Appendices

Risk Management Authorities

Risk Management Authorities	Responsibilities
Lead Local Flood Authorities (LLFAs)	LLFAs are county councils and unitary authorities responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets. They also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses.
District Councils	District Councils are key partners in planning local flood risk management and can carry out flood risk management works on minor watercourses, working with Lead Local Flood Authorities and others, including through taking decisions on development in their area which ensure that risks are effectively managed. District and unitary councils in coastal areas also act as coastal erosion risk management authorities.
Internal Drainage Boards (IDBs)	Independent public bodies responsible for water level management in low lying areas. IDBs work with other authorities and undertake works to reduce flood risk to people and property, and to manage water levels for agricultural and environmental needs within their district.
Highways Authorities	Highways Authorities are responsible for providing and managing highway drainage and roadside ditches and must ensure that road projects do not increase flood risk.
Water and Sewerage Companies	Water and Sewerage Companies are responsible for managing the risks of flooding from water and foul or combined sewer systems providing drainage from buildings and yards.

Table 16: Risk Management Authorities (RMAs)

Key Barriers

Category	Barrier	Description
Confidence	**Insufficient data and evidence**	Within the private sector, there is limited understanding of how NFM can benefit businesses, preventing them from fully understanding their own risks and the possible opportunities provided by NFM.
		Developing this understanding and data can be expensive, preventing potential demand opportunities from being identified at project outset.
		There is an insufficient track record of investable propositions for potential investors. It is therefore difficult for investors to assess NFM projects for risk return purposes.
	No nationally accepted design standards	There are no widely adopted set of design standards to which NFM projects can adhere to ensure high integrity. This results in a lack of confidence in the private sector when considering co-funding NFM delivery.
		Lack of country-wide natural asset register to record interventions and maintenance records. This leads to the private sector not having easy access to important information regarding assets they may have funded, to ensure they are working appropriately.
	Lack of clear government guidance	There is currently no government-endorsed, strategic, country-wide prioritisation of NFM potential that considers the wider environmental, social, and economic priorities in a region.
		No clear guidance on how NFM can form part of an integrated FCERM approach.
		A land use framework has not been developed for England, to guide competing priorities for the use of land.
		Explicit guidance from the UK Government on resilience targets is lacking, hindering the flow of private sector capital into NFM.

Category	Barrier	Description
Co-Benefits	**Co-Benefits Limitations of Partnership Funding system**	Environmental co-benefits of all FCERM schemes (including NFM) are not available in a tradeable commodity for the private sector to purchase. This reduces possible demand from the private sector who may be willing to pay for credits or units such as carbon or BNG generated by NFM projects.
	Ecosystem service stacking clarity	A lack of clarity around the ability to stack ecosystem services alongside NFM is reducing the potential number of buyers of NFM and its co-benefits.
	Natural capital assessment tool framework.	There is no consistent framework for the application of natural capital assessment tools to quantify ecosystem services benefits, leading to a lack of understanding from the private sector as to which tool is suitable for specific NFM projects based on geography, scale or delivery mechanism.
Coordination	**Lack of country wide NFM prioritisation**	As mentioned regarding confidence, a lack of prioritisation for NFM delivery creates a lack of confidence from potential buyers, that their contributions will align with where NFM has been prioritised to deliver maximum flood risk and wider environmental benefits.
	Lack of stakeholder mapping	A lack of a centrally coordinated stakeholder mapping exercise within a region results in additional time and expense for project developers looking to create revenue streams for NFM projects.
	Lack of coordinated buyer engagement	A large number of potential buyers may be required to make NFM projects viable. Engaging with multiple, individual businesses to develop an NFM project can be a considerable challenge for project developers.

Table 16: Risk Management Authorities (RMAs)

Natural Flood Management interventions

For the purpose of this report, the NFM interventions considered are based on the EA's Working with Natural Processes Evidence Directory, as set out below.[120] The scope of this project will look to cover fluvial (river) flooding, pluvial (rainfall flooding including surface water flooding), and groundwater flooding in England.

River and Floodplain Management

Managing rivers and floodplains aims to recreate or reinstate the natural processes of rivers, reducing water velocities, slowing the flow of water and encouraging more regular floodplain inundation and flood water storage. In doing so, the objective is to reduce flood peaks and reduce downstream flood depths.

Intervention	Description
River Restoration	Reinstatement of the natural physical processes and features that are characteristic of a river. Includes restoring meanders to straightened rivers, enhancing historic river features, improving river sinuosity, green bank protection, improving channel morphology, utilising spoil excavated from rivers, river diversions and removing or bypassing barriers.
Floodplain Reconnection & Restoration	Floodplain restoration aims to restore the hydrological connection between rivers and floodplains so that floodwaters inundate the floodplains and store water during times of high flows.
	Processes Include removing, setting back or lowering existing embankments, paleochannel reconnection, In-channel features and floodplain wetland restoration.
Leaky/Woody Barriers including beaver dams	Leaky barriers usually consist of pieces of wood, occasionally combined with some living vegetation, that accumulate in river channels as well as on river banks and floodplains.
	May form naturally along rivers as a result of trees falling locally into watercourses through snagging of natural wood, or through natural processes such as beaver activity. Similar structures can also be engineered by humans to restore rivers and floodplains to slow and store flood water.
Offline Storage Areas	Floodplain areas that have been adapted to retain and attenuate floodwater in a managed way with the aim reducing the flood peak further downstream.
	Positioned next to watercourses, these interventions can temporarily store additional water in the floodplain. Adjacent to run off pathways, interventions such as ponds or earth bunds can have runoff diverted into them.

120 Environment Agency, 2016. Working with Natural Processes – Evidence Directory

Woodland Management

Different woodland types can reduce flood risk through a variety of processes. These include intercepting and slowing overland flow through increased hydraulic roughness, thereby slowing the rate at which water is delivered to rivers and encouraging infiltration and soil water storage through the root network of trees.

There are three types of woodland based on scale and location type: Catchment Woodland; Cross-Slope Woodland; Floodplain Woodland; and Riparian Woodland.

Intervention	Description
Catchment Woodland	Total area of all woodland within a catchment. It combines general woodland cover of all types and species, including plantations, plus specific forms where present, such as cross-slope, riparian and floodplain woodland.
Cross-slope Woodland	Placement of smaller areas or typically belts of woodland across hill slopes. It can comprise all woodland types and species, and can be managed as either productive or unproductive woodland.
Floodplain Woodland	All woodland lying within the fluvial floodplain that is subject to an intermittent, regular planned or natural flooding regime
Riparian Woodland	Woodland located within the riparian zone, defined here as the land immediately adjoining a watercourse or standing water. Usually relatively narrow, often extending <5m on either side of watercourses. It typically comprises native broadleaved woodland and is often unmanaged.

Run-off Management

Restoring natural processes across the rural landscape can provide a wide range of benefits for the environment and people. From an FCRM perspective, these types of measures can intercept overland flow, restore soils to help store water, encourage infiltration and increase the hydraulic roughness and morphological complexity of rivers and floodplains, which in turn slows floodwaters and reconnects rivers to floodplains to store water.

Run-off Management includes: Soil and Land Management; Run-Off Pathway Management; and Peat Restoration

Soil and Land Management

Intervention	Description
Soil Aeration & Subsoiling	Soil aeration is a process that breaks up topsoil compaction and is believed to increase soil infiltration and water retention capacity and, increase the travel time for incident rainfall to reach the arterial drainage system. Subsoiling is also a type of soil aeration and involves loosening the subsoil to break it up to improve drainage and encourage better plant growth.
Changes in Arable Practices	Agricultural practices that use larger machinery to produce uniformly fine seedbeds for autumn sown crops and for late harvesting of crops can compact subsoils and exacerbate flooding. Changing these practices can reduce compaction and therefore risk of flooding.
Changes in Management of Grassland Systems	Grassland systems can contribute to an increase in flood risk in places where soil has become compacted, leading to a reduction in infiltration and an increase in surface water run-off.
Use of Agricultural Landscape Features	The planting, conservation and management of hedges to intercept overland flow across slopes in erosion-vulnerable areas; reducing the concentration of animal or machinery operations; and the creation of buffer strips to reduce sedimentation in rivers.
Agricultural Headwater Management	Measures used that hold back and store water by obstructing and slowing the flow of water across flow paths in fields, tracks, paths and roads, and ditches.
Improving Soil Organic Matter and Improving Soil Organic Carbon	Soils act as 'natural flood management infrastructure'. Poorly managed, compacted soils don't allow drainage, increasing surface runoff and watercourse pollution. Whereas well managed soil can slow the flow of water off agricultural land. The effectiveness of soil water storage depends on the soil texture and on the pore space between soil particles, which is determined by factors such as soil organic matter. The pore size distribution affects aeration, water holding capacity, and drainage capacity of soil.

Run-off Pathway Management

Intervention	Description
Bunds	Long earth bunds may be constructed across grassland slopes (particularly where there are depressions) to hold flows in extreme rainfall events. They are designed to emulate natural features of undulating terrain. They are typically designed to permit livestock grazing, and may be enhancements of features of the traditional farming landscape eg stone walls, wooden walls or hedge-banks.
Farm Ponds	A type of water retention structure that add flood retention capacity as either a permanent wet pond, or a temporary pond that is designed to dry out over time. Small ponds which store overland flow temporarily at the bottom of a field can be effective in reducing overland flow following storm events.
Swales	Also known as grassed waterways – are a linear, dry, grass channel laid with a shallow fall on its base. They are designed to collect and transfer run-off.
Sediment Traps	Usually an excavated area located on a surface run-off pathway where sediment is trapped and settled before being discharged via an outlet. Effectiveness of sediment traps on flood risk is not well known. No peer-reviewed evidence which suggests they can attenuate peak flows.

Peat Restoration

The UK uplands are dominated by blanket bog with variable peat depth (c. 0.5 m –10 m), a globally rare habitat that is only found in exceptionally wet and oceanic places around the globe. Lowland peat has a wider range of peatland types: fens; lowland raised bogs and blanket bog. Restoration of peat Includes a focus on re-wetting peat – restoring the water table to allow a functional ecosystem to accumulate peat and carbon. This is achieved through grip and gully blocking as well as the reintroduction of appropriate peat-forming vegetation – such as Sphagnum spp.

Intervention	Description
Grip Blocking	Grips are channels that were cut into peatlands in an attempt to drain them for agriculture. Blocking these grips restores natural drainage patterns, encourages revegetation, reduces erosion and minimises the effect of hydrological change downstream.
Gully Blocking	Gullies occur in peat when bare peat is exposed to the elements, and moving water can form channels (gullies). Blocking gullies and encouraging vegetative cover within them may increase travel time and cause other flow paths to develop during rainfall eventsoccur in peat when bare peat is exposed to the elements, and moving water can form channels (gullies). Blocking gullies and encouraging vegetative cover within them may increase travel time and cause other flow paths to develop during rainfall events
Vegetation Management	Replacing bare peat with appropriate vegetation can stabilise peat and can reduce run-off rates through increased hydraulic roughness.

Estuary Management

For this project, we will be focusing on intertidal saltmarsh management and restoration as natural flood management interventions. Saltmarsh and mudflats Saltmarshes represent accumulations of sediment in the intertidal zone that act to dissipate wave and tidal energy in front of flood defences, and are also important as natural habitats with a range of other ecosystem services.

Intervention	Description
Intertidal Saltmarsh Management and Restoration	Restoration of saltmarshes has historically been achieved through management realignment and regulated tidal exchange. Managed realignment involves setting back the line of actively maintained defences to a new line, inland of original defences. The aim of this is to create saltmarsh habitat between the old and new defences. Regulated Tidal Exchange (RTE) is the process of letting flood through behind sea defences through engineered structures such as sluices, pipes or tide gates, to create saline or brackish habitats.

Sustainable Drainage Systems (SuDS)

Sustainable drainage systems (SuDS) are designed to control surface water close to where it falls and mimic natural drainage as closely as possible.

Intervention	Description
Bioretention Strips	Bioretention strips are vegetated areas with sand and gravel beneath. They are designed to channel, filter, and cleanse runoff vertically. The runoff can either infiltrate into the ground below or drain into a pipe which carries the water elsewhere. The storage of runoff and rainwater can reduce peak runoff rates which reduces the overall flood risk. Bioretention strips also filter runoff and remove pollutants, nutrients, metals, suspended solids, and bacteria, which has a positive effect on the overall water quality of the stored water.
Swales	Swales are shallow and broad vegetated channels, that provide temporary storage, infiltration, and conveyance of storm water runoff to reduce peak flows in watercourses and drainage systems. Swales can be 'wet' and store water above ground in the channel, or 'dry' where water collects in a pipe or gravel layer beneath. In wet weather, rainwater flows down the sloped sides of the swale, along its length and infiltrates through the vegetation, which acts as a filter, trapping sediment and pollutants.
Rain Gardens	Rain gardens are small, shallow depressions that receive runoff from roofs and hard surfaces and are made up of vegetation that can withstand being inundated with water for up to 48 hours. They are an infiltration method that allows runoff to accumulate in the shallow depression, increase the amount of water entering the soil whilst filtering out sediment and pollutants, and reduce rates of runoff and volumes of surface water. Downpipes from roof guttering are often disconnected from sewers and redirected into these gardens.
Detention Basins	Detention basins are storage basins on open, usually flat areas of grass that are normally dry, except during a storm event. They store rainwater and surface water runoff then allow it to slowly soak into the ground, reducing the risk of flooding to the local area. They also filtrate the water to remove sediment and pollutants. When wet, they can be used as a pond for wildlife which will increase the biodiversity of the area and may be useful as an educational resource. When dry, the area is a safe space for leisure activities.
Retention Ponds	Retention ponds are areas of open and shallow water designed to store rainwater and attenuate runoff at a controlled rate during and after a rainfall event. They differ from detention basins as they are intended to hold water permanently, with the water level rising temporarily during heavy rainfall to accommodate for more water.
Wetlands	Wetlands are similar to retention ponds and are shallow, marshy areas filled mostly with aquatic vegetation. Wetlands attenuate and slow the flow of rainwater runoff, whilst filtering the water and improving its quality before it enters local watercourses. They remove fine sediments, dissolved nutrients, metals and particulates from the water by filtration through the vegetation and aerobic decomposition.

Co-benefits of NFM projects

Co-benefits	Landowners	Buyers	Investors	Government	Community
Flood Mitigation	Additional revenue stream	Decreased flood risk (downstream businesses); Decreased insurance costs	Investing in building resilience.	Avoided costs of flood response; decreased infrastructure costs; carbon savings	Increased resilience to flooding.
Water resources		Improved water availability for the water sector, reduced risk of over abstraction	Investing in water security measures	Improved water security	
Biodiversity Uplift through creation of habitats/connectivity	Increased pollinator numbers; Potential additional income stream (BNG)	Source of BNG units for purchase	Additional revenue stream	Contribute to 30x30 biodiversity targets etc.	Improved ecosystems; Contribute to Local Nature Recovery Strategy
Carbon Sequestration	Potential additional income stream (carbon)	Potential source of carbon credits	Potential source of carbon credits		
Improved soil quality	Improved soil fertility, supply chain resilience				
Decreased nutrient runoff (improved water quality)		Water Companies: decreased treatment costs		Contribute to water quality targets in EIP	Improved water quality
Eco-tourism	Potential additional income stream		Additional revenue stream to lend against.	Additional tax revenue.	Added revenue; recreation opportunities
Recreation (improved attractiveness/access to green space)	Potential additional income stream	ESG and CSR benefits	ESG and CSR benefits		Improved mental health; increased community engagement