and increasing wildlife habitat.

**NATURAL FLOOD MANAGEMENT PURPOSE**



- Trees increase surface roughness, slowing overland flows.
- Reduce volume of runoff by promoting rainfall infiltration into the soil. Woodland soils typically have a relatively open, organic rich upper layer, which facilitates the rapid entry and storage of rain water – a 'sponge' effect.
- Interception can reduce the amount of rainfall reaching the ground by as much as 45 %<sup>1</sup>.
- The roots of bankside trees and associated vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.

<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Trees create areas of shelter and shade for livestock.</li> <li>■ Trees trap and filter runoff, preventing loss of fertilisers, sediment and pesticides to watercourses, helping to meet cross compliance rules.</li> <li>■ Evidence suggests that the increase in soil moisture and climatic control provided by buffer strips aids in field grass growth and prolongs the grass growing season.</li> <li>■ Reducing soil erosion by protecting soil and crops from the full impacts of strong winds and rain.</li> <li>■ Planting trees can increase the potential for game shooting on farmland.</li> </ul>				
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ Cross slope planting should be along contours in areas with high overland runoff.</li> <li>■ Mixed woodland with a range of species including a significant conifer component offer the greatest natural flood management benefits.</li> </ul>				
<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Woodlands should be fenced from livestock to encourage growth of trees and vegetation under the canopy.</li> <li>■ Potential change in eligibility for Basic Payment Scheme.</li> <li>■ Trees need maintenance in at least the first three years to ensure establishment.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p><b>MEDIUM</b></p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Across a slope following a contour.</li> <li>■ Increasing existing gill woodlands, plantations and shelter belts.</li> <li>■ Alongside watercourses.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1" style="width: 100%;"> <tr> <td style="width: 30%;">SET UP</td> <td style="text-align: center;"><b>MEDIUM</b></td> </tr> <tr> <td>MAINTENANCE</td> <td style="text-align: center;"><b>LOW</b></td> </tr> </table>	SET UP	<b>MEDIUM</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>MEDIUM</b>				
MAINTENANCE	<b>LOW</b>				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Woodland Trust can help with on the ground advice, tree procurement and some small scale provision of grant funded materials.</li> <li>■ Local Rivers Trusts in certain project areas</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consents are unlikely to be required for small scale tree planting.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Woodland locations and forestry standards  <a href="http://www.forestry.gov.uk/ukfs">www.forestry.gov.uk/ukfs</a>                  Basic Payment Scheme (BPS)  <a href="http://www.gov.uk/government/collections/basic-payment-scheme">www.gov.uk/government/collections/basic-payment-scheme</a></p>				




# MANAGEMENT OF EXISTING WOODLANDS AND UNDERSTORY PLANTING










Woodrush planting to create understory in an existing woodland on the River Irt, West Cumbria. © West Cumbria Rivers Trust

Appropriate management of existing woodlands can enhance the benefits they deliver for both flood management and biodiversity.

Woodlands managed for a variety of ages, sizes and types of trees, with a dense understory of both ground cover and shrubs below the tree canopy, will have the greatest potential for slowing overland runoff and increasing infiltration and interception.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Understory of small trees and shrubs in existing woodland increases the surface roughness and slows overland runoff.</li> <li>■ Reduces the volume of runoff by intercepting rainfall and promoting infiltration into the soil.</li> <li>■ The roots of vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Understory planting increases the flood mitigation potential of woodland without extending the area of the woodland.</li> <li>■ Roots stabilise and strengthen the soil.</li> <li>■ Reduces runoff preventing loss of fertilisers, sediment and pesticides.</li> <li>■ Provides habitat for terrestrial wildlife.</li> <li>■ In poor weather, stock can use the woodland margin for shelter.</li> <li>■ Coppicing can provide firewood.</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ Coppicing stimulates growth of the trees and allows more light through, enhancing understory growth.</li> <li>■ Fencing off woodlands to exclude livestock access can allow natural regeneration of understory plants.</li> <li>■ Plant native species such as holly, blackthorn, hazel, hawthorn or woodrush.</li> </ul>

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Loss of open space in the woodland.</li> <li>■ Potential loss of grazing land if livestock are excluded.</li> <li>■ This technique is particularly beneficial where plantations are likely to need clear felling at some point in their management cycle. Establishing continuous cover means forest soils are less likely to be exposed after forestry operations and reduces soil erosion.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="text-align: center;"><b>MEDIUM</b></p> <p>Trees need some maintenance in at least the first three years after planting to ensure establishment.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Throughout catchment in existing woodland, especially along known overland flow pathways.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td style="background-color: #4CAF50; color: white;">LOW</td> </tr> <tr> <td>MAINTENANCE</td> <td style="background-color: #4CAF50; color: white;">LOW</td> </tr> </table>	SET UP	LOW	MAINTENANCE	LOW
SET UP	LOW				
MAINTENANCE	LOW				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Woodland Trust can help with on the ground advice, tree procurement and some small scale provision of grant funded materials.</li> <li>■ Cumbria Woodlands are managing funds provided by United Utilities to support the establishment of new woodlands and hedges in the Derwent Catchment.</li> <li>■ Local Rivers Trusts in certain project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consents are unlikely to be required for managing existing woodlands.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Managing woodlands &amp; forestry standards <a href="http://www.forestry.gov.uk/pdf/so-you-own-a-woodland.pdf/\$FILE/so-you-own-a-woodland.pdf">www.forestry.gov.uk/pdf/so-you-own-a-woodland.pdf/\$FILE/so-you-own-a-woodland.pdf</a>  <a href="http://www.forestry.gov.uk/ukfs">www.forestry.gov.uk/ukfs</a></p>				

# PLANTING AND MANAGING HEDGEROWS



Cross slope kested hedge planting in the River Eden catchment, near Carlisle. © Woodland Trust.

Hedgerows are an intrinsic part of the landscape and in many places owe their existence to the need to divide grassland into conveniently-sized grazing pastures for livestock.

Hedgerows provide excellent natural weather barriers and habitat for wildlife, but also perform a natural flood management function by intercepting rainfall, slowing overland runoff and increasing infiltration. Planting hedgerows on small embankments, known as kested hedgerows, can improve the growth of the hedge and enhance the NFM and water quality benefit by intercepting and temporarily storing overland flow.

These benefits can be achieved by planting new hedgerows across slopes, or restoring old hedgerow boundaries still evident in the landscape.

## NATURAL FLOOD MANAGEMENT PURPOSE



- Hedgerows reduce the volume of runoff by intercepting rainfall and promoting infiltration into the soil.
- Kested hedgerows can intercept surface runoff, temporarily storing flood water and increasing infiltration.
- Hedgerows trap sediment, reducing the amount of sediment and diffuse pollution reaching watercourses.

## AGRICULTURAL BENEFITS



- Hedgerows create areas of shelter and shade for livestock. In poor weather stock will use the hedge margin for shelter and evidence suggests a lower lamb mortality can result<sup>2</sup>.
- Hedges trap and filter runoff, preventing loss of fertilisers, sediment and pesticides to watercourses, helping to meet cross compliance rules.
- Reducing soil erosion by protecting soil and crops from the full impacts of strong winds and rain.
- Increased leaf litter improves soil quality.
- Can prevent animal to animal contact, reducing the spread of disease.
- Provide habitat for farmland birds and beneficial insects.



<sup>2</sup> Jones. P. (2016) Bangor University [www.agricology.co.uk/field/blog/how-can-two-sheep-shape-future-your-farm](http://www.agricology.co.uk/field/blog/how-can-two-sheep-shape-future-your-farm)

## METHODS



- Prepare the ground along a 1.5m wide strip to provide good soil conditions and as little competition from other vegetation as possible.
- Plant a double staggered row hedge using 6 plants per metre.
- Up to 75% of the species can be thorns – for example, hawthorn and blackthorn.
- Consider a mix of shrub species, including hazel, geulder rose, rowan and holly, to enhance the hedgerow for wildlife.
- Add in an oak, lime, aspen or alder every 10 m to grow out into a single landscape tree for additional future shade and shelter. Use a 1.2 m guard to protect the standard tree as it grows.
- Fence off the plants, keeping fences far enough away so the hedgerow can grow at least 2 m in width. Rabbit netting may be needed, either on its own or with stock fencing, if there is a known problem with rabbits or hares.
- Remove individual guards and tree shelters once the plants are established.



<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Planting can be undertaken throughout the winter but not in freezing weather or waterlogged ground. If planting into clay soils wait until March.</li> <li>■ If new hedgerows are planted consider linking existing hedgerows and habitats.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="text-align: right;"><b>HIGH</b></p> <p>Newly planted hedges will require annual maintenance until at least 1.5m tall. Competitive weeds should be controlled (including brambles, nettles and grasses) during the first growing season.</p> <p>The laying of hedge every 8-15 years will increase wildlife benefits and create a denser stock proof barrier.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consider planting a new hedge across a slope where runoff occurs or perpendicular to the river in a floodplain.</li> <li>■ Where hedgerows have been lost from an area or the network is very fragmented.</li> <li>■ Restoration of historic hedgerows.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td style="background-color: #f4a460;"><b>MEDIUM</b></td> </tr> <tr> <td>MAINTENANCE</td> <td style="background-color: #76c73a;"><b>LOW</b></td> </tr> </table>	SET UP	<b>MEDIUM</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>MEDIUM</b>				
MAINTENANCE	<b>LOW</b>				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Woodland Trust can help with on the ground advice, tree procurement and some small scale provision of grant funded materials.</li> <li>■ Countryside Stewardship scheme capital hedgerows and boundaries grant can fund hedgerow laying and maintenance providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> <li>■ Local Rivers Trusts in certain project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consents are unlikely to be required for work to establish hedgerows.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship scheme  <a href="http://www.gov.uk/government/collections/countryside-stewardship-get-paid-for-environmental-land-management">www.gov.uk/government/collections/countryside-stewardship-get-paid-for-environmental-land-management</a>                  Hedgelink  <a href="http://hedgelink.org.uk/index.php?page=23">http://hedgelink.org.uk/index.php?page=23</a></p>				



Growing hedgerow © Woodland Trust

HEDGEROWS PROVIDE EXCELLENT NATURAL WEATHER BARRIERS FOR LIVESTOCK AND HABITAT FOR WILDLIFE




# BUNDS AND DETENTION BASINS




Earth bund to temporarily store runoff during storm events at Greysouthern. A 150 mm pipe through the bund allows the field to drain down after flood events. With thanks to landowner and Greysouthern Parish Council. Image © Cumbria County Council.

Bunds are low earth mounds that are built following the contour of the slope. Water is held by the bund and allowed to disperse through a combination of infiltration into the soil, evaporation and slow release (for example through a small pipe or filter material).

Bunds work most effectively when constructed across known runoff pathways that appear after heavy rainfall. Bunds can be designed so that the area is normally dry and can remain productive, or to encourage the development of wetland habitat. This can be carried out on a small to large scale, depending on the size of the catchment area and the local soil conditions.


<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Creation of bunds across known run-off pathways can intercept water flowing over the ground, slow the flow and redirect runoff.</li> <li>■ They reduce volume of runoff by increasing the opportunity for infiltration and evaporation.</li> <li>■ They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Bunds reduce soil loss and surface scour.</li> <li>■ They filter diffuse pollutants and provide opportunity for nutrient reclamation.</li> <li>■ They provide pollutant treatment by allowing settlement.</li> <li>■ Bunds can be engineered in such a way as to provide access to fields in times of flood which would otherwise be inaccessible</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ Design of larger bunds or detention basin should be site specific and carried out by a land drainage specialist. Local Rivers Trusts may be able to help with this.</li> <li>■ Detention areas should be sized for the area draining into it.</li> <li>■ The slope of the sides should be less than 1 in 4 and vegetated.</li> <li>■ Construction materials will depend on the size of the detention basin, the method of flow control used, and consideration of future maintenance.</li> </ul>

**CONSIDERATIONS**



- Consideration should be given to where the water would go if the storage area becomes full and the bund overtopped. These exceedance flow paths should not create a new flood risk area.
- Flooded agricultural land is still eligible for BPS if the flooding is temporary and the land would otherwise still be available for agricultural activity. Deliberate and planned flooding of agricultural land to create new watercourses and permanent wetlands, is not considered to be a temporary flooding event as the land is not being maintained in a state suitable for grazing or cultivation which is the primary eligibility factor for BPS.
- Can make cutting and mowing practices more complex.


**LEVEL OF MAINTENANCE**



**MEDIUM**


Dependent on the scale and design. Require regular inspection to ensure that the bund is intact, the outlet is not blocked and the area behind the bund is not filled with silt.

**KEY LOCATIONS**



- Small vales and slopes prone to runoff during flood events.
- Areas where runoff with a heavy sediment load is known to compromise local drainage.

**COSTS**




SET UP	<b>MEDIUM</b>
MAINTENANCE	<b>MEDIUM</b>

**FUNDING**




- Bunds can be funded through the Countryside Stewardship scheme for mid and higher tier providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.
- Countryside stewardship payments may be available for flood mitigation on permeant grassland for higher tier agreements only, providing the land is eligible.
- Local Rivers Trust in specific project areas

**CONSENTS AND PERMISSIONS**



- Large structures may need planning permission.
- Activities carried out on the floodplain of a main river need a flood risk activity environmental permit, if you do not have planning permission.

**ADDITIONAL INFORMATION**



Countryside Stewardship grants  
[www.gov.uk/countryside-stewardship-grants/earth-banks-and-soil-bunds-rp9](http://www.gov.uk/countryside-stewardship-grants/earth-banks-and-soil-bunds-rp9)  
[www.gov.uk/countryside-stewardship-grants/sw16-flood-mitigation-on-permanent-grassland](http://www.gov.uk/countryside-stewardship-grants/sw16-flood-mitigation-on-permanent-grassland)  
 Basic Payment Scheme (BPS) criteria  
[www.gov.uk/guidance/bps-2018](http://www.gov.uk/guidance/bps-2018)  
 Design guidance  
[www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS\\_design\\_guidance.pdf](http://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf)  
[www.susdrain.org/resources/ciria-guidance.html](http://www.susdrain.org/resources/ciria-guidance.html)

# SWALES













Swale to divert and hold surface runoff © Eden Rivers Trust

Swales are shallow, linear, vegetated drainage features that store and redirect surface water flows that appear after heavy rain.

The vegetation in the swale increases roughness, slowing the flow of water. The water can be slowed further by the introduction of check dams and berms across the swale. Swales also increase the opportunity for infiltration and reduce downstream pollution by encouraging settlement of sediment.

Swales can be built across contours to intercept and store runoff and work well alongside kested hedgerows. Swales can also be built in combination with banded detention areas and act to direct runoff into the storage area.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>Swales reduce runoff rates by slowing the flow of water.</li> <li>They reduce volume of runoff by increasing the opportunity for infiltration and evaporation.</li> <li>They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>Swales reduce soil loss and surface scour.</li> <li>They provide pollutant treatment by allowing settlement.</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>Design of the swales should be site specific and take into account the contour of the surrounding land, the position in the landscape, and the soil type.</li> <li>Swales can be dug along boundaries, with the spoil used to create a hedge kest.</li> </ul>
<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>The location of the swale will be suggested by the reaction of the landscape to heavy rainfall. Their design should be tailored to each location.</li> <li>Consult with the Rural Payments Agency (RPA) about eligibility for the Basic Payment Scheme (BPS) as a swale may be considered a 'new watercourse' which would render that area as an ineligible feature.</li> </ul>

<p><b>LEVEL OF MAINTENANCE</b></p> 	<p><b>LOW</b></p> <p>Some vegetation control may be required. Sediment build up will need to be removed periodically. Maintenance is increased by the addition of structures within the swale.</p>	
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>Shallow slopes prone to runoff during flood events.</li> <li>Areas where runoff with a heavy sediment load is known to compromise local drainage.</li> </ul>	
<p><b>COSTS</b></p> 	<p>SET UP</p> <p>MAINTENANCE</p>	<p><b>MEDIUM</b></p> <p><b>LOW</b></p>
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>Swales can be funded through the Countryside Stewardship scheme for mid and higher tier providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> <li>Local Rivers Trusts in specific project areas</li> </ul>	
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>If the swale is on the floodplain of a main river the work must be registered with the Environment Agency (see Consents section to check whether this applies).</li> <li>If the total area is less than 0.1 Ha the swale will be registered as an exemption. This is free of charge.</li> <li>If the swale area is over 0.1 Ha the work will require a flood risk activity environmental permit.</li> </ul>	
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship grants  <a href="http://www.gov.uk/countryside-stewardship-grants/swales-rp11">www.gov.uk/countryside-stewardship-grants/swales-rp11</a>                  Swale design  <a href="http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZX.0HCIIIG33ALM59DZ">http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZX.0HCIIIG33ALM59DZ</a>  <a href="http://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf">www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf</a>  <a href="http://www.susdrain.org/resources/ciria-guidance.html">www.susdrain.org/resources/ciria-guidance.html</a>                  Basic Payment Scheme (BPS) criteria  <a href="http://www.gov.uk/government/collections/basic-payment-scheme">www.gov.uk/government/collections/basic-payment-scheme</a></p>	



# SEDIMENT TRAPS













Sediment trap filtering runoff from a farm track before discharging into a stream on River Leven, North Yorkshire. Image © Yorkshire Dales Rivers Trust, with thanks to Tees Rivers Trust.

Sediment traps can take many forms, but normally comprise of an excavation located on a surface runoff pathway. Runoff enters the excavation and is detained there, allowing sediment to settle out before the runoff is discharged via an outlet.

Sediment traps do not store large volumes of water to reduce flood risk but reduce inputs of sediment to watercourses, thus maintaining their capacity downstream. Sediment traps can also be used as a pre-treatment for water running into a temporary storage area.

Reducing sediment inputs to watercourses also benefits aquatic wildlife and reduced water pollution.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Sediment traps hold some excess floodwater, but many would be needed in a catchment to make a big impact on flood peak.</li> <li>■ They reduce siltation, maintaining capacity of downstream watercourses.</li> <li>■ They can be used as a pre-treatment for other natural flood management measures, such as retention ponds.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Retain washed off top soil allowing for re-spreading.</li> <li>■ Enhances longevity of other NFM measures such as bunds and ponds.</li> <li>■ Maintains capacity of watercourses and ditches reducing the need for maintenance.</li> <li>■ Improve water quality.</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ A small excavation is created, usually with a gravel outlet. Rocks and vegetation around the outlet will protect against erosion.</li> <li>■ The slope of the sides should be less than 1 in 4 and vegetated.</li> <li>■ Ensure access is provided for cleaning the sediment trap.</li> <li>■ The size will depend on the site and the runoff volumes to be intercepted; however, the greater the scale, the greater the removal efficiency.</li> </ul>

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Consent may be required to remove and spread sediment caught in a sediment trap.</li> <li>■ Sediment traps are not intended to treat wastewater or effluents.</li> <li>■ Sediment traps will be classed as ineligible features under the Basic Payment Scheme (BPS) rules if they are 0.01 hectares, or if together they add up to 0.01 hectares or more.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="text-align: center;"><b>MEDIUM</b></p> <p>Sediment traps will need to be regularly emptied – the frequency will depend on the area being drained and how much sediment is being intercepted.</p> <p>This can be re-spread onto agricultural land (may require an exemption for the use of waste to be registered with the Environment Agency).</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Within an area where surface runoff flows downhill.</li> <li>■ In conjunction with cross drains.</li> <li>■ As a pre-treatment for temporary water storage areas.</li> <li>■ Adjacent to, or within, ditches.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td style="background-color: #4CAF50; color: white;">LOW</td> </tr> <tr> <td>MAINTENANCE</td> <td style="background-color: #4CAF50; color: white;">LOW</td> </tr> </table>	SET UP	LOW	MAINTENANCE	LOW
SET UP	LOW				
MAINTENANCE	LOW				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Sediment traps can be funded through the Countryside Stewardship scheme for mid and higher tier providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> <li>■ Local Rivers Trusts (RT) within their project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Constructing a sediment trap on the floodplain of a main river may require a flood risk activity environmental permit. Contact the Environment Agency for guidance.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/sediment-ponds-and-traps-rp7">www.gov.uk/countryside-stewardship-grants/sediment-ponds-and-traps-rp7</a>                  Agri-environment scheme guidance on sediment traps and bunds  <a href="http://www.ruralpayments.org/publicsite/futures/topics/all-schemes/agri-environment-climate-scheme/management-options-and-capital-items/rural-sustainable-drainage-systems---sediment-traps-and-bunds">www.ruralpayments.org/publicsite/futures/topics/all-schemes/agri-environment-climate-scheme/management-options-and-capital-items/rural-sustainable-drainage-systems---sediment-traps-and-bunds</a>                  Basic Payment Scheme (BPS) criteria  <a href="http://www.gov.uk/guidance/bps-2018">www.gov.uk/guidance/bps-2018</a></p>				




# LEAKY BARRIERS OR LARGE WOODY DAMS



A series of 24 woody dams installed in Cumrew beck to reduce flooding in Cumrew village, near Carlisle. © Eden Rivers Trust

Leaky barriers constructed in streams and ditches are designed to hold back flood water within the channel or encourage water to spill onto the banks, reducing the downstream flood peak by temporarily storing water and slowing the flow.

Leaky barriers are designed to replicate naturally fallen trees and create a variety of habitats and flow conditions. They are set above normal stream level, so normal flows and fish movement are not impeded. When whole trunks are used, secured into place, they are referred to as large woody dams.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>Leaky barriers slow high flows, increasing the time it takes for storm water to pass downstream, thereby reducing the maximum flood peak.</li> <li>Leaky barriers can be constructed so that floodwater spills onto the floodplain for additional temporary storage where conditions are suitable.</li> <li>They are designed to slowly drain trapped water once the flood flow has passed.</li> </ul>
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>Leaky barriers can successfully reduce localised flooding within the farm holding.</li> <li>Trap sediment, improving water quality</li> </ul>
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>Large woody dams are created by laying large tree trunks in a cross formation across the channel to rest safely on both banks, wedged and secured in position. Smaller timbers can be held in place between the larger ones.</li> <li>Leaky barriers are constructed by securing a support across the channel and securing slats to form a barrier that lets some water pass through.</li> <li>The height of the lowest timber should allow normal flows to pass underneath. This will also permit fish passage.</li> <li>To maximise impact, it is recommended to create a series of at least three leaky barriers.</li> <li>If possible, use locally sourced wood.</li> </ul>

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>Many barriers are likely to be needed in a catchment and their implementation will need careful planning to make sure that they do not cause flood peaks to coincide.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="text-align: center;"><b>MEDIUM</b></p> <p>Large woody dams will need periodic checking to ensure the logs are still wedged in the right position. Periodic clearance of debris and sediment from the leaky dams will prevent blockage and overflow of water.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>Generally suited to smaller watercourses (&lt; 2 m wide) and ditches throughout the catchment, where holding water back is not going to create additional problems.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td style="background-color: #28a745; color: white; text-align: center;"><b>LOW</b></td> </tr> <tr> <td>MAINTENANCE</td> <td style="background-color: #28a745; color: white; text-align: center;"><b>LOW</b></td> </tr> </table>	SET UP	<b>LOW</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>LOW</b>				
MAINTENANCE	<b>LOW</b>				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>Leaky barriers can be funded through the Countryside Stewardship scheme for mid and higher tier providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> <li>Local Rivers Trusts within project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>Constructing in-channel will require flood defence consent from the Lead Local Flood Authority.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/rp32-small-leaky-woody-dams">www.gov.uk/countryside-stewardship-grants/rp32-small-leaky-woody-dams</a>  <a href="http://www.gov.uk/countryside-stewardship-grants/rp33-large-leaky-woody-dams">www.gov.uk/countryside-stewardship-grants/rp33-large-leaky-woody-dams</a>                  (only available under higher tier)                  Design guidance:  <a href="http://www.yorkshiredalesrivertrust.com/wp-content/uploads/2018/01/Natural-Flood-Management-Techniques-Leaky-Dams.pdf">www.yorkshiredalesrivertrust.com/wp-content/uploads/2018/01/Natural-Flood-Management-Techniques-Leaky-Dams.pdf</a></p>				



Leaky barriers on Dovenby beck, near Cockermouth © West Cumbria Rivers Trust








# PONDS AND SCRAPES






Floodplain scrape on River Cocker. © West Cumbria Rivers Trust

Ponds and shallow scrapes capture and store water during flood events. They should drain down slowly after flood events to maintain capacity but can be designed to hold some water permanently.

Offline ponds and scrapes are situated in the floodplain to capture overland runoff. Online ponds have a stream channel flowing through. The flood water is then stored temporarily and is released back into the watercourse in a controlled manner.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Provides water storage capacity during storm events. The water slowly drains from the pond once the flood period has passed via infiltration or an outlet point.</li> <li>■ Ponds can be designed to hold some water all year, adding to the wildlife value of the farm.</li> </ul>				
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Sediment is removed from the flow which maintains capacity of watercourses and ditches and can be returned to the land.</li> <li>■ Can be designed to incorporate a silt trap, improving water quality.</li> <li>■ Retention of water is also beneficial in times of drought.</li> </ul>				
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ Ponds must be individually designed according to the characteristics of the site.</li> <li>■ Ponds should drain within 10 -24 hours, so that there is storage available in the eventuality of multi-day extreme events.</li> <li>■ A liner may be required.</li> <li>■ The pond can include an armoured spillway to avoid erosion damage when overtopped.</li> </ul>				
<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Test pits will be needed to see how well the pond will hold water, if a permanent source of water is desired.</li> <li>■ Ponds will be classed as ineligible features under the Basic Payment Scheme (BPS) rules if they are 0.01 hectares or more, or if they add up to 0.01 hectares or more.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="text-align: center;"><b>MEDIUM</b></p> <p>Check for scouring of inlet and outlet features. Sediment may accumulate to the level of the outlet and may need removal. Management of vegetation may also be required.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Near to watercourses in non-productive areas of land - buffer strips, inside small meanders or field corners, throughout the catchment.</li> <li>■ At the bottom of slopes, particularly in fields draining to a single corner.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td data-bbox="1007 1563 1171 1608">SET UP</td> <td data-bbox="1176 1563 1474 1608" style="background-color: #c00000; color: white; text-align: center;"><b>HIGH</b></td> </tr> <tr> <td data-bbox="1007 1615 1171 1659">MAINTENANCE</td> <td data-bbox="1176 1615 1474 1659" style="background-color: #008000; color: white; text-align: center;"><b>LOW</b></td> </tr> </table>	SET UP	<b>HIGH</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>HIGH</b>				
MAINTENANCE	<b>LOW</b>				



<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Scrape creation and pond management can be funded through the Countryside Stewardship scheme for higher tier only providing the land is eligible. Contact your local Natural England Catchment Sensitive Farming Officer for advice.</li> <li>■ Local Rivers Trust in project areas</li> </ul>
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Larger ponds may require planning permission.</li> <li>■ Ponds on the floodplain of a main river will require a flood risk activity environmental permit from the Environment Agency if they do not have planning permission.</li> <li>■ If the pond alters the flow of an ordinary watercourse, land drainage consent will be required from the Lead local flood authority.</li> <li>■ The County Council or National Park historic environment team should be consulted before construction of a pond.</li> </ul>
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/creation-of-scrapes-and-gutters-wn2">www.gov.uk/countryside-stewardship-grants/creation-of-scrapes-and-gutters-wn2</a>  <a href="http://www.gov.uk/countryside-stewardship-grants/pond-management-first-100-sq-m-wn5">www.gov.uk/countryside-stewardship-grants/pond-management-first-100-sq-m-wn5</a></p> <p>Design guidance  <a href="http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Fluvial_Design_Guide_-_Chapter_10.sflb.ashx">http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Fluvial_Design_Guide_-_Chapter_10.sflb.ashx</a></p> <p>The Runoff Attenuation Features Handbook (Newcastle University and the Environment Agency, 2011): <a href="https://research.ncl.ac.uk/proactive/belford/papers/Runoff_Attenuation_Features_Handbook_final.pdf">https://research.ncl.ac.uk/proactive/belford/papers/Runoff_Attenuation_Features_Handbook_final.pdf</a></p>



Newly created offline pond at Whit beck, near Cockermouth © West Cumbria Rivers Trust

OFFLINE PONDS AND SCRAPES ARE SITUATED IN THE FLOODPLAIN TO CAPTURE OVERLAND RUNOFF

# WOODLAND CREATION



Upland woodland creation near Keswick, Cumbria. © West Cumbria Rivers Trust.

Well-sited and well-managed woodlands have significant benefits for natural flood management as well as sheltering livestock, providing wildlife habitat and stabilising soils. There are several different grants available for the establishment of new woodlands and, if managed as a commercial woodland, they have the potential to generate income for the landowner.

Woodlands reduce flood risk in a number of ways. Trees are very good at intercepting rainfall, between 25-45% (conifers) and 10-25% (broadleaves) less water reaches the ground annually by being intercepted and evaporated from the leaves<sup>1</sup>. Woodlands also slow the flow of runoff and increase infiltration by up to 60 times compared to grazed pasture<sup>3</sup>.

**NATURAL FLOOD MANAGEMENT PURPOSE**



- Interception can reduce the amount of rainfall reaching the ground, conifers being particularly effective.
- Planting of trees increases the surface roughness, slowing the flow of water during a flood event, especially when combined with understory planting.
- Woodlands reduce the volume of runoff by promoting rainfall infiltration into the soil and increasing evaporation.
- The roots of bankside trees and associated vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.
- Provides habitat for terrestrial wildlife and improves water quality.
- Stores carbon, helping to regulate climate.

**AGRICULTURAL BENEFITS**



- Timber production creates diversified income generation and tax efficient opportunities. The forestry sector is resilient and demand for UK grown timber is consistently increasing.
- Trees provide important shelter and shade for livestock, ideally outside rather than inside the wood. Reduced wind speed around the wood can result in higher lamb survival rates and reduced hypothermia and energy loss in animals<sup>2</sup>.
- Grazing areas sheltered by trees have shown up to 20 % increase in average annual pasture growth<sup>4</sup>, up to 21 % increase in live weight of sheep<sup>5</sup> and increases of up to 17 % in dairy milk production<sup>6</sup>.
- Reduced floodwater damage on productive farm land.
- Woodlands trap and filter runoff, preventing loss of fertilisers, sediment and pesticides to watercourses, helping to meet cross compliance rules.
- Planting trees can increase the potential for game shooting on farmland.

**METHODS**



- The optimum area and species to be planted varies at each potential site.
- Mixed woodland with a range of species including a significant conifer component offer the greatest natural flood management benefits.

**CONSIDERATIONS**








- New planting will need protection from livestock grazing.
- Adding leaky barriers within the woodland will increase the natural flood management benefits.
- If woodland creation is funded through the Countryside Stewardship scheme, the BPS payment on the site is retained.

**LEVEL OF MAINTENANCE**

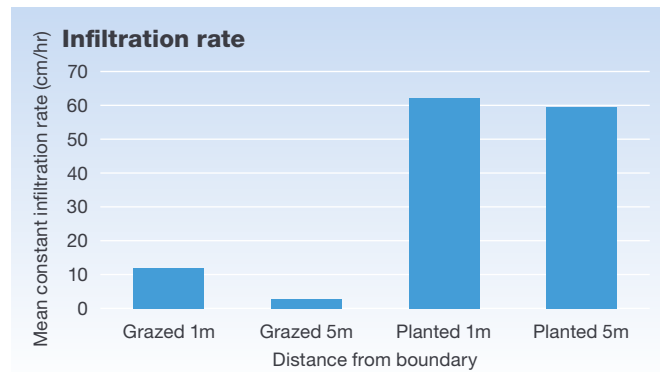


**MEDIUM**

For new native woodland – this will involve weeding, checking or straightening guards, and replacing failed trees as the plantation becomes established. Guards will need to be removed when the trees are grown.

<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>Throughout the catchment – in particular, remote upper catchment areas.</li> <li>Linking up with existing woodland or hedgerows to create a wildlife corridor effect.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td><b>MEDIUM</b></td> </tr> <tr> <td>MAINTENANCE</td> <td><b>LOW</b></td> </tr> </table>	SET UP	<b>MEDIUM</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>MEDIUM</b>				
MAINTENANCE	<b>LOW</b>				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>Engage the Forestry Commission early for advice and support.</li> <li>Countryside Stewardship Woodland Creation Grant provides a capital grant of up to £6,800/ha with annual maintenance payments of £200/ha, Basic Payment Scheme payments are retained subject to eligibility criteria.</li> <li>Forestry Commission Woodland Carbon Fund can fund larger tree planting schemes. Woodland Creation Planning grant is also available under this scheme to fund the development of woodlands.</li> <li>Woodland Trust can help with on the ground advice, tree procurement and some small scale provision of grant funded materials.</li> <li>Local Rivers Trusts and Cumbria Woodlands in certain project areas.</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>An Environmental Impact Assessment (EIA) determination will be required if more than 2 ha of woodland is to be planted. The Forestry Commission is responsible for administering this. Further details can be found at <a href="http://www.forestry.gov.uk/forestry/bee-h-amdegy">www.forestry.gov.uk/forestry/bee-h-amdegy</a></li> <li>Forestry Commission consent is required to fell a woodland.</li> <li>Contact your local FC Woodland Officer for further information.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship scheme woodland grants  <a href="http://www.gov.uk/government/publications/countryside-stewardship-woodland-management-plan-grant-manual-2017">www.gov.uk/government/publications/countryside-stewardship-woodland-management-plan-grant-manual-2017</a></p> <p>Woodland locations and forestry standards  <a href="http://www.forestry.gov.uk/ukfs">www.forestry.gov.uk/ukfs</a></p> <p>Woodland Carbon Fund  <a href="http://www.forestry.gov.uk/england-wcf">www.forestry.gov.uk/england-wcf</a></p> <p>Forestry Commission Tree Selection Tools (Ecological Site Classification)  <a href="http://www.forestry.gov.uk/tools-and-resources/forest-planning-and-management-services/ecological-site-classification-decision-support-system-esc-dss">www.forestry.gov.uk/tools-and-resources/forest-planning-and-management-services/ecological-site-classification-decision-support-system-esc-dss</a></p>				

**MEAN INFILTRATION RATES FOR SHEEP GRAZED AND RECENTLY PLANTED AREAS (2-7 YEARS AFTER ESTABLISHMENT) IN PONT BREN MID WALES<sup>3</sup>**



**WOODLANDS REDUCE FLOOD RISK, SHELTER LIVESTOCK AND STABILISE SOILS**

<sup>3</sup> Caroll S.E., Bird S.B., Emmett B.A., Reynold B. and Sinclair F.L. (2004) Can tree shelterbelts on agricultural land reduce flood risk? Soil use and management, 20, 357-559.

<sup>4</sup> Fitzpatrick, D., (1994) Money Trees on Your Property. Inkata Press, Sydney; p.174.

<sup>5</sup> Lynch, J.J., and Donnelly, J.B., (1980). Changes in Pasture and Animal Production Resulting from the Use of Windbreaks. Australian Journal of Agriculture, 31, 967-979.

<sup>6</sup> Blore, D., (1994), Benefits of Remnant Vegetation: focus on rural lands and rural communities, Prepared for Protecting Remnant Bushland. Orange Agricultural College, Orange



# SHORT ROTATION WILLOW COPPICE



A short rotation willow coppice plantation at Trout Beck, Mungrisdale.  
© Iggesund paperboard.

Willow is an energy crop that provides a source of income to landowners when it is harvested approximately every three years. Like all trees, willow increases infiltration and evaporation, reducing the volume of flood water.

Willow plantations are very effective at slowing surface runoff and can trap flood debris, preventing it causing damage to downstream infrastructure. Willow plantations can also provide habitat for a variety of wildlife.

There are several willow plantations across the North West, harvested by Iggesund paperboard, which have allowed farms to diversify, provided a resilient source of income and are effective at 'slowing the flow'.

## NATURAL FLOOD MANAGEMENT PURPOSE



- Willow crop increases the roughness of the vegetation, slowing runoff during flood events.
- Reduces volume of runoff by increasing the opportunity for infiltration and evaporation.
- Traps flood debris and sediment reducing the risk of blockages and increased flood risk downstream.

## AGRICULTURAL BENEFITS










- Willow is an energy crop that offers a new source of income and long term resilience.
- Iggesund paperboard 'Grow Your Income' initiative works directly with landowners to plant and manage the crop.
- Willow is very resilient and fast growing and grows well on marginal land.
- The harvesting is flexible; if there's a flood one year it can be left until the next year to harvest at no loss to the farmer.
- Willow traps flood debris, reducing the risk of damage to farm bridges, fences and other structures downstream.

## METHODS



- Iggesund paperboard will advise on the planting and variety of willow.
- The minimum recommended field size is 4-10 Ha.
- Harvesting is difficult on steep inclines. Gradients over 25 % should be avoided.
- The soil's pH level should be between 5.5 and 7.5. Clay soils are suitable for willow cultivation. Sandy soils may also be suitable if the plants have access to water or if organic nutrients can be applied to provide moisture retention.
- Land preparation takes place in the year before planting by eradicating perennial weeds and removing large stones from the field.
- The field must be ploughed during the autumn before planting, which takes place from mid-March until mid-June.
- Before planting the land must be harrowed as before normal arable seeding.
- Iggesund will supply a harvester and also provide transport for the harvest to the biomass boiler in the mill.

<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Historic features could be damaged by ploughing. Consult with the National Park or County Council historic environment team before you create plantations.</li> <li>■ There must be an access route to the field and at the end of each row of willow there must be a turning area of 8-10 m, as the harvesting machines need space to be able to turn.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p style="text-align: center;"><b>MEDIUM</b></p> <p>Controlling weeds during the establishment phase of SRC willow is extremely important. Once the SRC willow plantation is established, fertilisation may be required. If so it is usually nitrogen that may need to be added. In older plantations nitrogen will be released from the layer of fallen leaves that is formed, which means that the need for fertilisation is reduced.</p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Floodplains prone to inundation during flood events.</li> <li>■ Areas with surface runoff.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td>SET UP</td> <td style="text-align: center;"><b>MEDIUM</b></td> </tr> <tr> <td>MAINTENANCE</td> <td style="text-align: center;"><b>LOW</b></td> </tr> </table>	SET UP	<b>MEDIUM</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>MEDIUM</b>				
MAINTENANCE	<b>LOW</b>				
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Agreement with Iggesund paperboard and payments for crop harvesting every three years.</li> <li>■ Some help with set up costs may be available from local Rivers Trusts in specific project areas</li> </ul>				
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Discussions with Iggesund paperboard to design planting.</li> </ul>				
<p><b>ADDITIONAL INFORMATION</b></p> 	<p><a href="http://www.biofuel.iggesund.co.uk">www.biofuel.iggesund.co.uk</a>  <a href="http://www.fwi.co.uk/livestock/grassland-management/willow-can-reduce-flood-risk-earn-farms-618-ha">www.fwi.co.uk/livestock/grassland-management/willow-can-reduce-flood-risk-earn-farms-618-ha</a></p>				



A willow crop near Keswick trapped debris during Storm Desmond without damage to the crop, preventing the flood debris causing damage downstream. © Iggesunds paperboard

WILLOW PLANTATIONS ARE VERY EFFECTIVE AT SLOWING SURFACE RUNOFF AND CAN TRAP FLOOD DEBRIS

# RIVER AND FLOODPLAIN RESTORATION



Remeandering of the River Lyvennet near Maulds Meaburn © Eden Rivers Trust

Many rivers have been straightened and flood embankments built to increase the land available for agriculture. Even small becks have often been altered. These changes disconnect rivers from their natural floodplain reducing the area naturally available to store floodwater. This results in a greater volume of flood water travelling more quickly downstream to villages and towns.

River and floodplain restoration encompasses a range of different techniques which are often used in conjunction. They include restoring meanders, removal or setting back of flood banks, reconnecting old side channels and connecting the river to floodplains.

Restoring the connection between a river and its floodplain allows floodwater to spill naturally onto land to provide significant flood storage, reducing risk to lives and property further downstream. This also allows the river to drain back into the channel more rapidly after flood events, reducing prolonged inundation of fields and the need for channel maintenance.

Restoration always needs to be carefully planned by specialist water engineers and ecologists as it will influence the behaviour of the flow of floodwater over a wide area. It will need detailed computer modelling and design, and will require planning and other permissions and consents. It is likely to be high cost and need specialist contractors. Initial advice as to a site's suitability can be given by local Rivers Trusts or Environment Agency staff, and early contact is highly recommended.

## NATURAL FLOOD MANAGEMENT PURPOSE



- Storage of potentially large amounts of floodwater on the floodplain, with a controlled discharge back to the river once the flood event has passed.
- Re-creating meanders will increase the time taken for the floodwater to flow downstream by making it take a longer route. The greater length of a meandered river allows it to carry a greater volume of water before it spills out of its channel.
- Naturally functioning rivers will create features such as bars, riffles and pools which can help slow the flow.
- River and floodplain restoration can also create habitats such as wetlands and wet woodlands which benefit a wide range of species including breeding and wintering wading birds.

## AGRICULTURAL BENEFITS



- Allowing more natural lower energy flooding reduces risk of bank and embankment failure.
- The river can drain back into the channel rapidly as levels fall rather than water being trapped behind embankments.
- Removes need for maintenance of artificial engineering works
- Provides rich wildlife habitat and better fisheries.

## METHODS









- Dimensions are entirely site dependent and will need detailed specialist advice.
- Pre-work assessments and surveys will be required to ensure that works do not increase flood risk (for example, an embankment may be holding water back during a flood event and removal could increase flood risk).
- Previous meanders and curves in the water course can be identified by historic aerial photographs and maps.

## CONSIDERATIONS



- The Rural Payments Agency (RPA) will need to be informed about any changes to the land parcel areas.
- Flooded agricultural land is still eligible for BPS if the flooding is temporary and the land would otherwise still be available for agricultural activity. Areas where agricultural land is deliberately flooded to create a new watercourse or permanent wetlands is not eligible for BPS.
- Environment Agency advice and consent will be required as part of the planning process for this kind of project.



<p>LEVEL OF MAINTENANCE</p> 	<p><b>LOW</b></p> <p>Very little, once the initial work is done.</p>				
<p>KEY LOCATIONS</p> 	<ul style="list-style-type: none"> <li>Where there is no risk to property or infrastructure from an altered river course or floodplain inundation.</li> <li>Re-meandering needs careful planning and is most likely to be practical where the same landowner owns both sides of the channel. Small becks in the upper parts of the catchment will be easier to restore than main rivers.</li> </ul>				
<p>COSTS</p> 	<table border="1"> <tr> <td>SET UP</td> <td><b>HIGH</b></td> </tr> <tr> <td>MAINTENANCE</td> <td><b>LOW</b></td> </tr> </table>	SET UP	<b>HIGH</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>HIGH</b>				
MAINTENANCE	<b>LOW</b>				
<p>FUNDING</p> 	<ul style="list-style-type: none"> <li>Specialist advice on funding is needed. Contact Local Rivers Trust or Environment Agency staff.</li> <li>Countryside Stewardship 'Making space for water' grants may be available as part of higher tier agreements. Contact Natural England for advice.</li> </ul>				
<p>CONSENTS AND PERMISSIONS</p> 	<ul style="list-style-type: none"> <li>Planning permission and bespoke consents are likely to be required for a re-meandering project. Your local Rivers Trust will lead on obtaining required consents.</li> </ul>				
<p>ADDITIONAL INFORMATION</p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/making-space-for-water-sw12">www.gov.uk/countryside-stewardship-grants/making-space-for-water-sw12</a>  <a href="http://www.gov.uk/countryside-stewardship-grants/sw16-flood-mitigation-on-permanent-grassland">www.gov.uk/countryside-stewardship-grants/sw16-flood-mitigation-on-permanent-grassland</a></p> <p>Example re-meander projects          Whit beck  <a href="http://www.westcumbriariverstrust.org/projects/river-restoration-strategy/whit-beck">www.westcumbriariverstrust.org/projects/river-restoration-strategy/whit-beck</a>  <a href="http://www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/1.11_Highland_Water.pdf">www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/1.11_Highland_Water.pdf</a></p> <p>Example floodplain project  <a href="http://www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.3_Long_Eau.pdf">www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.3_Long_Eau.pdf</a></p>				



Whit beck, near Cockermouth before and after river restoration  
 © West Cumbria Rivers Trust

RESTORING THE CONNECTION BETWEEN A RIVER AND ITS FLOODPLAIN REDUCES PROLONGED INUNDATION OF FIELDS AND THE NEED FOR CHANNEL MAINTENANCE

# BLOCKING MOORLAND DRAINAGE GRIPS AND GULLIES



Gully blocking with leaky bunds on Tebay Common. © Cumbria Wildlife Trust.

Upland drainage ditches (also known as grips) reduce the ability of moorlands to hold water. By speeding up the removal of water from the moorland into streams and rivers, grips increase flood risk downstream<sup>7</sup>.

Blocking grips (man-made drainage channels) and gully systems (naturally occurring drainage channels) in moorland areas will cause the moorland to rewet and increase its ability to store water. Grips/gullies are generally not filled in completely but blocked by a series of dams made from peat, heather bales, plastic piling or wooden planks.

Where grip/gully blocking is done on peat soils, the increased height of the water table behind the dams will create conditions for Sphagnum moss to form, which helps the bog act as a water storage facility. This work is often undertaken in conjunction with work to re-stabilise blanket bog which may require revegetation with moorland species.

On mineral soils, grip blocking may result in the moorland reverting to wet heath habitat with dwarf shrub, sedges and heather vegetation. Wet heath vegetation increases surface roughness and promotes infiltration, reducing the volume and rate of runoff.

Moorland restoration by grip blocking also increases carbon storage in peat soils and reduces soil erosion, thus improving water quality by reducing discoloration and sediment load.

## NATURAL FLOOD MANAGEMENT PURPOSE



- Slows runoff that would otherwise flow quickly through the grips.
- Increases storage of water and promotes infiltration reducing the volume of runoff.
- Creates active blanket bog with vegetation recovery, increasing the 'sponge' effect, the amount of water the bog can hold.
- Reduces the energy of the water and its capacity to erode, carry sediment, and generate water colour.
- Stores carbon, helping to regulate climate.

## AGRICULTURAL BENEFITS



- Blocking grips can reduce the numbers of lost livestock in deep gullies and grips.
- Re-wetting reduces severity of wildfire and effects of drought.
- Reduced soil erosion and reduced transfer of sediment into rivers.

## METHODS



- Number, type and material for dams will vary according to the ground conditions, depth of erosion, and slope. Specialist technical assessment of a drained moorland is required prior to works being undertaken.
- Different types of dams can be used. These include heather bales, machine built peat dams, plastic dams, stones dams and timber dams.

## CONSIDERATIONS








- Some research suggests that selective grip blocking can reduce flood risk in some areas but in some places can increase it, depending on which grips are blocked and the balance between connectivity and storage. Specialist help is therefore needed to assess the moorland prior to any works being undertaken.
- Wildlife Trusts and peatland restoration partnerships can advise on these interventions.

## LEVEL OF MAINTENANCE



LOW

<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Drained moorland, especially in areas where use for livestock grazing is reducing.</li> <li>■ Gully blocking is particularly applicable on drained moorland and in grips or gullies that are actively eroding.</li> </ul>	
<p><b>COSTS</b></p> 	<p>SET UP</p>	<p><b>HIGH</b></p>
<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Countryside Stewardship scheme grants may be available for grip blocking and moorland rewetting as part of a higher tier agreement, providing the land is eligible. Contact Natural England for advice.</li> <li>■ Wildlife Trusts may be able to help with on the ground advice and identification of funding sources.</li> </ul>	
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Planning permission may be required for peatland restoration projects. Contact your local Wildlife Trust for help with consents.</li> </ul>	
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/grip-blocking-drainage-channels-wn1">www.gov.uk/countryside-stewardship-grants/grip-blocking-drainage-channels-wn1</a>  <a href="http://www.gov.uk/countryside-stewardship-grants/moorland-re-wetting-supplement-up5">www.gov.uk/countryside-stewardship-grants/moorland-re-wetting-supplement-up5</a>                  Cumbria Peat Partnership  <a href="http://www.cumbriawildlifetrust.org.uk/what-we-do/groups-and-partnerships">www.cumbriawildlifetrust.org.uk/what-we-do/groups-and-partnerships</a>                  Design guidance  <a href="http://www.moorsforthefuture.org.uk/factsheets">www.moorsforthefuture.org.uk/factsheets</a></p>	



Blocking grips with peat bunds at Tebay © Cumbria Wildlife Trust

UPLAND DRAINAGE  
 DITCHES REDUCE  
 THE ABILITY OF  
 MOORLANDS TO  
 HOLD WATER

<sup>7</sup> Holden J., Evans M.G., Burt T.P. and Horton M.M. (2006) Impact of land drainage on peatland hydrology. Journal of Environmental quality, 35, 1764-1778.



# STABILISING AND REVEGETATING BLANKET BOGS













Regrading the steep bank of a peat hag on an area of degraded peat on Kinmont Buckbarrow, near Millom, Cumbria. © Cumbria Wildlife Trust.

Blanket bogs in the uplands are natural wetlands. As they dry out, they lose their capacity to store water and become more susceptible to wildfire and erosion. Creating or maintaining stable, vegetated blanket bog with a high water table reduces the volume and speed of runoff flowing off high ground.

Water flows rapidly from exposed peaty soils. Eroded peat soils entering watercourses can discolour water. Treating this discolouration is costly and can result in raised water bills. Active blanket bogs dominated by Sphagnum mosses hold water. The continued growth of Sphagnum moss in wet conditions increases the volume of water that can be held by the bog.

Stabilising degraded peat bogs may require re-grading of steep peat hags or revegetating bare areas of peat. Creating peat bunds around low lying areas can further increase the amount of water stored on a fell.

<p><b>NATURAL FLOOD MANAGEMENT PURPOSE</b></p> 	<ul style="list-style-type: none"> <li>■ Increased surface roughness, slowing overland runoff.</li> <li>■ Maximises the amount of water that can infiltrate into peat soils and be stored by vegetation.</li> <li>■ Stores carbon, helping to regulate climate.</li> </ul>				
<p><b>AGRICULTURAL BENEFITS</b></p> 	<ul style="list-style-type: none"> <li>■ Re-wetting reduces severity of wildfire and drought.</li> <li>■ Reduces soil erosion and reduced transfer of sediment into rivers.</li> <li>■ Improves habitat for moorland species.</li> </ul>				
<p><b>METHODS</b></p> 	<ul style="list-style-type: none"> <li>■ Depending on extent of degradation, bare peat is stabilised with heather brush or geotextiles, treated with lime, seed and fertiliser mix to knit the surface, and then seeded with moorland species including Sphagnum mosses to produce a functioning blanket bog.</li> </ul>				
<p><b>CONSIDERATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Removing livestock such as sheep can be a requirement for success.</li> <li>■ Dependent on scale and complexity, this work will require specialist technical assessment before revegetation. There are peatland restoration partnerships which can advise these interventions.</li> </ul>				
<p><b>LEVEL OF MAINTENANCE</b></p> 	<p><b>LOW</b></p>				
<p><b>KEY LOCATIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Upper catchment. Areas of degraded blanket bog characterised by bare peat or dominated by heather or native grasses, sedges and rushes (graminoids) without a healthy mix of moorland species including Sphagnum mosses.</li> </ul>				
<p><b>COSTS</b></p> 	<table border="1"> <tr> <td data-bbox="1007 1471 1171 1541">SET UP</td> <td data-bbox="1176 1471 1481 1541"><b>HIGH</b></td> </tr> <tr> <td data-bbox="1007 1541 1171 1585">MAINTENANCE</td> <td data-bbox="1176 1541 1481 1585"><b>LOW</b></td> </tr> </table>	SET UP	<b>HIGH</b>	MAINTENANCE	<b>LOW</b>
SET UP	<b>HIGH</b>				
MAINTENANCE	<b>LOW</b>				

<p><b>FUNDING</b></p> 	<ul style="list-style-type: none"> <li>■ Countryside Stewardship scheme grants may be available for moorland rewetting as part of a higher tier agreement, providing the land is eligible. Contact Natural England for advice.</li> <li>■ Wildlife Trusts may be able to help with on the ground advice and identification of funding sources</li> </ul>
<p><b>CONSENTS AND PERMISSIONS</b></p> 	<ul style="list-style-type: none"> <li>■ Planning permission may be required for peatland restoration projects. Contact your local Wildlife Trust for help with consents.</li> </ul>
<p><b>ADDITIONAL INFORMATION</b></p> 	<p>Countryside Stewardship  <a href="http://www.gov.uk/countryside-stewardship-grants/moorland-re-wetting-supplement-up5">www.gov.uk/countryside-stewardship-grants/moorland-re-wetting-supplement-up5</a></p> <p>Cumbria Peat Partnership  <a href="http://www.cumbriawildlifetrust.org.uk/what-we-do/groups-and-partnerships">www.cumbriawildlifetrust.org.uk/what-we-do/groups-and-partnerships</a></p> <p>Factsheets are available that give detail on stabilisation and revegetation of blanket bogs  <a href="http://www.moorsforthefuture.org.uk/factsheets">www.moorsforthefuture.org.uk/factsheets</a></p>

BLANKET BOGS IN THE UPLANDS ARE NATURAL WETLANDS. AS THEY DRY OUT, THEY LOSE THEIR CAPACITY TO STORE WATER AND BECOME MORE SUSCEPTIBLE TO WILDFIRE AND EROSION



Stabilisation and rewetting of blanket bog © Cumbria Wildlife Trust

# CONSENT AND APPROVAL

Some interventions may require consent prior to construction. It is recommended that each NFM measure is constructed to standard dimensions to enable faster approval. Standard construction dimensions for NFM measures can be found in design standards and additional material from the Environment Agency, the Forestry Commission and other organisations found in the Contacts section below. Contact your local Rivers Trust if you need advice on required consents.

## PERMITS FOR WORKS IN WATERCOURSES AND ON FLOODPLAINS

The required consents/permits differ for main rivers and ordinary watercourses. Use this link to check whether the site is on a main river: [www.gov.uk/government/collections/main-river-map-for-england-proposed-changes-and-decisions](http://www.gov.uk/government/collections/main-river-map-for-england-proposed-changes-and-decisions)

### Main River Environmental permits

Consent will be required from the Environment Agency for any works within 8 m of the watercourse or on the floodplain of a main river if you do not have planning permission.

[www.gov.uk/guidance/flood-risk-activities-environmental-permits](http://www.gov.uk/guidance/flood-risk-activities-environmental-permits)

Telephone: **03708 506 506**

Email: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk)

### Ordinary Watercourse Land drainage consent

Works in the water course may require land drainage consent from the Lead Local Flood Authority. Contact your local County Council or Unitary Authority.

## AREAS WITH PROTECTED STATUS

Interventions that are proposed to be undertaken on land with protected status such as Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC) and Special Protection Areas (SPA) will require Natural England consent. Interventions on SAC or SPA land will also require a habitat regulations assessment from Natural England. It is possible to find out whether your site has protected status by searching online using the website [www.magic.gov.uk](http://www.magic.gov.uk).

Natural England Telephone: **0300 060 3900**

Email: [enquiries@naturalengland.org.uk](mailto:enquiries@naturalengland.org.uk)

[www.gov.uk/guidance/protected-areas-sites-of-special-scientific-interest](http://www.gov.uk/guidance/protected-areas-sites-of-special-scientific-interest)

## SCHEDULED MONUMENTS

Scheduled Monuments Consent will also be required for intervention measures proposed to be undertaken on or near to Scheduled Monuments.

It is possible to find out whether your site has protected status by searching online using the website [www.magic.gov.uk](http://www.magic.gov.uk) or by contacting Historic England.

Historic England North West Telephone: **01612 421416**

Email: [northwest@HistoricEngland.org.uk](mailto:northwest@HistoricEngland.org.uk)

[www.historicengland.org.uk/advice/planning/consents/smc](http://www.historicengland.org.uk/advice/planning/consents/smc)

## PLANNING CONSENT

Planning permission may be required may be required for larger structures, and a discussion about proposed works should be held with the local planning authority (County Council or National Park Authority). Standard construction dimensions are recommended for each intervention treatment to enable quicker approval.

### New woodlands

An Environmental Impact Assessment (EIA) determination will be required if more than 2 ha of woodland planting is to be planted in sensitive landscapes, such as a National Park. The Forestry Commission assess EIA determination documents submitted. Further details can be found at

[www.forestry.gov.uk/forestry/bee-h-amdegy](http://www.forestry.gov.uk/forestry/bee-h-amdegy)

### Public Rights of Way & Open Access land

Public footpaths, public bridleways and byways are managed by the County Council or Unitary Authority unless they are within the National Park where they are managed by the National Park Authority. Consent must be obtained before any work takes place that might affect either the physical right of way or those using it. Be aware that the actual 'used' route that the public walk or ride across your land could differ from the legal definitive line.

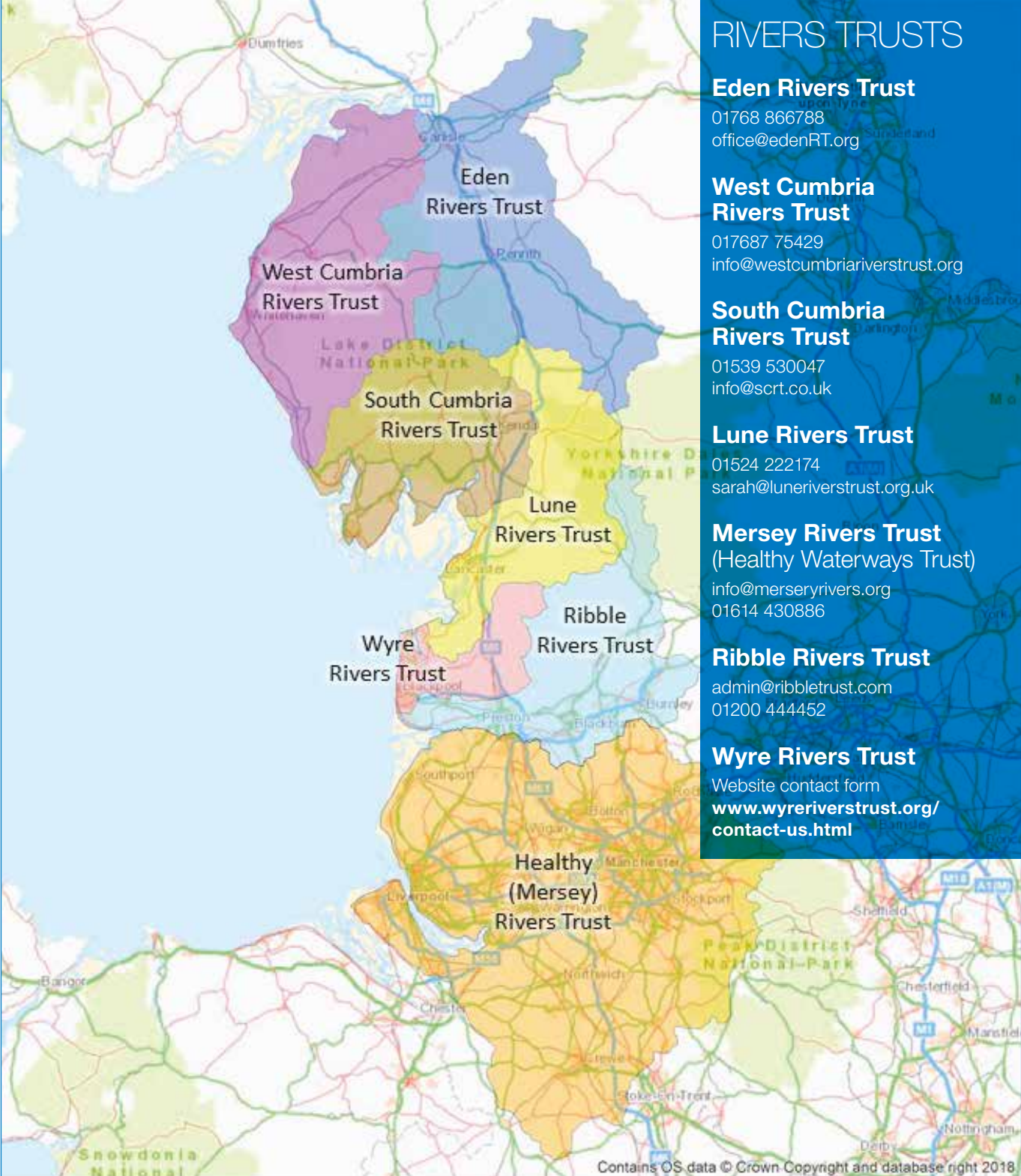
Almost all moorland and high rough pasture is designated as Open Access land. The public have a legal right of access on this land and, before any works take place that might affect this access, consent may be required.



# SOURCES OF ADVICE

## RIVERS TRUSTS

If you would like a general discussion about Natural Flood Management options on your land, please contact your local Rivers Trust as your first point of contact.



**RIVERS TRUSTS**

**Eden Rivers Trust**  
01768 866788  
office@edenRT.org

**West Cumbria Rivers Trust**  
017687 75429  
info@westcumbriarivertrust.org

**South Cumbria Rivers Trust**  
01539 530047  
info@scrt.co.uk

**Lune Rivers Trust**  
01524 222174  
sarah@lunerivertrust.org.uk

**Mersey Rivers Trust (Healthy Waterways Trust)**  
info@merseryrivers.org  
01614 430886

**Ribble Rivers Trust**  
admin@ribbletrust.com  
01200 444452

**Wyre Rivers Trust**  
Website contact form  
[www.wyrivertrust.org/contact-us.html](http://www.wyrivertrust.org/contact-us.html)

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# SOURCES OF ADVICE

## RURAL PAYMENTS AGENCY

To confirm if a flood mitigation feature is permanently ineligible, temporarily ineligible or eligible for Basic Payment Scheme (BPS) funding, call 01900 702 404.

## ENVIRONMENT AGENCY

Telephone: 0370 8506506  
Email: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk)

## NATURAL ENGLAND

Tel: 0300 060 3900  
Email: [enquiries@naturalengland.org.uk](mailto:enquiries@naturalengland.org.uk)

## CATCHMENT SENSITIVE FARMING

Local contacts to discuss water quality capital items in a Countryside Stewardship Mid Tier application can be found here: [www.gov.uk/government/publications/catchment-sensitive-farming-officer-contacts](http://www.gov.uk/government/publications/catchment-sensitive-farming-officer-contacts)

## FORESTRY COMMISSION

Tel: 0300 067 4190  
Email: [nwwm@forestry.gsi.gov.uk](mailto:nwwm@forestry.gsi.gov.uk)

## LAKE DISTRICT NATIONAL PARK AUTHORITY

Tel: 01539 724555  
Email: [hq@lakedistrict.gov.uk](mailto:hq@lakedistrict.gov.uk)

Ask for Farm Conservation, Historic Environment or the ranger for your area regarding public rights of way.

For planning enquiries, a duty planner is available for brief informal verbal advice on 01539 724555 (Monday – Friday, 9.30 am to 12.30 pm).

Written advice and meetings are also available (chargeable services). See [www.lakedistrict.gov.uk/planningadviceinwriting](http://www.lakedistrict.gov.uk/planningadviceinwriting) for details.

## WOODLAND TRUST

Tel: 01476 581111  
Email: [england@woodlandtrust.org.uk](mailto:england@woodlandtrust.org.uk)

## CUMBRIA WOODLANDS

Tel: 01539 822140  
Email: [info@cumbriawoodlands.co.uk](mailto:info@cumbriawoodlands.co.uk)

## FARMER NETWORK

Tel: 01768 868615  
Email: [info@thefarmernetwork.co.uk](mailto:info@thefarmernetwork.co.uk)

## WILDLIFE TRUSTS

### Cumbria Wildlife Trust

Tel: 01539 816300  
Email: [mail@cumbriawildlifetrust.org.uk](mailto:mail@cumbriawildlifetrust.org.uk)

### Lancashire, Manchester and North Merseyside Wildlife Trust

Phone number: 01772 324129  
Email: [info@lancswt.org.uk](mailto:info@lancswt.org.uk)

### Cheshire Wildlife Trust

Phone number: 01948 820728  
Email: [info@cheshirewt.org.uk](mailto:info@cheshirewt.org.uk)

## FARMER-LED NATURAL FLOOD MANAGEMENT GROUPS

### **Abbeystead Farmer Group**

Tom Myerscough  
tom@wyriverstrust.org

### **Pendle Hill farmer group**

Sarah Robinson  
sarah.robinson@lancashire.gov.uk

### **Sandstone Ridge Farmers Network**

Dr Nichola Hall  
Nichola@reaseheath.ac.uk

### **Dane Headwater**

Jim Pimblett  
jpimblett@cheshirewt.org.uk

### **Lower Dane farmer group**

Carl Smethurst  
carl.smethurst@merseyforest.org.uk

### **Borrowdale Landscapes**

Ian Wrigley  
ian@ianwrigley.co.uk

### **Stockdalewath NFM Group**

Paul Arkle  
paul@cumbriaefp.co.uk

### **Glenderamackin NFM Group**

Paul Arkle  
paul@cumbriaefp.co.uk

### **Cocker catchment farmers group**

Philippa Chadwick  
West Cumbria Rivers Trust,  
philippa@westcumbriariverstrust.org

### **Lower/Leith catchment farmers group**

Sarah Kidd, Eden Rivers Trust  
sarah.kidd@edenrt.org

### **Lunesdale Catchment Group**

Hannah Fawcett  
Hannah.Fawcett@yorkshiredales.org.uk

### **Ribblesdale Farm Group**

Adrian Shepherd  
Adrian.shepherd@ydmtd.org

## CASE STUDIES

### **The Pontbren project: A farmer-led approach to sustainable land management in the uplands**

[www.woodlandtrust.org.uk/mediafile/100263187/rr-wt-71014-pontbren-project-2014.pdf](http://www.woodlandtrust.org.uk/mediafile/100263187/rr-wt-71014-pontbren-project-2014.pdf)

### **Stroud Natural Flood Management/Rural Sustainable Drainage scheme**

[www.stroud.gov.uk/environment/flooding-and-drainage/stroud-rural-sustainable-drainage-rsuds-project](http://www.stroud.gov.uk/environment/flooding-and-drainage/stroud-rural-sustainable-drainage-rsuds-project)

### **From source to sea: natural flood management – the Holnicote experience (2015) National Trust**

[www.nationaltrust.org.uk/holnicote-estate/documents/from-source-to-sea---natural-flood-management.pdf](http://www.nationaltrust.org.uk/holnicote-estate/documents/from-source-to-sea---natural-flood-management.pdf)

### **Slowing the flow at Pickering, Forest Research**

[www.forestry.gov.uk/fr/slowingtheflow](http://www.forestry.gov.uk/fr/slowingtheflow)

## FURTHER INFORMATION

### **Natural Flood Management Handbook (2015), Scottish Environment Protection Agency**

[www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf](http://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf)

### **Runoff Attenuation Features (2011), Newcastle University/Environment Agency**

[https://research.ncl.ac.uk/proactive/belford/papers/Runoff\\_Attenuation\\_Features\\_Handbook\\_final.pdf](https://research.ncl.ac.uk/proactive/belford/papers/Runoff_Attenuation_Features_Handbook_final.pdf)

### **Simply Sustainable Water (2013), Linking Environment and Farming (LEAF)**

[www.leafuk.org/resources/000/691/685/SSW.pdf](http://www.leafuk.org/resources/000/691/685/SSW.pdf)

### **Farming in the uplands for cleaner water and healthier soil (2010), Natural England**

<http://publications.naturalengland.org.uk/publication/9031>

### **Water Friendly Farming and catchment management, Game & Wildlife Conservation Trust, Freshwater Habitats Trust, The University of York, Syngenta**

<http://freshwaterhabitats.org.uk/research/water-friendly-farming>

### **Working with natural processes to reduce flood risk, Environment Agency**

[www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk](http://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk)

# NATURAL FLOOD MANAGEMENT MEASURES

A PRACTICAL GUIDE FOR FARMERS

