Lowland Natural Flood Management Measures
– a practical guide for farmers

Dales to Vale
Rivers Network

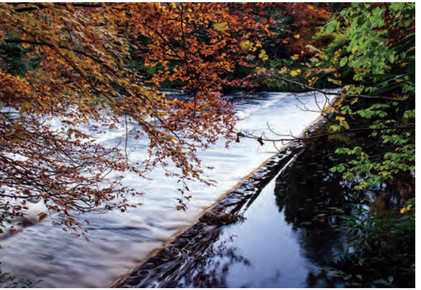


Image © Paul Skirrow

Natural Flood Management Measures – a practical guide for farmers

This guide has been produced to provide simple, clear advice on the provision of natural flood management measures for lowland areas.

This document is based on the publication 'Natural Flood Management Measures – a practical guide for farmers (2017),' produced by the Yorkshire Dales National Park. It has been compiled by the Yorkshire Dales Rivers Trust, Hull & East Riding Catchment Partnership, Dales to Vale River Network and North Yorkshire County Council, with support from Natural England and the Environment Agency.

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.

If you have any comments or need further information about this publication please contact us at dvrn@ydrt.co.uk

Introduction

Floods are nothing new. Humans have lived with extreme weather for thousands of years. However, climate change science predicts an increase in occurrence and severity of high rainfall events. Subsequent increases in extreme flooding will follow suit.

Within the UK, our flood defence system includes large-scale, hard engineered solutions in and around major cities, flood banks and small scale engineered solutions for rural communities and farmland, and coastal engineering. There is increasing political and public interest in how the management of the wider countryside can contribute to the country's flood defence system, with reference made to natural flood management (NFM) sometimes called Working with Natural Processes (WwNP).

The conundrum faced by landowners and managers is associated with pressure to increase crop yield related to market forces, to achieve the same level of farm income. This guide aims to provide information to landowners to allow them to decide on which NFM measures will match their farm business.

Image © Yorkshire Dales River Trust

What is natural flood management?

Natural flood management aims to reduce the downstream maximum water height of a flood (the flood peak) or to delay the arrival of the flood peak downstream, increasing the time available to prepare for floods.

This is achieved by restricting the progress of water through a catchment using a range of techniques. These techniques work with the natural features of the catchment to slow down or store flood waters. They rely on one, or a combination, of the following underlying mechanisms:

1. **Increasing soil infiltration:** an open soil structure that will make saturation less likely, potentially reducing surface runoff.
2. **Evaporation** from vegetation and soil can also make space for water.
3. **Slowing water:** by increasing resistance to its flow – for example, by planting floodplain or riverside woods, or blocking grips on moorland.
4. **Storing water** by using, and maintaining the capacity of, ponds, ditches, embanked reservoirs, channels or land.
5. **Reducing water flow connectivity** by interrupting surface flows of water – for example, by having buffer strips of grass, hedges or trees.

Natural flood management measures have been designed so that they do not significantly impact on farming. They are typically small in size and can be considered an extension to the farm's land drainage or as part of an Internal Drainage Boards maintained network.

Each structure or technique performs a small amount of runoff storage or attenuation, gradually releasing flood water over 12 to 24 hours. It is the collective network, rather than individual features, that aims to provide flood mitigation in the immediate vicinity and further downstream.

In lowland Yorkshire, good management of soil is critical to productivity and natural flood management. This includes practices which are beneficial for soil and water health, including increasing organic matter, contour ploughing and appropriate drainage as well as sensitive ditch management, employing buffer strips and rainwater harvesting.

This publication covers lowland areas in Yorkshire. It is one of two publications, the other one being specifically for upland areas and is available from the Yorkshire Dales National Park.

Natural flood management is not the complete solution to flooding but is one of many tools needed to manage flood events and water levels by taking a total catchment management approach. These tools are proven to be effective at reducing the frequency of flooding for high probability fluvial events (for example, less than a one in twenty-year return period) rather than extreme events (for example, a one in 200-year return period). Used in conjunction with other flood management solutions like hard engineering, natural flood management will have a beneficial impact on slowing the flow of flood water downstream. Research at several small-scale catchments has shown this to be the case.

Why land management in Lowland Yorkshire can play its part

Most of the main rivers which flow through the Yorkshire lowlands arise in the hills of the Pennines and North York Moors. They can cause problems by directly flooding farmland and settlements, but it can be the smaller tributaries which affect homes, businesses and infra-structure in their catchments. Natural flood management techniques often work well on a smaller scale, and whatever your focus is, as a farmer, land/water level manager such as an Internal Drainage Board (IDB), you may be in a position to help contribute to the reduction of flooding locally or regionally.

Research carried out by Leeds University in the Yorkshire Dales indicates that a combination of simple flood management measures over 10% of the catchment area can help slow down the flow of water during high rainfall events by up to 12%. This is a significant effect and is something that can be achieved from a farming, land and drainage management perspective without sacrificing production levels or greatly altering land or water level management practices.

Help us keep track

Please keep us updated! If you choose to implement a natural flood management technique on your land, let us know:

- the date of construction
- which technique was used
- the size and number of treatments used

This will help us monitor the use of natural flood management in our area and enable us to evaluate the success.

Contact details: **dvrn@ydrt.co.uk**

Using the guide

This guide has been developed to provide the advice and key information needed to aid decision-making, should you wish to install flood management features on your farm. We have included funding sources to support the work you may want to undertake.

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 Local Authority or local Internal Drainage Board consent or Environment Agency (EA), local Internal Drainage Board consent. These measures are usually low cost and simple to install, but extremely effective.
Level 2	Measures requiring a certain level of consultation and possibly consent of authorities (see summary of consents section). These measures are a mix of low to medium cost and may need contractors' help to install them.
Level 3	Measures involving a level of design that is targeted to certain locations within the catchment, requiring planning permission and consents from authorities, and, in most cases, involving professional water management consultant advice. 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 production, and its overall cost. Set up and maintenance costs have been colour-coded, with the definition provided here:

Set up costs

HIGH

Requires significant raw materials, specialist equipment, or expert involvement

MEDIUM

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

LOW

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

Maintenance costs

HIGH

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

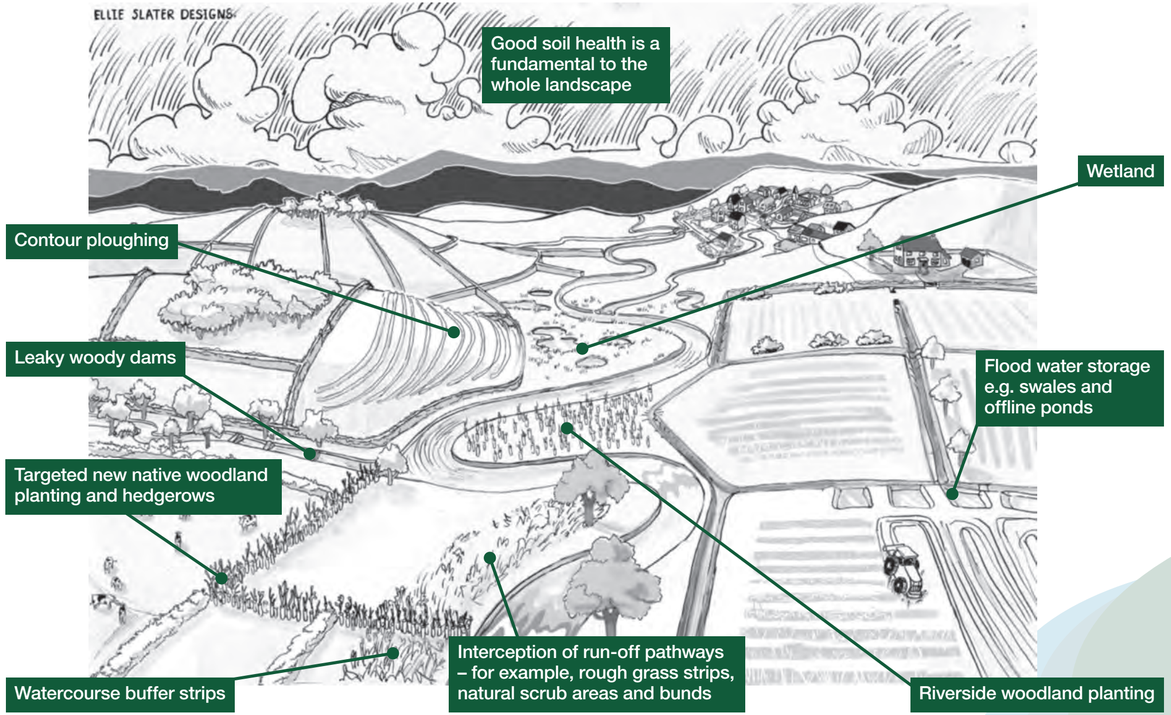
MEDIUM

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

LOW

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

Possible locations of natural flood management measures within the Yorkshire lowland landscape



Intervention treatments: Level 1

Arable field with Challenger © Natural England

Increasing Soil Health – reducing soil compaction

Compaction is where soil particles are pressed together reducing pore space between them, turning the soil into a solid, impermeable layer either at the surface or within the topsoil. This band restricts the movement of air, water and nutrients down through the soil profile.

Hence heavily compacted soils contain few large pores and have a reduced rate of both water filtration and drainage. Soil compaction can be caused by a range of things, from grazing livestock (hooves, gathering in gateways) to farm machinery (frequent passages of machinery, heavy machinery).

The effects of soil compaction can be detrimental to grass/crop production, reducing the ability of crops to pick up nutrients, including phosphates, nitrogen and potassium from the soil. It creates conditions for waterlogging and poaching, and increases the risk of runoff, leading to soil and nutrient loss. Wet soils stay colder for longer, reducing the number of available grazing days. In an arable situation it can reduce the windows for all machinery operations on the land. Runoff from compacted soils is 50-60% higher than on aerated healthy soils.*

*Agriculture and Horticulture Development Board (AHDB), 2016

Natural flood management purpose

- Managing soil compaction is an effective treatment farmers can undertake to reduce overland flow, lower flood risk and improve soils
- It can help to increase the water holding capacity of the soil.
- It improves connectivity with groundwater by promoting strong root growth.

Agricultural benefits

- More efficient crop growth.
- Stronger roots.
- Enhanced soil water uptake.
- Improved nutrient uptake and use.
- Improved soil structure with reduced cultivation costs
- Reduced water runoff and soil loss
- Improved air exchange between the soil and atmosphere.
- Enhanced heat and drought stress tolerance.
- Enhanced beneficial soil biology for example more earthworms.

Methods

Check your type and soil condition:

- Assess current soil structure by digging a hole, up to 40cm deep, to look at condition of soil and depth of compaction in topsoil and subsoil – look out for signs of waterlogging and look for evidence of soil biota, particularly earthworms.
- Produce a cultivation plan to include subsoiling, sward lifting through to minimum tillage techniques, where appropriate, to improve soil condition.
- Consider introducing solid manure to increase soil water retention capacity, increase biodiversity, encourage worms to aerate the soil making nutrients more accessible to plants
- Undertake soil test to identify pH – add lime if below 6. This encourages separation of soil particles from one another, creating air pockets.

Increase soil aeration:

- Implement your updated cultivation plan
- To help reduce compaction consider crop rotations and livestock grazing regime
- Avoid using heavy machinery on wet soils to reduce soil damage
- Check you are using the optimum tyre pressures for the soil condition
- Consider the use of cover crops, re-seeding or over-seeding using deep rooting plant species.
- Consider Controlled Traffic Farming to reduce the area of field travelled on

Considerations

- Consider all archaeological features before starting and mechanical treatment as – as these can be damaged– particularly where these operations have not been carried out before.

Level of maintenance

LOW

Key locations

- Any field where water is seen to flow across the surface in high rainfall events.
- Fields used for winter grazing.

Costs

Set up	LOW
Maintenance	LOW

Funding

- Currently, the Countryside Stewardship (CS) scheme contains a range of buffer strip, grass margin, and riparian management strip options, with payments ranging from £170 to £557 per hectare. Consideration needs to be given to the access required by IDBs and the management regime under CS
- Local Rivers Trusts (RT) may assist with riparian fencing cost in their project areas.
- Farmer can use his Ecological Focus Area (EFA) fallow options to create buffers

Additional information

Soils

http://beefandlamb.ahdb.org.uk/wp/wp-content/uploads/2016/07/BRP-Improving-soils-for-better-returns-manual-3.pdf
https://ahdb.org.uk/projects/documents/ThinkSoils.pdf
http://www.landis.org.uk/soilscapes/
Soilandwater.org.uk

Soil health © YDRT

Increasing Soil Health – managing soils in an arable rotation

Soil health is a measure of how able a soil is in sustaining maximum plant growth and biodiversity whilst offering additional benefits for sustainability such as flood mitigation and drought resistance.

Soil health is essential for efficient crop production, water and nutrient movement, drought and flood resilience.

Natural flood management purpose

- Good soil health increases resilience to flooding and drought, absorbing water and releasing it in a controlled manner.
- A soil in good condition has a greater ability to mitigate changes in water levels.
- Contour ploughing prevents the development of compacted tracks and runnels which channel water downhill. Plough lines perpendicular to flow paths will inhibit runoff and water will pool in the tracks.
- Solid manures, properly introduced, will reduce soil erosion and runoff through increasing soil organic matter to improve soil structure, resulting in improved water infiltration and increase water-holding capacity

Agricultural benefits

- Increased soil stability to work towards more sustainable rotational cropping regime
- Increased windows for cultivation, drilling and harvesting
- Better uptake of nutrients
- Contributing to an increase in crop yield
- Increasing water holding capacity with addition of organic matter to the soil, more resilient to impact of drought, reducing soil erosion and increased nutrient retention
- Improved drainage
- Improved drought resistance
- Improved resilience to flooding impacts
- Potential to reduce Fixed & Variable Costs of machinery
- Reduced nutrient requirements
- Contour ploughing
  - Increases the volume of water held in the soil
  - Varying ploughing direction can reduce soil compaction due to heavy machinery

Methods

- Increase water filtration
- Establish soil health – when sampling include Soil Organic Matter analysis
- Based on your analysis of soil health use:
  - Appropriate measure for cultivations including Minimum tillage, Contour ploughing
  - Appropriate timing for working the land
  - Appropriate arable crop choice
  - Extend rotations to include cover crops
  - Select right Cover Crop for the soil condition/right issue/level of compaction/Nitrogen Mop up post-harvest
  - CTF and Precision faming e.g. yield mapping
- Apply Organic manures, either livestock or industrial manures (Solids or liquids)
- Consider your use of contractors and the timing of the work
- Remove livestock when fields are wet

Considerations

Over cultivation can lead to damaged soil health so consider:

- Timing of work
- Level of maintenance
- Yield mapping – IT precision farming
- Use of contractors – timing, passes,
- Length of crop rotations and use of cover crops – see section on cover crops

Level of maintenance

LOW

Key locations

- Any field where water is seen to flow across the surface in high rainfall events
- Any field where an impact on crop development is seen
- Areas such as gateways, headlands and headlands used for travelling.

Costs

Set up	MEDIUM HIGH
Maintenance	LOW

Funding

- Countryside Stewardship (CS) scheme capital grants – mid and higher tier, hedgerows and boundaries grant.
- Woodland Trust (WT)

Additional information

thinkSoils EA
Agriculture and Horticulture Development Board
Soilandwater.org.uk

Pollinator buffer strip © Shires Group IDB

Creating and managing buffer strips

Management of vegetated/grass strips next to watercourses and ditches – known as riparian buffer strips – can provide a physical barrier that helps restrict the flow of storm water, carrying sediment and nutrients, and prevents them from being washed from the field into the watercourse. They can be used in both arable and grass fields and give the same result. They also protect the watercourse from erosion, increase biodiversity and prevent poaching.

In-field buffer strips, as their name implies, are found adjacent to field boundaries, be they ditches, watercourses, hedges etc. and across fields. They can reduce overland flow reducing soil loss impacting roads and neighbouring properties. Buffer strips that run perpendicular to flow paths will inhibit runoff and hold water tracks.

Natural flood management purpose

- Vegetation in the buffer strip increases the roughness of the land surface, which slows the flow of runoff and increases infiltration.
- Buffer strips trap sediment, reducing sediment flow into watercourse.
- They stabilise the banks of watercourses, helping prevent erosion and siltation from bank material.

Agricultural benefits

- Buffer strips trap and filter runoff, by catching soil sediment protecting most valuable asset, reduce fertiliser loss, and hold herbicides and pesticides. Ten-metre-wide strips reduce sediment loss by 30%. This aids compliance with the New Farming rules for Water.
- They create wildlife corridors and sites for ground-nesting birds, small mammals and beneficial insects including pollinators.
- They reduce frequency of ditch management through decreased rates of siltation and weed development from increased nutrient levels.
- They enhance crop management operations by straightening irregular field edges.
- They control or prevent erosion of valuable top soil from fields into watercourses, so reducing levels of silt and contamination by organic wastes.
- The root system of the vegetation in the buffer strip will absorb nitrogen
- They help reduce nitrate leaching as vegetation growing on the buffer strip absorbs nitrogen.
- They reduce effects of spray drift into watercourse or onto hedges.

Methods

- Riparian buffer strips should be a minimum of 6m wide for maximum effect and may require fencing to exclude livestock from the riverbanks.
- The in-field buffer strips should be 2m wide. By building a small mound down the in-field buffer strip, a beetle bank can be created, further benefiting the wildlife and encouraging natural predators of crop-eating insects. this can be done easily by ploughing in opposite ways.

Considerations

- These measures can be applied to any small watercourses without restrictions
- Implementation next to main rivers may require Environment Agency consent, if it is to be fenced against livestock.
- Similarly implementation next to ordinary watercourses may require consent from IDBs or the Local Authorities depending on where you are.
- Check the Basic Payments Scheme (BPS) handbook for further guidance if the strip is to be fenced from grazing. If the fence is within 3m of the middle of the river or field boundary, then the eligible area remains unchanged. Wider than this and there may be implications for field boundary changes and reduction in eligible land area.
- IDBs will need access for maintenance of the ditch sides
- Buffer strips will have no impact on the loss of nitrates through field drains.

Level of maintenance

LOW

Key locations

- Throughout the catchment, adjacent to any watercourse, especially on grazed land next to streams and ditches that suffer from high sediment loads.
- In-field strips on arable land at risk of soil erosion caused by wind and/ or water. This option works well alongside other run-off incepting options, such as contour bunds and hedgerows.
- Areas next to stream/ditches/rivers that flood regularly

Costs

Set up LOW

Maintenance LOW

Funding

- Currently, the Countryside Stewardship (CS) scheme contains a range of buffer strip, grass margin, and riparian management strip options, with payments ranging from £170 to £557 per hectare. Consideration needs to be given to the access required by IDBs and the management regime under CS
- Local Rivers Trusts (RT) may assist with riparian fencing cost in their project areas.
- Farmer can use his Ecological Focus Area (EFA) fallow options to create buffers

Additional information

Basic Payment Scheme (BPS)

www.gov.uk/government/news/new-farming-rules-for-water
www.gov.uk/government/collections/basic-payment-scheme
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/705756/BPS_2018_scheme_rules_v5.0.pdf

Grass buffer strips and beetle banks

www.cfeonline.org.uk/1-grass-buffer-strips-next-to-a-watercourse-or-pond
www.swarmhub.co.uk/index.php?dlrid=3991
www.cfeonline.org.uk/2-in-field-grass-strips-to-avoid-erosion
www.rspb.org.uk/Images/Beetle%20banks_tcm9-133200.pdf

Species rich mature hedgerow © Shire Groups IDB

Planting and managing hedgerows

Hedgerows provide excellent natural weather barriers, protecting crops, soils and livestock, provide ideal habitat for farmland birds and wildlife species, but also perform a natural flood management function by trapping and slowing water flow.

Hedgerows are important landscape features and were originally used to divide the land into fields and pens, marking the boundaries of farms and parishes. The older a hedge is the more species and biodiversity it will contain – 100m of hundred-year-old hedge can contain up to 600 species of plant, invertebrates, arthropods, moths, butterflies, snails and other animals. They have an important role as wildlife havens and highways, barriers and wind-breaks.

Natural flood management purpose

- Hedgerows reduce the volume of runoff by promoting rainfall infiltration into the soil and reducing the rate of runoff .
- They remove water faster from the soil than crops during periods of excessive rainfall through increased evapotranspiration.
- They trap sediment and reduce sediment flow into watercourse .

Agricultural benefits

- Hedgerows create areas of shelter and shade for livestock.
- They trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.
- Plant and soil health may also be improved through reductions in standing water from increased infiltration rates.
- Hedgerows provide a barrier to the spread of disease, reducing animal-to-animal contact.
- They provide habitat for farmland birds, beneficial insects such as pollinators, habitat for small mammals, reservoirs for invertebrates and plant species
- Help to balance the predator/prey cycle and act as wildlife corridors
- Hedgerows are a food source from leaves, to fruit, to nuts
- New hedges will also double up as barriers between fields and protect some crops from wind damage

Methods

- New planting: plant a double staggered row hedge using 4-6 plants per metre, with a distance between the rows of 1-1.5m and plant a varied row of trees between these rows. Use tree tubes (0.7m tall) to protect young plants from rabbit damage. Protect both sides of a new hedge with a stock proof fence, erected at least 1m from the centre of the hedge.

Considerations

- Planting should be carried out between November and March.
- Up to 75% of the species can be thorns – for example, hawthorn and blackthorn.
- Consider a mix of shrub species, including hazel, guelder rose, rowan and holly, to enhance hedgerow for wildlife.
- Banked hedgerows provide additional benefits for flood measures by breaking overland flow of water and sediments.
- Trees can also be incorporated.•

Level of maintenance

MEDIUM

- Newly planted hedges will require annual maintenance until at least 1.5m tall, particularly regarding weed control and watering
- Hedgerows can be cut every two years once established.
- The laying of hedge every 12-15 years will increase wildlife benefits and the overall health of the hedge and improve stock proofing.

Key locations

- Consider planting a new hedge across a slope where runoff occurs or perpendicular to the river in a floodplain.
- Where hedgerows have been lost from an area or the network is very fragmented.
- Restoration and management in areas where there are good networks of hedgerows.

Costs

Set up MEDIUM

Maintenance LOW

Funding

- Countryside Stewardship (CS) scheme capital grants – mid and higher tier, hedgerows and boundaries grant.
- Woodland Trust (WT)

Additional information

Countryside Stewardship (CS) scheme

www.gov.uk/government/collections/countryside-stewardship-get-paid-for-environmental-land-management

Ditch management © Natural England

Ditch Management

Drainage ditches play an important role in the lowlands, effectively removing water from agricultural land. Installing natural flood management options in your ditch network can create multiple benefits whilst also fulfilling your duties as a riparian owner. Ditches can help slow the flow of water into main rivers and streams by holding water during rainfall events. With rainfall patterns predicted changed in the future holding water in ditches and encouraging infiltration could help to mitigate against drought.

Ditches are important habitats for wildlife especially where ditch management is designed to take biodiversity into account. They can be connected to small ponds and water storage lagoons, providing corridors for wildlife to pass along.

On large ditches creating a staged or stepped berm will help to protect the bank sides and creates more water storage areas – an important consideration in drier summers.

Natural flood management purpose

- Ditches can hold excess water in rainfall events, encouraging infiltration and sediment drop out, as well as offering storage opportunities in times of drought
- In-ditch barriers, such as woody material dams or coir rolls planted with vegetation, can slow the flow of water into rivers, giving time for sediment to fall out and infiltration of water. They work well in areas where flow is due to gravity.
- Instream and bank side vegetation can filter sediment and pollution improving water quality

Agricultural benefits

- Well managed ditches help to remove excess water from productive fields
- Trap sediment from leaving farm system
- Ditches are habitats for beneficial invertebrates and amphibians
- Increased groundwater recharge

Methods

- Cutting Vegetation: on low/medium flood risk channels cut in autumn and, where conveyance capacity allows, leave sections of emergent vegetation or cut every second year. Different cutting regimes will create dominant vegetation type of your choice. Machines that cut form the bank side can be more selective, removing small patches of vegetation or silt. Avoid entry of cuttings into the watercourse.
  - Selectively cut aquatic plants and/or removal of silt (where applicable) to create a sinuous route. Take care not to create a bathtub effect in the drain bottom as this will undermine the ditch sides
  - Create alternating sections of cut and uncut vegetation in low flood risk channels to slow the flow. The areas of uncut vegetation help to remove nitrates and phosphates from the water.
  - Leave headwaters uncut
  - Dense plant a reedbed to filter and reduce diffuse pollution and trap sediment, which will also hold back water
  - Coppice and pollard trees and shrubs instead of removing them.
- Keep any structures clear of debris.
- Create a management plan to remove/avoid the spread of non-native invasive species such as Himalayan Balsam and Giant Hogweed, these can weaken bank stability and reduce biodiversity.
- Removing culverts, where suitable, reconnects the watercourse to its floodplain
- If using grazing to manage riparian vegetation, carefully monitor to ensure poaching is not happening
- Use soft engineering techniques and local natural material to protect banks from erosion, e.g. willow bundles
- Consider semi-permeable in channel barriers to hold back high flows while allowing the normal flow to continue in the ditch (see in-channel barriers, intervention level 2).

Considerations

- Works well together with soil and land management to avoid soil erosion, sediment traps and riparian buffer strips
- Site specific advice can be given by Local Drainage Board or Environment Agency, especially in particularly flat or pumped catchments
- Consult IDBs where obstructions are being placed in the channel.
- Check for potential impacts upstream – the build-up of silt will need removing from both natural and manmade silt traps
- When cutting aquatic and bank side vegetation precautions will need to be made if protected species are present, such as nesting birds, Great Crested Newts and water voles.
- Ditch reprofiling can also be undertaken (see Ditch Restoration & Management, intervention level 3).
- Buffer strips for cross compliance purposes are measured as 2 metres from the centre of the watercourse or 1 metre on the landward side of the top of the bank running along a watercourse
- On-going maintenance will include removing sediment and overgrown vegetation, and monitoring stability of banks and in channel barriers

Level of maintenance

LOW

Key locations

- Ditches and artificial drainage channels throughout the catchment, mainly found on low-gradient agricultural land.

Costs

Set up	LOW
Maintenance	LOW

Funding

- Countryside Stewardship (CS) Scheme – Mid tier

Additional information

Association of Drainage Authorities (ADA). Value of Water Level Management Environment **https://www.ada.org.uk/downloads/publications/Value-of-Water-Level-Management-Environment-web.pdf**

Environment Agency. Living on the Edge **https://www.spelthorne.gov.uk/CHttpHandler.ashx?id=3555&p=0m**

The Drainage Channel Biodiversity Manual **https://www.ada.org.uk/wp-content/uploads/2017/01/The-Drainage-Channel-Biodiversity-Manual.pdf**

Using trees © YWT

Using trees

Well-sited and well-managed woodland can contribute to the delivery of a host of outcomes both on the floodplain and riparian areas. They provide important wildlife habitat, increased canopy shade, shelter and habitat for water-based flora and fauna. They can also provide shade and shelter for livestock and prevent damage to crops and soil erosion.

There is growing interest in the potential to use woodland measures to help reduce flood risk. The Forestry Commission (FC) has been directly involved in several trials and demonstration projects – for example, at Pickering. These projects have shown that looking after existing native woodlands and plantations, and targeting certain areas for tree planting, will significantly slow overland flow of water and reduce riverbank erosion within that area.

Tree planting can vary from planting in hedges, buffer strips, corner planting to Agro-forestry, a land use system in which tree or shrubs are grown around or among crops or grassland, integrating the benefits of trees with agricultural production and helping to control surface run off during heavy rain.

Natural flood management purpose

- Planting of trees including understorey, increases the roughness of the surface vegetation, slowing the flow of water during a flood event.
- Fencing off tree planting areas increases vegetation cover – even in the first year
- It reduces the volume of runoff, by promoting rainfall infiltration into the soil
- Installing smaller out of stream storage/interception methods such as brash dams will also increase surface roughness and slow runoff.
- Well-managed woodland cover can increase the capture and evaporation of rainfall.
- Interception can reduce the amount of rainfall reaching the ground by as much as 45%, or more for some types of woodland. A reduction of even half of this amount could therefore make a major contribution to flood control.
- Woodland soils typically have a relatively open, organic, rich upper layer, which facilitates the rapid entry and storage of rain water – a 'sponge' effect.
- The roots of bankside trees and associated vegetation help to bind and strengthen stream banks, reducing the risk of bank collapse, erosion and siltation.

Agricultural benefits

- Using trees creates areas of shelter and shade for livestock.
- They reduce floodwater damage on productive farm land.
- They trap and filter runoff, preventing loss of fertilisers, sediment and pesticides.
- They increase biodiversity

Methods

- The optimum area to be planted and the mix of suitable species varies at each potential site.

Considerations

- Existing woodlands should ideally be fenced from livestock to encourage tree regeneration and increase vegetation under the canopy.
- New planting will need protecting from livestock grazing.
- Under-planting of shrubs and young tree saplings improves the infiltration rates of existing woodland.
- For new areas, link up with existing woodland or hedgerows to create a wildlife corridor effect.
- Works well alongside the leaky woody dam technique (See In-channel barriers).
- Check Basic Payments Scheme (BPS) Handbook for further guidance; however, if woodland creation is funded through the Countryside Stewardship (CS) scheme, the BPS payment on the site is retained.

Level of maintenance

LOW

- For management of existing woodlands

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.

Key locations

- Throughout the catchment – particularly in upper parts of the catchment.
- Across slope following a contour.
- Existing woodlands, plantations and shelter belts.
- Creating links between woodlands and features
- Alongside watercourses.

Costs

Set up	MEDIUM
Maintenance	LOW

Funding

- Countryside Stewardship (CS) scheme – higher and mid-tier.
- Woodland Trust (WT).

Additional information

Countryside Stewardship (CS) scheme woodland grants **www.gov.uk/government/publications/countryside-stewardship-woodland-management-plan-grant-manual-2017**

Woodland locations and forestry standards **www.forestry.gov.uk/pdf/FR_STF_Pickering_P2_May2015.pdf** **www.forestry.gov.uk/ukfs**

Basic Payment Scheme (BPS) **www.gov.uk/government/collections/basic-payment-scheme**

Pollinator buffer strip © Environment Agency

Winter cover crops

A cover crop is a non-cash crop grown primarily for 'protecting or improving' the soil in between periods of regular crop production. Cover crops can be used repeatedly as part of an arable rotation's long-term strategy to reduce winter runoff and soil loss, improve soil quality and organic matter, and provide other benefits.

Agriculture and Horticulture Development Board (AHDB), 2015

Natural flood management purpose

- Planting of vegetation on land that would otherwise be left bare over winter months after harvest reduces overland flow and increases infiltration of rain into the soil.

Agricultural benefits

- Each cover crop has a different ability such as fixing nitrogen to soil or breaking the soil pan.
- Used consistently over the years, they improve the soil structure and nutrient content, thereby enhancing soil health, increasing soil biological activity and improving crop yields.
- Reduces the need for herbicides and other pesticides.
- Prevents soil erosion and reduces nutrient losses via runoff and leaching.
- Conserves soil moisture.
- Protects water quality.
- Improves soil condition for spring cropping

Methods

- Sow any plant that is suitable for winter sowing and is fast growing to provide adequate cover over winter
- Leaving crop residues throughout winter can also act to protect the soil surface and increase infiltration.
- To reduce the cover crop acting as a green bridge for pests and fungi, it is best to plough it in as a green manure or cut and plough it in.

Considerations

- Deep-rooting plants will provide additional benefits by loosening compacted soils. Using cover crops will require altering the arable rotation away from winter drilling towards spring.
- Can be used as part of Ecological Focus Area (EFA) for the Basic Payment Scheme (BPS) when two species of cover crop are grown.

Level of maintenance

LOW

Key locations

- Works well on arable fields where compaction/soil health is a known problem
- Where water is seen to flow across the surface in high rainfall events in lower parts of a catchment.
- Land vulnerable to nitrate leaching.

Costs

Set up — MEDIUM

Maintenance — LOW

Funding

- Certain types of cover crop can be grant-aided through the Countryside Stewardship (CS) scheme.

Additional information

Basic Payment Scheme (BPS) guidelines
www.gov.uk/guidence/bps-2017

Cover crops
www.cfeonline.org.uk/5-winter-cover-crops
https://cereals.ahdb.org.uk/media/655816/is41-opportunities-for-cover-crops-in-conventional-arable-rotations.pdf

Countryside Stewardship (CS) grants
www.gov.uk/government/publications/countryside-stewardship-mid-tier-including-water-quality-capital-items-manual

Cross drains in farm tracks © YDNPA

Cross drains in farm tracks

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 watercourses.

Tracks are costly to repair but are essential to the farm. A cross drain is a system to move water across a path or route and can be used to collect runoff from a vulnerable area. This can help to reduce erosion of farm tracks and pollutants entering a watercourse. These can come in different forms; channel, depression/hump or sleeping policeman.

Natural flood management purpose

- Cross drains divert the main pathway of water, reducing flow volume, velocity and sediment load.
- When used with a sediment trap, they can slow the flow of storm water significantly.

Agricultural benefits

- Farm tracks suffer from less erosion, less sediment is lost, and they last longer.
- Stone caught in traps can be re-used on the track, saving time and money.
- Cross drains potentially reduce flooding of the track and water gathering at the end of the track.
- Potentially reduce pollution incidents

Methods

- The size of the cross drain will depend on local conditions. Small drains are typically 0.1 x 0.1m, constructed of concrete, wood or clay pipe. For heavy rainfall, 0.2 x0.2m drains can be constructed from stone or wood.

Considerations

- On steep slopes or where runoff volume is high, a number of cross drains will be required, located at specific intervals along the track.
- 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.
- Direct any runoff towards well managed, low risk areas

Level of maintenance

LOW

- Cross drains should be inspected after major storms – cleaned out or reshaped to original capacity if needed

Key locations

- Tracks on steep slopes, adjacent to yards or roads, or within close proximity of a watercourse.
- Vulnerable runoff destination; houses, highways and waterways.
- Hardstanding areas, to segregate dirty (slurry) and clean water.

Costs

Set up — LOW

Maintenance — LOW

Funding

- Countryside Stewardship (CS) scheme.
- Local Rivers Trusts (RT) in their project areas.

Additional information

Countryside Stewardship (CS) grants
www.gov.uk/countryside-stewardship-grants/cross-drains-rp5

Intervention treatments: Level 2

Bunds and detention basins © YWT

Bunds and detention basins

A bund is stone or earth formed into an embankment to hold back water, and often involves the creation of a corresponding detention area. This work can be carried on a wide range of scales depending on the local opportunity, size of the catchment area and the local soil conditions.

Earth bunds work most efficiently when they are located across known surface runoff pathways which appear following heavy rainfall or when the soil is saturated. The detention area holds water until it disperses through a combination of infiltration, evaporation and controlled slow release such as a small pipe, orifice plate or filter material.

The reprofiling of the land can be designed so that the retention area is normally dry and can remain productive, or levels can be set to so that wetland habitat develop by permanently retaining some water. Bunds can be constructed to double up as an access track to drive vehicles and machinery over the waterlogged zones of the field during wetter periods (e.g. Belford), or as beetle banks through larger agricultural fields.

Requirements for Environmental Permiting, Land Drainage Consents, Planning Permission etc will vary depending on the scale of the works, and on whether materials need to be imported from off site. Consideration of this should form part of the design process.

Natural flood management purpose

- Bunds reduce runoff rates by retention and controlled flow release.
- They reduce volume of runoff by increasing the opportunity for infiltration and evaporation .
- They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.

Agricultural benefits

- Bunds reduce soil loss and surface scour.
- They provide opportunity for nutrient reclamation.
- They provide pollutant treatment by allowing settlement.
- Some field pond areas have delivered improved crop yields due to sediment deposited during attenuation (see references for details of the Runoff Attenuation Feature Handbook)
- Holding water in detention basins and encouraging infiltration could help to mitigate against drought.

Methods

- Design of the bunds or detention basin should be site specific and carried out by an appropriate land drainage specialist.
- Detention areas should be sized for the area draining into it.
- Design of bunds should take into account the contour of the surrounding land, the position in the landscape, and the soil type. Construction materials will also depend on the size of the detention basin, the method of flow control used, and consideration of future maintenance.

Considerations

- The location of these solutions may well be suggested by the reaction of the landscape and drainage network to heavy rainfall. Their design should be tailored to each distinct location
- 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.
- For larger schemes, use of time lapse photography to check it is working effectively
- If looking at already wet field corners, consider the habitat already developed. If the habitat that has developed is good then leave it, if not then consider altering it to act as a temporary storage area or wetland habitat.
- Permanent standing water 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. Bigger features will be mapped by the Rural Payments Agency (RPA) and farmers must deduct them from their eligible areas.
- An impoundment licence from the Environment Agency (EA) may be needed if the structure affects a river, stream or lake.
- Where barriers are constructed in already damp field corners, improved habitat can be created by enhancing the wetness.
- This feature should be able to drain and empty completely within 24 hours to allow further storage.
- Raising the outlet pipe above ground level will encourage maximum settlement of any sediment.
- Removal of sediment and re-spreading to land will require a waste exemption licence from the Environment Agency (EA).

Level of maintenance

MEDIUM

- Dependent on the scale and design.
- Arrangements for on-going maintenance may need to be submitted as part of any planning application.
- Clearing of pipes and sediment.

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.
- Low points on the fields, buffer strips or woodland.
- The best method to confirm pathways is to visit site during heavy rainfall and to photograph pathways as they are active (RAF Handbook)

Costs

Set up	MEDIUM
Maintenance	MEDIUM

Funding

- Countryside Stewardship (CS) scheme

Additional information

Design guidance
www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf
www.susdrain.org/resources/ciria-guidance.html
Basic Payment Scheme (BPS) criteria
www.gov.uk/government/collections/basic-payment-scheme
Waste Exemption U10 guidance
https://www.gov.uk/guidance/waste-exemption-u10-spreading-waste-to-benefit-agricultural-land

Swales © JBA Consulting

Swales

Swales are linear, shallow, vegetated drainage features that store surface water and provide the opportunity for infiltration and water treatment by encouraging settlement.

They can be built in combination with bunded detention areas or soakaways, or on their own to channel and redirect water flow that happens after heavy rain.

Easily incorporated into the landscape, the increased roughness of the vegetated channel helps to slow the flow of water. This can be reduced further by the introduction of check dams and berms across the swale.

Swales may be designed to be either wet or dry, depending on land use.

They can also be installed next to tracks and water directed off the track and into the swale e.g. Stroud. This helps to prevent loss of the track material and the development of ruts on the tracks – can save the owner a lot on money on track maintenance. Swales can also be used to direct runoff into wooded areas where the ground is rougher and the water has more opportunity to infiltrate, or into soakaways next to a track.

Natural flood management purpose

- Swales reduce runoff rates by slowing runoff flow.
- They reduce volume of runoff by increasing the opportunity for infiltration and evaporation.
- They trap sediment and pollutants, in high water flow, which can reduce the function of neighbouring watercourses and drainage systems.

Agricultural benefits

- Swales reduce soil loss and surface scour.
- They provide pollutant treatment by allowing settlement.
- Can help protect access tracks and other surfaces from scour.

Methods

- 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.
- Consider vegetation cover once established, and future maintenance e.g. access for mowing.
- Swales are best constructed along a contour or, if down a slope on a gradient of no more than 2 degrees.
- They can be wet or dry (on a day to day basis) depending on land use – good for grazing animals.

Considerations

- The location of these solutions may well be suggested by the reaction of the landscape to heavy rainfall. Their design should be tailored to each location.
- 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.

Level of maintenance

LOW

- Some vegetation control may be required. Maintenance is increased by the addition of structures within the swale.
- Removal of sediment and re-spreading to land will require a waste exemption licence from the Environment Agency (EA).

Key locations

- Shallow slopes prone to runoff during flood events.
- Areas where runoff with a heavy sediment load is known to compromise local drainage.
- Next to farm tracks

Costs

Set up	MEDIUM
Maintenance	LOW

Funding

- Countryside Stewardship (CS) scheme

Additional information

Swale design
http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZX.0HCIIG33ALM59DZ
www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf
www.susdrain.org/resources/ciria-guidance.html
Basic Payment Scheme (BPS) criteria
www.gov.uk/government/collections/basic-payment-scheme
Waste Exemption U10 guidance
www.gov.uk/guidance/waste-exemption-u10-spreading-waste-to-benefit-agricultural-land

Sediment traps © Environment Agency

Sediment traps

Sediment traps are small to medium scale runoff attenuation features that can provide localised slowing of surface flood water and, used across a catchment, can accumulate to result in a reduction in flood peaks downstream.

In addition, these features can benefit water quality by retaining soils and nutrients, effectively minimising the ability of faecal bacteria and fertilisers from reaching the watercourses through runoff.

The features themselves can take many forms, but normally comprise an excavation located on a surface runoff pathway or are created making use of the natural topography of the landscape. Runoff is retained in the depression for a short period by a mechanism such as an earth bund, sluice or leaky dam which allows the slow release of the water. This allows the sediment to settle out while the water in the trap drains down over a period of 24 to 48 hrs.

Soils and nutrients retained in the traps require periodic removal to maintain the storage capacity.

Natural flood management purpose

- Sediment traps hold some excess floodwater, but many would be needed in a catchment to make a big impact on flood peak.
- They reduce siltation of watercourses, so maintaining capacity.
- They can be used as a pre-treatment for other natural flood management measures, such as retention ponds.

Agricultural benefits

- Sediment traps improve water quality.
- They retain washed-off top soil.

Methods

- Optimum position of sediment traps is often indicated by the preferred flow path of water in times of heavy rain or when the land in saturated
- Position can also be indicated by heavy sediment in local watercourses
- Design should be site specific and take into account the contour of the surrounding land, the position in the landscape, and the soil type.
- Consider ease of future maintenance e.g. access for machinery
- If using an earth bund height ideally should not exceed 1.3m and the field side bank should be as gentle as possible, ideally no steeper than 1 in 20, to provide a filter strip function. Ensure access is provided for dredging.
- Raising the outlet pipe above ground level will encourage maximum retention of the sediment load.

Considerations

- Consent from the EA may be required to remove and spread sediment caught in a sediment trap.
- Sediment traps are not intended to treat wastewater or effluents.
- 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. Bigger features will be mapped by the Rural Payments Agency (RPA), and farmers must deduct them from their eligible areas.

Level of maintenance

MEDIUM

- Sediment traps will need to be regularly emptied – the frequency will depend on the area being drained and how much sediment is carried by the stream or ditch. Removal of sediment and re-spreading to land will require a waste exemption license from the Environment Agency (EA).

Key locations

- Within an area where surface runoff flows downhill.
- Adjacent to, or within, ditches.
- Lowest/dampest part of a field

Costs

Set up LOW

Maintenance MEDIUM

Funding

- Countryside Stewardship (CS) scheme.
- Local Rivers Trusts (RT) within their project areas.

Additional information

Agri-environment scheme guidance on 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/guidance-for-sediment-traps-and-bunds/

Basic Payment Scheme (BPS) criteria
www.gov.uk/government/collections/basic-payment-scheme

In-channel barriers © YDRT

In-channel barriers

In-channel barriers can be installed in lowland streams and ditches to hold back floodwaters. These barriers are typically whole tree trunks, secured into place above normal stream level, so that under normal weather conditions water flows naturally but, under storm conditions, flood flows are held back.

This method of holding back flood waters through in-channel barriers is often called 'large woody dams' or 'leaky dams'. As a result, water is stored within the channel behind constructed dams, reducing the downstream flood peak by slowing the flow.

They can also help to reconnect the stream with the floodplain by encouraging the river to overtop its banks

There are a range of different designs of woody dams which are best suited to different types of watercourses

Natural flood management purpose

- A network of in-channel barriers installed on a local scale can control channel flows.
- The dams are created to be slowly leaky, draining the trapped water once the flood period has passed.
- In-channel barriers could reduce the 1 in 100-year flood peak by 20%.
- Dams can be constructed so that floodwater spills onto the floodplain for additional temporary storage where conditions are suitable.

Agricultural benefits

- These structures can successfully reduce localised flooding within the farm holding.

Methods

- Large woody dams are created by laying two large tree trunks in a cross formation across the channel to rest safely on both banks and secured in position, using pins or lashing them to other trees. Smaller timbers can be placed in-between larger ones. The length of the logs needs to be 1.5 twice the width of the ditch. Barriers must be installed in a minimum sequence of 3 and the distance between each barrier should be 7 times the channel width. Leaky dams are constructed by securing a support across the channel and securing slats, either horizontally or vertically to form a discontinuous barrier.
- Varying the height of the timber above normal flow will determine the rate and volume of retained floodwater. This will also permit fish and gravel passage.

Considerations

- Many barriers are likely to be needed in a catchment and their implementation will need careful planning to make sure that the overall pattern of flood flows is not altered as this can cause flood peaks to coincide.
- Barriers must be installed in a minimum sequence of 3 and the distance between each barrier should be 7 times the channel width
- Debris bundles can also be constructed in wooded areas to further roughen the surface of the floodplain and trap overland flows.
- Removal of sediment and re-spreading to land will require a waste exemption license from the Environment Agency (EA).
- In channel barriers may be not appropriate in watercourses that are pumped and would require IDB consent.

Level of maintenance

LOW

- Large woody dams will need periodic checking to ensure the logs are still wedged in the right position. Periodic clearance of debris from the leaky dams will prevent blockage and overflow of water.

Key locations

- Generally suited to a variety of watercourses and ditches throughout the catchment, where holding water back is not going to create additional problems.
- Areas of woodland away from sensitive areas (houses), where the supply of materials is readily available or where naturally fallen trees could be employed.
- Areas of woodland, recommended to be implemented alongside runoff attenuation features – for example, understory planting.
- Can also be located within fields on overland flow pathways.

Costs

Set up LOW

Maintenance LOW

Funding

- Countryside Stewardship (CS) scheme.
- Local Rivers Trusts (RT) within project areas.

Additional information

Slowing the flow at Pickering
www.forestry.gov.uk/pdf/FR_STF_Pickering_P2_May2015.pdf

Offline flood storage ponds © YDNPA

Offline flood storage pond/basin (permanent structure)

Offline flood storage ponds are constructed adjacent to watercourses and – during periods of high flow – some of the river flow is diverted out and into the pond. By forcing some of the flow to travel through a storage pond, the route for the flow downstream is more tortuous, and therefore flood peaks downstream are slower to rise.

Can be combined with in-channel barriers, such as leaky woody dams, which divert flow into the designated offline storage areas, reducing the extent of flooding and protect valuable land/crops

Ponds can be designed to hold some water all year round for ecological benefits or they can be dry and kept in production, only coming into use during low frequency events. By constructing a dry basin with the potential to receive excess water from the channel flooding can be controlled and the extent, and damage, of floods limited.

Natural flood management purpose

- Floodwaters are directed out of the channel into a pre-constructed storage area. The water then slowly infiltrates or is released back into the channel via an outlet point once the flood peak has passed.
- Ponds can be designed to hold some water all year, adding to the wildlife value of the farm.
- Offline ponds reduce runoff rates by retention and controlled flow release.
- They trap sediment which can reduce the function of neighbouring watercourses and drainage systems.

Agricultural benefits

- Sediment is removed from the flow which improves water quality and it can be returned to the farmer's field during maintenance.
- The depth and the speed of drainage can be manipulated according to the site and the requirements of the farmer.
- They help to control the location and extent of flooding, protecting valuable land and crops.
- They contain the floods and prevent dirty flood water contaminating land.
- Offline ponds can be designed to respond to events of varying severity so there is flexibility in how often the area is inundated
- Multiple small ponds can be dug along a water course on less valuable land.

Methods

- Offline ponds must be individually designed according to the characteristics of the site and as part of a wider consideration of how flood events affect the wider catchment.
- Ponds should drain within 6-10 hours, so that there is storage available in the eventuality of multi-day extreme events. Example size range e.g. can be about 10-20m square and about 1m deep.
- Offline ponds can be constructed in combination with other NFM measures such as in-channel barriers giving more flexibility to the location of the features.
- The maximum height of the water in the pond, when full, needs to be greater than the height of the in-channel barriers restricting the flow to ensure the pond's banks are not breached.

Considerations

- Test pits will be needed to see how well the pond will hold water, if a permanent source of water is desired.
- Where the channel is large enough to support fish, features should be designed to allow fish caught in the ponds to find a route back to the channel as the flood waters recede (RAF Handbook)
- Ponds 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. Bigger features will be mapped by the Rural Payments Agency (RPA), and farmers must deduct them from their eligible areas. An impoundment licence from the Environment Agency (EA) may be needed if the structure affects a river, stream or lake.

Level of maintenance

MEDIUM

Sediment Check for scouring of inlet feature. The soil barrier may erode but should stabilise after grass has established. Sediment may accumulate to the level of the pipe and may need removal.

- Dependent on the scale and design.
- Arrangements for on-going maintenance may need to be submitted as part of any planning application.
- Any in-channel features will also need to be maintained.
- If the basin is dry and only inundated occasionally, maintenance will be even less.

Key locations

- Near to watercourses in non-productive areas of land – buffer strips, inside small meanders or field corners, throughout the catchment.
- Areas where high value land is in danger of being flooded (dry basin would limit the spread of the flood)

Costs

Set up HIGH

Maintenance LOW

Funding

- Countryside Stewardship (CS) scheme

Additional information

Design guidance
http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Fluvial_Design_Guide_-_Chapter_10.sflb.ashx

Intervention treatments: Level 3

Floodplain restoration

While natural flood management measures associated with land management seek to reduce flood water generation, natural flood management measures in the river channel or on its bank or floodplain seek to improve the ability of rivers to manage those floodwaters.

Scottish Environment Protection Agency (SEPA), Natural Flood Management Handbook, 2016

Restoring the connection between a river and its floodplain provides a valuable contribution to natural flood management, allowing floodwater to spill naturally onto land to provide significant flood storage, reducing risk to lives and property further downstream. The mid and lower parts of the river system, where the river enters the flatter floodplain, are the most appropriate areas.

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 (RT) and Environment Agency (EA) staff and early contact is highly recommended.

River and floodplain restoration encompasses a range of different techniques which are often used in conjunction. They include restoring meanders and removal or setting back of flood banks, often together with habitat creation such as wetlands, habitat for breeding and wintering waders, and wet woodland.

Ditch/Dyke Restoration © YWT

Ditch/Dyke Restoration © Chris McGregor

Ditch/Dyke Restoration & Management

This is working to alter drainage ditches so that the water holding capacity is increased and/or the flow of water is slowed down

Restoring drainage ditches to a more natural state will need consultation with organisations like Wildfowl & Wetlands Trust, Rivers Trust and your local Internal Drainage Board if you're in an IDB District. There is no 'one case fits all' for restoring drainage ditches, some drainage ditches may require slight alteration or re-meandering, some may be best removed altogether. Restoring natural features to drainage ditches of any size, has many benefits including a reduction on the amount of management required, flood risk reduction and habitat creation.

Restoration techniques include:

- Bed restoration – improves the stability of the channel and its resilience to erosion. A way to restore the channel bed is reinstate gravel, if the channel previously had gravel.
- Re-profiling – increasing the width of the drainage ditch to allow more gradually sloping banks increases flood storage volume. Incorporating berms (or terraces) along both sides of the banks at varying heights provides habitat for reeds and marginal plants, adding to the biodiversity value of the ditch. A 'silt trap' trench can be incorporated into the ditch to collect silt and pollutants, creating known points where silt collects, reducing the length of channel that needs dredging. Planting reeds, which act as a natural filter for soil in the water course, downstream of the 'silt trap' trench will collect any pollutants and sediment that do not collect in the trench. Reed planting can also act as a stand-alone feature.
- Tree and shrub planting – will shade the banks, which will limit the amount of vegetation that grows and that needs to be cut. They can also be used to help stabilise the banks, which reduces sediment erosion. It is important to plan any planting carefully as too many trees and shrubs will block out any light getting to the watercourse. See 'using trees' section for more details.
- Restoring meanders – see later section

Restoration of drainage ditches reduces the management needed, as the more gradually sloping sides planted with wetland species significantly reduces the amount of soil entering the water course. However, if it is not possible to restore the drainage ditch, then there are ways of incorporating natural flood management techniques to its general management.

Natural flood management purpose

- Restoration can increase flood storage volume.
- Reducing diffuse pollution with silt and pollutant traps, means that pollutants do not spread over the whole water course. Pollutants such as nitrates and phosphates result in algal blooms and blanket weed
- Capturing sediment with silt traps, means that silt does do not spread over the whole water course. These will need maintenance to remove the build up of silt which reduces the flood storage volume of the channel.

Agricultural benefits

- Less time and cost to maintenance
- Soil erosion is reduced significantly.
- Does not encroach too much on to agricultural land.

Methods

- Design and dimensions are entirely site dependent and will need detailed specialist advice.

Considerations

- Need to get advice from organisations like Wildfowl & Wetlands Trust, Rivers Trust and your local Internal Drainage Board if in an IDB District before starting to restore or incorporate natural features into the management of drainage ditches.
- Need to get advice on management of the ditch. Some times it is better for the ecology of the drain, if it is not cleaned out, or is cleaned out in sections
- Any restoration should be done in sections of around 100 metres along the bank, to allow wildlife to recolonise.
- Any work undertaken should not conflict with bird nesting seasons for example.

Level of maintenance

LOW

Key locations

- Any drainage ditch

Costs

Set up HIGH

Maintenance LOW

Funding

- Countryside Stewardship (CS) scheme
  https://www.gov.uk/countryside-stewardship-grants/ditch-dyke-and-rhine-restoration-wn3

Additional information

www.wwt.org.uk/uploads/documents/1429707026_WWTConstructedFarmWetlands150422.pdf
www.ada.org.uk/wp-content/uploads/2017/01/The-Drainage-Channel-Biodiversity-Manual.pdf

Image@ B Murphy, Rodley Nature reserve

Wetland creation

Wetlands are normally shallow ponds and marshy areas covered almost entirely in vegetation. Wetlands will hold some water all year round to support the plants and species found in these habitats and are designed to hold extra water in a flood event.

They are designed to accept water run-off that might otherwise discharge into a watercourse and to hold it for long enough to allow sediments to settle and for pollutants to be removed through plant uptake and breakdown in the soil.

Wetlands also provide significant biodiversity benefits. Designs for wetlands vary widely and can range from a simple wet area to systems with multiple stages and habitats

Natural flood management purpose

- Retention of some water all year round but with greater capacity in flood events
- Can reduce flood peak downstream
- Reduce sediment load

Agricultural benefits

- Can act as a sediment trap.
- Effective removal of water contaminants including suspended sediments and pathogens
- Retention of Year-round water
- Improvements to biodiversity

Methods

- Design and dimensions are entirely site dependent and will need detailed specialist advice.
- Wetlands should be designed with a significant storage capacity.

Considerations

- Requires land and maintenance
- Wetlands 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. Bigger features will be mapped by the Rural Payments Agency (RPA), and farmers must deduct them from their eligible areas. An impoundment licence from the Environment Agency (EA) may be needed if the structure affects a river, stream or lake.
- Wetlands should not be created in areas where they may pose a flood risk to nearby property.

Level of maintenance

LOW

Key locations

- Throughout catchments.
- Low lying areas that are already wet or often hold water
- Simple wetlands are more suited to a small-scale intervention plan on a single farm
- Complex multi-stage wetlands can be designed on larger areas and across estates where they can provide additional recreational benefits.

Costs

Set up HIGH

Maintenance LOW

Funding

- Countryside Stewardship (CS) scheme

Additional information

Design guidance
http://evidence.environment-agency.gov.uk/FCERM/Libraries/Fluvial_Documents/Fluvial_Design_Guide_-_Chapter_10.sflb.ashx

image@R Malster

image@R Malster

Reconnecting the river with its flood plain

This is working to directly reconnect the river with its floodplain using a wide range of techniques. Choice of technique is dependent upon the type and characteristics of the water body in which it is going to be applied, as well as the size of the water course in question

These include:

- River restoration
- Reconnecting old side channels
- Breaching of existing earth bunds
- Improving the operation of flap valves within embankments
- Lowering of flood defences
- Connecting the river to floodplain wetland
- Removing or modifying pumping stations
- Breaching embankments as part of habitat creation projects.

Reconnecting a river with its floodplain can be carried out on a variety of scales. When looking at re-connecting the floodplain consideration needs to be given to the size of the watercourse and the expected affect that the work will have on flood characteristics, not only at the site but also downstream. Other considerations should include the effect on peak flow, the flows in other tributaries, the impact of water coming back into the system and the impact on neighbouring land

For larger water courses and flood plain areas flood modelling is necessary.

Natural flood management purpose

- Storage of small or large amounts of floodwater on the floodplain, with a discharge back to the river once the flood event has passed.

Agricultural benefits

- Potential benefits will be specific to the location chosen.

Methods

- Dimensions are entirely site dependent and will needed detailed specialist advice.
- Pre-works 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).

Considerations

- The Rural Payments Agency (RPA) will need to be informed about any changes to the land parcel areas.
- Environment Agency (EA) advice and consent will be required as part of the planning for this kind of project.
- The Land Drainage Authority for the area will need to be consulted for advice and possibly consent during the planning of the project. The Lead Drainage Authority can be either the Internal Drainage Boards (IDBs) or the Local Authority depending on the area.

Level of maintenance

MEDIUM

Areas of restoration will need to be monitored to ensure that further erosion of the riverbanks or deposition does not occur.

Key locations

- Principally, where floodplains are wide and flat and there is no risk to property or infrastructure. [Scottish Environment Protection Agency (SEPA), Natural Flood Management Handbook, 2016]

Costs

Set up HIGH

Maintenance MEDIUM

Funding

- Specialist advice on funding is needed.

Additional information

Example floodplain project –
www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/6.3_Long_Eau.pdf

Image@YWT

Little Went, East Hardwick, Danvm DC District, coir rolls have been used to create meanders in this area and to protect the toe of the bank. Image @ Shire Group IDB.

Restoring meanders

In the past, rivers have been managed to increase the land available for agriculture by straightening the channel and to protect land from flooding by building embankments. Even small becks have often been altered. These changes combine to disconnect rivers from their natural floodplain, speed up the flow of water and reduce the available area for water storage, increasing the flood risk for those downstream.

Restoring meanders can be by physically digging out the meander or by encouraging the power of the water to form its own natural course. This can be enhanced with the installation of flow deflectors which can help to focus the flow to speed up the natural process. This can also create areas of still water which have benefits for fish and other aquatic species.

Natural flood management purpose

- Restoring the shape (morphology) of the beck or river by re-creating meanders which will increase the time taken for the floodwater to flow downstream.

Agricultural benefits

- Potential benefits will be specific to the location chosen.

Methods

- Dimensions are entirely site dependent and will need detailed specialist advice.

Considerations

- Reconstructed meanders usually substantially improve the fisheries of the beck.
- The Rural Payments Agency (RPA) will need to be informed about changes to the land parcel area.
- Environment Agency (EA) advice and consent will be required as part of the planning for this kind of project.
- The Land Drainage Authority for the area will need to be consulted for advice and possibly consent during the planning of the project. The Lead Drainage Authority can be either the Internal Drainage Boards (IDBs) or the Local Authority depending on the area.

Level of maintenance

LOW

Very little, once the initial work is done.

Key locations

- Re-meandering needs careful planning but can be used anywhere where becks and rivers have been straightened. It is most likely to be practical where the same landowner owns both sides of the channel. Small becks/ tributaries in the catchments will be easier to restore than main rivers. Remnant meanders can often be identified using aerial photos.

Costs

Set up HIGH

Maintenance LOW

Funding

- Specialist advice on funding is needed.

Additional information

Example re-meander projects –
www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/3.6_Dearne.pdf
www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/1.11_Highland_Water.pdf

Consent and approval

Some intervention treatments may require consent prior to construction.

Land drainage consent

On ordinary watercourses

Works in the water course may require land drainage consent from the Lead Local Flood Authority or Internal Drainage Board depending on the area. For guidance and application forms see your local council's webpages and local internal drainage board

On main rivers

Consent will be required from the Environment Agency (EA) for any works within 5m of the watercourse. For information on main rivers contact the Environment Agency.

Planning consent

This may be required for larger structures, and a discussion about proposed works should be held with the local planning authority. Standard construction dimensions are recommended for each intervention treatment to enable quicker approval.

New woodlands

An Environmental Impact Assessment (EIA) may be required if more than 2ha of woodland planting is grant funded from sources other than the national Agri-environment schemes. The Forestry Commission (FC) would need to undertake this assessment. If it is funded by the national Agri-environment schemes, an EIA would not be required. Website for further information: **www.forestry.gov.uk/forestry/infd-6dfl55**

Specialised consent

In some cases, a higher level of consent would be required before any intervention treatment can be put in place – for example, where Scheduled Monuments, Sites of Special Scientific Interest (SSSI) or Public Rights of Way are involved.

Public Rights of Way

Public footpaths, public bridleways and byways are managed by the Local Authority, which acts as the highway 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.

Open Access land

Some rough pasture land and lowland heath in the lowland areas of Yorkshire are 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.

Feature	Consent required from	Contact information
Scheduled Monument	Historic England	0370 333 0607
Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) or Special Protection Area (SPA)	Natural England	0300 060 3900
Public Rights of Way and Open Access land	Local Authority	

Summary of consents

Guideline consent required for each treatment level and type (consent required for treatments along major rivers may vary).

	Pre-application consultation & consents		Recommended consultation			Grant funding		Affect on schemes[1]	
Intervention treatments	**Planning permission GPDO*, full planning permission**	**Land drainage, main river works**	**Historic environment (Local authority)**	**Wildlife (Local authority)**	**Hydrological specialist support**	**Required**	**What/ who (enter initiatives or other funding opps)**	**BPS**	**ESS, CS**
Level 1									
Increasing soil permeability – reducing soil compaction	N	N	Y[2]	N	N	N		N	N[5]
Creating and managing buffer strips	N	N	N	N	N	Y	CS	Y	Y
Planting and managing hedgerows	N	N	N	N	N	Y	CS	Y	Y
Using trees	N	Y[3]	Y	Y	N	Y	CS	Y	Y
Winter cover crops	N	N	N	N	N	Y	CS	N	N
Cross drains in farm tracks	N	N	N	N	N	Y	CS	N	N
Level 2									
Bunds and detention basins	Y	N	Y	N	N	Y	CS	N	Y
Swales	Y	N	Y	Y	Y	Y	CS	Y	Y
Sediment traps	Y	N	Y	N	N	Y	CS	Y	Y
In-channel barriers	N	Y	N	N	N	Y	CS	N	N
Off line flood storage pond (permanent structure)	Y	N	Y	Y	Y	Y	CS	Y	Y
Level 3									
Ditch restoration	N	Y	Y	Y	Y	Y	CS	Y[6]	Y
Creating Wetlands	Y	Y	Y	Y	Y	Y	CS, EA	Y	Y
Restoring meanders	Y	Y	Y	Y	Y	Y	EA	Y	Y
Reconnecting the river with its flood plain	Y	Y	Y	Y	Y	Y	[4]CS, EA	N	Y

1 Applies if you receive payment from the schemes listed
2 Depends on which machinery is used – yes, for subsoiler and sward lifter
3 If tree planting is within 20m of a main river
4 CS grant funding available if river is designated SSSI
5 Depends on which machinery is used – yes, for subsoiler and sward lifter
6 if changes are made to cropping areas.

KEY:

Basic Payment Scheme (BPS)
Countryside Stewardship (CS) scheme
Environment Agency (EA)
Environmental Stewardship (ES) scheme
Forestry Commission (FC)
General Permitted Development Order (GPDO)
Local Rivers Trust (RT)
Wildlife Trust (WT)

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 0300 020 0301

Environment Agency

Call 03708 506 506

Swale, Ure, Nidd, Ouse and Wharfe
Claire Tunningley
Claire.tunningley@environment-agency.gov.uk

Aire and Calder
Rachel Kipling
rachel.kipling@environment-agency.gov.uk

Don and Rother
Joanne Briddock
Joanne.briddock@environment-agency.gov.uk

Hull and East Riding
Amanda Foster
amanda.foster@environment-agency.gov.uk

Derwent (Humber)
Victoria Murray
victoria.murray@environment-agency.gov.uk

Natural England

Natural England
County Hall, Spetchley Road
Worcester
WR5 2NP
United Kingdom
Telephone: 0300 060 3900
enquiries@naturalengland.org.uk

Forestry Commission

Leeds, Bradford, Kirklees, Calderdale, Nidderdale, Harrogate
Joost Van Schijndel , joost.vanschijndel@forestrycommission.gov.uk

East Riding, Vale of Pickering and North York Moors
James Shallcross, james.shallcross@forestrycommission.gov.uk

Vale of Mowbray and the YDNPA
Jeremy Dick, jeremy.dick@forestrycommission.gov.uk

Rotherham, Doncaster, North Lincs and North East Lincs
Miles Drury, miles.drury@forestrycommission.gov.uk

Rivers Trusts

Yorkshire Dales Rivers Trust (for Swale, Ure, Nidd, Ouse and Wharfe)
Dan Turner
dan.turner@ydrt.co.uk

Aire Rivers Trust
Simon Watts
Simon.watts@aireriverstrust.org.uk

Calder and Colne Rivers Trust
talk@calderandcolneriverstrust.org.uk

East Yorkshire Rivers Trust
Alan Mullinger
A1mullinger@btinternet.com

Association of Drainage Authorities

https://www.ada.org.uk/

map showing the areas covered by each IDB.
https://www.ada.org.uk/member_type/idbs/

Yorkshire Wildlife Trust

Jon Traill,
Jon.Traill@ywt.org.uk
https://www.ywt.org.uk/

Local Authority contact details

North Yorkshire County Council
https://www.northyorks.gov.uk

Bradford Metropolitan District Council
https://www.bradford.gov.uk/

Leeds City Council
https://www.leeds.gov.uk/

East Riding of Yorkshire
https://www.eastriding.gov.uk/

York City Council
https://www.york.gov.uk/

Wakefield
https://www.wakefield.gov.uk/

Doncaster
http://www.doncaster.gov.uk/

Rotherham
https://www.rotherham.gov.uk/

Kirklees
http://www.kirklees.gov.uk

Calderdale
https://www.calderdale.gov.uk/v2

Woodland Trust
https://www.woodlandtrust.org.uk

Wildfowl and Wetlands Trust

https://www.wwt.org.uk/

Existing lowland natural flood management projects

Collingham NFM Project
Marie Taylor,
Marie.taylor@ydrt.co.uk

Brompton NFM
Dan Turner,
Dan.turner@ydrt.co.uk

Backstone Beck, Ilkley
Kirsty Breaks-Holdsworth,
Kirsty.Breaks-Holdsworth@bradford.gov.uk

References and further information

Natural Flood Management Handbook (2015), Scottish Environment Protection Agency (SEPA)
www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf

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

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

From source to sea: natural flood management – the Holnicote experience (2015), National Trust
https://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

Working with natural processes to reduce flood risk (2014), Environment Agency
www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk-a-research-and-development-framework

Working with natural processes to reduce flood risk (2017) – Evidence base, Environment Agency, which includes 65 detailed case studies of NFM Schemes
https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk

The new Working with Natural Processes (WWNP) Potential Maps
http://evidence.environment-agency.gov.uk/FCERM/en/Default/FCRM/Project.aspx?ProjectID=3c089066-50a4-4d4e-9e86-61a8d8da0954&PageID=9719662d-81e9-4a8f-b46f-72675770cdce

Fully Interactive online WWNP maps
https://naturalprocesses.jbahosting.com/#6/54.188/-1.945

General NFM Information
https://catchmentbasedapproach.org/learn/natural-flood-management-toolbox-a-7-step-guide-to-developing-a-nfm-scheme/

Think Soils
http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=263233

Soils and NFM
http://wrt.org.uk/project/soils-and-natural-flood-management/

Dales to Vale
Rivers Network

Find out more about the
Dales to Vale Rivers Network

www.dvrn.co.uk