

Natural Flood Management Test & Trial Final Report



Kent Downs Area of Outstanding Natural Beauty

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Particular thanks are due to Chris Uttley (Environment Agency) and Nick Chappell (Lancaster University) for sharing their work findings with participants in the Test and Trial.

Cover photo kindly provided by FWAG SW – Wetland construction at Kinch Halse Farm

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This report has been prepared by Mike Phillips of White Horse Ecology and Angus Middleton of Viridian on behalf of the Kent Downs AONB Unit. The Test and Trial, as well as the production of this document, has been overseen by Nick Johannsen, Director of the Kent Downs AONB Unit

The Natural Flood Management Test and Trial is being carried out by the National Association for the Areas of Outstanding Natural Beauty on behalf of Defra. It forms part of the development of environmental land management schemes.



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This report has been supported by the findings of two European funded projects and has formed part of a National Lottery Heritage Fund supported landscape partnership scheme.

SCAPE (Shaping Climate Change Adaptive PlacEs) is a project that brings together partners from the UK, Netherlands and Belgium. It aims to develop 'Landscape-Led Design' (LLD) solutions for water management that make coastal landscapes in the 2 Seas area better adapted and more resilient to climate change.

Triple C (Climate resilient Community-based Catchment planning and management) is funded by the European Regional Development Fund and is a trans-national project looking to implement a set of cost-effective actions to reduce flooding and erosion. The project partners are based in Belgium, the Netherlands and the UK

1 Executive summary

Background

Natural Flood Management (NFM) is increasingly being seen as an important method to complement traditional engineered flood defences. As well as providing mitigation for flood events, often in areas where traditional flood measures are not appropriate, NFM has other multiple benefits which contribute to the delivery of public goods as defined by Defra for the purposes of environmental land management schemes.

Take-up rates for most NFM measures within Countryside Stewardship have been poor. This T&T aimed to identify what characteristics an environmental land management scheme requires in order to address this and avoid repeating the same poor take-up rates.

Research Questions

This Test and Trial attempted to answer three fundamentally important questions.

1. **What are the barriers that stop farmers and land managers implementing NFM?**
 - a. What are the knowledge-based barriers?
 - b. What are the logistical and financial barriers?

2. **How can NFM actions within environmental land management schemes maximise public benefits?**
 - a. Widespread adoption
 - b. Flood risk mitigation
 - c. Multiple benefits

3. **How can environmental land management schemes help deliver protected landscape management plans and have a positive impact on landscape character?**

Methodologies

To try and answer the research questions the following activities took place:

1. **Workshops** were held with both farmers and NFM practitioners. These focused on the things that stopped people from installing NFM features and what an environmental land management scheme needed to have to address these barriers.
2. **Case studies** were carried out with seven practitioners and farmers in the Darent Valley that allowed a more detailed assessment of expert opinion as well as talking to farmers about how they felt about NFM on their land and using the 'Communication Tool' developed by the T&T.
3. A **database** of NFM measures was created and used to construct an **information tool** that allowed farmers and advisers to instantly access information about NFM measures as well as examples of its application.
4. HydroloGIS was used to create a **prioritisation model** for NFM measures in the Darent catchment. Additional information from the information tool and from landscape character mapping were incorporated to create a mock-up version of a '**Communication Tool**' to help

farmers make informed decisions about deploying NFM using environmental land management schemes on their land.

5. A simple mapping exercise attempting to create an alert system for **the impact of NFM on landscape character** was carried out looking at tree planting, hedge planting and the creation of large waterbodies.
6. The culmination of the T&T was to draw together all of the evidence from research, the trials conducted for this T&T as well as the opinions expressed at workshops to create a **design proposal of NFM measures** appropriate for the environmental land management schemes.

Results and recommendations

Enhanced **spatial prioritisation** is key. Identifying the best place to locate NFM features is complex and farmers need support. Dedicated catchment advisors twinned with GIS based modelling can best help farmers prioritise in order to develop NFM features on their land. Spatial prioritisation for NFM operates at two scales. The first is identifying catchments or sub-catchments where NFM measures will be promoted and rewarded. This work is being done by the Environment Agency and Local Nature Recovery Networks and will identify areas where NFM has the potential to reduce flooding of properties. The second scale is prioritising the placement of NFM measures within the target catchments. This T&T concludes that a combination of Catchment Based Advisers and GIS based modelling can help farmers to identify the best places on their land to locate NFM features that maximise flood mitigation and minimise loss of productive land.

Increased **advice and guidance** coupled with dedicated tools to simplify NFM decision-making and application processes are essential to ensure take-up of NFM measures. The lack of take-up of NFM within Countryside Stewardship, the need for consents and permissions and the lack of familiarity with NFM amongst many farmers are the three biggest factors behind this conclusion. If NFM is to have any impact at a catchment level support needs to be provided to farmers to help them understand and negotiate the route to effective NFM implementation. The recommendation from this report is that catchment based advisers are deployed in target areas and a 'Communication Tool' is developed to help simplify the decision making process.

Payment rates for public goods provided need to incentivise farmers to place NFM measures on land that is then lost from productive farming. Agreements need to be flexible enough for Catchment Based Advisers to work with all farmers in their target catchments, not just those that are nearing the end of existing agreements. Payments also need to reflect the multiple benefits derived from NFM measures, not just the flood alleviation benefits.

Five key findings:

1. Catchment Based Advisers will be essential to provide the levels of advice, reassurance, support and collaboration needed to avoid the low take-up levels of NFM measures experienced in Countryside Stewardship.
2. The use of models can aid the understanding of the best places to locate NFM measures within a catchment. Additionally, information can be incorporated into these GIS based models giving information to advisers and farmers about payment rates for different features, other considerations such as protected species, consents and landscape character issues. The creation of these models at a catchment scale needn't be cost prohibitive.
3. Some NFM measures such as soil improvement can be applied universally through the Sustainable Farming Incentive whilst others such as leaky dams are more suited to promotion in targeted catchments or sub-catchments.
4. Flexibility of scheme agreements is needed in order to maximise the take-up rate of NFM actions. There needs to be provision to add NFM features to agreements in order to allow farmers to experiment and gain confidence and to allow Catchment Based Advisers to promote NFM with incentives through the schemes.
5. Payment rates need to reflect the multiple benefits that are generated by NFM measures. The public goods of many NFM measures are not restricted to flood mitigation.

View of the Darent Valley



2 Definitions and Acronyms

Word or Acronym	Description or Definition
AONB	Area of Outstanding Natural Beauty
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
Farmers and land managers	Farmers, or farmers and land managers is used in this document as a catchall term for farmers, landowners, land managers and other individuals or organisations that may be eligible to take part in environmental land management schemes.
GIS	Geographical Information System
HydroloGIS	A hybrid GIS and hydrological planning tool that has been developed to mitigate dangers to the water supply in river landscapes using nature-based solutions.
NFM	Natural Flood Management – a series of measures that use natural features to slow the passage of water through the landscape and reduce the intensity of peak flows during flood events. Often used interchangeably with Working with Natural Processes (WWNP).
Practitioners	Those professionals that work with farmers and landowners to facilitate, install and assist in the uptake of NFM measures. These can be people who work for statutory authorities, non-governmental organisations or be contractors.
Schemes	This term is used to reflect all of the different schemes that are often referred to as environmental land management schemes that may reward farmers and land managers for producing public goods or schemes that reward environmental benefits. Specifically, these refer to the Sustainable Farming Incentive, Local Nature Recovery and Landscape Recovery.
T&T	Test and Trial for the environmental land management scheme

3 Introduction

3.1 Background

Schemes that reward environmental land management are often described as the cornerstone of the government’s new agricultural policy. Protection from and mitigation of environmental hazards is one of the headline ‘public goods’ that farmers and land managers may be paid for by environmental land management schemes. This Test and Trial provides evidence as to how this objective can be met through Natural Flood Management (NFM) measures in a way that is beneficial to farmers and land managers as well as reflecting the multiple other benefits that NFM can provide.

Climate change has increased the intensity and severity of flood events in the UK. There are many studies that have looked at the impact of human induced climate change including one (Otto, 2018)¹ that suggested heavy rains associated with Storm Desmond were 60% more likely due to human induced climate change. The Committee on Climate Change (HM Government, 2017)² estimated flood damage from non-coastal sources cost just over £1 billion annually. The 2021 Flood and Coastal Erosion Risk Management Strategy Action Plan (Environment Agency, 2021)³ also states that once a century events could become annual events by 2100 and that, “in the face of a changing climate, we also need a broader range of resilience actions.”

High profile flooding events such as the floods in mid Kent in 2013 and the serious flooding in the Somerset Levels in winter 2013/14 has focussed attention on methodologies for reducing the severity and frequency of flood events. Traditional engineered flood defences often aim to move water out of a catchment as quickly as possible or to physically defend towns and cities. These measures on their own cannot always be effective and other methods are needed. By contrast, NFM attempts to hold more water in the landscape during flood events and reduce the intensity of peak flow. By doing this, the intensity of flooding can be reduced (CaBA, 2021).⁴

There are a range of measures that are collectively called Natural Flood Management (NFM) and these are often grouped with other processes that reduce flood risk, prevent soil erosion and manage coastlines in a group of measures known as Working with Natural Processes. The Environment Agency produced an excellent piece of work that reviewed the available evidence relating to the efficacy of NFM (Burgess-Gamble et al, 2018)⁵. This body of work provided a comprehensive analysis of data from multiple pilot programmes and assesses the confidence that specific measures mitigate flood risk. This work forms the basis of the assumptions around the effectiveness of measures in this

¹ Climate change increases the probability of heavy rains in Northern England/Southern Scotland like those of storm Desmond—a real-time event attribution revisited: <https://iopscience.iop.org/article/10.1088/1748-9326/aa9663/pdf>

² Climate Change Risk Assessment 2017: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584281/uk-climate-change-risk-assess-2017.pdf

³ Flood and Coastal Erosion Risk Management Strategy Action Plan 2021: <https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england-action-plan/flood-and-coastal-erosion-risk-management-strategy-action-plan-2021>

⁴ What is Natural Flood Management? – CaBA: <https://catchmentbasedapproach.org/learn/what-is-natural-flood-management/>

⁵ Working with Natural Processes: <https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk>

report. NFM measures fall into several broad categories. Some measures create space for water to accumulate during flood events such as leaky dams and offline pools, others slow the passage of water through the soil and increase evapotranspiration such as cover crops and tree planting, whilst others work to reduce erosion that decreases the capacity of river channels and speeds up run off.

The benefits of NFM are complex to quantify. Many analysts concentrate on the total volume of water stored by NFM features, since this is how engineered structures work. Unfortunately, this does not consider all the NFM mechanisms such as slowing flows and does not allow for interactions between the NFM features and surrounding landscape. It is only by including all these aspects that NFM can be placed most effectively and their benefits properly understood.

Until now, most NFM measures have been implemented by either Environment Agency or externally funded pilot projects that have used project officers to work with farmers and land managers to install NFM features. Schemes that reward environmental benefit represent an opportunity to create a step change in the application of NFM and bring it into the mainstream of farming activities. Although NFM options have been available through Countryside Stewardship, uptake of the more technical options has been poor. This T&T will look at ways that schemes can avoid the low success levels of Countryside Stewardship and target the areas that will have the greatest impact if NFM features are installed.

Another of the issues that is faced by proponents of NFM is the complexity of measuring the impact of interventions. There is research underway funded by NERC (2021)⁶ that is looking at the ability of NFM to prevent flooding but this is only part of the picture. Measures such as tree planting not only slow the flow of water through the landscape but they also sequester carbon, reduce soil erosion and diffuse pollution, provide biodiversity benefits and clean the air that we breathe.

These multiple benefits are difficult to quantify but are the underpinning principles of scheme payments providing public goods. Maximising the delivery of multiple benefits from individual actions will offer the best return on investment for the public purse. Unfortunately, few projects to date have proactively targeted interventions to deliver multiple benefits and there is therefore little evidence relating specifically about delivering multiple benefits. Instead, most projects design interventions around single objectives, such as carbon sequestration or flood alleviation, then investigate if they will deliver any additional benefits. (Oppla, 2021)⁷

This T&T has not only focused on reducing river flooding. The multiple benefits accruing from NFM have also been fundamentally important in assessing the potential for NFM to deliver the government's 25 Year Environment Plan (HM Government, 2018)⁸ as well as delivering the public goods (Defra, 2020)⁹ that will be delivered by environmental land management schemes.

⁶ NERC Natural Flood Management research programme: <https://research.reading.ac.uk/nerc-nfm/>

⁷ Case studies | Oppla: <https://oppla.eu/case-study-finder>

⁸ 25 Year Plan: <https://www.gov.uk/government/publications/25-year-environment-plan>

⁹ Environmental Land Management and Public Money for Public Goods: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955920/ELM-evidencepack-28jan21.pdf

3.2 Research questions and other aims

The T&T has three key research questions that emerged as the T&T progressed.

1. What are the barriers that stop farmers and land managers implementing NFM measures on their land?

- a. What are the knowledge-based barriers?
- b. What are the logistical and financial barriers?

Although an emerging science, NFM is not new but it is also not widely implemented. Many farmers and land managers have grown up with the rationale that water should be removed from farmland as quickly as possible to prevent flooding. Why is this the case? This research question will examine the reasons why farmers and land managers are reluctant to implement NFM. The approach will assess the level of understanding of NFM within the farming community as well as the level of confidence that the measures will work and not impact farming operations. Additionally, this question will address the financial uncertainties that might make NFM implementation a less viable option and any difficulties faced by those that choose to adopt NFM. The requirements for consents can be numerous and complex for some NFM interventions and the effect of this level of bureaucracy on farmers and land managers is also examined.

2. How can NFM actions within environmental land management schemes maximise public benefits?

- a. Widespread adoption
- b. Flood risk mitigation
- c. Multiple benefits

The schemes that reward environmental benefits are an opportunity to pay farmers and land managers for adding flood prevention measures on their land at a scale that has simply not been possible up to now. In order to do this, the barriers identified in the first research question must be overcome. Farmers and land managers must have confidence that the NFM interventions will work, won't lead to uninsurable liabilities and won't jeopardise the profitability of the farm. In answering this question, mechanisms for providing advice, guidance and support will be examined. NFM measures are fundable through Countryside Stewardship options but most of these are rarely used. The question will also address how schemes will need to make a different offer to farmers than Countryside Stewardship. Without a different approach, uptake of the new schemes is unlikely to be significant.

3. How can environmental land management schemes help deliver protected landscape management plans and have a positive impact on landscape character?

There are examples of NFM projects that have caused a degree of controversy as they may have a significant impact on the landscape character of an area. Activities such as planting trees in places where they are not usually found or planting species that are not typical of an area can cause issues. Equally structures, particularly those found in open landscapes, can have an impact on the character of a space and may be incongruous. Standing water in areas that are not typified by these kind of features can also be problematic. This question will identify potential issues and address how these can be avoided within the new schemes. Conversely, the multiple benefits that accrue from many

NFM interventions can also be harmonious with the policies and aims of protected landscape management plans. We will examine how these benefits can be maximised.

3.3 Key themes relating to Natural Flood Management

There are six overarching themes laid out by Defra for the T&Ts. These have been supplemented by six strategic objectives put forward by the National Association of Areas of Outstanding Natural Beauty (NAAONB) as part of the Farming for the Nation group of T&Ts. Table 1 shows how the NFM T&T contributes to each of the themes and strategic objectives. The NAAONB strategic objectives are in italic, while Defra themes are in roman text.

Table 1: Mapping themes, aims and T&T outputs (strategic objectives in italics)

Theme/<i>strategic objective</i>	Questions addressed during the research
Land management plans / <i>Integrated management plans</i>	<ul style="list-style-type: none"> • Are water management plans necessary to plan NFM measures at a landholding level? • Who should be responsible for writing plans? • Should plans be subsidised or free in priority areas?
Advice and guidance / <i>Testing guidance & indicators for success</i>	<ul style="list-style-type: none"> • How much guidance and support is needed for farmers to take up NFM actions within the schemes? • Can mapping and modelling be used to help guide the placement of NFM structures? • How do we measure the success of NFM and the multiple benefits that it brings?
Spatial prioritisation / <i>AONB Management Plans as strategic spatial frameworks</i>	<ul style="list-style-type: none"> • How can catchments where NFM measures provide public goods be identified? • How can the best places to site NFM interventions be established within a catchment or sub-catchment? • Can some NFM measures be applied everywhere (as part of the Sustainable Farming Incentive)? • Can AONB Management Plans and landscape character assessments guide placement of NFM interventions?
Collaboration	<ul style="list-style-type: none"> • How can land holdings work together to provide an integrated and complementary set of NFM structures within a catchment or sub-catchment?
Payments / <i>Monitoring, verification and trigger payments</i>	<ul style="list-style-type: none"> • Not addressed as part of this T&T. This theme is being addressed by NERC funded research programmes.
Innovative delivery mechanisms	<ul style="list-style-type: none"> • Not addressed as part of this T&T. This theme is being addressed by NERC funded research programmes.

It should be noted that this T&T is looking specifically at a specific activity rather than an element of the delivery mechanism for the schemes that reward environmental benefits. Consequently, the research questions do not easily fit into the themes laid out by Defra. Instead, the research questions posed and the evidence collected during our research cuts across multiple themes and strategic objectives.

4 Methodology

Central to the ethos of the T&Ts is the need to co-create proposed actions with the farming community. This was the fundamental principle that underpinned the collection of data for the T&T. It was also felt that practitioners were an important part of understanding the difficulties that farmers and land managers face when trying to implement NFM measures and understand some of the ways that these barriers can be overcome. Consequently, those that had been involved in planning and delivering NFM projects were invited to take part in the T&T.

4.1 Workshops

The primary technique used for gathering information from farmers and other interested parties were workshops. Due to the restrictions on travel and meeting in groups in place due to the Covid-19 pandemic, all of the workshops were held using online meeting software. It was not felt that this had a detrimental impact upon the workshops and had the added advantage of being able to invite participants from across the country as well as those that may not have been able to attend because of physical disabilities. There were two different audience groups that were invited to workshops: practitioners and farmers. All workshops lasted for two hours. This was felt to be the maximum amount of time people could be expected to concentrate and engage using online meeting software.

Table 2: Summary of workshops

Group – date - attendees	Workshop themes/key questions
<p>Group 1 – Practitioners Nature conservation land management organisations, Environment Agency and Natural England Staff. 2 workshops (September 2020) 27 attendees</p>	<ul style="list-style-type: none"> • Introduction to schemes and the T&T • What are the barriers to farmers installing NFM features? • How do we overcome these barriers? • How can we identify the best places to install NFM features? • What potential does the ‘Communication Tool’ (see section 4.4) have to guide placement of features and build confidence amongst farmers?
<p>Group 2 – Farmers - Farmers, landowners, land managers, land agents and other members of the farming community. 3 workshops (September to December 2020) 40 attendees</p>	<ul style="list-style-type: none"> • Introduction to themes and the T&T • What stops farmers and land managers from adopting NFM measures? • What kind of support and guidance is needed? • What would make NFM an attractive option for farmers and land managers? • How should the scheme be administered? • What potential does the ‘Communication Tool’ (see section 4.4) have to guide placement of features and build confidence amongst farmers?
<p>Group 3 - Practitioners 1 workshop (November 2020)</p>	<ul style="list-style-type: none"> • What might NFM look like within the schemes? • What are EA priorities?

23 attendees Led by Chris Uttley at Environment Agency	<ul style="list-style-type: none"> • How can NFM delivery through schemes be effective?
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Although invites were distributed widely the attendees were self-selecting and all would have had an interest in Natural Flood Management matters. Hence, they were not a truly representative sample of farmers. However, the diversity of viewpoints that were expressed suggested that a wide range of different groups had been engaged. Some of the farmers had been involved in NFM pilot projects and worked with delivery organisations to install NFM measures on their land. Others were interested in what they could do to help alleviate local flooding. Practitioners ranged from those involved in the delivery of NFM pilots to landscape scale planners and employees of statutory agencies. More detail about the workshops can be found in [appendix IV](#) (Kent Downs, 2020c).

The role of advice and guidance – FWAG SW

FWAG SW have been delivering NFM projects which include both capital delivery and advice and guidance for farmers and landowners. Hills to Levels is an award winning catchment based project that was initiated after the serious flooding in the Somerset Levels that took place in the winter of 2013-14.

This project was designed to be a holistic approach to ‘slowing the flow’ and was funded by a range of organisations including the Environment Agency, People’s Postcode Lottery, the local authority, Somerset Rivers Authority and the European Union. It included:

- Promotion of NFM including videos and information sheets;
- Advice and guidance to farmers;
- Capital grants for NFM features and increasing flood resilience in lowland farms;
- Reverse auctions to achieve best value for money or features installed;
- An evaluation of measures installed.

It is estimated that the overall cost of NFM measures installed by the project consisted of approximately 50% staff time and 50% on capital improvements. This reflects the amount of effort required to build confidence and understanding in the farming community as well as create designs, receive sign off from statutory agencies and work with contractors to deliver capital works. Within an environmental land management scheme, these costs will either need to be reflected in the payment rates for NFM features or an adviser will be needed to help farmers and landowners to negotiate the bureaucracy involved in installing features. Even if payment rates are increased to reflect the level of bureaucracy involved in designing and installing features, this will still not address the advocacy role that advisers provide. Those farmers that had taken part in Hills to Levels and attended workshops said that they would not have considered NFM measures without the assistance provided by FWAG SW. These views were reflected in the farmer workshops undertaken as a part of this T&T.

4.2 Case studies

Case studies were used to gain an in-depth insight into individual farms or organisations. These one to one interviews took place between June 2020 and April 2021. The questions asked were tailored to the individuals being interviewed. They added depth to the work that was carried out at workshops.

A total of seven case studies were carried out over the course of the T&T. These can be grouped into two categories:

1. **NFM delivery organisations and statutory agencies (4)** – FWAG South-West, Environment Agency, Kent Wildlife Trust and Kent County Council were interviewed. Discussions centred around the delivery of NFM either as an organisation that works directly with farmers or that helped to co-ordinate NFM activities. These interviews specifically focused on the barriers that farmers have to joining schemes and what would be needed to improve take-up and focus interventions in the most appropriate places.
2. **Farmers and land managers (3)** – Three farmers were interviewed and visited by Viridian Logic. The farmers discussed local flooding issues, ground truthed the NFM priorities identified by HydroloGIS modelling and talked about how they would like NFM to be applied on their land.

The case studies can be found in [appendix VII](#) (Kent Downs AONB Unit, 2021c).

4.3 Database of measures and information tool

The first piece of work carried out by the T&T was to gather information about the different NFM measures that could be applied. This work looked at the evidence that was publicly available and created a database of links to the most valuable information. This included links to case studies where measures had been implemented and to instructional videos. It assessed some of the things that might provide barriers to farmer uptake such as whether planning permission was required, whether consent from a statutory agency was required or whether protected species and habitats legislation was relevant.

The resulting work was used to create an information tool. Essentially, this was a spreadsheet that could be used by farmers to easily find more information about an NFM measure they may be interested in, what permissions would be required and how it might be implemented. This information tool can be found in [appendix III](#) (Kent Downs AONB Unit, 2020b).

4.4 Modelling and Communication Tool

The **NFM modelling** for the Darent catchment was carried out using HydroloGIS, Viridian's proprietary system for prioritising the creation of Nature-based Solutions. This splices a fully-distributed, overland hydrological model with GIS analysis of landscape characteristics. The entire region of interest is divided into pixels and all flows into and out of each pixel is found, considering interaction between climate, topography, vegetation and soil. Calculations are iterated up and down flow paths, so interactions between pixels can be discovered. The impact on local water problems of changing the land use on each pixel is calculated, and every pixel ranked for the effectiveness of using Nature-based Solutions on that pixel.

The results were maps ranking all possible NFM actions across the Darent¹⁰ for how much impact they will have on local flooding: showing what to do and where to do it to give best results. It also created similar maps for erosion, diffuse nitrate pollution and diffuse phosphate pollution, as this could help with multiple benefit analysis.

The HydroloGIS outputs were used to populate a mock-up of a ‘**Communication Tool**’, using Powerpoint to demonstrate what the online tool would look like if created. The ‘Communication Tool’ combines the HydroloGIS modelling with information on payment rates, the information tool (described in 4.3) and the landscape character mapping (described in 4.5) to create a single tool that facilitates decision making at the farm scale. It would allow farmers to delineate their farm or area of interest, either manually or importing Rural Payments Agency data, then query the best use of their land for NFM. They could do this in two different ways that answer the following questions:

- 1. What are the best ways of using my land to reduce local flooding?** The tool would identify the best locations on the farm to create NFM features. The farmer could then click on those areas that they were most interested in and the tool would list all the NFM features that are appropriate for that location. They could then click on the option that most suited their aspirations and information would appear on how to create the feature, sources of additional information/help, payment rates and the like.

Figure 1 shows the most effective locations for land-based NFM in blue; the most effective places for in-stream features in orange; and the options of land-based features in the table. The blue font in the table identifies a hyperlink to further information and online resources.

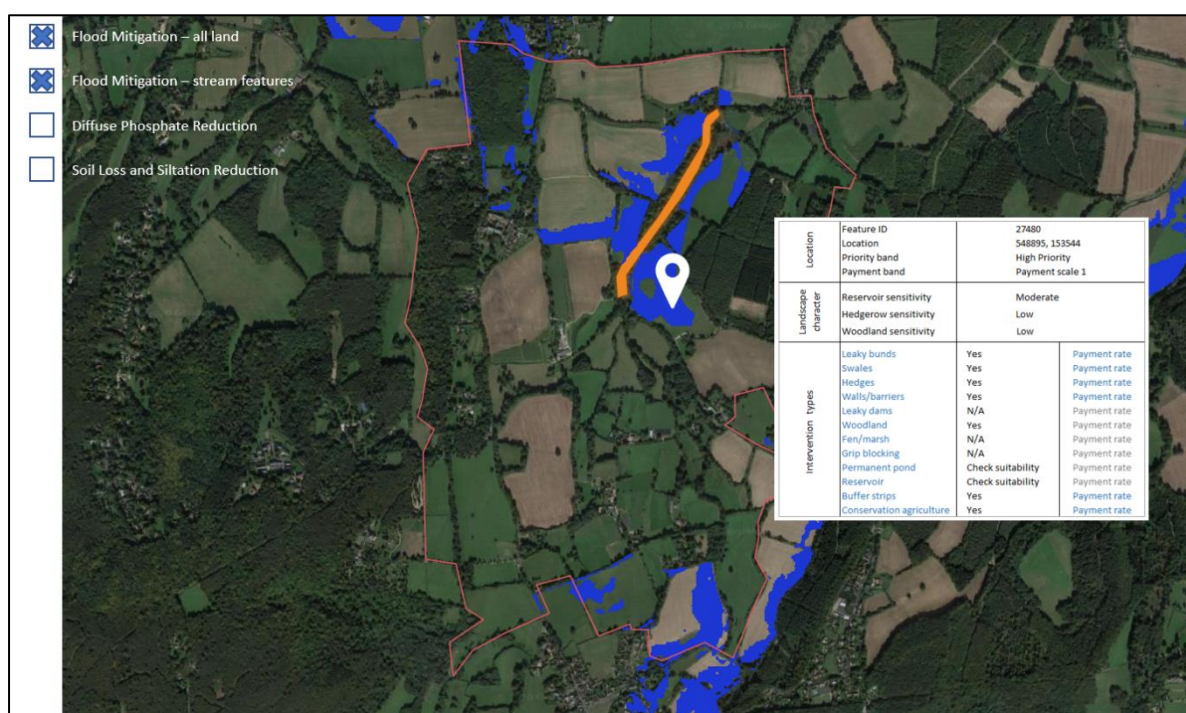


Figure 1: What are the best ways of using my land to reduce local flooding?

- 2. I know what I want to do, but where is the best place to do it?** The farmer would select the ‘what to do’ feature(s) they wish to create and the tool would identify the most appropriate

¹⁰ Considering water retention, woodland creation and reversion to semi-natural grassland.

locations to create them. This could focus on flooding, other benefits or a mixture of many benefits. The farmer could then click on a location of interest and further information would appear.

Figure 2 shows that the farmer selected ‘leaky bunds’ and ‘woodland’ as their options of interest. The tool then identified the best places to create these features to reduce local river flooding. The farmer then clicked on a location where they are most interested in creating leaky bunds and a table appeared with further details of that location. Clicking on any of the blue text would bring up the relevant information and resources.

The HydroloGIS model also identifies overland flow paths and natural depressions in the ground, which can be used for planning other nature-based activities. For instance, it may require comparatively little engineering to create a reservoir where a large degree of overland flow coincides with a natural depression. More information on the mapping can be found in [appendix I](#) (Middleton & Baruah, 2020).



Figure 2: Prioritising specific NFM measures on a landholding

4.5 Mapping landscape character issues

It is important that all NFM features fit within and complement the surrounding landscape, especially in protected areas such as AONBs. There will be areas where certain features are acceptable, others are unacceptable and some can only be decided from local circumstances.

An attempt was made to map these considerations using Landscape Character Assessments (LCA). The Darent catchment was divided into areas of high, medium and low sensitivity to woodland planting, hedgerow planting and reservoir creation based on the characteristics of each area described in the LCA. Those areas with high sensitivity were deemed inappropriate for the associated NFM features; areas with moderate sensitivity would need additional local review; and areas with low sensitivity were deemed appropriate for associated features. The resulting maps can be seen in figure 3.

This mapping was added to the 'Communication Tool'. When a farmer clicked on a location within the communication tool to gather more detail on NFM features to create there, the landscape sensitivity would be displayed and only acceptable features in that location would be allowed to proceed. Uncertain features would be flagged for further review and unacceptable features would be shaded out. More detail about this mapping exercise can be found in [appendix II](#) (Kent Downs AONB Unit, 2020a).

This T&T also assessed the likely impact of NFM measures on landscape character and the kinds of issues that may need to be considered when installing NFM features. This can be found in [appendix VI](#) (Kent Downs AONB Unit, 2021b).

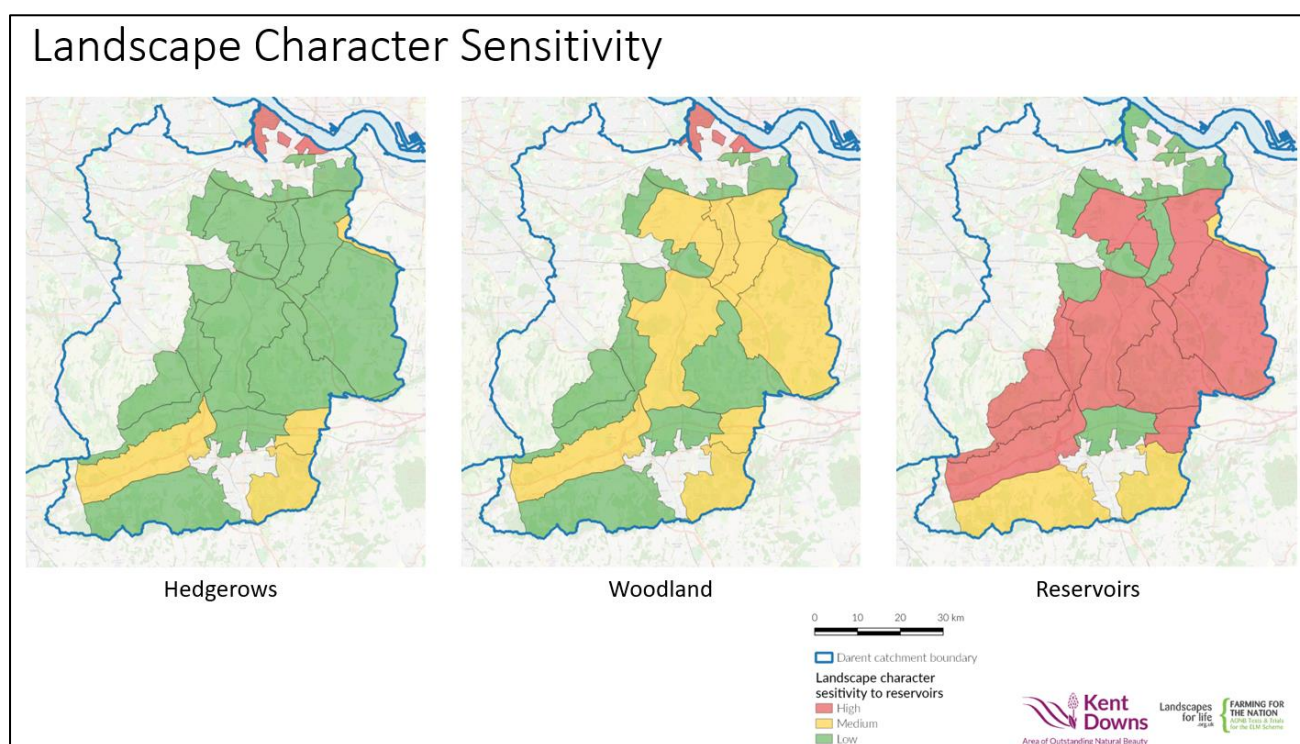


Figure 3: Landscape character sensitivity in the Darent Valley

4.6 Evaluation of measures and design proposal

The final element of work within the T&T was to make an evaluation of how effective the different NFM measures were. This was done by using published work, primarily through the body of work collected by the Environment Agency under the Working with Natural Processes banner. Additional information was taken from evidence collected by Darent Valley Landscape Partnership Scheme partners.

This information was then used, along with all of the other evidence gathered by the T&T to create a list of NFM measures and recommendations. This is the design proposal. Recommendations were made about how best each measure could be taken forward as part of the NFM-based actions within schemes that reward environmental benefits.

More detail about this work can be found in appendices [V](#) and [VI](#) (Kent Downs AONB Unit 2021a & 2021b).



The River Darent near Shoreham

© FWAG SW

Leaky pond and catchment tree planting, Odcombe, Somerset



NFM in Countryside Stewardship

NFM measures have been funded through Countryside Stewardship and here we will look at the take-up rate of some of these measures in agreements signed between 2015 and 2020. In all, 425,100 options were agreed. However, 56% of these agreements consisted of just ten options, the most common of which include management of hedgerows (63,181), permanent grassland with very low inputs (43,416) and 4-6m buffer strip on cultivated land (30,141). Many of the options available in Countryside Stewardship are used very rarely.

Take-up of options that may have incidental NFM value

Within Countryside Stewardship there are a number of options that may have NFM or diffuse pollution/soil erosion benefits, but the NFM benefits are not the primary reason for them being implemented.

Option	Number of times agreed	% of all agreements
Management of hedgerows	63,181	14.86
Planting new hedgerows	3,904	0.92
12 to 24m watercourse buffer	1852	0.41
Buffering infield ponds and ditches	997	0.22
Cross drains	797	0.17
Woodland creation – maintenance payments	602	0.13
Management of grassland adjacent to watercourse	150	0.03

Take-up of options that are targeted at NFM

These options have the primary aim of either reducing flood risk, diffuse pollution or soil erosion. They may of course have other multiple benefits that result from their implementation.

Option	Number of times agreed	% of all agreements
Winter cover crops	775	0.17
Sediment ponds and traps	80	0.02
Flood mitigation on grassland	44	0.01
Swales	39	0.01
Earth banks and soil bunds	32	0.01
Check dams	29	0.01
Grip blocking drainage channels	27	0.01
Small leaky woody dams	15	0.00
Silt filtration dams or seepage barriers	10	0.00
Large leaky woody dams	4	0.00

The two tables above show that specific NFM options within Countryside Stewardship are not taken up very often. With the exception of cover crops, take-up rate has been negligible. However, some of the options that may have an incidental NFM benefit can be popular, none more so than management of hedgerows. The reason for the lack of take-up of NFM within Countryside Stewardship was explored in some detail during one to one interviews and at workshops. Some of the most often quoted reasons for lack of take-up include:

- Not enough is known about NFM amongst the farming community;
- Farmers, advisers and agents tend to only choose options that they are familiar with;
- The most popular options are those that either improve productivity or are part of day to day management of the farm (e.g. management of hedgerows);
- There is little advice and guidance available for NFM options;
- The options are often very specific and may require permission and approval;
- Payment rates are not high enough to justify the amount of work involved;
- Farmers may consider NFM options when contacted by a third party about their potential but can't be added mid-way through an agreement.

5 Results and discussion

The results for this T&T will be grouped by research question rather than by research method or the T&T themes. It is felt this will allow for the most coherent narrative. Ultimately, this will most effectively present what is felt to be a strong case for schemes that reward environmental benefits to prioritise NFM actions and how these actions are most likely to be successful.

5.1 What are the barriers that stop farmers and land managers implementing NFM measures on their land?

The biggest risk to the success of NFM actions within the schemes that reward environmental benefits is that take-up rates are low. For some actions this is a high risk, especially if farmers and land managers are not familiar with the NFM actions and there are administrative burdens that are associated with installing the features such as planning permissions or consents. The lack of take-up of some of the NFM measures within Countryside Stewardship exemplifies this. Unless lessons are learned from this the same thing is likely to happen in the new schemes.

The table below summarises the main barriers identified at workshops by both farmers and NFM professionals. Outline solutions to help overcome these barriers are also suggested here, but these are expanded upon in section 5.2.

Many of the barriers identified can be solved by implementing the recommendations of this report. Others are more entrenched and difficult to solve using schemes that reward environmental benefits.

Table 3: Barriers identified by farmers and land managers for not implementing NFM actions on their land.

Barrier	Detail	Possible solutions
Not aware of the opportunity to apply NFM	<p>There are a large number of options within Countryside Stewardship that farmers can apply for. This may well be the case within environmental land management schemes as well and unless farmers, land agents and advisers are aware of the NFM options or actions it is unlikely that they will be applied for.</p> <p>There is a role to promote NFM opportunities to farmers and land managers across catchments and sub-catchments where NFM actions are prioritised</p>	<ul style="list-style-type: none"> • A Catchment Based Adviser can provide guidance to farmers and land managers in target catchments or sub-catchments. • The ‘Communication Tool’ described in this report can help to give online access to a series of options that might be appropriate on the land holding. • Farm clusters can help to disseminate information.
Compensation for lost income	<p>If NFM measures are implemented on land, productive land may be lost. Examples include if grassland or arable land are planted with trees or if productive</p>	<ul style="list-style-type: none"> • Whilst there is a desire within the schemes to pay specifically for public benefits, payment rates need to reflect and accommodate

	<p>land is inundated with water due to measures that slow the flow.</p> <p>Under the EA pilot schemes and EU funded projects it was not possible to compensate farmers for lost productive land and many interviewees stated that this was a barrier to them implementing certain NFM measures.</p>	<p>the loss of income, whether this is converting pasture to woodland or temporarily flooding an arable field using bunding during a flood event.</p>
Not knowing how NFM might be applied on their land	<p>NFM measures are not widely adopted in many areas and many land managers and farmers are unaware of their potential to alleviate flooding. Additionally, the concept of 'slowing the flow' can appear counter intuitive to those that have grown up in an environment where the received wisdom is that flooding is avoided by draining land of water as quickly as possible.</p>	<ul style="list-style-type: none"> • A Catchment Based Adviser can provide guidance to farmers and land managers in target catchments or sub-catchments. • The 'communication tool' described in this report can help to give online access to a series of options that might be appropriate on the land holding. • Farm clusters can help to disseminate information.
Lack of flexibility	<p>One of the criticisms made about NFM measures within Countryside Stewardship (particularly for measures such as leaky dams) was that the design guidelines were very rigid. This often made it difficult to apply measures on a land holding even if they were wanted.</p> <p>Additionally, NFM measures could not be added to a Countryside Stewardship agreement once an agreement had been reached making it difficult for those promoting NFM to farmers to offer funding through Countryside Stewardship.</p>	<ul style="list-style-type: none"> • Allow Catchment Based Advisers to work with landowners to develop NFM solutions that both work and fit into the morphology and character of the land. • Allow farmers and land managers to add NFM actions to existing environmental land management scheme agreements.
Unsure about the best way to fund NFM	<p>As well as the proposed environmental land management schemes, farmers may also have the opportunity to install NFM measures through water companies, as part of other offsetting schemes or by projects that will pay for the installation of NFM measures. Several respondents talked about 'stacked payments'. With so many potential opportunities to develop NFM projects and so little certainty over payment rates, it can be difficult to know</p>	<ul style="list-style-type: none"> • Clarity over payment mechanisms for NFM is needed. Decisions about environmental land management scheme payment rates should not be delayed. • Clarity over possible 'stacked payments' is needed.

	which decision to take. Consequently, decisions are delayed.	
Payment rates	Many of the landowners and farmers that attended workshops were very keen to take action that would benefit their neighbours and reduce the likelihood of local properties flooding. However, there is a need to ensure that, at the very least, the cost and time taken to organise and install NFM features as well as be compensated for any lost production is met by the schemes. Many would also look to these NFM actions to help make up lost BPS payments.	<ul style="list-style-type: none"> Although payment rates need to reflect the public benefit that is received, they also need to be high enough to warrant the amount of work and expense that it takes to install features and compensate for lost land.
Loss of BPS	When land is flooded, some fear that BPS payments will be withdrawn as these are based on the area of farmed land.	<ul style="list-style-type: none"> As BPS is being phased out this will cease to be a barrier.
Legal liability	Some landowners stated that they were concerned that they may be liable for flooding caused if any of their NFM features fail or they choose to remove them at some point in the future.	<ul style="list-style-type: none"> Catchment Based Advisers can ensure that liability is held elsewhere as much as possible (e.g. with contractors for design and build).
Maintenance liabilities	Some farmers were concerned that they would be left with the cost of maintaining features after they had been installed.	<ul style="list-style-type: none"> Payments should include contributions to maintenance where appropriate.
Payment timing	Some of the smaller farmers in particular expressed concerns that they could not afford to cover the costs of installing many of the NFM features and be compensated for this expenditure later.	<ul style="list-style-type: none"> Flexible or staged payment mechanisms could be created in high priority areas.
Damage to productive land	Whilst many of the workshop attendees were prepared to sacrifice marginal land to NFM measures, many were not happy to use their most productive land for NFM measures.	<ul style="list-style-type: none"> The 'communication tool' and the Catchment Based Advisers can help to identify the best places to locate NFM features and also alternatives to those on the most productive land.
Permissions and consents	Some NFM measures will require planning permission. Others will require EA consent or permission from the Lead Local Flood Authority or Internal Drainage Board. These processes can be a considerable barrier to farmers implementing NFM measures. These can be costly as well due to the size of some NFM features.	<ul style="list-style-type: none"> A Catchment Based Adviser would be able to either provide advice or develop plans on behalf of farmers. The financial cost should also be covered by schemes irrespective of whether it is successful.

What was the response to the 'Communication Tool'?

The 'Communication Tool' described in section 4.4 was demonstrated at each of the workshops and case studies were carried out applying the tool to three specific holdings within the Darent Valley. More information about these discussions can be found in appendices [IV](#) and [VII](#) (Kent Downs AONB Unit, 2020c and 2021c). In general terms, farmers were much more enthusiastic about the use of a tool such as this to simplify the decision making process than NFM practitioners. The table below summarises the comments received about the tool:

Advantages

- Several practitioners agreed that it is important to give landowners options and that mapping should not be prescriptive. HydroloGIS outputs were seen as good for this, as the ranking gives landowners informed choice; other NFM opportunity maps often lack this ability.
- Landowners generally found the ranking of NFM interventions to be useful, with one farmer observing that they are used to their land being ranked for its agricultural quality and so would find it useful and intuitive to rank land for NFM.
- Numerous landowners and practitioners commented that it is important to consider multiple benefits rather than just NFM. The majority of landowners and practitioners who commented thought that mapping was a useful resource and necessary to give them technical information, but that local knowledge and information is vital to inform final decisions on NFM design and placement.
- One practitioner felt that Countryside Stewardship uptake was poor in some areas because farmers had to pay upfront for modelling to prove that their proposals would have an impact. This barrier could be eliminated if schemes paid for a catchment-based modelling tool that could not only prioritise intervention locations but calculate the amount of water held back.
- Several practitioners and farmers warned against relying too heavily on modelling to both prioritise areas for interventions or payment rates unless confidence levels for the models can be established.

Case Study: using the 'Communication Tool' on Castle Farm

Castle Farm comprises mainly of arable land with some woodland and grazing, forming the base and lower slopes of the Darent valley. The soil comprises a thin, chalky loam with clay loam on the tops of hills. The soils are directly underlain by chalk and the chalky loam drains so rapidly that none of these fields experience overland flows. The grazing fields neighbouring the river are prone to being flooded by the River Darent.

The 'Communication Tool' was presented to the farmer Mr Alexander, so that he could compare the outputs to his knowledge of the farm. Mr Alexander found the Tool understandable and intuitive, but only some of the outputs were appropriate to his farm. The main findings were:

- The Tool suggested creating NFM in places that would not be appropriate on Castle Farm due to the rapidly draining soils.
- The Tool suggested creating floodplain storage ponds in locations that had been identified by the Environment Agency and/or seemed most advantageous to Mr Alexander.
- The Tool appeared to identify suitable locations for NFM in the surrounding area, due to the presence of clay rich soils outside of the farm. This could help coordinate action at the landscape scale.
- The Tool would need to use better soil drainage data to give fully reliable outputs.
- Local knowledge must be incorporated into a final NFM prioritisation tool, as the modelling alone is not sufficient to capture all local detail.

5.2 How can NFM actions within environmental land management schemes maximise public benefits?

The evidence used to answer this question comes from a variety of sources. Primarily, the views of the farming community and other landowners were sought in a series of workshops and in-depth interviews used to create case studies. Although largely qualitative in nature, these highlight farmers willingness to engage with and implement NFM under the right conditions, as well as providing a compelling narrative to support this report's recommendations.

Three elements of this question have been considered separately. More details of the responses of farmers can be found in appendices [IV](#) (Kent Downs AONB Unit, 2020c) and [VII](#).

5.2.1 How can we ensure NFM interventions are effective at reducing flooding?

Some practitioners focus mainly on the volume of water features store, but this overlooks actions that slow overland flows and does not consider interactions across landscapes. Habitats and farm management techniques should be aligned to maximise overall flood reductions.

- **Targeting.** Prioritisation modelling can be important, especially for coordinating actions at the landscape scale and as a tool for practitioners to engage farmers. It is vital that local knowledge is integral to decision making and that farmers can choose interventions that fit within their wider farm management plans. Modelling may therefore be most appropriate to identify options and help practitioners design schemes with farmers. It is also important that the number of features installed is in proportion to the scale of local flooding, which requires landscape scale coordination.
- **Design.** Local circumstances will dictate which types and designs of NFM features will be effective. This variation means that farmers should be advised by knowledgeable practitioners with access to case studies from similar farms and an understanding of latest best practice. Only one farmer said they felt comfortable creating NFM features themselves without an adviser, since they felt they could learn from farms that have already installed NFM.
- **Maintenance.** All NFM features will need maintenance, although this will again vary depending on type of features, specific designs and local conditions. Standard maintenance cycles are unlikely to be appropriate, so some ongoing advice from a local practitioner may be necessary.

5.2.2 How do we maximise the provision of multiple benefits from NFM features?

Many NFM features will also enhance biodiversity, reduce diffuse pollution, capture carbon and offer a range of other services. Conversely, many habitats created for other reasons will also reduce flooding.

- **Incentives.** The potential for 'crowding in' funding should be enabled through the ability to receive multiple payments due to the different benefits that single interventions can deliver. Alternatively, environmental land management scheme payments could also be higher for

NFM features that offer additional benefits. These measures would encourage farmers to consider multiple benefits rather than focusing exclusively on flood mitigation.

- **Targeting.** Even experienced experts find it difficult to consider multiple objectives when reviewing options at a location. Modelling can supply this information and becomes more important as more objectives are targeted. It is also useful to coordinate action at scale across landscapes. Modelling outputs can be offered to farmers themselves, but the complexity of NFM and overwhelming support for on-farm advice suggests that it will be best for practitioners to use multi-benefit modelling when advising farmers.
- **Flexibility.** Schemes should allow farmers to alter features and add new elements to improve the delivery of multiple benefits as incentives, priorities, knowledge and techniques change.

5.2.3 How do we encourage widespread adoption?

The key message from farmers is that schemes should be simple, flexible and properly funded. There was interest from all workshop participants in implementing NFM on their farms, but they have rarely done so due to practical and financial constraints. The following provisions will unlock NFM within environmental land management schemes:

- **Advice.** Almost all farmers expressed a desire for on-farm assistance from advisers, suggesting that they may be unwilling to entertain NFM without it. Only one farmer said they would be happy with no advice other than online maps showing where NFM should be targeted. The NFM practitioners all found on-farm advice to be beneficial in persuading farmers to accept NFM, with most finding modelling or mapping useful when engaging farmers. It also helped practitioners coordinate actions at a landscape scale.
- **Flexibility.** Several farmers and practitioners stated that Countryside Stewardship was too inflexible. Widespread adoption of NFM will only happen if schemes can be varied during the contract period to meet changing farm circumstances, evolving best practice and integrate with other schemes. The design of individual NFM features also needs to be more flexible, as the most effective designs vary according to location.
- **Simplicity.** Several farmers in the workshops stated a desire to know they would be doing the right things in the right places to make a difference. NFM can be complicated and variable, so messaging to farmers needs to be understandable. This can be facilitated by having advisers to explain on a case-by-case basis. Prioritisation modelling to target options can help, but most felt a local adviser would be essential to get buy-in and help farmers create schemes that work on their farms.
- **Payment.** Payment levels will need to reflect lost income from land given over to NFM, as well as all costs associated with creating and maintaining NFM features. Payments should reflect liability of features failing if this rests with the farmer. Several farmers felt that penalties for non-compliance would stop them installing NFM, due to the complexities and uncertainties. Instead, additional support should be given to help them remedy the situation. Monitoring compliance or payments-by-results could be difficult, so payment for actions may be required. Several practitioners suggested that the full range of benefits offered by NFM (such as biodiversity and water quality) should be considered so the full value of features can be captured, especially in areas of lower flood risk.

- **Longevity.** Some farmers found that the benefits of stewardship schemes were lost just as they matured enough to deliver their full potential. Future schemes should avoid this with longer, flexible or renewing contracts.

5.3 How can environmental land management schemes help deliver protected landscape management plans and have a positive impact on landscape character?

Two methods were considered in an attempt to assess the possible impact of NFM measures on landscape character.

1. A geographic assessment of the sensitivity of different Landscape Character Areas to tree planting, hedgerow planting and the addition of large water features. This mapping was carried out for the Darent catchment and is shown below in figure 3 (section 4.5). More detail about this work can also be found in [appendix II](#) (Kent Downs AONB Unit, 2020a). This mapping could either be used as written guidance to farmers and land agents, as the basis for guidance given by advisers or incorporated into ‘Communication Tools’.
2. An assessment of each of the recommended NFM actions on landscape character was made, highlighting potential issues that need to be considered. These can be found in [appendix VI](#) (Kent Downs AONB Unit, 2021b).

It was clear from discussions about landscape character and the visual impact of NFM measures at workshops that awareness of these issues amongst the farming community was mixed. Although some are acutely aware of the potential impact of agriculture and environmental land management on landscape character this understanding is not uniform within the farming community.

In order to address these potential issues the favoured solutions would include:

1. **Advice and guidance** – Advisers need to be aware of the sensitivities of landscape character when providing guidance. Catchment Based Advisers were favoured by farmers and NFM professionals as the method for ensuring that negative landscape character impacts could be minimised. They would ensure that landscape character was considered when working up agreements with farmers and landowners. The nature of landscape character is that the impacts need to be assessed locally. Protected landscapes should have a role in establishing these priorities with those that provide advice for environmental land management schemes.
2. The ‘Communication Tool’ can integrate landscape character **spatial prioritisation** so that NFM measures that would not be appropriate due to their negative impact on landscape character can be filtered out of the options suggested. Further developments could also give higher levels of prioritisation to NFM features that have a positive impact on landscape character such as afforestation in areas where this is a target.

What can schemes learn from pilot projects?

The case for catchment advisers

The Environment Agency has run a series of NFM pilots across the country. Several of the staff involved in the delivery of these projects took part in interviews and shared their experiences of delivering NFM to farmers. Additionally, some of those farmers that took part in the pilots also attended workshops. Some of the participants had also delivered NFM through European Union funded projects. Those that took part identified a range of advantages and disadvantages in delivering NFM this way.

Advantages and disadvantages of delivering NFM through pilot projects

Advantages	Disadvantages
<ul style="list-style-type: none">• Advice and guidance could be given to farmers.• Site visits could be made to discuss how NFM might work on a holding and demonstrations could be given.• Help could be given to get the necessary permissions and consents.• Delivery organisations could work directly with contractors.• Farmers didn't have to make any payments.	<ul style="list-style-type: none">• Approximately 50% of project costs were staff time and 50% were capital works. Obviously, this varied depending upon the type of project.• Farmers could not be paid for their participation in the project so no income could be derived.• No compensation could be made for land lost to flooding which was a disincentive to take part for some.

Essentially, the role that the organising body played was to make the process easy for farmers and landowners. The advisers were able to visit farmers in target catchments, talk about NFM and what it might achieve, what kind of impact it might have on farming and generally demystify the issue of NFM. Almost all farmers who had taken part in NFM pilots said that they would not have got involved had it not been for the project officer who introduced them to the work and helped to make it happen. Conversely, take-up of NFM within Countryside Stewardship schemes has been very low and most who commented said they simply didn't know about its existence. The disadvantages faced by pilot projects was that farmers could not receive payments for the public goods that they provided. Consequently, actions that compromised profitable farming land were rarely considered. Had compensation to farmers been available in these areas, more NFM projects could have been undertaken.

How can environmental land management schemes learn from the pilots?

The new schemes can take the best elements of the pilot projects and address some of the problems that these projects faced to create a scheme that both incentivised the installation of NFM measures as well as provided the advice and guidance required to encourage farmers to consider NFM measures as a viable option for their farms. The elements of a successful environmental land management scheme would include:

- A catchment adviser that can
 - promote NFM to farms and drive local NFM strategies;
 - co-ordinate local NFM clusters that share best practice and experiences;
 - give advice and assistance with permissions, designs and consents;
- Provide payments that incentivise participation;
- Provide payments that compensate when productive land is lost or provide payments for public goods that allow farms to make decisions around the loss of productive land;
- A structure that is flexible enough to allow farms to 'bolt on' additional NFM actions. Without this flexibility, the catchment adviser's job becomes very difficult.

“There is a clear need for investment of time and funding in engagement. Engagement is crucial to gaining support from landowners and other local people, and to forming and sustaining the partnerships needed for NFM.” (Environment Agency, 2019)

6 Conclusions

This work has generated a consistent message around two of the T&T themes in particular and these will form the primary conclusions for this report. Multiple comments were made about payments as well and these also merit a mention in these conclusions. The workshops and interviews focused specifically on the placement of NFM structures and the advice required, but the links to other T&T themes were also discussed and this is shown in the Themes table. This is followed by a summary table of the actions that this T&T recommends.

Spatial prioritisation

Spatial prioritisation for NFM needs to happen at two scales. The first is to establish which catchments and sub-catchments will be targeted for NFM measures through environmental land management schemes. The Environment Agency have informed this T&T that these catchments will be identified nationally and confirmed using Local Nature Recovery Networks. This prioritisation has been modelled nationally based on the number of properties that could be protected from flooding and areas where NFM could replace or complement traditional engineered flood defences. Consequently, this T&T has not focused on this kind of spatial prioritisation.

The second scale is within catchments and on the land holdings that make up these target areas. Some places on a farm are more appropriate for NFM measures than others. The ‘Communication Tool’ developed for this project has shown that priority areas can be identified. It could provide farmers and advisers with information about how the measures are installed; what permissions, consents and other considerations need to be taken into account; and whether there is likely to be an impact on landscape character. The relatively low price tag of this tool of circa £40 per square kilometre (based on the preliminary modelling carried out by this T&T) makes it a viable option for target catchments.

Prioritisation modelling will be effective at targeting actions across whole regions and coordinating actions between farms. It will also materially improve the targeting and design of features to deliver multiple benefits, whilst also considering trade-offs and constraints.

Farmers were generally comfortable with prioritisation modelling for NFM (with many genuinely enthusiastic about its application) and found it useful in visualising where certain interventions should be created. Any ‘Communication Tool’ using such modelling must help farmers make decisions for themselves and not be prescriptive.

Catchment Based Advisers will be most effective at recruiting farms into NFM Schemes and most farmers desire assistance in designing NFM on their farms. Modelling may therefore be most appropriate for use by advisers when going beyond simple NFM targeting to maximise the delivery of multiple benefits.

Advice and guidance

NFM measures are unfamiliar to many farmers and landowners. They are not always straightforward to install as the wrong measures in the wrong places can even exacerbate flooding. Design approvals, consents and permissions may also be required for some features. It is for this

reason that a primary recommendation of this report is that Catchment Based Advisers are required to facilitate NFM uptake within the new schemes in the target catchments. These advisers could be specially trained Natural England advisers or this could be part of the role of Catchment Sensitive Farming officers. Alternatively, there are multiple non-governmental organisations with expertise in NFM and these organisations could be paid to deliver advice on a catchment by catchment basis. These decisions can be taken at a local level.

The role of the adviser will be to:

- Promote NFM within specific target catchments or sub-catchments;
- Raise awareness amongst farmers of NFM;
- Assist farmers with water management plans;
- Promote collaboration between holdings through the use of clusters and working with landowners where measures might straddle holding boundaries;
- Identify potential on farms for NFM measures and help farmers prioritise their placement;
- Assist farmers with applications, consents and permissions as well as identifying contractors where necessary.
- Co-ordinating larger projects covering several holdings (e.g. floodplain reconnection)

The overwhelming majority of workshop participants felt that this type of advice and guidance was key to ensuring that there will be take-up of NFM within environmental land management schemes. The availability, but lack of uptake, of NFM measures within Countryside Stewardship has shown that this role is essential if these mistakes are not to be repeated within environmental land management schemes.

Payment

Flexibility around signing up to NFM measures through environmental land management schemes is essential as:

- Many farmers are not familiar with NFM measures. Consequently, there are few who are likely to sign up to a range of measures on their holding at the beginning of an environmental land management scheme agreement. Flexibility allows farmers to try out a feature and then adopt it more widely on their land;
- Catchment Based Advisers need to be able to work with all of the farmers and land managers in their target areas, not just those that have a scheme renewal pending. Momentum can be lost if a farmer is enthused and ready to adopt NFM measures but is unable to change an existing scheme agreement;

Equally, the longevity of agreements needs to be addressed if measures that may have a long term impact on the income of land holdings (such as tree planting) are to be adopted by farmers.

The payment rates for measures need to reflect the various costs that accrue as well as the multiple benefits that are delivered by actions. Tree planting is an example of an action that may reduce flooding but also delivers benefits for biodiversity, clean air and clean water as well as sequestering carbon to help mitigate climate change. To make a payment solely for the flood mitigation value of tree planting would not adequately reward the public benefits derived from the action.

Finally, with regard to payments, those farmers attending workshops were concerned about the loss of productive land that may occur when installing NFM measures. An example was an estate owner who questioned how trees could be planted on currently productive land to help alleviate flood risk as the economic penalty to the estate and subsequent generations would be ongoing. Even after the trees became large enough to harvest this would not compensate for the loss of income provided by arable land or pasture. The payment rates for this public good would need to be substantial to make economic sense for the estate.

Other important findings of the T&T

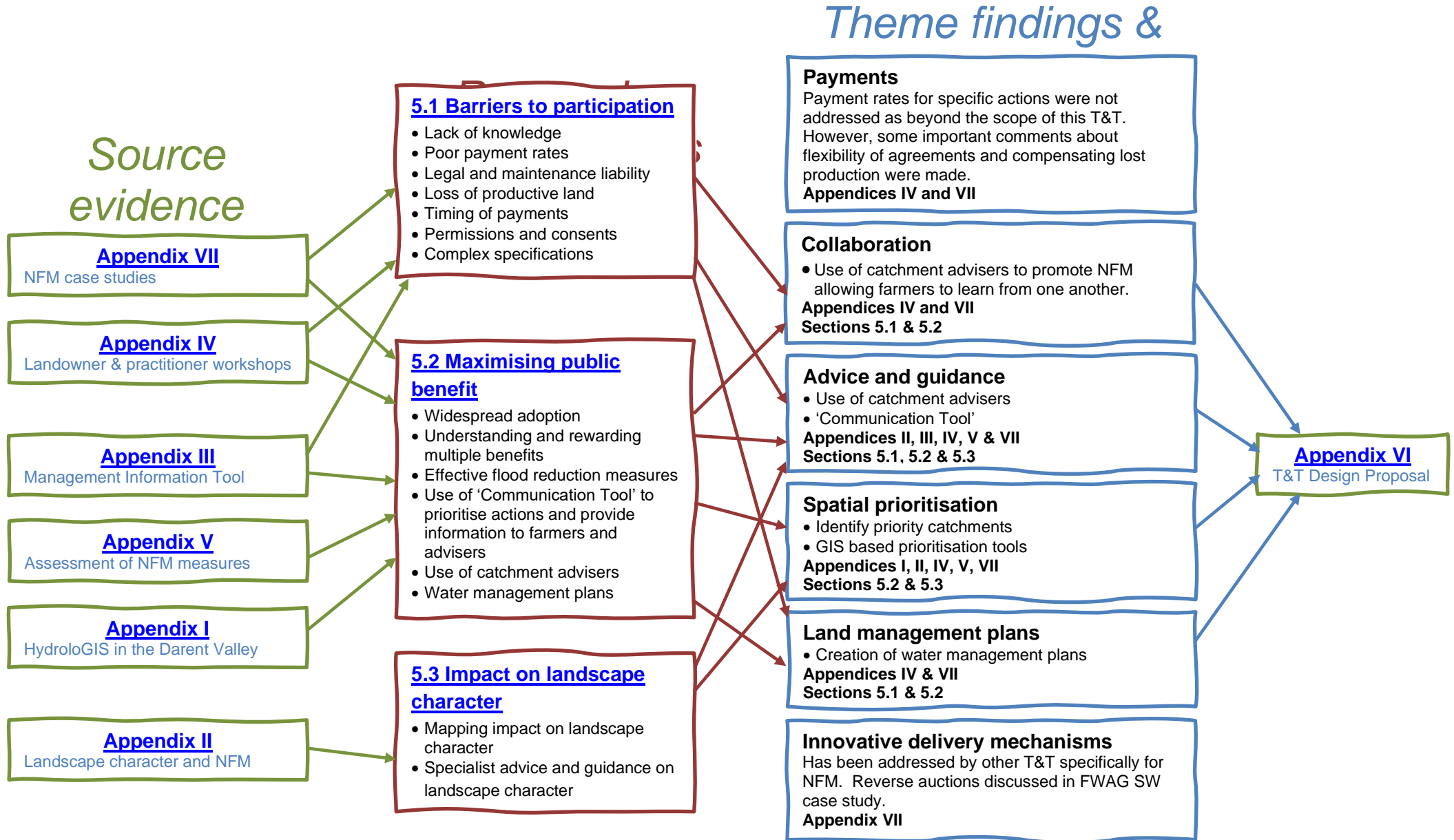
When talking to NFM practitioners it became evident that the **Environment Agency** and **Natural England** had not communicated effectively enough in the development of NFM options within Countryside Stewardship. This is an error that should not be repeated within the environmental land management schemes.

Some NFM measures can be delivered through the **Sustainable Farming Incentive** such as winter cover crops, soil aeration and other measures that do not require consents and provide benefits that are universal across all farms and holdings. Others will only be available through the **Local Nature Recovery** scheme such as leaky dams, leaky bunds and leaky ponds. These measures will only be funded in target catchments or sub-catchments where there are specific flood mitigation objectives.

Water management plans should be a pre-requisite for applying for NFM payments through environmental land management schemes. These plans could be co-created by farmers and Catchment Based Advisers should this recommendation be taken up.

Mapping the Test and Trial Themes

The key themes of the Defra sponsored T&Ts were not established until after this Test and Trial had been approved. However, these themes have been addressed by the work carried out to answer the research questions of this T&T. How these results link to the themes is shown below.



Design Proposal of NFM actions within environmental land management schemes

The culmination of the work of this T&T was to produce a draft list of actions that relate to NFM and provide some more detailed information about the benefits, uncertainties and issues that relate to them. This **Design Proposal** can be found in full in [appendix VI](#) (Kent Downs AONB Unit, 2021b) but a summary of these proposed actions can be found in the table below.

Action (and suggested component)	Additional detail	Multiple benefits/public goods
<p>1. Water Management Plan</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive • Local Nature Recovery 	<p>It is envisaged that Water Management Plans for land holdings will be co-developed between growers and either a Catchment Based Adviser (action 2) or suitably qualified bodies (either individuals such as ecologists and hydrologists or organisations such as FWAG and Protected Landscape Authorities).</p> <p>The Water Management Plan will look at all areas of water management on the holding including NFM measures, water saving and retention schemes as well as reducing run off and soil erosion. The plans will be available to all those who are in the catchment and sub-catchments that have been prioritised for NFM. They will be delivered by somebody with good knowledge of NFM and in conjunction with modelling that might identify the most appropriate places for interventions.</p> <p>The subsequent actions set out in a Water Management Plan will form the basis of an environmental land management scheme funding application.</p>	<p>Whilst not delivered by the Plan alone, its design and subsequent implementation will be designed to deliver:</p> <ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>2. Catchment Based Advisers</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive • Local Nature Recovery 	<p>The Catchment Based Adviser would work with farmers and landowners to devise Water Management Plans and help with the delivery of the plans. Their work will be to help prioritise works, gain permissions and consents and help landowners access funding for the actions. They would allow flexible access to environmental land management scheme funding that would allow newly installed NFM</p>	<p>Although not directly delivered by the Catchment Based Adviser, the actions of their work with farmers will result in:</p> <ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife

	<p>features to attract maintenance payments and payments for lost productive land. These agreements could be added on to existing scheme agreements rather than need to be in place at the beginning of each funding cycle.</p> <p>These actions will help to address many of the barriers to adoption identified in workshops.</p> <p>The economies of scale generated by having a Catchment Based Adviser could also make it cost effective to model catchments in a way that would identify flow pathways and optimal sites for actions to be installed.</p>	<ul style="list-style-type: none"> • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>3. Winter cover crops</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive 	<p>Planting of a crop on arable land during the winter that is removed before spring sowing. This reduces soil loss and slows flow. Reducing stocking density on grassland can have a similar impact. As well as reducing soil loss it can improve soil quality by increasing water infiltration rates and increasing carbon content of the soil.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change
<p>4. Buffer strips</p> <ul style="list-style-type: none"> • Sustainable farming Incentive 	<p>Strips of land next to watercourses that are unmanaged (except to remove woody vegetation) and slow down flow towards watercourses, increase infiltration and reduce soil runoff into watercourses. They can also help stabilise banks.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>5. Cross drains</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive 	<p>The addition of a drain across a track or field gate diverting water and reducing the speed of run off as well as reducing erosion of paths. May be combined with a sediment trap to use silt on fields or tracks. Recommendation for installation will be driven by water management plan.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Protection from environmental hazards • Mitigation of and adaptation to climate change

<p>6. Stocking density</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive 	<p>Reduce stocking density which reduces compaction and increases surface roughness and vegetation cover. In turn this reduces soil loss through run off, slows the flow of water and reduces the amount of nitrates entering watercourses.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>7. Conservation tillage</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive 	<p>A catchall term for a number of methods of cultivating land without ploughing the land. May involve a range of processes that increase soil permeability and reduce compaction. Run off can be reduced and the amount of water stored in soils increased. This can be done using a range of good soil husbandry techniques including sub soiling, minimum tillage, avoiding the use of heavy machinery on wet soils etc.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change
<p>8. Catchment woodland</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive • Local Nature Recovery • Landscape Recovery 	<p>Planting trees within the catchment can slow water flow as well as increase sediment deposition and improve the amount of water that can be held in the ground. Soil erosion is also reduced.</p> <p>Payments will be made to plant trees in areas that are within the catchment and are targeted in areas that are likely to impact the peak flow during flood events.</p>	<ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>9. Floodplain woodland</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive • Local Nature Recovery • Landscape Recovery 	<p>Planting trees within the floodplain can slow water flow as well as increase sediment deposition and improve the amount of water that can be held in the ground. Soil erosion is also reduced.</p>	<ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>10. Riparian woodland</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive 	<p>Planting of trees along the stream or riverbank will slow flow towards the watercourse and reduce soil loss into the watercourse.</p>	<ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards

<ul style="list-style-type: none"> • Local Nature Recovery • Landscape Recovery 		<ul style="list-style-type: none"> • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>11. Cross slope woodland</p> <ul style="list-style-type: none"> • Sustainable Farming Incentive • Local Nature Recovery • Landscape Recovery 	<p>Planting trees or a hedgerow that follows contour lines can intercept run off and increase infiltration rates as well as reduce soil loss and nitrate levels in water.</p>	<ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>12. Leaky woody dams</p> <ul style="list-style-type: none"> • Local Nature Recovery 	<p>Use of felled trees and other simple structures that slow flow through the stream channel whilst allowing normal flow rates to pass unhindered. It is considered that multiple barriers are required for structures to be effective.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards
<p>13. Sediment traps</p> <ul style="list-style-type: none"> • Local Nature Recovery 	<p>A shallow trench within a runoff area that slows water and allows silt to fall out. The water drains away either through gravel or an outlet pipe. Accumulated silt can be redistributed.</p> <p>This action is particularly well suited to preventing soil loss and avoiding diffuse pollution.</p>	<ul style="list-style-type: none"> • Clean air • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
<p>14. Offline ponds</p> <ul style="list-style-type: none"> • Local Nature Recovery 	<p>Offline ponds cover a wide range of features that provide additional storage for water. Their size can vary but water will either collect or be diverted into during high flow. They may be constructed as permanent features with capacity to hold more water during storm events with this water rejoining the watercourse slowly after the flood event.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change
<p>15. Bunds</p> <ul style="list-style-type: none"> • Local Nature Recovery 	<p>These features can be used to store water temporarily or divert water away from areas where it causes flooding. The size can vary greatly and can be designed to hold water temporarily or permanently (depending upon the underlying geology). The release of water can be controlled using pipes through the bund or gaps in the bund</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Protection from environmental hazards

16. Filter barriers <ul style="list-style-type: none"> • Local Nature Recovery 	<p>Predominantly a feature that reduces loss of soil to watercourses but this also means there is greater capacity within channels so reducing flood risk. They can be large nets filled with compost or other material or can be semi-permanent fencing that traps any silt. The latter are more often used on development sites.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Protection from environmental hazards
17. In-ditch features <ul style="list-style-type: none"> • Local Nature Recovery 	<p>A range of features designed to slow the flow and/or increase the capacity of ditches. These range from wooden blocks in ditches to gabions and widening of ditches to increase capacity and create swales during peak flow. These features attenuate more water during flood events as well as producing additional freshwater habitats.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards
18. River restoration <ul style="list-style-type: none"> • Local Nature Recovery 	<p>Restoration of the natural processes within a river. Removal of straightened and engineered flow channels and restoring meanders and other river features. These projects can be complex in nature and require an understanding of the potential impacts of work carried out. Gaining consents will be an important part of establishing the need for works.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
19. Reconnecting floodplains <ul style="list-style-type: none"> • Local Nature Recovery 	<p>A range of works that allow flooding where river flows have been restricted. This may include removing embankments allowing field inundation, lowering flood defences and modifying pumping stations.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement
20. Headwater management <ul style="list-style-type: none"> • Local Nature Recovery • Landscape Recovery 	<p>Measures that generally increase the amount of water stored in upland areas including blocking drainage channels. This both restores peat bog and increases the water storage capacity of moorland.</p> <p>Tends to include removing or blocking drainage measures in upland areas with the aim of storing more water in soils and restoring peat creation capacities of the land.</p>	<ul style="list-style-type: none"> • Clean and plentiful water • Thriving plants and wildlife • Protection from environmental hazards • Mitigation of and adaptation to climate change • Beauty, heritage and engagement

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8 Appendices

A number of documents have been produced that have shaped this final report and give much greater detail than it has been possible to provide here. All of these appendices are available online and can be found by clicking on the name of the appendix.

[Appendix I: NFM Test and Trial – HydroloGIS in the Darent Valley](#)

A guide to the HydroloGIS modelling that was carried out by Viridian Logic on the Darent Valley catchment.

[Appendix II: NFM Test and Trial – Sensitivity of landscape character to NFM measures](#)

A short report that attempts to provide guidance on how the impact of NFM measures on landscape character can be mapped.

[Appendix III: NFM Test and Trial – Management Information Tool](#)

A spreadsheet based tool to provide farmers and advisers with information and considerations about a variety of NFM measures. This and the HydroloGIS mapping form the basis for the 'Communication Tool'.

[Appendix IV: NFM Test and Trial – Findings from landowner workshops](#)

A summary of the responses from farmers and NFM professionals at the six workshops held in autumn 2020.

[Appendix V: NFM Test and Trial – Assessment of NFM measures](#)

A review of the evidence that supports the use of NFM.

[Appendix VI: NFM Test and Trial – Design proposal](#)

A spreadsheet containing a list of proposed actions for the environmental land management schemes.

[Appendix VII: NFM Test and Trial – Case studies](#)

Case studies completed with both farmers and NFM professionals.