Information on How to Deliver and Assess Agroforestry for Nutrient Mitigation

Part 2 – Framework for Agroforestry

March 2024

Natural England Commissioned Report NECR539

www.gov.uk/natural-england

NATURAL ENGLAND

About Natural England

Natural England is here to secure a healthy natural environment for people to enjoy, where wildlife is protected and England's traditional landscapes are safeguarded for future generations.

Further Information

This report can be downloaded from the Natural England Access to Evidence Catalogue. For information on Natural England publications or if you require an alternative format, please contact the Natural England Enquiry Service on 0300 060 3900 or email enquiries@naturalengland.org.uk.

Copyright

Catalogue code: NECR539

Report details

Author(s)

Peggy Lloyd

Jenny Mant

Gabriel Connor-Streich

Natural England Project Manager

Helen Wake, Water Quality Senior Specialist, Chief Scientist's Directorate

Contractor

Ricardo Energy & Environment

Keywords

Nutrient neutrality, Nature-based solutions, agroforestry, silvopasture, silvo-arable, nutrient mitigation, nitrogen, phosphorus

Acknowledgements

We would like to thank Natural England and the partnership of wetland designers from the CWA and The Rivers Trust for sharing their Framework Approach for Responding to Wetland Mitigation Proposals. We would also like to thank the Natural England steering group for supporting the development of this work and for providing useful discussions on the content and structure of this report.

Citation

Lloyd, P., Mant, J., and Connor-Streich, G. 2024. Framework for Agroforestry. NECR539. Natural England.

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

This report was commissioned by Natural England to build knowledge and understanding on a range of nature-based solutions which potentially could be used to reduce nutrients. Ricardo was commissioned by Natural England to understand the mechanisms of nutrient removal for the different solutions, the factors which affect this and review the evidence on the scale of nutrient reductions that they could achieve. This report sets out a framework for the design, implementation, monitoring and maintenance and how (if it is possible) to determine any upfront scheme specific nutrient reduction for agroforestry schemes that will provide sufficient scientific certainty in the assessment of nutrient neutrality mitigation schemes.

Executive summary

The objective of this project is to provide support to Natural England (NE) employees and those of other relevant organisations (such as Competent Authorities) to enable them to make informed judgements on agroforestry proposals for nutrient mitigation. This report takes the form of a Framework, for the design, implementation, monitoring and maintenance and how to determine scheme specific nutrient reduction for agroforestry schemes to achieve nutrient neutrality (NN). The project comprises three parts where:

- **Part 1** (the literature review) provides the evidence base on the effectiveness of four different NbS for nutrient mitigation including the methodology applied.
- **Part 2** (this document - The Framework) considers the design, implementation, monitoring and maintenance needs and how to determine a scheme specific nutrient reduction (where applicable). There are four framework documents, one for each of the four mitigation solutions considered in part 1.
- **Part 3** (the lookup tool – separate spreadsheet) comprises a user-friendly lookup tool with high-level practical information on a wider range of potential nutrient mitigation solutions.

This Framework specifically provides advice on achieving scientific certainty for agroforestry schemes to achieve NN. Owing to the lack of data, no credits can be claimed upfront for agroforestry (silvopasture and silvo-arable) schemes. However, this Framework sets out how to determine a scheme specific nutrient efficiency reduction to determine the number of N and / or P credits which can be generated following baseline and post-implementation monitoring. The Framework follows the following structure to set out what information needs to be provided to evidence that the scheme is appropriate:

- Stage 1 – Design Objectives
- Stage 2 – Feasibility
- Stage 3 – Design Process
- Stage 4 – Implementation Process
- Stage 5 – Post-implementation Monitoring and Evaluation

As nutrient credits cannot be claimed upfront, this Framework outlines how to carry out baseline and post-implementation monitoring to claim credits once the scheme is functional.

Contents

1. Introduction

The overall objective of this project is to provide support to Natural England (NE) employees and those of other relevant organisations (such as Competent Authorities) to enable them to make informed judgements on Nature-based Solutions (NbS) proposals for nutrient mitigation. The overall project comprises 3 parts where:

- **Part 1** (the literature review – separate report) provides the evidence base on the effectiveness of four different NbS for nutrient mitigation;
- **Part 2** (this report known from now on as the **Framework**) considers the design, implementation, monitoring and maintenance needs and how to determine a scheme specific nutrient reduction. There are four framework documents, one for each of the four mitigation solutions considered in **Part 1** (the literature review).
- **Part 3** (the lookup tool – separate excel tool) comprises a user-friendly lookup tool with high-level practical information on a wider range of potential nutrient mitigation solutions.

1.1. Framework objectives and aims

Key Aims:

Support NE staff to identify NbS for Nutrient Neutrality (NN) mitigation that are:

- Compliant with habitat regulations assessment (HRA) requirements and;
- Can achieve improvements to water quality, specifically through the reduction of nitrogen (N) and / or phosphorus (P) loading and;
- Have robust design, implementation, and monitoring and maintenance plans.

Part 2 (this document) provides the FRAMEWORK for agroforestry which can be used in conjunction which is underpinned by evidence set out in **Part 1** and also feeds into **Part 3** (the lookup tool).

The mitigation measures in this project were determined in **Part 1** (the literature review – separate report) and comprise:

- River channel re-naturalisation and floodplain reconnection;
- Engineered logjams;
- Buffer strips; and
- Agroforestry

For each mitigation measure, there is a separate Framework document. This Framework document advises on the agroforestry mitigation measure and what is required to achieve scientific certainty for NN. It does not consider whether it is possible and how to achieve practical certainty that the measures can be secured.

This Framework sets out how to determine a scheme specific nutrient efficacy reduction through a combination of baseline and post-implementation monitoring as not enough evidence was found in **Part 1** (the literature review) to determine precautionary efficacy estimates without monitoring. Stages 1 to 5 (explained in Figure 1:1) of the framework set out what information needs to be provided to evidence that the scheme is appropriate for the location and all factors in the design, implementation and maintenance of the scheme have been considered to ensure that there is confidence the scheme will achieve the required nutrient reductions. Checklists are provided at the end of each section to help the assessment of whether all the required information has been provided.

Although this framework focuses on agroforestry in the context of NN mitigation, there can be potential synergies between different mitigation solutions. Implementing a system of multiple NbS to achieve NN will provide greater nutrient reduction benefits through floodplain reconnection, reduced velocities, and increased contact time between nutrient rich flows and sediments to which they can bind. Capitalising on the synergies between NbS to achieve NN will allow for reduced nutrient loads from each scheme to be stacked together to achieve more nutrient credits than any one scheme would mitigate. The load reduction benefits of synergistic interactions between NbS would need to be addressed on a case-by-case basis for realistic credit generation. In addition, NbS have the potential to provide many wider benefits. These wider benefits are also considered as part of the feasibility process which may support other biodiversity and societal net gain ambitions as part of the planning process.

Part 3 (the lookup tool) when used in conjunction with this Framework enables assessment of appropriateness alongside a wider range of potential mitigation measures for a given scenario.

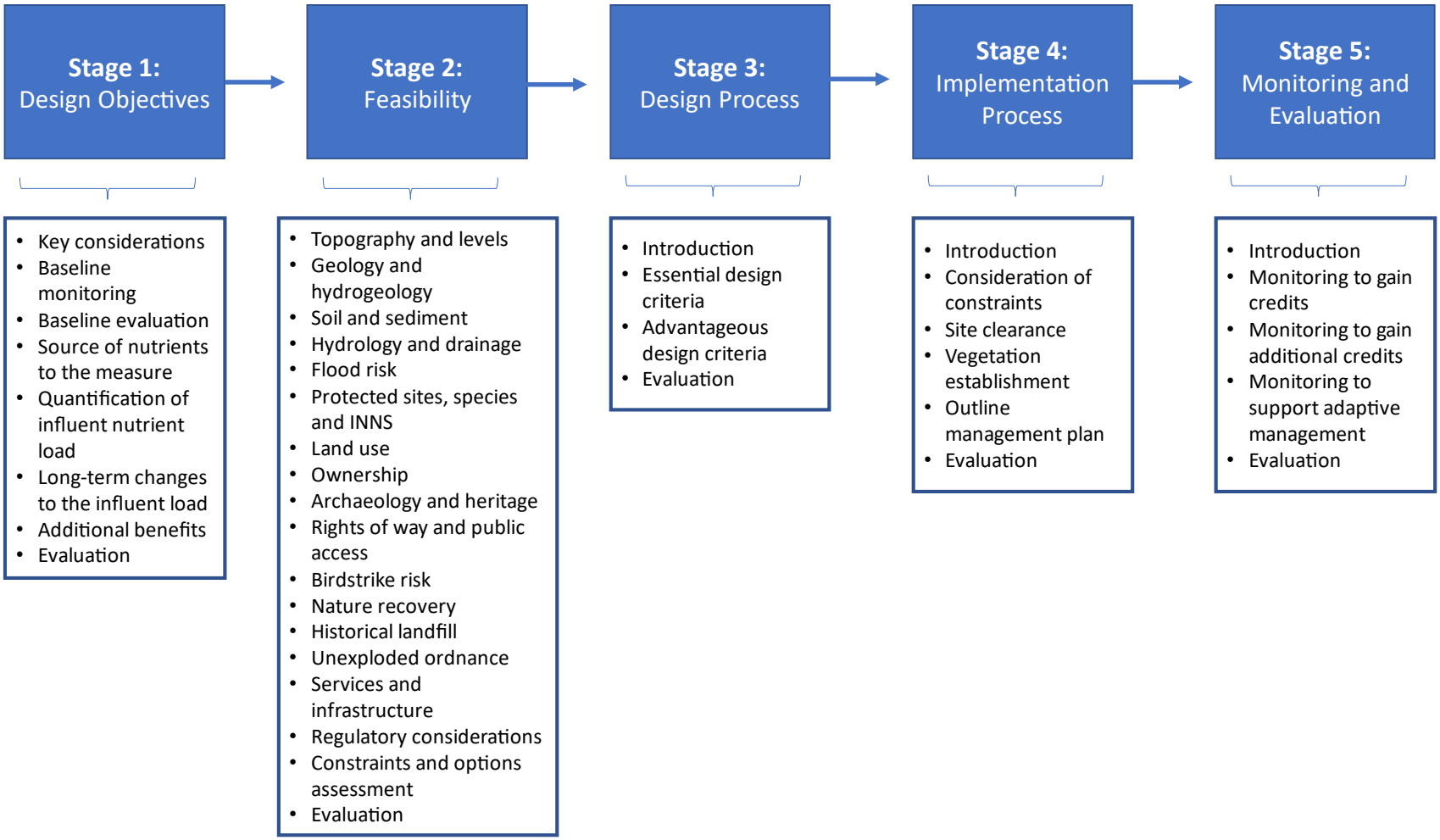

Figure 1:1. The outline structure for this framework*

*Note: the level of detail and key information categories may vary between mitigation options. A version of this figure for that can be used by screen-reading software has been included on the following page.

Stage 1: Design Objectives	Stage 2: Feasibility	Stage 3: Design Process	Stage 4: Implementation Process	Stage 5: Monitoring and Evaluation
- Key Considerations - Baseline monitoring - Baseline evaluation - Source of nutrients to measure - Quantification of influent nutrient load - Long-term changes to the influent load - Additional benefits - Evaluation	- Topography and levels - Geology and hydrogeology - Soil and sediment - Hydrology and drainage - Flood risk - Protected sites, species and INNS - Land use - Ownership - Archaeology and heritage - Rights of way and public access - Birdstrike risk - Nature recovery - Historical landfill - Unexploded ordnance - Services and infrastructure - Regulatory considerations - Constraints and options assessment - Evaluation	- Introduction - Essential design criteria - Advantageous design criteria - Evaluation	- Introduction - Consideration of constraints - Site clearance - Vegetation establishment - Outline management plan - Evaluation	- Introduction - Monitoring to gain credits - Monitoring to gain additional credits - Monitoring to support adaptive management - Evaluation

1.2. Limitations to this framework

This Framework focusses on the key considerations required for a NbS proposal to achieve suitable mitigation solutions. There are, however, limitations to its use as outlined below.

This framework relies on expert judgement related to mitigation applicability: Certainty of the efficacy of a solution beyond reasonable scientific doubt is essential even though absolute certainty is not required for a solution to be deemed suitable. Therefore, judgement over the efficacy needs to be based on a combination of the level of confidence in the data, the design, and the consistent use of precautionary input values. Judgement on a site-specific basis will be required since only a generic overview of the requirements for each mitigation scheme is provided in this Framework.

Uncertainty in quantity of nutrient mitigation for a given solution: This applies to solutions whereby percentage removal efficiencies cannot be applied to estimate nutrient load reductions before implementation. Some mitigation measures, such as agroforestry schemes, need to be deployed and monitored since predictions cannot be made in advance regarding the quantity of nutrient pollution reduction they will achieve. This limits their applicability as nutrient credits will only be provided once sufficient baseline and post-implementation monitoring has taken place.

Prescriptive monitoring: Given the uncertainties highlighted above, and potential variation of geological conditions and locations, any monitoring will need to be bespoke (based around specific criteria) and dependent on incoming nutrient loads. This Framework, therefore, emphasises the importance of showing the principles of a robust approach, without limiting the options of the provider.

Detailed engineering design: This Framework is limited to the use of agroforestry for nutrient mitigation and considering at a high level the key design, implementation, monitoring and maintenance requirements of any scheme to ensure there is confidence any scheme will provide the proposed efficacy reduction relative to baseline environmental conditions. This Framework is not intended to provide detailed engineering advice on how to implement a NbS. This will need to be sought separately although this guidance provides the list of expected outputs.

2. Determining scheme specific efficacy

This section sets out how to determine a scheme specific efficacy using the results of baseline and post-implementation monitoring and undertaking a confidence assessment looking at key design criteria and the calculation of the baseline load.

2.1. Maximum efficacy reductions

A review of studies was conducted on the efficacy of agroforestry schemes in reducing nutrients leached from the soil within **Part 1** (the literature review). Owing to the lack of data on N and P removal efficacy outlined in **Part 1** (the literature review), no value has been provided for total phosphorus (TP) or total nitrogen (TN). Robust baseline and post-implementation water quality and velocity monitoring is therefore required (to calculate the credits available on a scheme-specific basis) to evidence the N and / or P removal capacity of a scheme to gain any credits. An alternative approach could be to consider the annual uptake of nutrients into the crop/tree biomass which is permanently removed or locked away.

2.2. Calculating the baseline export

This section primarily considers how to determine a baseline where a water quality monitoring approach is being used.

A good baseline of key environmental variables is needed to robustly calculate the baseline nutrient export from future land use(s) and crop types on a site where agroforestry schemes will be implemented. This is especially important related to NN, in the context of demonstrating beyond reasonable scientific doubt that the reductions will be achieved in perpetuity in line with the Habitats Regulations requirements. Without a robust estimate of exports it will be difficult to demonstrate upfront the benefits that a scheme provides.

To calculate scheme specific baseline nutrient exports from farming systems without trees, site specific information such as crop types must be identified. With this information, Farmscoper can be used to characterise site specific estimates of baseline nutrient exports, prior to the implementation of an agroforestry scheme (see more detail in section 3.2.2).

The means by which nutrient loads are characterised and the confidence the approach will have will differ between each scheme, however the broad requirements are uniform. These are as follows:

- If modelling: It is expected that Farmscoper modelling will be used to establish the baseline export from the future land use(s) of agricultural land. The modelling must account for all future crop types, including any potential future rotations, and must provide export values for the land use(s) with no trees present. The approach must

be suitably precautionary where future land use(s) is not certain. This must be verified on a scheme-specific basis.

- If undertaking scheme specific monitoring: Monitoring the nutrient export of agricultural land is complicated therefore a method must be identified on a scheme-specific basis as a comprehensive methodology has not yet been established. There are, however, some minimum requirements which will need to be met. For example, all crops within future rotations must be included as part of the monitoring in order to provide a strong understanding of nutrient cycling in the system. Additionally, the length of the dataset for each crop type needs to be long and frequent enough to cover the full range of likely flow and water quality conditions, which could vary spatially and temporally. The programme should aim to capture nutrient loads exiting the field following different magnitude rainfall / flow events. This may require a reactive sampling programme. The monitoring must account for the time lag between events that mobilise nutrients and the point at which they can be monitored in flows. The location(s) of the sampling point(s) needs to be representative of what will exit the mitigation scheme. The number of locations which will need to be monitored will depend on the type of scheme and the likely spatial variability of the flows / concentrations exiting the scheme.
- This is likely to be a complex process and the specifics of the monitoring approach have not yet been established therefore any methodology followed will need approval from NE. An alternative approach could be used to determine the nutrients which will be taken up each year into the crop / tree biomass and are permanently removed/locked in. This would require the determination of the nutrient content of the specific crop/tree biomass taking account of any temporal and spatial variability and an estimate of the amount of new biomass which will permanently remove nutrients each year.

Further details on baseline monitoring requirements can be found in section 3.2.2

2.3. Confidence assessment

A specific scheme load reduction can only be determined through robust baseline and post-implementation monitoring for agroforestry schemes. The confidence in the load reduction calculated is dependent on the scheme being designed robustly and the baseline load being accurate. Overestimation of the baseline load will lead to an overestimation of the likely load reduction the scheme will achieve. Table 2:1 enables a confidence assessment to be undertaken on each of the key elements which will determine whether or not the baseline has been robustly calculated. If it has been, there will be confidence in the baseline load used to calculate the nutrient reduction post implementation.

Whilst filling out this table it should be noted that:

- The result (high, medium, or low) of each question's answer will help to determine whether or not credits can be claimed post-implementation.
- Based on the criteria specified for each question, the relevant boxes should be ticked.

The key questions need to be considered at the scheme idea stage to provide upfront clarity of the requirements and to encourage consideration at an early stage of the best practices.

Table 3:2 must also be filled in to enable a confidence assessment of the scheme's design. The result of each question will impact the overall confidence rating of the scheme as the results inform the answers to Table 2:1.

Table 2:1. Confidence assessment

	High	Medium	Low
Have you accounted for all sources of water / nutrients in your monitoring or, modelling approach to calculating baseline loads?	Yes, all sources – groundwater, surface water, rainfall, point sources, etc. No – but the way it is considered is more precautionary in the context it is used	Most of the sources considered – those not considered are likely to be minor.	Only some sources considered and not considered some which could be significant source OR don't know as insufficient information has been presented.
Have you accounted for any and all land-uses and crops to be included in future rotations	Yes, all crops have been accounted for in the monitoring / modelling approach and the assumptions regarding future land-uses are precautionary.	Most crops have been considered – those not considered are likely to have a minor impact.	No, only some crops / land-uses considered and not considered some which could significantly increase exports OR don't know as insufficient information has been presented.
Has the baseline export been accurately determined?	Yes – Any flow bypassing the scheme has been removed. For schemes which have spatially diffuse inflow (rather than one single inflow) this has been robustly characterised. If using monitoring data, the location of any monitoring points	The vast majority of load has been accounted for. Any flow bypassing the scheme has been removed. If using monitoring data the location of any monitoring points means that any load exiting the scheme that not accounted for are likely to be minor.	No there is significant uncertainty in how it has been determined including: No consideration as to whether any flow bypasses the scheme OR If using monitoring data, there are additional significant export loads

	High	Medium	Low
	are representative of the flow and concentration exiting the scheme. If using modelling, then precautionary assumptions / values have been used.	If using modelling, then precautionary assumptions have not always been used. Where this is the case they don't have a significant effect on the predicted export.	that have not been taken into account due to the location of monitoring points. OR If using modelling, precautionary assumptions and values have not been used.
Does the baseline export calculation take account of the temporal variability including seasonality?	There is a robust estimate of temporal variability both seasonally and annually. If using monitoring data: data is collected at a frequency which captures seasonality and different magnitude rainfall / flow events. If using modelling: there is a robust estimate of seasonal/annual variability and	Not all temporal variability is accounted for, however evidence is provided that the methodology takes account of the majority of the seasonal and annual variability and takes into account the worst-case situations[1].	There has been no consideration of seasonal or annual variability in flow or concentration.

[1] In this context, worst-case refers to scenarios where the conditions support low nutrient removal compared to the year-round average. It is not acceptable to look only at the data showing the best-case scenario for nutrient credit generation.

	High	Medium	Low
	precautionary assumptions have been used.		
Have you taken account of any known anticipated future long term changes in baseline export e.g. due to climate change or existing planned development/activities?	Yes – everything relevant considered and the assessment has been undertaken in a robust way applying precautionary assumptions.	N/A	There has been no consideration of known anticipated future long-term changes OR precautionary assumptions have not been used.
Are the appropriate forms of N and / or P considered[2]?	Yes OR No – but the form considered is more precautionary in the context it is used.	N/A	No and the form considered is less precautionary in the context it is used.

[2] To claim credits using this Framework's efficacy reductions, nitrate and TP must be used to remain consistent with Farmscoper's approach.

	High	Medium	Low
Is the baseline assessment method appropriate to the scheme type?	Yes – monitoring or modelling carried out in line with the requirements in Section 3.2.2	N/A	No – approach used is unjustified with insufficient information. For example, an unjustified modelling approach is used, or monitoring does not meet the requirements of Section 3.2.2.
Have the key design criteria been met in Table 3:2?	Yes – all minimum design criteria have been met	N/A	No – not all of the minimum design criteria have been met
Is there is robust maintenance plan?	Yes, there is a detailed maintenance plan covering all maintenance requirements for the lifetime of the scheme.	N/A	No – schemes should not be agreed without detailed maintenance plans.

After answering all questions in Table 2:1, the following criteria must be considered to provide a percentage of the total efficacy value which can be applied to the baseline nutrient export.

- If **any** answer low, the scheme design and baseline monitoring method are not robust enough to be able to generate any credits through post-implementation monitoring
- If **all** answers medium and high, the scheme design and baseline monitoring method are robust enough to endeavour to claim credits through post-implementation monitoring

Considering how any scheme will deliver against the confidence assessment throughout its development and particularly at the start, will ensure it can be designed in a way to maximise or optimise the credits that may be generated post implementation versus the costs and taking account of any constraints.

It should be noted that once credits can be claimed via post-implementation monitoring, adaptive monitoring will still be required to inform any maintenance to ensure that the scheme continues providing nutrient mitigation in perpetuity (or if using as a temporary measure for as long as the scheme is required). Adaptive management monitoring should focus on scheme function.

2.4. Calculating scheme specific load reductions

Owing to the lack of data collected in **Part 1** (the literature review), agroforestry schemes cannot claim any credits upfront. As such, in order to calculate scheme specific load reductions, either baseline and post-implementation water quality monitoring must be carried out as per the guidance in Section 2.2 and Section 3.6.2 or a precautionary estimate of the annual uptake of nutrients into the crop/tree biomass which is permanently removed or locked away could be determined.

3. Framework for Agroforestry

3.1. Key considerations

Agroforestry is a farming system where trees are planted within the areas used for arable food or livestock production. These two types of agroforestry are often termed:

- **Silvo-pasture**: the incorporation of trees within areas of livestock pastures, and
- **Silvo-arable**: the incorporation of trees within areas of arable agriculture.

Both agroforestry systems rely on the same nutrient removal mechanisms to achieve NN, however they are considered separately in this Framework due to their varying efficiencies, as outlined in **Part 1** (the literature review). The primary mechanism these systems rely on, in the context of NN, is vegetative assimilation of nutrients. Additional mechanisms of nutrient removal include a reduced need for fertilisers, reduced wind erosion of sediment bound nutrients, increased denitrification because of the consistent source of organic matter (OM) to the soil, as well as sedimentation of sediment bound P due to increased surface roughness.

Key Headline Messages:

- Agroforestry to achieve NN may not be suitable for deployment in all locations.
- There are key considerations that can help identify where a proposal may not be viable and / or needs more investigation to increase confidence of success noting that evidence is required to demonstrate a favourable NN outcome.
- If sufficient evidence related to the point above is not provided, further information will need to be requested and reviewed.

A checklist for these points is provided below.

Mitigation schemes may not be suitable for deployment in all locations within a given catchment and there are certain key considerations that might indicate proposed options are not viable. A summary of the key upfront considerations that should be considered in the first stages of planning for agroforestry schemes is provided in the checklist below.

Table 3:1. Key considerations checklist (Note: some cells have been left blank)

Key considerations	Evidence to be provided	Evidence provided (Y/N)
The Local Planning Authority has confirmed	A nutrient mitigation scheme needs to have practical certainty that can be secured and will provide the mitigation for the lifetime of the	

Key considerations	Evidence to be provided	Evidence provided (Y/N)
that it is possible to secure the mitigation.	development or if being used as a temporary measure for the length of time that the mitigation is required. It may not be possible in all cases to adequately secure that the mitigation will continue to provide the reduction for the required length of time. Mitigation proposals should demonstrate engagement with the Local Planning Authority to ensure schemes can be sufficiently secured and there is certainty that they will provide the required reductions for the length of time the mitigation is required.	
That the implementation of an agroforestry scheme will not have an adverse impact on any protected sites or species or negatively affect existing habitats, or the ability to achieve other environmental objectives	An evidence statement will be required. If adverse impacts are identified, the scheme will need to be reviewed / changed noting that all agroforestry schemes will be subject to ecological survey prior to implementation.	
There are no land constraints	Key example includes landowner agreement to alter current agricultural practices.	
There is sufficient and robust baseline data to calculate the baseline load	Account for what data exists. Where insufficient, further data collection may be required prior to implementing a project. This may delay development.	
The Local Planning Authority has been engaged to ensure the mitigation will serve developments impacted by NN	Nutrient mitigation schemes must remove at least the equivalent quantity of nutrients than what will be added by new development before impact on a Habitats site waterbody takes effect. The mitigation measure will need to be upstream of the location where the development site run off and wastewater input will have its effect on the Habitats site. This means if the wastewater / run off is direct to	

Key considerations	Evidence to be provided	Evidence provided (Y/N)
	(i.e. within) the Habitats site boundary the measures will need to be upstream of this location. If the discharge is indirect i.e. upstream in the catchment of the Habitat site, then the mitigation measures can be up or downstream within the catchment, as long as it will provide the offsetting before the point at which the development impacts the Habitat site. Mitigation proposals should demonstrate engagement with the Local Planning Authority to ensure schemes will provide sufficient NN.	
There are no insurmountable reasons why any required permissions or consents would not be granted.	Proposal should show that the relevant competent authorities (e.g. Environment Agency) have been consulted from an early stage to ensure there are no evident or insurmountable concerns early on. This approach can also mitigate any potential risks regarding consents and permissions.	

3.2. Stage 1 – Design Objectives

3.2.1. Introduction and objective setting

Agroforestry is a farming system where trees are planted within the areas used for arable food or livestock production. It is a long-term solution to land availability, declining crop yields and biodiversity, whilst simultaneously maintaining, and often increasing the productivity of agricultural land. There are extensive environmental benefits, including livestock health and reduced stress, carbon sequestration, reduced soil degradation and improved nutrient cycling through mycorrhizal associations (Raskin & Osborn, 2019). As such, agroforestry is rarely implemented with the goal of NN in mind; however, research suggests it can be used as a reasonable mitigation measure (Michel, Nair, & Nair, 2007; Briggs, 2012; Franklin, Mcentee, & Bloomberg, 2016). The primary difference to traditional farming is the presence of phreatophitic trees, with access to previously inaccessible nutrients.

To further provide confidence that an agroforestry scheme will deliver the allocated levels of nutrient removal, clearly defined objectives are required and must be set early in the process. For example, a primary objective may be related to N, P or indeed both pollutants with secondary objectives / ambitions related to a combination of hazard risk reduction (e.g. flood and drought), ecological (e.g., habitats for fish, aquatic inverts, mammals etc), and societal benefits (well-being etc).

Key Headline Messages:

Defining appropriate objectives to support NN requires initial understanding key factors including:

- Knowledge of the sources of water entering the scheme;
- Knowledge of the concentration of nutrients in the water exiting the field;
- The overall quantity of water flowing into the mitigation scheme;
- Predicting how concentrations and flows might fluctuate over time; and
- The level of confidence there is in the understanding of these factors.

For the design objectives to be robust enough to meet the Habitat Regulations requirements, sufficient evidence and information needs to be provided for each of the above.

The following sections 3.2.2 - 3.2.7 need to be evaluated in this context.

3.2.2. Has a robust baseline monitoring / modelling method been employed to inform scheme efficacy?

This section primarily considers where a water quality monitoring/modelling approach is being used rather than the potential alternative approach to consider the annual uptake of nutrients into the crop/tree biomass which is permanently removed or locked away.

Key questions

- **Why is baseline monitoring / modelling required?** The output of baseline monitoring / modelling provides the baseline loading value against which post-implementation monitoring results can be compared to gain credits. Depending on the scheme, this will likely be done via physical monitoring, or modelling. It is unlikely that secondary datasets will be available.
- **What is baseline monitoring / modelling?** Baseline data characterises the nutrient load exiting the site of the scheme, prior to implementation. Understanding nutrient concentrations and flow rates exiting the proposed scheme together with sediment movement is essential as a minimum. There will likely be complexities associated with designing a monitoring scheme that accounts for all surface, subsurface and groundwater flows, their respective nutrient concentrations as well

as the spatial variability across the scheme. Monitoring, however, is still feasible with a robust methodology where approaches are explained and justified.

Baseline monitoring also needs to incorporate an understanding of nutrient concentrations and flow rates exiting the scheme.

- **Have suitably precautionary values from the data been used?** The input data, model assumptions and any modelling or monitoring output data must be considered holistically, with specific reference to the most precautionary scenarios which have been characterised. It is not acceptable to look only at the data showing the best-case scenario for nutrient credit generation.

If modelling

- **What is a modelling-based approach to calculating nutrient loading?** There are various possible modelling-based approaches to determine the baseline load to the scheme. Whilst this Framework cannot be prescriptive in the specific elements of a modelling-based approach, a proposal that uses modelling to determine nutrient loads is likely to include the following steps:
    1. Use of FarmScoper to model the nutrient export coefficients of the future land use type / types without the trees to ascertain the quantity of nutrients that would be exported if the trees were not present. If crop rotations are in place, these will need to be accounted for in the modelling process by forming a bespoke approach involving running several different crops within the programme or identifying a generic farm type which is representative of all crops within the rotation, for example. The export value / values identified represent the quantity of nitrate and or TP that would leave the agroforestry system if the trees were not present, prior to entering the river.
    2. Use the baseline loading export values with relevant post-implementation monitoring data to calculate the likely nutrient load reductions.[3]

    There are other methods that can be used to calculate nutrient load reductions. If a different modelling approach is used it should be fully documented to show how model calibration and validation data have been generated and applied.

If monitoring

- **What is a monitoring-based approach to calculating baseline nutrient loads?** Monitoring-based approaches collect real-world data that can be used to calculate the export nutrient load to an agroforestry system. There is no standard monitoring method to collect data on nutrient loading from agroforestry systems as this is yet to be developed due to the complexities and variation in requirements from scheme to scheme. However, a monitoring programme to collect data on export nutrient loads should adhere to the following principles:

[3] If a modelling approach is used to calculate baseline exports, it is likely that a monitoring approach will still be required to calculate credits via post-implementation monitoring.

1. A monitoring design should be specified that shows how data on concentrations and flow rates exiting the system will be collected – these variables are combined to calculate nutrient load[4]. For an arable system, the quantity of N and P, as well as the quantity of water, exiting the system must be measured. A bespoke approach must be identified for each solution, although it should be noted that undertaking water quality monitoring will be difficult due to the need to take account of all exports from the system.
2. Monitoring must take place before the system is in place and must consider all crop types included within future crop rotations (i.e. the crops monitored must be the same as the crops which will be present within the agroforestry system). Sampling must be carried out monthly at a minimum for the baseline data to be robust.
3. Concentration and flow rates data should be captured for both surface and subsurface flow pathways.
4. Monitoring should also capture the export nutrient load generated by different magnitude rainfall events across all four seasons. This may require a reactive sampling programme[5].
5. The number of monitoring points should increase with the size of the system, to reduce the risk of missing local variations in hydrology and water quality that will impact the nutrient load.

- **What should happen to the monitoring data?** This should be decided and agreed at the beginning of the monitoring programme including approaches to assess data. It is likely to be of interest to LPAs, NE and other third-party stakeholders (e.g. local catchment groups and academics). Building a supporting open-source database including the efficacy rates will be highly beneficial for future programmes.

Key information required

- A clear, repeatable description of the methodological approach to calculate the nutrient load, alongside a rationale for the methodology that has been used.
- The methodology should detail the monitoring or modelling design and how this design supports a robust estimation of the baseline nutrient load from an agroforestry system, accounting for the issues detailed above.
- Confirmation that the export nutrient load has been calculated for nitrate and / or for TP.
- **Optional:** A plan detailing how data from baseline monitoring will be made available to stakeholders.

[4] By multiplying concentration with flow rate, the nutrient load is expressed as a mass per unit time, which are the required units for calculating nutrient removal using the percentage reduction efficiencies.

[5] I.e., sampling at a non-standardised frequency in response to different size rainfall events.

3.2.3. Have the source of nutrients and export values been clearly defined

Key questions

- **Do you have a clear picture of where the nutrients will be entering the agroforestry system?** Agroforestry schemes can treat a range of terrestrial sources of pollution, such as agricultural diffuse pollution, and aim to reduce nutrient run-off from excess fertiliser. Agroforestry is also likely to reduce the need for nitrate and phosphate fertilisers, reducing the overall input into the soil system. Understanding where fertiliser is applied is important in predicting the potential loading and ensuring that the nutrients will be transported to the nearest waterbody via the agroforestry system. This is important to understand as it might influence where baseline monitoring should take place.
- **What is the nutrient export at the site?** The nutrient export from current and future land use(s) will influence the applicability of a site for an agroforestry scheme but may not greatly impact the design. Nutrient removal processes generally operate better at higher concentrations.
- **Has a detailed condition assessment of the receiving waterbody been completed?** In general terms, demonstrating consideration of agricultural catchments which drain to areas that are not in good status and ideally poor status where agriculture is a reason for not achieving good (RNAG), is likely to provide an opportunity for greatest mitigation.

Key information required

- Maps showing nutrient sources and where they are / will be entering the agroforestry scheme.
- Ecological status and RNAG of water course related to the proposed mitigation.

3.2.4. Has any allowance been made for long-term changes to the export nutrient load

Key questions

- **Has climate change impact been considered in terms of the potential impacts on export nutrient loads?** This could have a future impact on the efficiency of an agroforestry scheme at mitigating nutrient pollution in the future. At this stage it is recommended that key open-source data is reviewed to ascertain long term local predicted trends[6].

[6] To account for climate change, see: Product Selection - UKCP (metoffice.gov.uk). Search for the relevant area to determine the environmental impact of climate change on rainfall, and therefore export nutrient concentrations. Use this to support research.

- **Have planned changes been considered in terms of the potential impacts on export nutrient loads?** Already planned local changes which might result in either increasing or decreasing loads to the site could have a future impact on the efficiency of an agroforestry scheme at mitigating nutrient pollution. A HRA would only require an allowance for changes that are known at the time of the assessment, therefore all improvements that have been secured at this stage need to be considered.
- **Are there any known site-specific land use changes that may affect long-term nutrient impacts?** An evidence log is required to understand if any changes planned result in either increasing or decreasing loads.
- **How should long-term changes in export nutrient loads be acknowledged?** Mitigation proposals will need to incorporate known long-term increases or decreases in export nutrient loads e.g. due to climate change or already planned land use change, and the impact this might have on the amount of nutrient mitigation an agroforestry scheme will deliver in perpetuity or if using as a temporary measure for as long as the scheme is required.

Key information required

- Summary statement outlining all planned improvements within the catchment, with reference to likely impacts.
- Account for climate change that is evidenced.
- Statement of any known land use changes and potential effect (positive and negative).

3.2.5. How are credits calculated?

Key questions

- **When can credits be calculated?** Credits can be calculated after post implementation monitoring for a minimum of three years and once a quasi-equilibrium can be evidenced. The monitoring must account for all seasonal variability.
- **How is the generation of credits calculated?** To calculate the quantity of credits that can be claimed by the mitigation scheme, an analysis of the variation of exports will be required to provide a strong understanding of nutrient dynamics within the system. There is no current verified methodology the analysis should follow, however it will need to take account of time lags between nutrient mobilisation and the point at which the nutrients can be monitored within the system. To achieve this will require monitoring of a range of land uses as well as a range of flow / concentration conditions with the aim of characterising export nutrient trends. It is not sufficient to monitor only the present land use, therefore a sufficient monitoring approach will be very challenging to achieve. Due to the unavailability of a verified methodology, any chosen approach must be approved by NE.

  See Section 3.6 for information on calculating credits post-implementation. It will be extremely challenging to undertake water quality monitoring post-implementation

due to the need to take account of all inputs and exports to calculate the nutrient reductions from an agroforestry scheme post implementation.

Key information required

- Evidence of a sound methodology including the calculations and justifications for the method used.
- The load of N and / or P in kg / year which can be mitigated against by the scheme.

3.2.6. What additional benefits can be delivered through the design objectives?[7]

Key questions

- **Have wider benefits to the environment and society been considered?** Agroforestry schemes can provide much wider benefits than water quality, including for example; habitat resilience under flood and drought conditions for a range of species, enhance human health and wellbeing, recreation, air quality, carbon sequestration and local economic benefits. Outside of the scope of NN, these benefits are often simplistically restricted to a small subset of values such as biodiversity net gain, natural flood management and carbon sequestration. Every scheme provides the opportunity for wider benefits via the encouragement of ecosystem services.
- **Have wider benefits been considered in the context of biodiversity net gain, natural and societal capital?** Whilst mitigation should firstly focus on NN benefits and meeting the needs of Habitat Regulation, understanding how any mitigation can support wider development requirements to support regulatory BNG and associated Natural Capital parameter is valuable. This understanding will help to establish how different ways of packaging multiple ecosystem goods and services can incentivise conservation-based funding support for the proposed mitigation (i.e. support stacking and bundling concepts) and avoid undervaluing nature.

Key information required

- Consideration should be given to the potential for agroforestry schemes to provide wider benefits to the local, and wider, community such as amenity value, pollination, job creation, food supply, local climate regulation and timber production.
- An ecosystem services assessment of the available wider benefits can be carried out to support the proposal. This should seek to link the benefits to the beneficiaries, focussing predominantly on wider values at this stage. A simple

[7] Whilst wider benefits assessment is out of the direct scope of NN it is highly recommended that this assessment is included since planning does require assessment of biodiversity net gain and wider net zero opportunities (e.g. carbon sequestration) whilst opportunities for natural flood and drought management and resilience can support local ambitions.

assessment based on a high-level RAG assessment would be acceptable at this stage.

3.2.7. Overall evaluation of design objectives

For the design objectives to be robust enough to meet the requirements of the Habitat Regulations, the key evidence and information required must be provided for each of the above categories. If any information is missing or the information provided is not commensurate with the obligations of the Habitat Regulations, the objectives must be re-considered to meet the mandatory criterion for NN mitigation.

The series of questions within the confidence assessment outline the stages required to be able to evidence that the design objectives and baseline monitoring method for an agroforestry scheme are robust (Section 2.3). Table 2:1 and Table 3:2 should be completed to provide verification that likely nutrient loads have been robustly estimated.

To establish the strength of the design, the tables below can be used in conjunction with Table 2:1 and Table 3:2. Note that some cells are left blank.

Report Section	Comment	All information has been provided in the relevant format (mapped, tabular, or summary)	There are gaps in the information provided
3.2.2	Baseline monitoring method		
3.2.3	Source of nutrients to the measure		
3.2.4	Allowance for long-term changes		
3.2.5	Credit calculation		
3.2.6	Additional benefits		

	Response statements
If ALL green (noting that 3.2.6 is optional)	This is a well-structured feasibility assessment that maximises the likelihood that this agroforestry scheme will be a sustainable natural asset within this catchment.
If SOME red	The application is missing mandatory feasibility information, as shown by the rows populating the red column. Please provide this information so that the feasibility assessment can be evaluated.

3.3. Stage 2 – Feasibility

3.3.1. Introduction

Before an agroforestry scheme is designed, a proposal should consider the feasibility of the scheme. The sub-sections below detail the key factors that will impact of the feasibility of a proposed solution. For most of these factors, there will be options to mitigate potential constraints on feasibility. An agroforestry proposal will need to show how constraints on feasibility have been mitigated. There are some circumstances where evidence to show feasibility is not required but is strongly recommended. These areas are highlighted in the text alongside areas where optional information should be incorporated where possible. Including optional information to support scheme feasibility will help to reduce the risk of unforeseen problems in delivering the scheme.

3.3.2. Topography and levels

Key questions

- **Can agricultural land be too steep?** The gradient of the land needs to be considered. If the land is too steep there is a risk that surface water runoff will pass over the scheme with minimal infiltration. This needs to be considered on a site-specific basis as a maximum gradient for agroforestry effectiveness cannot be ascertained without first understanding local soil and vegetation characteristics.
- **Can local topography impact effectiveness?** The local topography of the agricultural land needs to be assessed to show that it will not concentrate surface flows into a braided channel pattern which can cause local scouring. Land on which agroforestry schemes are deployed should have a relatively even surface that will support laminar sheet flow, which is optimal for infiltration and nutrient removal.

Key information required

- A map showing the gradient of the proposed land dedicated to agroforestry, showing that water will flow through it under gravity and that it is not too steep.

- An assessment of the topography to show that overland flows will be evenly distributed across the agroforestry scheme to allow for maximum infiltration and to reduce the risk of scour.

3.3.3. Geology and hydrogeology

Key questions

- **What is the site geology?** This is important because it provides the parent material for the soil and determines the vulnerability of any associated groundwater impacts related to water quality. Parent materials which equip subsequently derived soils with characteristics such as high P sorption capacity and permeability are favourable. Geology will also affect the hydrogeology of the agroforestry scheme's catchment, which will in turn impacts how subsurface flows reach the scheme.
- **Can hydrogeology impact the efficacy of an agroforestry scheme?** There is a potential risk of subsurface flows being through groundwater that flows underneath agroforestry. It is also possible that subsurface flows flow away from land dedicated to agroforestry due to groundwater gradients that do not follow surface topography.
- **Are any aquifers present which may result in upward discharge into the land dedicated to agroforestry?** Under this scenario it is likely that the concentration of nutrients would reduce in subsurface flows, hence reducing the nutrient removal efficiency of any associated floodplain soils. The opposite is also possible if subsurface flows have high N or P concentrations. Export monitoring locations therefore need to consider possible locations of springs to accurately characterise the nutrient loads exiting the agricultural land.

Key information required

- A map of the expected geology beneath and in close proximity to the proposed mitigation site. This is likely to be highly indicative at this stage and based on open-source data.
- An assessment of the potential issues that may be caused by the catchment hydrogeology.

3.3.4. Soil and sediment

Key questions

- **What is the composition?** The composition of soil will affect the nutrient removal capacity of an agroforestry scheme. Soils should support a balance between infiltration capacity and other chemical and structural properties that may limit infiltration capacity but increase nutrient removal capacity. Sandy soils, for example, have a high infiltration capacity but a much lower nutrient removal potential than clay soils, which have higher nutrient removal potential but very low infiltration capacities.
- **Will soil type preclude locations for deployment of agroforestry schemes?** The implications of soil type will be site-specific and can vary within a single deployment location. Furthermore, agroforestry schemes deployed in locations with

sub-optimal soil conditions may still provide nutrient mitigation, though it may be lower than in locations with more optimal soils.

- **What is the likely soil mobilisation during implementation?** Nutrients from agricultural soils may be mobilised during the implementation process and lost to the wider environment. This is likely to be a temporary issue but should be accounted for and minimised during the design process.

Key information required

- A map of the expected sediment type or types for the designated land and an overview of associated hydraulic properties.
- **Optional:** A site investigation identifying the local soil type along with an estimate of the hydraulic conductivity[8]. This will help to support the assessment of the impact of soil type on nutrient removal.

3.3.5. Hydrology and drainage

Key questions

- **What are the optimal drainage conditions for an agroforestry scheme?** Nutrients will enter agricultural land via fertiliser application. Overland flows should mainly be infiltrated into the soil within the land dedicated to agroforestry, with little overland flow exiting the scheme's boundaries to reduce nutrient exports from the site.
- **Can subsurface flows be too deep?** If runoff infiltrates into groundwater and flows underneath an agroforestry scheme, the nutrients will be transported at a depth inaccessible to plant roots, rendering the scheme largely ineffective.
- **How shallow does the water table need to be?** Agroforestry supports the uptake of excess nutrients from fertiliser, whilst also supporting denitrification (a key N removal process). For denitrification to occur, oxic and anoxic conditions are required. If the water table is too high, anoxic conditions dominate, whereas if the water table is too low, oxic conditions dominate. Both scenarios limit denitrification potential[9]. It is favourable for the water table in an agroforestry scheme to be at a similar depth to the rooting depth of vegetation. Tree planting is likely to lower the

[8] Soils are preferable where hydraulic conductivity supports a longer residence time of water in the soil without resulting in the soil becoming waterlogged and generating overland flow.

[9] The primary forms of N from wastewater are nitrate and ammonia. To cycle ammonia to nitrate (as is required prior to denitrification), oxic conditions are required. The primary forms of N from agriculture are nitrate and ammonium (which also requires oxic conditions to be nitrified into nitrate). Denitrification (the process of cycling nitrate into gaseous forms of N) requires anoxic conditions. Where only anoxic conditions are present, the denitrification process to remove N from the system is limited to nitrate inputs only.

water table, providing nutrients from fertilisers with more time to be assimilated prior to entering groundwater.

Key information required

- An assessment should characterise flow paths of overland and subsurface flows, as well as the water table height within the boundary of the scheme.

3.3.6. Flood risk

NOTE: This is unlikely to be an issue for agroforestry schemes. Expert judgement will be required to determine if an assessment is needed (e.g. movement of plant to remote site for tree planting).

3.3.7. Protected sites, species, and Invasive Non-Native Species (INNS)

Key questions

- **Will the agroforestry scheme impact a protected site or other environmental objectives?** If the deployment location for the proposed mitigation is within, or near, a protected site, either its implementation or operation phases may impact the site. The following authorisations might be required:
    - As the owner or occupier of a SSSI, notice must be given, and NE's permission (consent) is required before a planned activity is carried out on the site. This only applies to owners of land within the SSSI itself.
    - Public bodies must give notice and get NE's agreement (assent) before carrying out a planned activity that's likely to damage a SSSI or land near the site's boundary.
    - For proposals within European sites and Ramsar sites, a competent authority must undertake a HRA for any plan or project which is not necessary for management of the site.
- **Will the agroforestry scheme impact protected species?** If protected species are present at or near the deployment location and could be impacted by the scheme, a conversation will need to be had with NE to gain consent.
- **Are there any known INNS at the site?** There may be INNS at the deployment location, which would require an INNS risk assessment to show how these species will be removed and disposed of to remove the risk of spreading INNS to other locations in the catchment.
- **Will the scheme impact other natural habitats or environmental objectives?** The scheme should not compromise the restoration of other natural habitats or cause a negative impact on existing natural habitats. It should also not negatively the ability to achieve other environmental objectives.

Key information required

- Maps of international (SAC, SPA, Ramsar) and national (SSSI) protected sites for nature conservation.

- Maps of locally protected nature / environment sites (local nature reserves, local wildlife sites and local geological sites) and other protected areas (National Parks, AONBs) that may have requirements which need consideration when deploying agroforestry schemes.
- Maps of priority habitats and areas that are currently under habitat restoration. Map of INNS locations using any local observations and the NBN Atlas[10] with INNS statement on pathways and impacts.

Depending on the interaction of the scheme with the above designations, a full ecological assessment may be required to provide confidence that there will be no impacts on these designations because of the scheme

3.3.8. Species considerations

Key questions

- **How might the combination of species chosen affect the efficacy of the scheme?** Consideration must be given to the combination of species chosen prior to implementing a silvopasture or silvo-arable scheme. Any sort of incompatibility has the potential to compromise the productivity of the system and hence will affect the likely nutrient uptake.
- **Are there species requirements specific to silvopasture systems?** It is possible for species to harbour pests and diseases which could infect adjacent species. Rhododendron fungal diseases, for example, affect larch. Additionally, crops must be able to receive enough light year-round. This should be considered regarding the leafing period of the chosen trees in relation to when the crops need the light, as well as the distance between rows of trees. Too little distance and the canopy can close, causing crops to fail.
- **Are there species requirements specific to silvo-arable systems?** Livestock species can cause damage to trees in silvo-pastural systems. Sheep for example have bark stripping tendencies and cattle are likely to cause damage by using the trees as scratching posts. Livestock may be inclined to consume the trees, especially if planted as saplings. Consideration needs to be given to the combination of species and their interspecific tendencies. Mitigation plans can involve implementing protective casings or using non-toxic deterrents.

Key information required

- A plan of the proposed species and evidenced consideration towards their compatibility.

[10] See: NBN Atlas - UK's largest collection of biodiversity information

3.3.9. Land use

Key questions

- **Can previous land use impact the efficacy of an agroforestry scheme?** The current and previous land use at an agroforestry deployment location needs to be considered to ascertain the risk of legacy nutrients being remobilised. This is more of a problem for P than N, as N is less readily stored in soils and is most likely to occur during implementation.
- **Are there interactions with other land management schemes?** If the land is currently under an agri-environment scheme, payments may be lost through the deployment of an agroforestry scheme.

Key information required

- Map of current land use and explanation of any previous land uses that might cause an elevated risk of pollution during project implementation.
- Map of active agri-environment schemes where appropriate.

3.3.10. Ownership

Key questions

- **Has the landowner, and any surrounding landowner agreed to the mitigation in principle?** A project can only be delivered with the agreement of the landowner and following discussion with any other landowners where there may be a direct effect. It is likely that this type of mitigation would be received favourably. A legal agreement should be confirmed with the landowner that the land used for the agroforestry will remain in place in perpetuity (practically this is 80+ years) or if using as a temporary measure for as long as the scheme is required.

Key information required

- Evidence of engagement with the landowner regarding the deployment of the proposed scheme.
- Outline details of any in principle, legal or management agreements to secure the land required for the agroforestry scheme.

3.3.11. Archaeology, landscape and heritage

Key questions

- **Is there any known archaeological remains or potential for them?** Where agricultural land is known to be close to archaeological important sites, excavations investigations may be necessary to ensure there will be no impacts. Areas might include scheduled monuments, Roman remains, peat soils that have preserved records of past landscapes and people, or well-preserved water meadow systems, noting that some maybe scheduled monuments. Early checks are recommended.

- **How might landscapes and heritage be impacted?** Planting trees and vegetation has the potential to disrupt landscape character and heritage features in some areas (e.g historic vistas). This will need to be checked with landowners and bodies such as English Heritage.
- **Has any disruption been accounted for?** The loss of landscape and heritage features can be mitigated through early identification of possible disruptions and the use of suitable mitigation measures.

Key information required

- Archaeological or heritage value risk assessment based on advice from the Local Authority.
- Map of scheduled monuments.
- In areas of high archaeological or heritage risk, a bespoke archaeological risk assessment and any planned mitigation may be required. This will minimise the risk of costly delays during construction and shows that the design is managing risk proactively.

3.3.12. Rights of way and public access

Key questions

- **What if an agroforestry scheme blocks a public right of way?** Public rights of way cannot be closed or diverted, even temporarily, without permission from the local authority. Implementing an agroforestry scheme has the potential to cause changes in the landscape which could affect public rights of way.
- **Are there benefits to public access?** Public access to the scheme will improve its amenity value, with the potential to provide education and public awareness of nutrient pollution issues. However, it may also increase the risk of degradation that might reduce nutrient removal efficiencies. Benefits could be considered in terms of better access for all.
- **Where wider benefits have been identified would there be any risk to NN efficiencies?** Soil compaction via access, for example, might reduce nutrient removal efficiencies locally so effective measures to avoid this would need to be considered.

Key information required

- Map of the nearest public rights of way and any plans for any required mitigation.
- Demonstration that the local authority has been engaged regarding changes to public rights of way, if required.
- If possible / relevant, consider opportunities available for education and raising public awareness while minimising risks to degradation of the scheme.

3.3.13. Birdstrike risk

Key questions

- **Is the site near an airfield?** Agroforestry schemes can attract birds which may be an issue if the site is near an airfield. This is especially an issue for large birds, such as geese and swans, and for large flocks of birds such as starlings. The risk of birdstrike will depend on the type of airport and its associated usage by planes. An evaluation of risk needs to be within the context of the type of airport.
- **Will a bespoke birdstrike risk assessment be needed?** Airports may have their own birdstrike risk management programmes or plans. These should be consulted and any mitigation of birdstrike risk should be derived through consultation and the development of a mutually agreed strategy.

Key information required

- Map showing the nearest airfields and the type of airfield (commercial, military etc) along with any proposed mitigation strategy where necessary.

3.3.14. Nature recovery

Key questions

- **Does the agroforestry scheme have the potential to be part of a habitat network or natural recovery area etc?** Agroforestry schemes have the potential to be part of a habitat network which will help with nature recovery. However, there are locations in which they would not be appropriately placed to benefit nature recovery networks as they could displace more valuable habitat types.

Key information required

- Map identifying that the proposed deployment location is suitable for agroforestry schemes. In time the Local Nature Recovery Strategy (LNRS) should be used to minimise the risk that a scheme will compromise a local habitat network.

3.3.15. Historical landfill, coal mining and contaminated ground

NOTE: This is unlikely to be an issue for agroforestry unless excavations or earthworks are required to plant trees. It is recommended that this is checked to determine any potential risk.

3.3.16. Unexploded ordnance

NOTE: This is unlikely to be an issue for agroforestry schemes. Expert judgement will be required to determine if an assessment is needed (e.g. movement of plant to remote site for tree planting).

3.3.17. Services and infrastructure

Key questions

- **Has an assessment of services both underground and overhead (water, gas, and electricity) been conducted?** Moving services is expensive and time-consuming and requires the involvement of the service provider. Above services may impact the ability to deliver the project during to constraints of plant access the site.

Key information required

- A full search and a map of all local services, if any.
- A mitigation strategy for any services identified.

3.3.18. Regulatory considerations

Key questions

- **Does the implementation of an agroforestry scheme require any environmental permits or permissions?** The regulatory requirements might include, but are not limited to, the following:
    - Environmental permits
    - Flood risk assessment
    - Flood defence consent from EA regarding works within 8m of a main river
    - Archaeology and pathway assessment
    - Wildlife licences
    - Planning permission

Key information required

- A list of permits or licenses required along with an assessment of the likelihood that they will be granted.
- A narrative on each permit identifying any engagement with the relevant regulator and advice already received would be useful as supporting information is available.

3.3.19. Constraints and options assessment

Key questions

- **Is the proposed agroforestry scheme a suitable nutrient mitigation option?** The feasibility assessment may have identified a range of constraints. It is important to consider these constraints and any knowledge gaps that the feasibility assessment has found. This will help to provide a justification that the agroforestry scheme is a suitable option as it has been proposed. It will be useful to condense the key information identified in the feasibility assessment into a summary which, in a successful proposal, will highlight that the proposed deployment location is well suited to the scheme, and that the scheme is the best option available. Although

this step is not mandatory, it will show that the proposal given significant thought to the feasibility of the mitigation scheme.

Key information required

- **Optional:** a summary table of the constraints associated with the scheme.
- **Optional:** a description of the scheme's suitability in the proposed location, based on the feasibility assessment.

3.3.20. Evaluation of feasibility assessment

For an agroforestry scheme to pass the feasibility assessment, it must include all required pieces of information from Stage 2 including each topic from 3.3.2 to 3.3.19, noting that the requirements identified in 3.3.19 are optional. Providing evidence for each key piece of information shows that the risks have been considered, with plans in place for management and mitigation.

To establish the strength of the feasibility assessment, the tables below can be used. Mapped information is required where possible. Some cells have been left blank.

Report Section	Comment	All information has been provided in the relevant format (mapped, tabular, or summary)	There are gaps in the information provided
3.3.2	Topography & Levels		
3.3.3	Geology & hydrogeology		
3.3.4	Soil and sediment		
3.3.5	Hydrology & drainage		
3.3.6	Flood risk and floodplain reconnection		
3.3.7	Protected sites & species		
3.3.8	Species considerations		
3.3.9	Land use		
3.3.10	Ownership		

Report Section	Comment	All information has been provided in the relevant format (mapped, tabular, or summary)	There are gaps in the information provided
3.3.11	Archaeology, landscape and heritage		
3.3.12	Rights of way and public access		
3.3.13	Birdstrike risk		
3.3.14	Nature recovery		
3.3.15	Historic landfill, coal mining and contaminated ground		
3.3.16	Unexploded ordnance		
3.3.17	Services & infrastructure		
3.3.18	Regulatory considerations		
3.3.19	Constraints and options assessment		

	Response statements
If ALL green (noting that 3.3.19 is optional)	This is a well-structured feasibility assessment that maximises the likelihood that this agroforestry scheme will be a sustainable natural asset within this catchment.
If SOME red	The application is missing mandatory feasibility information, as shown by the rows populating the red column. Please provide this information so that the feasibility assessment can be evaluated.

3.4. Stage 3 – Design Process

3.4.1. Introduction

There is no standard procedure regarding the use of agroforestry schemes to achieve NN since success and design is very dependent on location, geology, and topography etc. as outlined in **Part 1** (the literature review). Each proposal will therefore need to be assessed individually based on best available information with a set of key design principles needed to achieve desirable water quality objectives and provide confidence that its function will be maintained in-perpetuity (or if using as a temporary measure for as long as the scheme is required) within the bounds of reasonable scientific certainty based on current knowledge. The scheme design should be based on the *best available evidence* of how the scheme functions to remove or immobilise the sources of nutrients set out in the design objectives. This will in turn show that the scheme will achieve nutrient mitigation *beyond reasonable scientific doubt* and meet the requirements of the Habitats Regulations. A robust scheme design should also help to show that the agroforestry scheme will provide mitigation *in perpetuity* or if using as a temporary measure for as long as the scheme is required.

The sections below provide further details on the design criteria deemed to be essential to achieving the percentage nutrient removal efficiencies as well as essential practical considerations. Further optional design criteria are provided that will help to increase the certainty with which the scheme will deliver these percentage nutrient removal efficiencies.

This document does not cover the detailed design requirements for on-the-ground delivery of an agroforestry scheme.

Design process outlined in this document is related to key requirements to support the understanding of NN mitigation in the context of silvopasture and silvo-arable farming systems.

A design engineer will be required to take this forward using supporting information provided in the feasibility stage.

3.4.2. Essential design criteria

Table 3:2 provides a summary of the minimum design criteria which must be met to claim credits from an agroforestry scheme. The evidence required from Table 3:2 must be provided. Additionally, Table 3:3 provides a summary list of documentation that should be covered as part of the detailed design. It should be used as a ‘tick list’ and to check key statements related to success. Where not completed, a justification will be needed. This will be used to provide details of on-the-ground design criteria at a level that can be used by a contractor. Confidence factors of success for agroforestry schemes and NN should

be included based on physical, water quality and ecological parameters. Any uncertainties should be flagged using RAG risk register.

Table 3:2. Minimum design criteria

Design criteria	Minimum requirements	Evidence required
General design	To implement an agroforestry scheme for the purpose of NN and claim credits, there is a requirement for the scheme to be robustly designed. It is essential that guidance documents such as The Agroforestry Handbook[11] and Agroforestry – A new approach to increasing farm production[12] are consulted for detailed design suggestions.	The required evidence will vary significantly from one project to another depending on the proposed scale of intervention. Stage 2 will provide an indication of the level of detail required for the design, together with the relevant support evidence. Evidence must be provided to show that the relevant guidance documents have been consulted and used in the design process.
Yields	Utilising short rotation coppice (SRC) systems or planting fruit / nut trees with harvesting capabilities will ensure that biomass, and by default the assimilated nutrients, is permanently removed from the system. Depending on the choice of SRC system, this might increase the efficiency of the scheme, allowing for additional credits to be generated, post-implementation.	Routine harvesting of yields from trees within agroforestry systems will need to be carried out if the trees have harvestable yields such as fruits, nuts, or timber, for example. A plan needs to be put in place for routine harvesting of yields, clearly stating the timeframes in which harvesting needs to occur and the party responsible.

[11] See: the-agroforestry-handbook.pdf (soilassociation.org)

[12] See: Agroforestry - a new approach to increasing farm production | Nuffield Farming Scholarships (nuffieldscholar.org)

Design criteria	Minimum requirements	Evidence required
		This plan should ensure that the harvesting is rotational to ensure nutrient uptake is consistent year-round.
Tree density	The proposed agroforestry scheme must have a minimum of 100 trees / ha.	A planting plan is required. The plan should identify the location, planting density, and alley orientation of the species to be planted.
Alley width	The alley width between rows of trees must always be greater than the tree height. Lack of light will otherwise cause a production decline, ultimately reducing the nutrient removal capacity of the system.	
Orientation	Orienting rows from North to South will optimise the light available to crops and tree stands, minimising shade within the system. This will improve the productivity of the system, benefitting the farmer by increasing yields whilst supporting the likelihood that the system achieves greater nutrient reductions[13].	

[13] Orienting rows from North to South may increase the risk of runoff if the site is perpendicular to a watercourse. In this instance this should be addressed on a site specific basis and this requirement may be bypassed if evidence is provided outlining that the proposed orientation will have favourable impacts on nutrient retention.

Design criteria	Minimum requirements	Evidence required
Vegetation	Vegetation should be present under the line of trees in arable systems where crops are not present in order to reduce the risk of runoff.	A planting plan and vegetation management plan.
Maintenance of trees	Agroforestry tree species must be pruned to reduce shade for crops near the tree and to remove nutrient rich biomass from the system.	A maintenance plan is required. The plan should detail pruning plans as well as protection measures, such as fencing, to stop plants being eaten or damaged following colonisation It is recommended that proposals also provide a supplementary planting plan detailing checks on vegetation and further planting where required.
Previous land-use	Agroforestry is only an applicable scheme where agricultural land currently exists therefore cannot be implemented where land is not currently in agricultural production.	Evidence of previous land-uses going back 10 years to prove that the land was previously in agricultural production. This

Design criteria	Minimum requirements	Evidence required
Nutrient inputs	The future nutrient inputs to the field through fertiliser or manure for example, must remain equal to or less than the current agricultural nutrient inputs[14].	must make reference to the previous nutrient inputs to evidence that the agroforestry system will input equal to or less than the previous agricultural inputs.
Future maintenance access requirements	It is important to understand what sort of maintenance and monitoring the scheme will require and allow for access to conduct this maintenance where necessary. The design should account for the type of access that will be required and whether vehicular access will be necessary.	Evidence that the design accounts for the required access for maintenance and monitoring.

Table 3:3. Key information to include using data from Stage 2

Key information to include (using data from Stage 2)	*Why*
Land access statement	Identify risks, required mitigation to avoid damage and permits
Method Statement	Planned construction with associated maps. This should include information on slope, cross section dimensions, requirements to remove current trees or other infrastructure, requirements for

[14] The current agricultural inputs refer to the nutrient inputs to the soil via agricultural practices over the last 10 years on the site, prior to the implementation of an agroforestry scheme.

Key information to include (using data from Stage 2)	*Why*
	pre-construction surveys, materials, specific design features and proposed timing relative to environmental considerations
Construction Design and Management (CDM) statement[15]	To support health and safety.
Bill of quantities	To support construction. This should include volumes of required excavation of materials[16], construction, vegetation removal, import of material to support cost estimation and how this links to land access. This information supports future cost estimations for material and labour.
Monitoring plan[17]	To demonstrate success in the context of NN and determine any future maintenance requirements. Monitoring of surface and subsurface flows can support the precautionary approach to avoid overly favourable estimates from being calculated. See also section Stage 5 (Section 3.6).
Report of the combination of the above	To provide details for on-the-ground design criteria and confidence factors of success for agroforestry and NN based on physical, ecological and water quality parameters.

[15] See: The Construction (Design and Management) Regulations 2015 (legislation.gov.uk)

[16] See Section 3.3.4 for more information regarding sediment removal during implementation.

[17] Using a planner to support your monitoring may help. See: Monitoring Planner | The RRC

3.4.3. Advantageous design criteria for optimisation

Key questions

- **Have design requirements beyond the minimum criteria been met?** Although not mandatory, designing the scheme with advantageous design criteria for the purpose of NN and wider benefits in mind is beneficial to evidence the robustness of the scheme.
- **Will the species considerations impact the efficacy of the system?** The species of tree should be considered to optimise the nutrient retention capacity of the system. Some species are likely to assimilate more N and P than others. Ash, for example, is leafless for a lot of the year and therefore has a reduced need to assimilate nutrients into biomass.
- **How can soils be augmented to support nutrient removal?** A lack of carbon is often a limiting factor on denitrification within soils. Vegetation establishment will provide a source of organic matter and carbon help promote N cycling. Plant root systems and root exudates also help to improve soil structure and water holding capacity, which is good for both N and P removal by the system.

Key information required

- **Optional:** Evidence that design criteria beyond the minimum requirements have been included.

3.4.4. Evaluation of the design process

For an agroforestry scheme to be conducted with reasonable scientific certainty that it will reduce nutrient loading downstream, the design must consider and provide all of the necessary information explained in Stage 3. This process aims to minimise the uncertainty associated with the mitigation scheme whilst mitigating any possible risks. The below table should be filled in at this stage to ascertain firstly if the scheme is suitable, and if relevant, where further information needs to be provided.

Report section	Comments	All information has been provided	There are gaps in the information provided
3.4.2	Essential design criteria		
3.4.3	Advantageous design criteria for optimisation		

	Response statements
If ALL green (noting that 3.4.3 is recommended, not required)	The information provided regarding the design detail is appropriate and sufficient.
IF SOME red (noting that 3.4.3 is recommended, not required)	No information has been provided regarding the design detail proposed for the scheme. Additional information is required regarding 3.4.3. Without this information the scheme designs cannot be evaluated.

3.5. Stage 4 – Implementation Process

3.5.1. Introduction

Once the requirements for the design process have been completed, the proposal must be supported with a plan for implementation covering the stages and issues which need to be considered prior to implementation. For the plan to progress, consideration also needs to be given to the management and maintenance requirements of the agroforestry scheme. These are outlined below to aid the formulation of a plan to assess the requirements for operating and maintaining a robust and effective mitigation scheme in perpetuity or if using as a temporary measure for as long as the scheme is required.

Headline Messages:

Agroforestry schemes must be supported with an implementation plan. This plan must outline the following subsections:

- Constraints
- Site clearance
- Vegetation establishment
- Management plan

A checklist for these points is provided below.

3.5.2. Consideration of constraints

Key questions

- **Have any constraints been identified in the feasibility assessment?** There may have been constraints on the deployment of an agroforestry scheme that were

identified during Stage 2 – Feasibility and / or Stage 3 – Design Processes. The implementation plan should consider how these constraints will impact the implementation of an agroforestry scheme.

Key information required

- A description of how constraints identified at the feasibility stage will be mitigated in order to reduce risks to the implementation of an agroforestry scheme.

3.5.3. Site clearance

Key questions

- **Will the location for deployment of an agroforestry scheme require preparation?** Agroforestry is only an applicable scheme where agricultural land currently exists. Depending on the vegetation present at the location and the planting plan for the site, clearance of existing vegetation may be required.

Key information required

- An environmental management plan must be provided. This must ensure that:
    - Existing biodiversity is protected;
    - Trees and vegetation are not detrimentally impacted unless they need to be cleared to plant replacement vegetation;
    - Soil compaction is minimised during implementation;
    - Soil erosion and sediment pollution is mitigated during implementation;
    - Buried services are protected; and,
    - Topsoil and subsoil are handled separately, and the disposal of surplus soil is suitably managed.
- There must also be an indication of what site clearance and earthworks procedures are likely during the implementation phase.
- Information regarding incident management and waste management, if relevant, should be provided.

3.5.4. Vegetation establishment

Key questions

- **How will the planting process take place?** Agroforestry schemes require the establishment of vegetation through planting. Details should be provided on how the planting will be implemented, including the mix of species that will be planted. This should include detail as to the locations in which trees are planted, the row direction and width between alleys.
- **Will vegetation require management?** Nutrient removal via assimilation by vegetation can be temporary unless suitable vegetation management plans are in place to remove dead vegetation from the agricultural land. If vegetation is being removed from the scheme, a plan is required to show how disposal of the

vegetation will not result in re-circulation of the stored nutrients within the same catchment, as this would reduce the efficacy of the scheme.

- **Do soils and vegetation need any protection?** Planting vegetation may result in soil exposure, which can be mobilised along with associated nutrients during rainfall events. The implementation plan should account for the risk of soil erosion following vegetation planting. Protection measures need to be in place to preserve new vegetation and trees, especially during their establishment phase. This is required to prove they are protected against consumption and damage, especially in silvo-pastural systems.

Key information required

- A planting plan is required. This plan should identify the location and plating density of the species to be planted.
- The implementation plan should detail protection measures, such as fencing, to stop plants being eaten or damaged following colonisation and measures to mitigate soil erosion risks during planting.
- Plants may die as a result of disease, consumption, or damage. It is recommended that proposals provide a supplementary planting plan detailing checks on vegetation and further planting where required.
- A vegetation management plan is needed to show how risks of nutrient mobilisation from vegetation decomposition will be managed.

3.5.5. Outline management plan

Key questions

- **Why is an outline management plan required?** For an agroforestry scheme to provide effective treatment in perpetuity (or if using as a temporary measure for as long as the scheme is required), a robust management and maintenance plan must be formulated prior to implementation. Any routine operation and maintenance requirements must be identified and there must be certainty that these will take place. The maintenance plan is highly dependent on the observations gained from the monitoring as described in Section 3.2.2. To assist with the establishment and maintenance of vegetation in an agroforestry scheme, fencing may be required. This fencing will require maintenance.

Key information required

- Operator and stakeholder's responsibilities should be clearly identified and outlined within the management plan, covering the key roles and responsibilities related to the scheme.
- A monitoring plan that is appropriate for adaptive management that ensures continuation of processes necessary to achieve NN. Key assessment should include:
    - Vegetation management: As detailed above, the management plan should consider possible needs for supplementary planting and vegetation removal.

    - If fencing is required, maintenance of fencing may be needed to protect vegetation.
    - Harvesting: Routine harvesting of yields from trees within agroforestry systems will need to be carried out if the trees have harvestable yields such as fruits, nuts, or timber, for example. A plan needs to be put in place for this, clearly stating the timeframes in which harvesting needs to occur and the party responsible. This plan should ensure that the harvesting is rotational to ensure nutrient uptake is consistent year-round.
    - All previous routine operations and management processes occurring when the system was in agricultural production, prior to becoming an agroforestry system, should still be carried out where possible.
- Stakeholder responsibilities should be clearly identified and outlined within the management plan, covering the key roles and responsibilities related to the scheme. Contact information for stakeholders should be provided.
- Contact information should be provided within the management plan, particularly with respect to emergency procedures.

3.5.6. Evaluation of the implementation process

For the proposal to progress, all pieces of information outlined above in Stage 4 must be provided to show evidence that all possible risks associated with implementation have been reduced as much as possible and that any remaining risks will be mitigated against. If necessary, the tables below can be used to identify which pieces of information are missing and the applicable response statement will outline exactly what steps are necessary to complete this stage. Some cells have been left blank.

Report section	Comments	All information has been provided	There are gaps in the information provided
3.5.2	Consideration of constraints		
3.5.3	Site clearance		
3.5.4	Vegetation establishment		
3.5.5	Outline management plan		

	Response statements
If ALL green	This provides comprehensive information regarding the implementation process for the agroforestry scheme and maximises the likelihood that this agroforestry scheme will be constructed appropriately and managed effectively.
If SOME red	The application is missing mandatory information from Stage 4. Please provide this information so that the implementation process assessment can be evaluated.

3.6. Stage 5 – Post-implementation Monitoring and Evaluation

3.6.1. Introduction

Monitoring is required to estimate the nutrient export of an agroforestry system. To prove the nutrient load reduction that has been achieved, robust post-implementation monitoring is required. The specifics regarding credit generation are outlined in the subsections below.

Monitoring should also always be included as part of an adaptive management regime that will support the mitigation scheme to continue providing nutrient mitigation in perpetuity (or if using as a temporary measure for as long as the scheme is required). Adaptive management monitoring should focus on scheme function.

Monitoring requires a plan that is bespoke to the individual scheme, therefore the following subsections must be considered alongside the site-specific environment.

These sections **MUST** be included, regardless of the desired credit outcome:

- Baseline monitoring or modelling.
- Post-implementation monitoring to support adaptive management focusing on scheme function.
- Post-implementation monitoring to gain credits.

3.6.2. Post-implementation monitoring to gain credits

This section primarily considers where a water quality monitoring/modelling approach is being used rather than the potential alternative approach to consider the annual uptake of nutrients into the crop/tree biomass which is permanently removed or locked away.

Key questions

- **What is post-implementation monitoring to gain credits?** Post-implementation monitoring is the only way to gain N and P credits as insufficient data is available to calculate an upfront efficacy figure to estimate nutrient reductions (see **Part 1**).
- An approved monitoring method has not yet been determined, however the post-implementation monitoring approach must match the baseline monitoring approach chosen for a given scheme. For example, a water quality monitoring approach will only be applicable to schemes which identified baseline exports via the same approach.
- **How should monitoring to gain additional credits be carried out?** Post-implementation monitoring to gain additional credits requires monitoring the nutrient concentrations and flow rates entering the agroforestry scheme. Monitoring should take into account nutrient mobilisation as a result of fertiliser applications. An understanding of nutrient concentrations and flow rates exiting the scheme is also required to gain additional credits to work out the reduction of nutrients that has occurred across the field. Modelling is not an applicable method to gain additional credits.

  It should be noted that it will be extremely challenging to undertake water quality monitoring due to the need to take account of all inputs and exports to calculate the nutrient reductions from an agroforestry scheme post implementation.

  An alternative approach could be to determine the nutrients which will be taken up each year into the crop / tree biomass and are permanently removed/locked in. This would require the determination of the nutrient content of the specific crop/tree biomass taking account of any temporal and spatial variability and an estimate of the amount of new biomass which will permanently remove nutrients each year.

  There is no verified approach to this method of monitoring, therefore any suggested methodology must meet be confirmed with NE and must meet the following requirements:

  - Monitoring must account for seasonality over multiple years
  - The appropriate form of N and / or P must be monitored
  - Suitably precautionary values from the data must be used, ensuring the collected data is considered wholistically. It is not acceptable to look only at the data which represent the best-case scenario for nutrient credit generation.
- **How long is monitoring to gain additional credits required for?** To gain additional credits, post-implementation monitoring should be conducted for a minimum of three years to capture seasonal variation in nutrient removal efficacy at inter-annual timescales to claim additional credits. It should continue until the system can be shown to have reached a quasi-equilibrium whereby its nutrient removal efficacy is approximately stable over time. More frequent monitoring

particularly in the initial few years may make it quicker to identify when stabilisation has occurred.

- **What should happen to the monitoring data?** This should be decided and agreed at the beginning of the monitoring programme including approaches to assess data. It is likely to be of interest to LPAs, Natural England and other third-party stakeholders (e.g. local catchment groups and academics). Building a supporting open-source database including the efficacy rates will be highly beneficial for future programmes.

Key information required

- For revised nutrient credits to be quantified, an evidence base of consistent monitoring is required. The nutrient credits should be calculated from a monitoring plan that demonstrates at least a minimum of three years of water quality and flow data beyond the baseline. Consistent monitoring will be required to prove that an equilibrium has been reached.

3.6.3. Post-implementation monitoring to support adaptive management

Key questions

- **What is monitoring to support adaptive management?** Monitoring should be undertaken with a focus on ensuring the scheme's function is maintained. Regular visual inspections and repeat photography will support early identification of any requirements for adaptive management and may help to highlight conditions whereby the nutrient removal being delivered could start to reduce; for example, problems related to vegetation establishment. The monitoring data should be used in an adaptive management regime that can highlight when different aspects of the management plan detailed in Section 3.5.5 may be required.
- **What are the requirements of monitoring to support adaptive management?** Regardless of whether the scheme has been implemented for N and / or P, visual inspections and repeat photography should begin after the scheme has been implemented. The period and regularity of inspections will depend on the scheme, location, and if other schemes are likely to be implemented. The scheme must be reviewed for at least 3 years annually and then the future required monitoring plan and timelines should be determined. This plan should ensure the scheme's in-perpetuity (or if using as a temporary measure for as long as the scheme is required) benefits.

Key information required

- A post implementation monitoring plan to support adaptive management. The monitoring plan does not need to specify water quality monitoring unless it is required to instigate maintenance. It should include consistent visual inspections and repeat photography to support adaptive maintenance.

3.6.4. Summary evaluation

All pieces of information outlined above in Stage 5 must be provided to show evidence that all management concerns have been accounted for and any possible risks have been mitigated against. If necessary, the tables below can be used to identify which pieces of information are missing and the applicable response statement will outline exactly what steps are necessary to complete this stage.

Report section	Comments	All information has been provided	There are gaps in the information provided
3.6.2	Post-implementation monitoring to gain credits		
3.6.3	Post-implementation monitoring to support adaptive management		

	Response statements
If ALL green	This provides comprehensive information regarding the monitoring and evaluation process for the agroforestry scheme and maximises the likelihood that this agroforestry scheme will be designed appropriately, function as intended and be managed effectively.
If SOME red	The application is missing mandatory information from Stage 5. Please provide this information so that the implementation process assessment can be evaluated.

4. References

Briggs, S. (2012). *Agroforestry: A new approach to increasing farm production.* Nuffield Farming Scholarships Trust.

Franklin, H. M., Mcentee, D., & Bloomberg, M. (2016). The potential for poplar and willow silvopastoral systems to mitigate nitrate leaching from intensive agriculture in New Zealand. *Environemental Science*.

Michel, G. A., Nair, V. D., & Nair, P. K. (2007). Silvopasture for reducing phosphorus loss from subtropical. *Plant Soil, 297*, 267–276.

Raskin, B., & Osborn, S. (2019). *The Agroforestry Handbook - Agroforestry for the UK.* Bristol: Soil Association Limited.

www.gov.uk/natural-england