Policy and social factors underpinning the current regulatory framework for smaller waters and Descriptive wastewater treatment plants

Future development to enhance outcomes for people, society and the environment

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1. Summary

Background and aims

This report reviews the scientific, policy and social factors that underpin the current regulatory framework for headwater catchments including headwater streams, ditches, small standing waters and Descriptive wastewater treatment plants. It makes recommendations for future developments in policy in the short, medium and long term to enhance outcomes for people, society and the environment though improved management of headwaters and their catchments.

Specifically, the report describes:

- The current regulatory framework for headwater catchments including the scientific, policy and social drivers that underpin this.
- Current knowledge of the value of small waterbodies in headwater catchments and the impacts of Descriptive wastewater treatment plants on headwater ecology, including a case study from the headwater catchments of the Water Friendly Farming project.
- Desirable quality outcomes for headwater catchments, if cost:benefit was not a limiting factor, identifying those actions which will allow policy to fully capitalise on the disproportionate societal importance of smaller waters.
- Regulatory and policy factors that restrict investment in small wastewater treatment plants, barriers to proposed regulatory changes and suggested routes for overcoming potential barriers.
- Policy and regulation changes that could provide benefits for people, society and the environment in the short, medium and long-term in headwater catchments.

The general objective of legislation and policy in aiming for a large proportion of freshwaters to be in Good condition, and protected from potentially damaging impacts, is desirable. However, current approaches have a number of shortcomings in headwater catchments. The most important of these is that, for various reasons, smaller running and standing waters are deprioritised in policy and practice either by the way in which legislation is interpreted or because of specific gaps in legislation.

Here we review these problems and make recommendations for legislation and policy to better account for the importance of headwater catchments, including the management of Descriptive wastewater treatment plants. We suggest ways in which regulators can obtain best value for money in delivering the goals of current legislation.

Methods

The report’s findings are based on a mixed method approach. Desk-study data were supplemented by information from a regional case study covering three upper catchments on the border of the Anglian Water and Severn-Trent Water regions, where detailed data are available from the Water Friendly Farming project. Key stakeholders from the water industry, regulators and NGOs provided expertise gathered via (i) a roundtable discussion (ii) and in subsequent 1-to-1 interviews with key actors, conducted under the Chatham House rule, to identify and guide suggestions for policy development.

What is the headwater catchment environment?

The headwater environment comprises mainly small (first and second order) streams, ditches, ponds and some wetlands. Although the waterbodies in these areas are typically small, they make up a considerable proportion of the water environment as a whole. Small streams, for example, comprise the majority of the linear length of the running water network in England (c.60-70%). In the case study area, which is a typical drained, productive, agricultural landscape dominated by headwaters, the stream network made up 50% of the water environment ***by area***, with ditches contributing 40% of total water area and ponds comprising the remaining 10% of surface water.

Over the last two decades there has been a global growth in understanding of the importance of small waters in headwater landscapes. Because of their abundance and ubiquity, small waters mediate most ecosystem services provided by the water environment. In terms of biodiversity, multiple studies in Britain have shown small waters to collectively, at landscape or catchment scale, support more freshwater species than larger waters, with ponds contributing significantly to the total. Small streams and ponds also support a wide range of Red List and endangered species (10% of *all* Priority species[1] found in England can be seen in ponds, for example, the same number as in rivers) and around 90% of Environment Act 2021 scheduled freshwater invertebrates.

What are Descriptive wastewater treatment plants?

Descriptive wastewater treatment plants are small sewage treatment works which serve up to 250 people (defined formally as Person Equivalents) with simple permit conditions allowing the legal discharge of small volumes of effluent, up to 50 m^3/day, after basic treatment.

Figure 1. Like many chalk streams, the River Pang starts as a series of seasonal ponds, here at East Ilsley in Berkshire

Threats to headwater catchments including the impact of sewage

The freshwaters in headwater areas are very widely exposed to pressures from polluting farmland and urbanisation, treated and untreated wastewater and physical (mis)management, all operating in an environment experiencing rapid perturbations due to

[1]We have used the term 'Priority species' when referring to NERC Act 2006 species of principal importance.

climate change. Of these, the high frequency of spills from sewage outfalls has recently entered public and media consciousness to become a national political issue.

A review of the published literature covering the effects of sewage from small wastewater treatment plants on headwater streams shows that, although the impacts of sewage on freshwater is one of the most intensively studied aspects of freshwater biology, with a history dating back 100 years, studies specific to headwaters are still available only from a handful of locations (including examples outside the UK). The findings from this research concur with what is known of the impacts of sewage on freshwaters generally: impacts can be substantial, typically resulting in reduction in sensitive organisms, such as Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, and increases in tolerant taxa. There is also evidence that other potential impacts (farming, urban landuse) may be of similar magnitude to those of sewage inputs but these are, so far, known only in outline. Effects on small streams due to sewage effluents are probably very widespread: a recent pan-European study, which included the UK, suggests that small streams (third order and below) are more vulnerable to wastewater pollution because of lower dilution, with impacts detectable when effluent volumes are over the surprisingly low value of 6.5% of receiving water flow. Despite this, there is little information with which to evaluate the true scale of Descriptive wastewater treatment plant impacts in the UK. There are about 3000 small wastewater treatment plants, about half of all works managed by water companies, in England and Wales. Potentially, each of these could be affecting 5 km of headwater stream, so that a plausible worst-case scenario is that these works are impacting 18,000 km of stream length, representing about 20% of the stream network.

Evidence from the Countryside Survey of headwater streams and from Environment Agency river monitoring shows that headwater streams are in worse condition nationally than lower catchment rivers. This may be because stresses on headwaters, and measures to protect them, cannot be easily located and controlled because most headwater streams, and virtually all small standing waters (ponds and small lakes), are in practice omitted from water management maps, plans and processes, such as those of the River Basin Management Plans.

Policy and legislation

Policy and regulation relating to headwater catchments and Descriptive wastewater treatment plants is, in theory, fully embedded in UK legislation intended to protect and restore the freshwater environment. In practice, the effect of laws and policies to protect freshwaters tends to be weakest in upper catchments, becoming stronger further downstream. Larger waterbodies enjoy greater protection than small ones, are more thoroughly monitored, and protective actions are better funded. This situation, in part, reflects a century-long bias in the way freshwater science has operated both in Britain and internationally, with a systematic underplaying of the significance of small waters, mirrored by low awareness among the public and media.

In terms of recent legislation and policy, the Environment Act 2021 sets out measures aimed at protecting and improving the environment in the UK, including water resources and biodiversity, with plans for implementation of the Act outlined in the Environmental Improvement Plan 2023. The Office for Environmental Protection (OEP) was introduced to oversee its execution. The Environment Act 2021 added to the range of legislation already implemented for water, particularly the Water Environment (Water Framework Directive) Regulations 2017 (WFDR). Most recently, the Plan for Water (2023) sets out more specific, but still broad-brush, government policy for '*enhancing the sustainability, availability, and quality of water resources across England*'. To do this the government has noted that "*when in a healthy and naturally functioning state, rivers, streams, ponds, lakes, wetlands, estuaries, and coasts deliver multiple benefits for society*".

In practice, the Office for Environmental Protection's (OEP) most recent report into the implementation of the WFDR and River Basin Management Planning (May 2024) suggests that there are significant shortcomings in the implementation of the Environment Act and the Water Environment Regulations:

> "*As things stand, the 2027 Environmental Objectives [for freshwaters] appear more likely to be missed by a large margin.*"

The OEP also found '*deeply concerning*' issues with how the laws in place to protect England's rivers, lakes and coastal waters are currently being put into practice and suggests the need for a reset in its approaches. Specifically:

> "O*verall…*[The OEP] s*ees a significant need to strengthen how environmental law on water is applied to increase its effectiveness and support Government's wider goals and targets. We encourage Government to pursue the major reset that we believe is required as it takes forward its 'Plan for Water*'"

In the context of this suggested need for a reset, the results from the present report indicate that small waters, which dominate the water environment and contribute significantly to freshwater biodiversity and ecosystem services, are an important element of that reset. Specifically, there is a need for regulators to strengthen the protection of the headwater environment, which should be more specifically taken into account in regulation, policy and practice.

Desirable quality outcomes

Desirable outcomes for small waters in headwater catchments are set in the context of the four most relevant Goals of the Environment Act 2021 and are that:

- Small waters are treated and managed holistically as a network of both standing and running waters, with measures implemented to both restore and create freshwater habitats.
- Small waters are more systematically managed to meet the targets of WFD Regulations.
- Small waters are assessed in terms of their contribution to the targets of the Environment Act, in terms of species abundance and the occurrence of endangered species.
- Habitat creation targets are developed for headwater catchments and fed into Local Nature Recovery Strategy plans with, typically, doubling of the extent of priority freshwater habitats which are in Favourable condition, either by habitat creation or by restoration and cleaning up of pollution.
- High status (*sensu* WFDR) headwater catchments are recognised, protected and prioritised and are used as the building blocks for improvements in areas of lower catchment quality downstream.
- Wetlands, including sites which are not nationally designated, are prioritised hydrologically in water resource management schemes.
- Land management funding is targeted to maximise the proportion of land in individual headwater catchments that is used to de-intensify the landscape and buffer streams, ponds and wetlands.
- Clean water ponds, which have considerable powers to protect freshwater biodiversity at landscape level, are created at scale; at least doubled in density in order to set freshwater biodiversity on an upward trend.
- The quality of a large representative sample of first and second order streams is assessed, in order to establish their condition and prioritise the awareness and protection of currently unknown, high quality, headwaters.
- Programmes of measures should ensure that:
    - Descriptive wastewater treatment plants no longer damage headwaters; no small waste water treatment plants should be discharging to waters which are outside the Safe Operating Space (*sensu* Büttner *et al*., 2022).

- Sufficient monitoring is undertaken to ensure that the desirable outcomes noted above can be evaluated.
- Catchment management plans should:
  - Identify all headwater catchments and waterbodies to ensure they are properly considered and managed
  - Catchment plans should embed the targets and plans which are specific to the headwater environment.

Barriers to policy change

Barriers to investment in headwater catchments and Descriptive wastewater treatment plants mainly arise from (i) a tradition of overlooking smaller waters generally and (ii) treating small wastewater treatment plants as insignificant (i.e. those below 250 Population Equivalents).

The main barrier to investment in headwater catchments has been the absence of strong statutory drivers, particularly the exclusion of smaller waters and smaller catchments that originated in the original classification scheme of the Water Framework Directive (i.e. excluding standing waters less than 50 ha in area; merging small streams with catchment areas of less than 10 km^2 into larger waterbodies, leading to them being widely overlooked). Although this is to some extent compensated for by recognition of small waters and wetlands as Priority habitats, it does not translate into effective protection, because protection mechanisms for Priority habitats have generally been weaker.

The main barrier to investment in Descriptive wastewater treatment plants is the lack of data on their effects. This can be resolved into three main issues:

- Lack of data on the impacts of smaller works and the length of the stream network impacted.
- Lack of standard modelling approaches to predict the effect of solutions (at present modelling is bespoke).
- Lack of evidence of the benefits of improving works in terms of ecology of headwater streams and delivery of other ecosystem services.

Overcoming the barriers to investment in headwater catchments and small wastewater treatment plants are comparatively straightforward, and can also be resolved into three key issues:

- Recognition of the importance of small waters in primary legislation; this can be done in the short term by modifying rules about small waters in existing WFDR legislation. In the longer term, new legislation to recognise freshwaters as a network of interdependent and interconnected habitats, adapting concepts and approaches developed in North America, may be needed. In this approach, small waters are managed at the whole landscape scale, and their influence on the ‘lower catchment’ water environment is properly recognised and managed.
- Effective trials of benefits to provide confidence that investments are effective.
- Monitoring programmes that can detect stresses and effects on waterbodies of all sizes, from small ponds to large rivers.

An example of approaches to overcoming these problems can be seen in the project case study area (see below), the Water Friendly Farming project in Leicestershire. In this area information about the extent of the impact of small wastewater treatment plants on headwaters, modelling techniques to evaluate impacts and practical solutions to the management of headwater catchments are all being demonstrated.

In the case study area, the first freshwater monitoring programme in the world which considers the whole water environment has been developed. This monitoring programme shows important long-term (10 year plus) trends in the condition of the water environment which cannot be detected at present in any other monitoring programme. This whole landscape monitoring programme also provides a method for evaluating the effect of environmental improvements.

Pilot projects investigating whole catchment approaches to headwater management by water companies (e.g. Pitsford Water Friendly Farming by Anglian Water, River Stour Phosphorus Reduction Scheme by Wessex Water) are showing initially positive results. Wider trialling of these approaches should be undertaken to reduce the barriers to improving the headwater environment with water companies encouraged to improve the water environment in the round i.e. rather than solely focusing on wastewater treatment plants, also work in headwater catchments with farmers and other land managers to restore the whole water system.

Case study

A case study was created based on the headwater catchment landscape of the Water Friendly Farming project, managed by Freshwater Habitats Trust, Game and Wildlife Conservation Trust and the Environment Agency, which lies on the boundary the Anglian Water and Severn-Trent regions in Leicestershire. The case study area comprises three adjacent headwater catchments in the Eye Brook, Stonton Brook and Barkby Brook. The first two are in the Anglian Water region and the Barkby Brook is in Severn-Trent Water's region.

Water Friendly Farming is a catchment demonstration project concerned with evaluating the effect of land and water management measures on freshwater biodiversity, water quality and flows. It is a Before:After:Control:Impact (BACI) design study. This area has the only freshwater monitoring programme in the UK that, as far as we are aware, takes account of the whole of the water environment i.e. in this case, headwater streams (first to third order), ditches and ponds. The project area has no waterbodies large enough to be rivers or lakes, following the definitions of Brown *et al.* (2008), which have widely applied in the UK.

The project area has several Descriptive wastewater treatment plants including Tilton-on-the-Hill works which is now scheduled for upgrading. Small wastewater treatment plants in the project area have measurable effects on stream quality, although investigating these individually in detail has not been a main focus of the project.

Information from the case study area provides some of the best evidence available on the characteristics of headwater catchments, their ecological importance, the stressors they are affected by (including phosphorus from both small wastewater treatment plants and septic tanks), trends in ecological quality, the role of headwaters in the provision of ecosystems services and the benefits of managing and creating habitats in headwater catchments. Evidence from the project has shown that creating small waterbodies has led to some of the most striking and rapid gains in freshwater biodiversity at whole landscape scale of any freshwater management project.

Conclusions and recommendations for policy change

We make recommendations on policy and regulation changes to achieve positive outcomes for headwater catchments in (a) the current policy and regulatory context and (b) with legislative and policy changes in the short (12-24 months), medium (up to 5 years) and longer term (5 years+). The full list of recommendations can be seen in Section 11; here we briefly summarise the most important.

Descriptive wastewater treatment plants are widespread but low priority in the water management system. This means that about half of all sewage works are discharging with very little knowledge of their impacts, which are assumed to be negligible. There is an urgent need for this approach to be properly evaluated. It is more than likely that many of these small works are outside their 'Safe Operating Spaces', and a new approach where a new mindset of 'start at the top and work down the catchment' is adopted. Although apparently logical and working with the grain of running water systems at a catchment level, this approach is not part of business as usual.

The recommendations made below, both short and longer term, are mainly made in the context of adjustments to existing policy. However, we note that specific new legislation may be needed to embed policies that fully merge 'water' and 'nature' law which, although gradually becoming more unified, still retain overlaps and discontinuities which hamper the protection of the water environment, especially in headwater catchments. Given its novelty this approach should be built into regional trials in the next Price Review.

For immediate implementation, requiring no policy or legislative adjustments, our recommendations include:

- Requiring water companies to provide evidence that wastewater plants discharging into first, second and third order streams are not outside the ecological 'Safe Operating Space' (i.e. effluent flows more than 6.5% of receiving water flows). This is likely to require an investigative programme evaluating the quality of all streams that are receiving effluents from Descriptive works to assess their quality and the length of stream sections which they impair. This information would then be used to quickly and progressively prioritise headwater streams which are discharging into chemically and/or biologically High status headwaters to ensure these waterbodies do not deteriorate in quality. In this context it should be noted that larger rivers have greater dilution potential and therefore, contrary to traditional thinking, are at less risk biologically.
- Developing a pilot programme to identify High status first and second order headwater stream catchments combining data review and field investigations, including use of citizen science techniques. This greater level of detail than is currently available would allow River Basin Management Plans to provide a much more targeted framework for stream improvement because it would capture the inherent heterogeneity of headwaters, helping landowners and managers to make much more informed decisions about where the greatest value could be derived from land management for water. Systematically identifying the small clean running water catchments would also make it easier to identify, protect and restore the catchments of small standing waters.
- Defra and Ofwat encourage and support water companies in leading and undertaking wider trials of approaches which consider the water environment in the round, balancing wastewater treatment plants and land use management i.e. rather than solely focusing on wastewater treatment plants, also work in headwater catchments with farmers to restore the whole water system. This work would build on existing pilot projects.

In the short-term (12-24 months) we make a total of 8 recommendations including that:

- The water industry reviews its operation of headwater wastewater management plants in the light of the OEP's recent recommendations on the effectiveness of the WFDR and River Basin Management Plans. Water companies should be required to develop demonstration projects in areas where easy wins could be achieved in delivery of WFDR goals through work on headwaters, with a view to ensuring that successful projects are then widely adopted.
- Government provides guidance to Responsible Authorities managing Local Nature Recovery Strategies to take account of small waters, placing advice on statutory footing as part of the Plan for Water.
- Through the Catchment-based Approach, provide support for catchment partnerships to take account of small waters by (a) making Ordnance Survey mapping of all small standing waters freely available and (b) identifying the catchments of all stream and ditches from first to third order and labelling national maps defining steam order.
- Develop a 'small waters' guidance manual and other materials dealing practically with all aspects of small waters to raise awareness of their importance, incorporating Important Freshwater Landscapes and Important Freshwater Areas concepts into water and nature planning (e.g. RBMPs, LNRSs).

In the medium term (1-5 years) we make six recommendations which include the need to:

- Modify Water Framework Directive Regulations to adopt System B (i.e. including standing water less than 50 ha in area and considering as separate waterbodies headwaters with catchments between 1-10 km^2) for monitoring and management of freshwaters in River Basin Management Plans so that small standing waters are included in practical regulation. To avoid perpetuating the spurious claim that this would create 'enormous' administrative burdens, smart monitoring programmes, like those adopted formerly in the Countryside Survey and currently in PondNet[2], should be designed.
- Update definition of Controlled waters to ensure that it unambiguously offers protection to all smaller waters and provide guidance that headwater streams are specifically recognised in River Basin Management Plans by updating advice originally given by the UK TAG for Water Framework Directive identification of small waters.
- Extend and modify Environment Act water and habitats targets; this is needed because the Act's targets are mandatory and create perverse incentives, particularly the nutrient targets which deprioritise small wastewater treatment plants, irrespective of their impact. The targets should include more outcome focused targets, including biological targets to integrate with EIP including:
  - Extent in hectares of WFDR 'clean water' (i.e. Good and High status water)
  - Extent in hectares of High and Good status biological assemblages
  - Refining targets for habitat creation in Environment Act to specifically recognise creation of small waters and small wetlands; despite their small size (making limited contribution to overall area-based targets) policy should specifically drive their creation.

In the longer term (5+ years) we make five recommendations including:

- Establishing a new 'Freshwater Act' developing the proposal made by Water UK in '21st Century Rivers Ten Actions for Change (WaterUK, 2021). Linked to the NGO-proposed 'Charter for Small Waters' this could provide an important long-term driver for investment in headwater catchments, clarify and simplify overlaps in water management and ensure a 'water focused' approach to land management.
- Ensuring Priority Habitats given equal status in law to Habitats Regulation sites and SSSIs.
- Creating a 'small waters' fund targeted on measures to protect High status small waters (i.e. first and second order streams, ponds and small lakes). The aim of the fund would be to redress the imbalance in water management created by the long history of bias against all kinds of small waters.
- Adjusting primary legislation to include a programme to create Water Environment Protection Zones to protect existing high quality small standing and running water catchments with an ambitious long-term programme to extend this network of sites, starting at the top of catchments and in areas with high concentrations of important standing waters, working downstream (running waters) and linking up sites (standing waters).

[2] https://freshwaterhabitats.org.uk/projects/pondnet-edna-surveys/: the PondNet survey design created in 2010 now underpins the world's longest running national, stratified random, eDNA-based sampling programme.

2. Aims

In this project we combined a review of water policies applying to the regulation of small, Descriptive wastewater treatment plants, with analysis of policies for protecting freshwater biodiversity and delivering other ecosystem services provided by the full range of standing and flowing smaller waters found in headwater catchments. We use this information to identify a set of recommendations for policy makers to improve the water environment in headwater catchments and the management of small wastewater treatment plants.

The report describes the main Project Outcomes which are:

- A description of the current water regulatory framework including scientific, policy and social drivers that underpin this. This includes an overview of the way the water industry is regulated, focusing in detail on regulation and management of 'small' or 'Descriptive' wastewater treatment plants and approaches to monitoring and evaluating the condition of headwater catchments.
- An up-to-date review of current knowledge of the value of small waterbodies in headwater catchments. This builds on Freshwater Habitats Trust's substantial published outputs on small waters, including new, previously unpublished, information from current catchment-scale projects, including those supported by Anglian Water.
- A review of knowledge of the impacts of small wastewater treatment plants on headwater ecology. This includes a case study based on examples from the catchments of the Eye Brook and Stonton Brook which are part of the landscape intensively studied in the Water Friendly Farming project.
- A description of desirable quality outcomes for headwater catchments, if cost:benefit was not a limiting factor, identifying those actions which will allow policy to fully capitalize on the disproportionate societal importance of smaller waters
- An assessment of the regulatory and policy factors that restrict investment in small or Descriptive wastewater treatment plants and barriers to proposed regulatory changes. In the light of stakeholder inputs we suggest routes for overcoming potential barriers.
- Identification of policy and regulation changes that could provide benefits for people, society and the environment in the short, medium and long-term in headwater catchments. Benefits in terms of evidence of positive outcomes and cost:effectiveness were evaluated including:
  - Identification of mechanisms for policy change
  - Barriers to policy change
  - The results of consultation with policy makers for overcoming any barriers identified
- Clear recommendation for policy makers and the water industry on changes to regulatory policy over the short, mid and long-term.

A standalone Powerpoint presentation outlining key recommendations and next steps is provided as an Annex to the report.

An important part of the project was a roundtable discussion with water sector stakeholders followed by individual interviews. Held on January 23rd 2024, the roundtable was attended by 16 people from the organisations shown In Table 1. This was followed by one-to-one discussion with representatives of the water sector including regulators, water companies, statutory bodies and NGOs.

Table 1. Programme of the CaSTCo Roundtable workshop on headwater catchment policy and protection, January 23rd 2024

Organisation	Attendee
Anglian Water	Chris Gerrard
	Becky Carter
	Anna Wilson
Consumer Council for Water	Karen Gibbs
Defra	Representative 1*
	Representative 2*
Environment Agency	Richard Handley
Environment Agency	Damian Crilly
National Trust	Stewart Clarke
Natural England	Nikolas Bertholdt
Nature Conservancy	Rob Cunningham
Northumbrian Water	Laura Mollon
Ofwat	Dominic Carver
Rivers Ecology	Lily Mackie
Wessex Water	Tim Stephens
Wildlife Trusts and Blueprint for Water	Ali Morse

We followed this up with longer 1 to 2 hour interviews with representatives of the following organisations where we address a standard set of questions about the headwater environment and water policy. The questions we discussed are shown in Appendix Table 1.

Organisation	Name
Broads Authority	Andrea Kelly
Consumer Council for Water	Karen Gibbs
Defra	Representative 1*
	Representative 2*
Environment Agency, CIEEM	Richard Handley
National Trust	Stewart Clarke
Natural England	Nikolas Bertholdt
Nature Conservancy Council	Rob Cunningham
Northumbrian Water	Laura Mollon
Ofwat	Dominic Carver
Wessex Water	Tim Stephens
Wessex Water	Jonathan Rayers

*Anonymity under the Chatham House Rule

3. Background

3.1 About CaSTCo

The Catchment Systems Thinking Cooperative ("CaSTCo") is a £7 million project funded by the Ofwat Innovation Fund and is led by United Utilities and the Rivers Trust, with collaboration between 24+ UK partner organisations including water and sewerage companies, environmental charities, communities and local partnerships, technical experts, academics, government, non-government organisations and the private sector.

The objective of CaSTCo is to co-create a national framework focussed on citizen science and low-cost monitoring to generate a robust body of evidence for improved decision making about our water environments and catchment health. This will include the governance processes, training systems and integrated data management processes to enable a standardised approach that can be applied in a range of situations.

To demonstrate the value of this framework, the approach will be piloted in eight test catchments across partnering water company regions. Anglian Water is one of the 24 partners in this three-year project and is specifically taking the lead on three deliverables in the Anglian Demonstrator area:

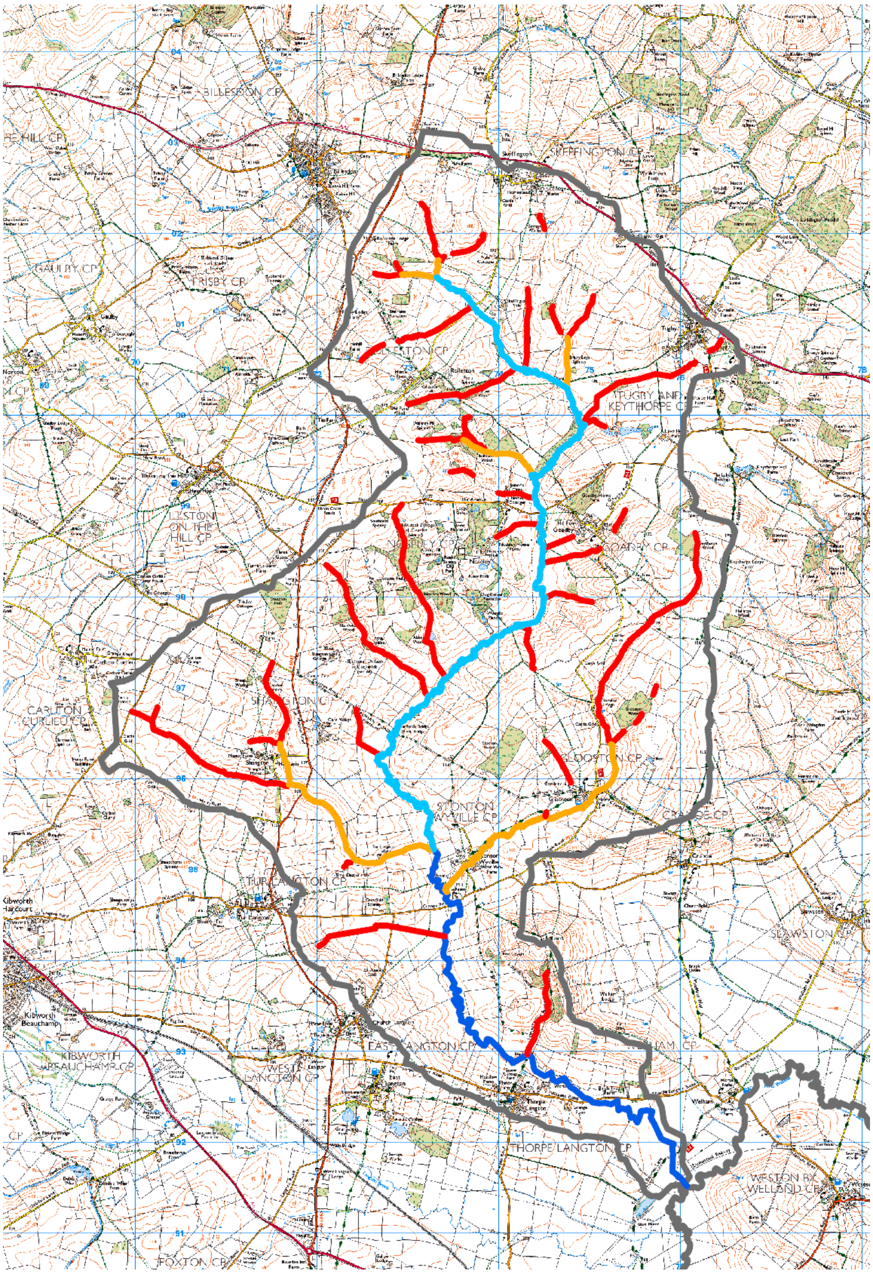
- Generating a baseline for headwaters of the Broadland Rivers management catchment
- Reporting on the policy and social factors underpinning the current water industry regulatory framework and how these could be developed in the future to enhance outcomes for people, society and the environment
- Evaluating the impact of treatment wetlands for delivering good water and improving ecological quality.

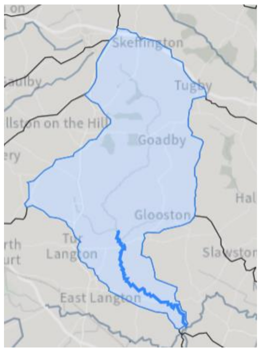
3.2 What is the headwater environment?

The headwater environment as described in this report has two parts:

- The running water network of first and second order streams including ditches, where these are also first and second order waterbodies.
- Other waterbodies and wetlands which may or may not be directly physically connected to running waters. This includes ponds, lakes (predominantly but not always those smaller than the 50 ha Water Framework Directive size cutoff) and wetlands.

The definition of first and second order headwater streams follows the Strahler system (Strahler, 1957). Figure 2 shows an example of the real-world distribution of first and second order streams in the case study area for the project in the catchment of the Stonton Brook, which is a tributary of the R. Welland in Leicestershire, and part of the Water Friendly Farming project area. Figure 3 shows the distribution of ponds in the same area.





WFD waterbody: Stonton Brook

Key

- First order streams (51%)
- Second order streams (15%)

Third order streams (34%):

- 3rd order streams shown on the WFD catchment map
- All other third order streams

Figure 2. Stream orders in the Stonton Brook catchment. Inset: waterbodies shown on Water Framework Directive catchment map

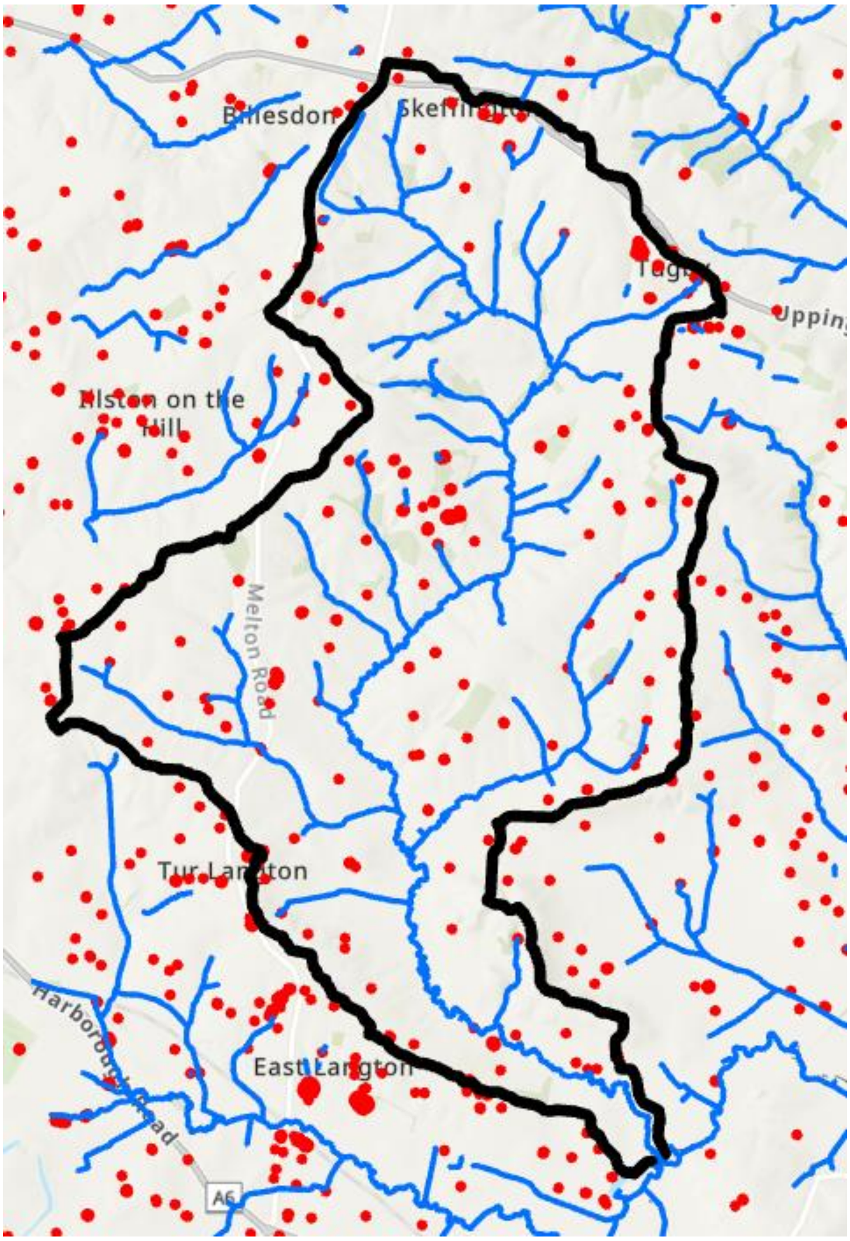


Figure 3. The distribution of ponds in the Stonton Brook catchment.

We have treated other waterbodies as part of the 'headwater environment' where they lie inside the catchments of first and second order streams. In this report we broadly refer to this network of freshwater habitats as 'small waters'. The proportion and numbers of small waters in Great Britain are shown in Table 2.

In the case study area, the landscape of the Water Friendly Farming project (Williams *et al.*, 2020), first and second order streams make up 66% of the running water network, by length (Figure 2). This figure is typical for landscapes in southern England. Davies *et al.* (2008), working in R. Cole landscape in Oxfordshire / Wiltshire, a typical lowland England landscape, showed that in an area of 100 km^2 there was just over 200 ha of freshwater habitats of which 38% was streams, ponds and ditches. Note that in that area most of the lakes would also be considered 'small' because all were below the Water Framework Directive 50 ha cutoff (Table 3 and Figure 4).

Table 2. Number of smaller waterbodies in Great Britain

Water body type	Number
Headwater streams: 1st and 2nd order	70-80% of network[1]
Ponds (up to 2 ha)	c.470,000[2]
Lakes between 2.1 and 50 ha	8500[3]
Lakes over 50 ha (WFD monitored)	480[3]

Sources:
1. Biggs, J., Von Fumetti, S. and Kelly-Quinn, M., 2017. The importance of small waterbodies for biodiversity and ecosystem services: implications for policy makers. *Hydrobiologia*, 793: 3-39.
2. Williams, P., J. Biggs, A. Crowe, J. Murphy, P. Nicolet, A. Weatherby & M. Dunbar, 2010. *Countryside Survey: Ponds Report from 2007*. Pond Conservation and NERC/Centre for Ecology & Hydrology. (CS Technical Report No. 7/07 CEH Project Number: C03259).
3. UK Lakes Portal: https://eip.ceh.ac.uk/apps/lakes/

In the catchment study for the R. Cole the total area of each habitat type was estimated by Davies et al, 2008. Rivers and lakes, the larger waters comprised about two-thirds of the area of surface water.

Table 3. The area of different freshwater habitats in the R. Cole, Wiltshire/Oxfordshire study area (Davies *et al*., 2008).

Habitat type	Area (hectares) in the 11 x 9 km study area
Lakes	77.9 (38%)
Rivers	49.2 (24%)
Ditches	41.0 (20%)
Streams	28.7 (14%)
Ponds	8.2 (4%)
Total	**205.0**
Rivers and lakes	**62%**
Ditches, streams, ponds	**38%**

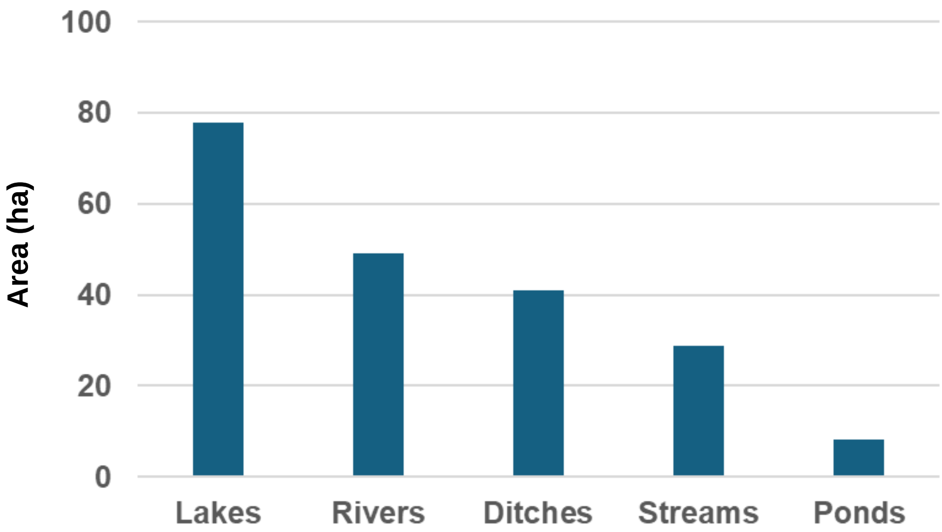


Figure 4. Area of water in five different freshwater habitat types in the R. Cole landscape study area (Davies *et al.,* 2008).

3.2.1 About headwaters (from Richardson, 2019)

Headwaters, the sources of all stream networks, provide habitats that are unique from other freshwater environments and are used by a specialised subset of aquatic species. The features of headwaters that provide special habitats include predator-free or competitor-free spaces; specific resources (particularly detrital based); and moderate variations in flows, temperature and discharge.

Headwaters provide key habitats for all or some life stages for a large number of species across most freshwater phyla and divisions. Some features of headwaters, including isolation and small population sizes, have allowed for the evolutionary radiation of many groups of organisms within and beyond those habitats. As small and easily engineered physical spaces, headwaters are easily degraded by streambank development, ditching and even burial. Headwater streams are among the most sensitive of freshwater ecosystems due to their intimate linkage with their catchments and how easily they are impacted. As a unique ecosystem with many specialist species, headwater streams deserve better stewardship.

3.2.2 About ponds

Ponds, which occur in all terrestrial landscapes and often grade imperceptibly into other kinds of freshwater habitats (e.g. fens, bogs, streams, wet grasslands), are an ancient and natural habitat type, created by a wide range of natural processes, as well as human activity (Biggs and Williams, 2024). Ponds provide predator-free or competitor-free spaces; specific resources (particularly detrital based); and substantial heterogeneity from site to site, more than for other freshwaters.

Ponds provide key habitats for a very wide range of species and are a lynch-pin of freshwater biodiversity in most landscapes. As small and easily engineered physical spaces, ponds are easily damaged or destroyed. Like headwaters, growing awareness of their value should improve their stewardship.

3.3 Definition of Descriptive wastewater treatment plants

In this report we refer to small sewage works as Descriptive wastewater treatment plants, sometimes shortened to Descriptive works. These are wastewater treatment plants that have permits to discharge effluents for less than or equal to 250 Person Equivalents (PE). Such works should also have no expected trade flows and an expected flow <50m^3/d. Descriptive permits require discharges to be of good visual quality.

Sewage works of all sizes may be called Water Recycling Centres, wastewater treatment works/plants or sewage treatment works. In this report we refer to larger works (greater than 250 PE) as Numerical wastewater treatment plants or Numerical works. These are wastewater treatment plants which instead of descriptive controls, have numerical limits for key determinands written in to their discharge permits.

4. Value of headwater environments

4.1 Value of smaller waterbodies in headwater catchments

The value of small waterbodies in headwater catchments for people, society and the environment, depends on three features of small waters:

- Their inherent biological richness and biogeochemical activity which make them hotspots of biodiversity. Headwater freshwater habitat networks (i.e. comprising standing and running waters) typically support about 85-90% of freshwater species seen in the landscape as a whole, *and* species which are specific to this environment. Ponds alone support more species than larger rivers, and support as many priority species (Figure 5).
- The large proportion of the water environment that they comprise (see Table 1): typically, 70% of the length of the running water network and a surprisingly large proportion of the total freshwater habitat area.
- The potential for headwater catchments to be protected from stressors which otherwise occur widely.

4.2 Inherent richness of the headwater environments

In this analysis we make use of a range of related studies undertaken by Freshwater Habitats Trust over the last 20 years focussing particularly on more recent studies, including data currently unpublished in the peer-reviewed literature.

Since about 2000 Freshwater Habitats Trust has undertaken catchment studies of patterns in freshwater biodiversity in different waterbody types at varying scale from 60 km^2 to 3000 km^2 (in, respectively, Doddington, Lincolnshire and Fyn, Denmark) in 15 different landscapes in Britain and the rest of Europe (Table 4).

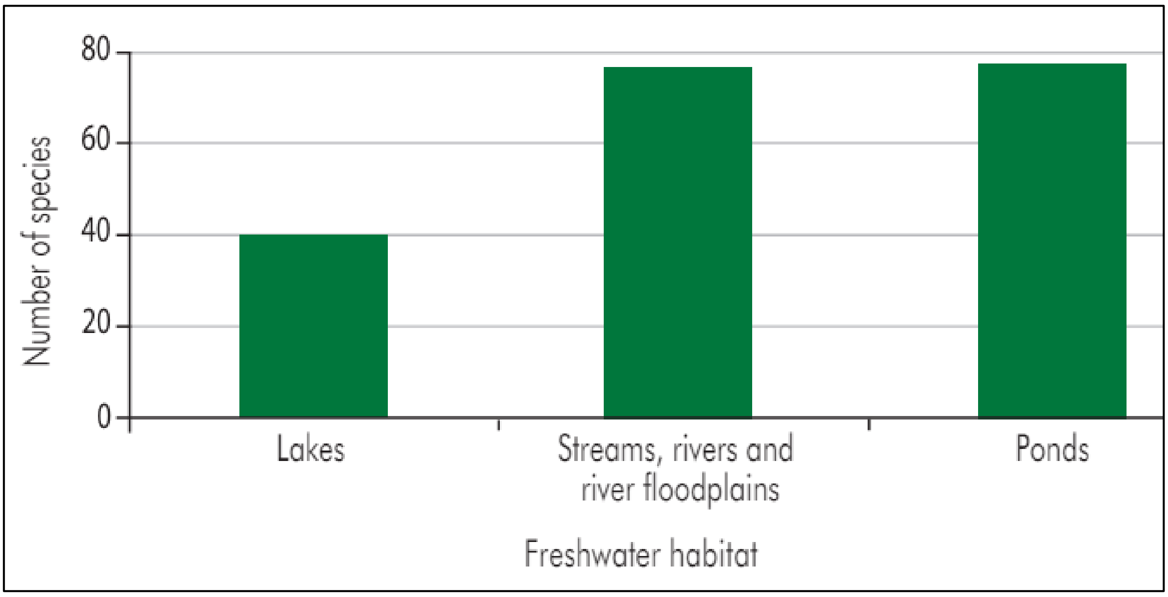


Figure 5. Number of priority species (now known as Species of Principal Concern) in different freshwater habitat types; small waters and upper catchments are hotspots for uncommon and endangered species (Maltby et al., 2011).

Table 4. Freshwater Habitats Trust projects which have obtained landscape scale data comparing biodiversity of different freshwater habitat types

Project title	Area	Year (s) undertaken	Published
Coleshill study	Wiltshire/Oxfordshire, UK	2000	Williams et al., 2004
Whitchurch	Shropshire, UK	1997	Davies et al., 2008
Syngenta Landscape Study	Fyn, Denmark	2001	Davies et al., 2008
	Braunschweig, Germany	2001	Davies et al., 2008
	Avignon area, France	2002	Davies et al., 2008
Conwy Landscape Study	R. Conwy catchment, Powys	2015	FHT, unpublished data
Water Friendly Farming	Leicestershire, UK	2010-2024 (on-going)	Williams *et al.*, 2004
Pitsford Water Friendly Farming	Northamptonshire, UK	2020 to 2025	FHT, unpublished data
Wootton Brook Natural Flood Management Project	Northamptonshire, UK	2018-19	FHT, unpublished data
R. Irfon Catchment Project	Powys, Wales	2022	FHT, unpublished data
Doddington 'Wetter, Better' project	Lincolnshire, UK	2022	Biggs and Graham, 2023

The main finding of all of these studies is that, surprisingly, in every case (with the exception of the Avignon area in France where data limitations prevented a full analysis), ponds were at landscape scale the richest habitats.

Freshwater Habitats Trust's work was amongst the first to show the importance of small waters and wetlands for freshwater biodiversity at catchment scale. In brief:

- The value of small waters, focusing particularly on freshwater biodiversity, shows in widely distributed studies from the UK, continental Europe (Table 4): (a) the exceptional richness of ponds and (b) the richness of headwater streams and ditches, which make a similar contribution to freshwater biodiversity as larger rivers as well as comprising about the twice the habitat area (Davies *et al*., 2010);
- Elsewhere, in Asia, similar results have also been obtained recently (Sun *et al*., 2022).

The latest unpublished information from the Water Friendly Farming project, running up to the 2023 field season, confirm the findings of studies listed in Table 4 showing that ponds are the richest habitats in upper catchments and also support the largest number of uncommon species (see Figure 5, Section 4.2).

4.3 Role of small waters in providing ecosystem services

Biggs *et al*. (2017) summarised the value of small waters, including springs, for biodiversity and ecosystem services globally. The review both shows the importance for biodiversity described above and the role of small waters in providing other ecosystem services. Since 2017 a range of further evidence has been generated on the importance of small waters including in:

- maintenance of water quality
- the control of flooding
- management of the carbon cycle.

In addition to the 'traditional' ecosystem services known to freshwater managers, there are also new approaches to ecosystems services known as 'Nature's Contributions to People', a more inclusive language for ecosystem services which has been developed by IPBES, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Maintenance of water quality

Work in North America, in particular, has shown the importance of networks of freshwater and wetland habitats not connected directly to streams and rivers in maintaining the quality of those stream networks. Specifically, the technical review undertaken by the US EPA (2015) has shown that (this is a quotation to ensure accuracy, with our emphasis added):

- The scientific literature unequivocally demonstrates that streams, regardless of their size or frequency of flow, are connected to downstream waters and strongly influence their function.
- The scientific literature clearly shows that wetlands and open waters in riparian areas (transitional areas between terrestrial and aquatic ecosystems) and floodplains are physically, chemically, and biologically integrated with rivers via functions that improve downstream water quality. These systems act as effective buffers to protect downstream waters from pollution and are essential components of river food webs.
- There is ample evidence that many wetlands and open waters located ***outside*** of riparian areas and floodplains, ***even when lacking surface water connections***, provide physical, chemical, and biological functions that could affect the integrity of downstream waters. Some potential benefits of these wetlands are due to their isolation rather than their connectivity. Evaluations of the connectivity and effects of individual wetlands or groups of wetlands are possible through case-by-case analysis.

- Variations in the degree of connectivity are determined by the physical, chemical and biological environment, and by human activities. These variations support a range of stream and wetland functions that affect the integrity and sustainability of downstream waters.
- The literature strongly supports the conclusion that the ***incremental contributions of individual streams and wetlands are cumulative across entire watersheds***, and their effects on downstream waters should be evaluated within the context of other streams and wetlands in that watershed.

So far, the concepts developed in North America about the role of this network of habitats in maintaining the quality of downstream habitats have not been widely applied in Europe, although other parts of the analysis are familiar. However, the concepts as a whole are highly relevant to the management of headwater catchments.

We recommend that further investigation of the relevance of these approaches are undertaken because of their applicability to whole landscape management. During a period of policy transition in the UK, where there is considerable emphasis on the role of land management to mitigate the impacts of agriculture, concepts developed in the Clean Water Act work, will be of considerable relevance.

The very extensive legal debate about the structure of freshwater networks, and what is and is not a waterbody, has many parallels with the European situation. Indeed, the recent rejection by the US Supreme Court of the prevailing interpretation of the Clean Water Act, to include small streams and wetlands, has clear European echoes. Speaking about the decision, the US EPA Administrator Michael S. Regan said that: “While I am disappointed by the Supreme Court’s decision in the *Sackett* case, EPA and Army have an obligation to apply this decision alongside our state co-regulators, Tribes, and partners". Other independent observers noted more pithily that the decision “has no basis in science” (https://www.nrdc.org/stories/what-you-need-know-about-sackett-v-epa).

In the UK context, a potentially simpler solution would be to include as recognised waters (or redefined controlled water, to maintain consistency with earlier legislation) all first and second order streams and ponds shown on national maps held by the Ordnance Survey.

The control of flooding

Small waters and headwater catchments can play a role in the control of downstream flows, helping to reduce flooding. The present project’s case study area, the Water Friendly Farming project, provides evidence of the effects of holding back water in small headwater streams with effects including:

- Reductions of peak flows at the catchment outlet of 22 ± 6% and delayed the peak in flow by up to 5 h for 11 storm events.
- Detection of flow reductions up to 10 km downstream from sets of leaky dams in headwater systems (Villamizar *et al.*, 2024).

A range of other studies of the effects of natural flood management are available, the majority being on small streams.

Management of the carbon cycle

There is growing evidence of the role of small waters in the carbon cycle. Since John Downing in the United States first suggested that ponds trapped as much carbon as the oceans there has been a growing interest in ponds and the carbon cycle and their potential to trap or emit greenhouse gases. In contrast, running waters are generally thought to be emitters of CO_2, or conduits for carbon from the land to the oceans. They are not substantial carbon stores except potentially in floodplain or headwater mires.

Ponds have shown substantial variations in the ability to store or emit CO_2 particularly when polluted. Generally, polluted ponds seem to emit greenhouse gases. Emissions are generally lower where water has lower background nutrient levels (i.e. ponds are not eutrophicated). Deoxygenated ponds are also likely to be methane emitters. However, ponds do sequester N_2O (nitrous oxide), which is emitted particularly by nitrogenous fertlisers.

Headwater wetlands and carbon-rich soils may be substantial stores of carbon but research in this area is still active and there is a high degree of uncertainty in the ability of soils to trap carbon, despite many assertions that this is a 'given'. Currently unpublished observation of floodplain wetland mosaics, being undertaken as part of Natural England's 'Nature Returns' programme, suggest high degrees of variability in emission and storage of carbon in floodplain soils.

Nature's Contribution to People

The ecosystem services provided by small waters are dependent on their unique character, location, and ongoing management. For example, a single pond, considered in isolation, already offers valuable habitats for wildlife, and may also provide several other ecosystem services. From the 18 categories of Nature's Contributions to People identified by IPBES, ponds are particularly efficient for addressing 11 of them.

At present, the concept of 'Nature's Contributions to People' have not been widely adopted in the UK but as this will be the international language of ecosystem services it is likely to increasingly influence the approach taken to evaluating benefits we gain from the natural environment.

In this respect small waters are likely to provide significant benefits given that they are the 'local waterbody'. Taking ponds as an example, the Nature's Contributions to People provided this type of small waterbody are shown in Table 5. Box 1 summarises some of the often confusing language about ecosystem services.

BOX 1. Societal challenges, nature-based solutions, ecosystem services and Nature's Contributions to People

The enormous urgency of the biodiversity and climate crises has spawned an often bewildering jargon used by specialists to describe the benefits and 'services' we get from nature. These are an important part of the role of managing headwater catchments to maximise the benefits we obtain from them. In this report we have applied this terminology as correctly as possible, while making it accessible to practitioners.

In brief:

Societal challenges are the threats we all face (drought, lack of food, lack of water, loss of biodiversity); we use a definition from IUCN to define these challenges. Many of these threats can be reduced and controlled with ***nature-based solutions***, practical techniques based on habitats and species that make the most of the essential qualities of ecosystems to address societal challenges, helping both people and nature (we use the definition from IUCN and also take account of the EU and UN definitions of nature-based solutions, which are similar). Examples of nature-based solutions include creating new ponds or restoring streams to reduce floods.

Nature-based solutions that address societal challenges provide us with services from nature that we benefit from. Two classifications have been used to categorise these benefits: ***ecosystem services*** and, most recently, ***Nature's Contributions to People***.

Table 5. The role of ponds in providing Nature’s Contributions to People	
Nature’s Contributions to People	**Role of ponds**
Regulation of hazards and extreme events	**Definition**: Reduction, by ecosystems, of the impacts on humans or their infrastructure caused by e.g. floods, wind, storms, hurricanes, heat waves, tsunamis, high noise levels, and fires. **Contribution**: Ponds can be used to regulate flood hazards, hold water in the landscape during dry weather and provide cooling in high temperatures (especially in cities).
Regulation of freshwater quantity	**Definition**: Regulation, by ecosystems, of the quantity, location and timing of the flow of surface and groundwater used for drinking, irrigation, transport, hydropower, and as the support of non-material contributions. **Contribution**: Ponds store water, making them valuable for runoff management and the provision of natural flood control.
Regulation of freshwater quality	**Definition**: Regulation, through filtration of particles, pathogens, excess nutrients, and other chemicals, by ecosystems or particular organisms, of the quality of water used directly or indirectly. **Contribution**: Every pond has purification potential, which increases with size and depth. Therefore, the cumulative impact of many ponds can mean a high pond density has substantial potential for purifying water.
Regulation of climate	**Definition**: Climate regulation by ecosystems (including regulation of global warming) through positive or negative effects on emissions of greenhouse gases (e.g. biological carbon sequestration, methane emissions from wetlands). **Contribution**: Ponds play a substantial role in storage of carbon and regulation of greenhouse gases; managing ponds is essential for management of the carbon cycle.
Food and feed	**Definition**: Production of food from wild, managed, or domesticated organisms, such as fish, beef, dairy products, edible crops, wild plants, mushrooms, and honey. **Contribution**: Water storage supporting wild and domesticated animals and crops is probably one of the most ancient nature-based solutions linked to ponds in agricultural landscapes.
Pollination	**Definition**: Facilitation by animals of movement of pollen among flowers, and dispersal of seeds, larvae or spores of organisms beneficial or harmful to humans. **Contribution**: Large numbers of pollinators around and near ponds facilitates pollination.

Table 5 (cont). The role of ponds in providing Nature's Contributions to Peopel	
Physical and psychological experiences	**Definition**: Provision, by landscapes, seascapes, habitats or organisms, of opportunities for physically and psychologically beneficial activities, healing, relaxation, recreation, leisure, and tourism, and aesthetic enjoyment based on the close contact with nature. **Contribution**: Ponds provide a range of experiences, including contact with water (e.g. swimming) and nature (tourism and leisure).
Learning and inspiration	**Definition**: Provision, by landscapes, seascapes, habitats or organisms, of opportunities for the development of the capabilities that allow humans to prosper through education and knowledge **Contribution**: Ponds are important resources for learning about, and drawing inspiration from, the natural world.
Supporting identities	**Definition**: Landscapes, seascapes, habitats or organisms being the basis for religious, spiritual, and social-cohesion experiences. **Contribution**: Ponds support social cohesion (e.g. Toads on Roads campaigns, UK), regional identity (e.g. fish ponds, Czech Republic), and 'Fêtes des Mares' celebrating ponds (France).
Habitat creation and maintenance	**Definition**: The formation and continued production, by ecosystems or organisms within them, of ecological conditions necessary to, or favourable for, living beings of direct or indirect importance to humans. **Contribution**: Ponds are substantial contributors to freshwater and terrestrial biodiversity at waterbody and whole landscape scale.
Maintenance of options	**Definition**: Capacity of ecosystems, habitats, species or genotypes to keep options open in order to support a good quality of life. **Contribution**: By maintaining biodiversity, ponds can play a substantial role in maintaining options for future management of the environment.

5. The state of the headwater environment

In the UK, only two programmes, one national and one local, provide data for the *whole* headwater water environment specifically.

The national data come from:

- Countryside Survey, which was run by Centre for Ecology and Hydrology and included headwater streams and ditches and, in work undertaken in collaboration with Freshwater Habitats Trust, ponds.
- Landscape scale studies by Freshwater Habitats Trust which have been undertaken at seven locations in England (see Section 4.2 above), covering all waterbody types in these areas.

Detailed local data providing a long run of monitoring information come only from the Water Friendly Farming project which is the case study area for the present report. Additional data with a shorter time run are also now becoming available from the Anglian Water funded Pitsford Water Friendly Farming project, which is replicating the approach of the core Water Friendly Farming project, starting in 2020.

5.1 Countryside Survey

The Countryside Survey leads to two principal conclusions about headwater streams nationally, using data from invertebrate survey results, and comparing these with Environment Agency national WFDR monitoring data on invertebrates:

1. Headwater streams are in poorer condition than lower catchment rivers (Figure 6, Table 6). Comparing data from the Countryside Survey 2007 for England and the nearest year available of Environment Agency WFD monitoring (2010), headwater streams had fewer sites overall at High and Good status (54% of headwater sites vs 65% of lower catchment sites) and more headwater sites that were at Moderate, Poor or Bad status than lower catchments (46% vs 34% respectively).
2. Over the period 1998 to 2007 there was good evidence of an increase in the biological quality of headwater streams. This reflected trends seen in invertebrate assemblages more generally, although the reasons for the improvement were not clear from the Countryside Survey results and may have reflected increases in shade, changes in land use and recovery from drought.

Practically, the most important result to note is that headwater streams were, overall, in poorer ecological condition than lower catchments.

Table 6. Macroinvertebrate community status in headwater streams and the wider network of river sites monitored by the Environment Agency

Water Framework Directive status	Countryside Survey 2007 headwater stream survey	Environment Agency river monitoring data 2010
High	37%	31%
Good	17%	34%
Moderate	20%	19%
Poor	20%	10%
Bad	6%	5%

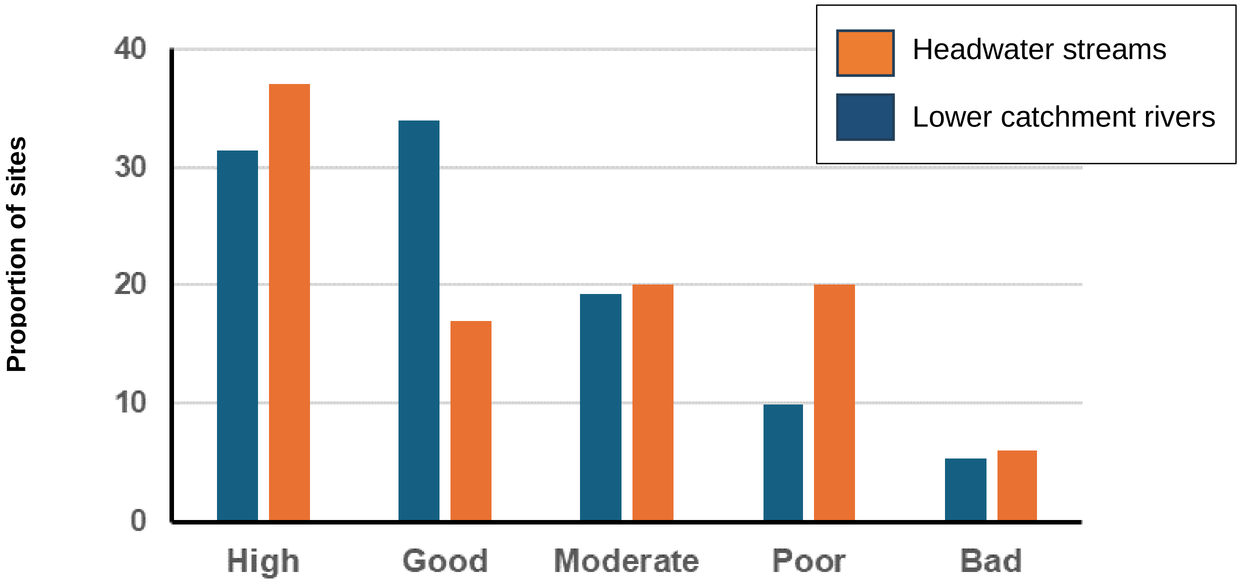


Figure 6. Water Framework Directive status of headwater streams and lower catchment rivers assessed using invertebrate data in England.

2. Countryside Survey ponds are also widely degraded but 20% sites had 'Good' PSYM[3] scores indicating that they were at or close to reference condition. Monitoring of ponds at two timepoints (1996 and 2007) showed that pond numbers increased nationally during this period, but pond *quality* declined (Williams et al., 2010).

[3]PSYM, the Predictive System for Multimetrics, is the standard UK system for assessing the ecological quality of ponds and small lakes up to 5 ha. More information is available about PSYM on the Freshwater Habitats Trust website at: https://freshwaterhabitats.org.uk/advice-resources/survey-methods-hub/psym/.

5.2 Landscape-scale studies of the whole freshwater environment

The landscape scale studies of Freshwater Habitats Trust are described in more detail in Section 12 below. They provide the main line of evidence on the richness of ponds as part of the water environment.

Additionally, they provide the only data that we are aware of providing monitoring information on the condition of the whole freshwater environment.

This shows that in the case study site in the East Midlands, which is a typical area of lowland England farmland, there has been a gradual 0.6 species/year loss of aquatic biodiversity measures in terms of wetland plant species richness since 2010 (Figure 7).

Note that this is an absolute measure based on census data (i.e the whole environment is surveyed) rather than samples surveys with statistical errors.

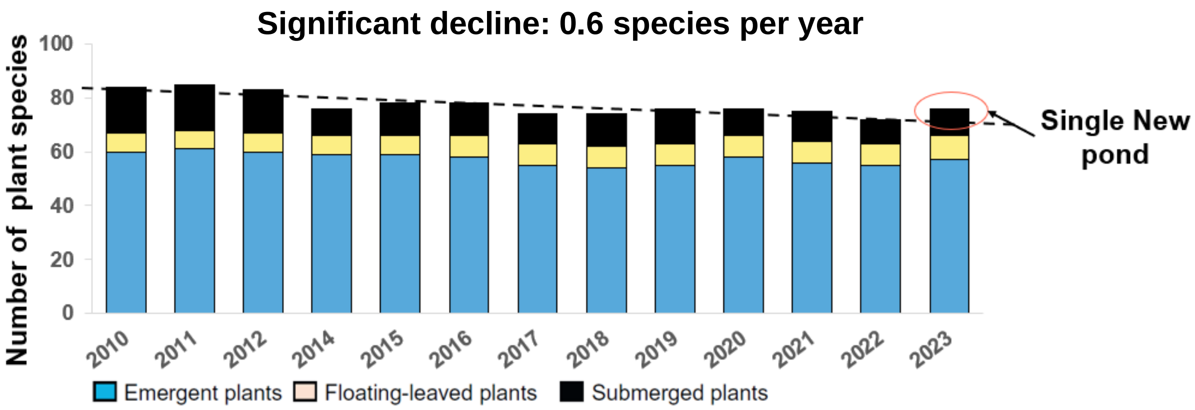


Figure 7. Long-term decline of whole landscape level freshwater wetland plant diversity in the Water Friendly Farming landscape, the case study area for this report

6. Results

6.1 Regulatory framework as it applies to headwater catchments and the scientific, social and policy drivers

6.1.1 Background: who is responsible for managing water overall?

The UK government, principally through Defra, is responsible for setting the overall legal and policy framework for water in England. Defra is also the lead department for the so-called arm's-length bodies and regulators. Recognising the monopoly afforded to water and sewerage companies alongside their statutory obligations, Ofwat acts as the economic regulator holding the water companies to account on cost-effective delivery of agreed plans. The government issues a Strategic Policy Statement to Ofwat, setting government's priorities for Ofwat's regulation of the water industry in England.

The Environment Agency implements the permitting and licensing regimes, with inspections and enforcement action protecting freshwaters. The Environment Agency also leads on the development of the Water Industry National Environment Programme and is responsible for assessing the water resource planning for each water company. Natural England protects and improves England's natural environment, including the water environment, and advises on the impacts on water dependent habitats. The Drinking Water Inspectorate provides independent reassurance on the quality of drinking water. It also investigates disruption to supply, and the quality of water supplied, including the role of local authorities regarding private water supplies. Drinking Water Inspectorate expects water companies to have programmes of catchment management as part of their plans to provide safe secure drinking water.

Government and regulators use a variety of powers and levers to improve the water system, particularly focusing on regulation of the water industry, and licences and permits for industry. New powers through the Environment Act 2021 are now being introduced by the Government to improve the water environment and the resilience of our water supply.

6.1.2 The regulatory framework: an overview

Around a dozen major pieces of legislation govern the management of the water environment, drawn from 'water' and 'nature' law (Table 7). In short, water law aims, in theory, to protect <u>all</u> of the water environment, whereas 'nature' law is concerned with special places. In reality, the difference is less clearcut: water law does not protect all of the water environment and conservation law often applies to very large parts of the water environment (e.g. the R. Wye SSSI covers the 200 km length of the river, which is the fifth longest in Britain with a catchment nearly the size of Norfolk). With the advent of the Environment Act 2021, provisions for both nature and water are now beginning to be drawn together in a more coherent fashion, reflecting a growing trend in environmental management.

The current water industry regulatory framework includes extensive legal obligations, government targets and statutory requirements. Water companies must address any damage arising from their activities, and are expected to protect, restore, and enhance the environment (Defra, 2022a,b). But perhaps the most distinctive feature of water-related law and policy is its complexity. As The Office for Environmental Protection recently noted with respect to implementation of Water Framework Directive Regulations and their Environmental Objectives:

> *"[They] sit within a complex, somewhat fragmented wider framework of water law and policy. The interaction between different measures, and any hierarchy among them, are not clear."*

And…

"We [The OEP] see a lack of coherence between the Environment Act water targets and the scale and pace of change required to meet the Environmental Objectives.

Although complex, this picture is not necessarily detrimental to small waters as it provides opportunities for unification and clarification through the creation of a whole landscape approach to water management. This is beginning now to develop, albeit in a piecemeal fashion, through the consideration of the whole landscape context. We discuss this point further in Section 10.6.2. "Routes to overcoming barriers to policy change"

6.1.3 Underlying legislation

Preventing pollution of a large proportion of *all* watercourses, and many standing waters, so-called 'controlled waters', is rooted in the provisions of the Water Resources Act 1991 and by subsequent and well-established water industry regulatory frameworks including the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, the Environment Act 2021, the Environmental Improvement Plan 2023 and government guidance such as the Water Industry Strategic Environmental Requirements (WISER).

Controlled waters are defined, slightly opaquely, as any relevant river or watercourse where "any relevant river or watercourse means":

> *'.....any river or watercourse (including an underground river or watercourse and an artificial river or watercourse) which is neither a public sewer or drain which drains into a public sewer'* (Subsection 104/3).
>
> Likewise, a pond, whether natural or artificial, may be a controlled water if it: '*discharges into a relevant river or watercourse or into another lake or watercourse which is itself a relevant lake or pond'* (Subsection 104/3),

where a relevant river or watercourse means:

> '.....*any river or watercourse (including an underground river or watercourse and an artificial river or watercourse) which is neither a public sewer or drain which drains into a public sewer'* (Subsection 104/3).

In both cases it is within the power of the Secretary of State to finally decide what is, or is not, a controlled water. In theory the provisions of the regulation could be purpose made for the protection of small waters but in practice they are outweighed by the long tradition, based in freshwater science, of overlooking small waters (the Downing 'saliency error').

Some changes to this traditional situation are now occurring, and discussion in this report particularly focuses on new regulations and opportunities which have arisen since the adoption of the Environment Act 2021. Rooted in pollution control and water supply, there is a long-term trend for legislation to be more concerned with the protection of the water environment *sensu lato*, perhaps epitomised by the essentially ecosystem-based approach of the Water Framework Directive.

Protection and management of the water environment is governed by several key pieces of primary legislation, and the statutes arising from this legislation. These are:

- Water Industry Act 1991
- Environment Act 1995 and related legislation (eg NERC Act 2006: duty to further conservation and enhancement of biodiversity)
- Flood and Water Management Act 2010: encourage use of sustainable urban drainage systems (SUDs).
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017:
- Environment Act 2021 and policy guidance arising from that Act.

- Environmental Improvement Plan
- The Plan for Water.

Key points of those most relevant to small waters and Descriptive wastewater treatment plants, and the limitation and opportunities they provide are briefly discussed below.

6.2 Legislation and policy affecting headwaters

The role of the major pieces of legislation for the headwater environment and, where specifically relevant, Descriptive wastewater treatment plants, is described below. WISER, the Water Industry Strategic Environmental Requirements programme is discussed in Section 6.3.

***Water Environment (Water Framework Directive) (England and Wales) Regulations 2017*:** The Water Environment Regulations (here referred to as WFDR) apply an ongoing, six-year cycle of developing, implementing, reviewing and updating 'River Basin Management Plans' (RBMPs) which describe practical measures to protect and improve waterbodies including, to a variable degree, headwater streams. Implementation of the WFD Regulations involves setting binding Environmental Objectives for water bodies in 10 'River Basin Districts' (RBDs) in England. For these RBDs, the EA and Government produce 'River Basin Management Plans' (RBMPs) which include the Environmental Objectives and summarise 'Programmes of Measures' to meet them. These plans should then cascade through to decision making and physical action to realise the intended outcomes.

In theory, the Water Environment Regulations should apply directly to all parts of the running headwater network. Technically headwater streams should be included in larger waterbodies as recommended in UKTAG (2003). The CIS Horizontal Guidance on Water Bodies, on which the UKTAG advice is based, proposes that, 'where possible', small elements of surface water are incorporated within a contiguous larger water body of the same surface water category and of the same type. The application of this principle in relation to headwater streams is illustrated in Figure 8. Where necessary it was recommended that, to simplify the mapping of river water bodies, the minor tributaries that are included within the water body in accordance with this principle need not be shown. Clearly this leads to them being overlooked in general, as what is not mapped is not investigated.

Table 7. The main legislation controlling management of the water environment

'Water' legislation

1. ***Environmental Protection Act 1990*****:** This act provides a framework for controlling pollution and protecting the environment in the UK particularly in the context of waste management. It includes provisions related to water quality management and pollution control, which are essential for maintaining healthy freshwater ecosystems and safeguarding aquatic species.
2. ***Water Resources Act 1991*****:** This legislation provides the framework for the management and regulation of water resources in England and Wales. It covers issues such as water abstraction, pollution control, and water quality and replaced the Water Act 1989.
3. ***Water Industry Act 1991*****:** This act privatized the water industry in England and Wales, defining the powers ofOfwat to oversee water companies and ensure the provision of water and wastewater services.
4. ***Water Act 2003*****:** This legislation introduced reforms to the water industry, including measures to improve water quality, promote water efficiency, and enhance flood risk management.
5. ***Flood and Water Management Act 2010*****:** This act updated and consolidated various laws related to flood risk management, surface water drainage, and water resources planning in England and Wales. It established the role of Lead Local Flood Authorities (LLFAs) and introduced measures to improve flood resilience and response.
6. ***Water Environment (Water Framework Directive) (England and Wales) Regulations 2017*****:** These regulations transpose the EU Water Framework Directive into UK law, aiming to protect and improve the quality of surface waters and groundwater bodies.
7. ***Environmental Permitting Regulations (England and Wales) 2016*****:** These regulations control activities that may have an impact on water quality, such as discharges to water, water abstraction, and the operation of water treatment plants. They require operators to obtain permits and comply with environmental standards.

'Nature' legislation

8. ***Wildlife and Countryside Act 1981*****:** Provides legal protection to certain freshwater habitats and species by listing them under Schedules 5 and 8. This includes protection for species like otters and water voles, as well as certain wetland habitats.
9. ***Natural Resources Body for Wales (NRW) Regulations***: These regulations govern the functions and powers of NRW, which is responsible for managing natural resources, including water, in Wales.
10. ***Habitats Regulations 2017***: These regulations implement the EU Habitats Directive in the UK and aim to conserve important habitats and species of European importance. Several freshwater habitats and species, such as rivers, lakes, and certain fish species, are included in the directive's annexes and receive protection under UK law.

Table 7 (cont). The main legislation controlling water management

11. **The Natural Environment and Rural Communities (NERC) Act 2006** is a significant piece of legislation in the UK that has implications for the conservation and management of freshwater environments including:

    - a duty on relevant authorities in England and Wales to promote the conservation of biodiversity when carrying out their functions, freshwater ecosystems, including rivers, lakes, wetlands, and associated species
    - provisions for the conservation of species and habitats of principal importance for the conservation of biodiversity (e.g. endangered fish species like the European eel) and habitats (e.g., rare or unique wetland habitats) including several types of small waterbodies.
    - Access and recreation, invasive species control and consideration of natural capital and ecosystem services in decision-making processes.

12. **The Environmental Targets (Water) (England) Regulations 2023** set the long-term targets in respect of four matters within the priority area of water under section 1 of the Environment Act 2021 (c. 30).

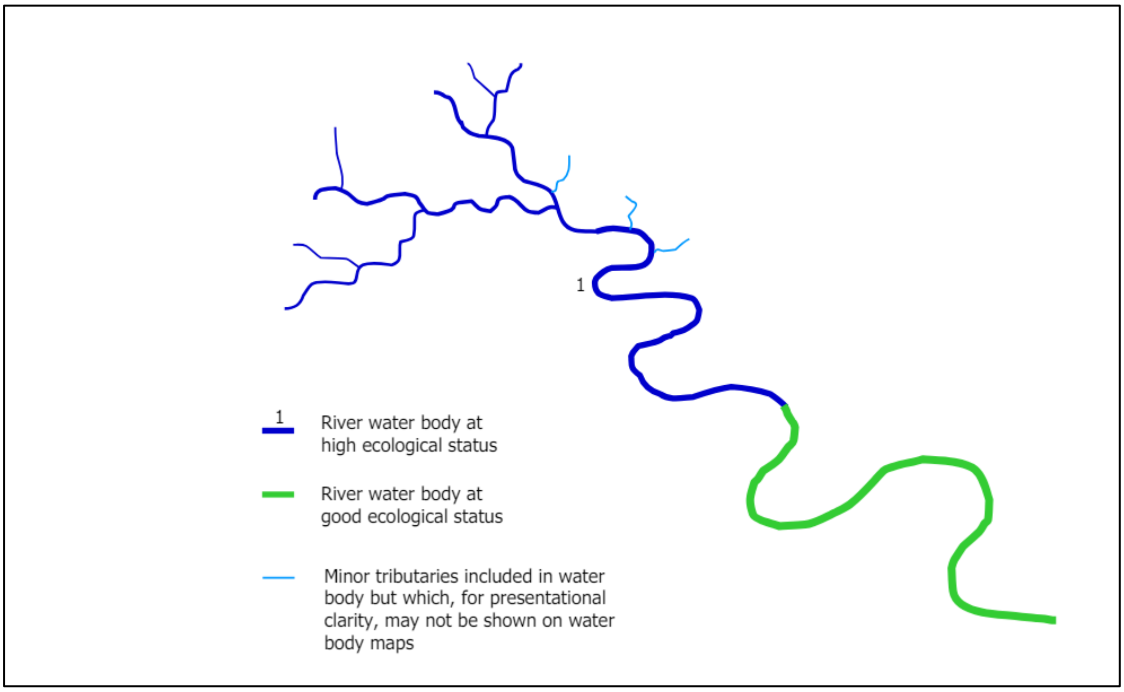


Figure 8. Approach to the inclusion of small headwater streams in the Water Framework Directive (UKTAG, 2003), now transposed to the Water Environment Regulations. Example shows small headwater streams included within single river water body.

The main policies involved are:

Water Industry Act 1991 and Environment Act 1995 and related legislation. The original water resources legislation requires measures to protect all controlled waters. As noted by Laura Mollon of Northumbrian Water this provides a clear mechanism for the inclusion of headwater streams in measures with Statutory (S) justification (see Table 8). This example is discussed further in Section 10.7.

Natural Environment and Rural Communities (NERC) Act 2006: Duty to further conservation and enhancement of biodiversity. The NERC Act provided the first unequivocal recognition of small waters in the recognition of priority habitats (later 'Habitats of Principal Importance'). There is a duty to further conservation of these habitats, but this is a weaker power and regarded as "Statutory+" by the government - that is, subject to cost effectiveness assessments (see Table 8).

Flood and Water Management Act 2010. The Flood and Water Management Act encourage use of sustainable urban drainage systems (SUDs) which are likely to be widely used to prevent polluted water entering headwater streams. At present there is no information on the effect of SUDS on small headwaters although they should have a role in the protection of upper catchment waterbodies.

Local Nature Recovery Strategies and Biodiversity Net Gain. These two components of the development of the Nature Recovery Network are of relevance to the management of headwater catchments particularly because of government expectations that water companies should:

- contribute to Local Nature Recovery Strategies
- undertake actions that contribute to the restoration and recovery of habitats and species under the NERC Act, including supporting delivery of the Nature Recovery Network

Environmental Improvement Plan (EIP23). The Environment Improvement Plan sets out the targets and action to deliver the goals of the 25 Year Environment Plan. These are discussed in Section 3.4: Desirable quality outcomes.

River Basin Management Plans

River Basin Management Plans aim to enhance nature and the natural water assets that are the foundation of everyone's wealth, health and wellbeing, and the things people value, including culture and wildlife. A river basin management plan contains the following:

- The local environmental objectives for water bodies and protected areas that government, the Environment Agency, and other public bodies use to make planning decisions, decide on the conditions to include in environmental permits and target action, including informing funding decisions.
- An assessment of the current condition of each water body and, if it is not in good condition, the reasons why.
- Summaries of the programmes of measures, to include the condition of some waterbodies including the government's legal and administrative framework for protecting and improving waters in England, current and planned programmes of improvement actions, principles to be followed when choosing future actions and summaries at a catchment scale, including the local catchment partnership's vision and priorities for future action.

RBMPs exclude virtually all small standing waters, many of which are Priority habitats, part of SSSI designations and habitat for a range of legally protected species. The inclusion of smaller running waters is largely determined by local interest in this type of habitat.

Plan for Water

The Plan for Water has 3 key aims:

1. Transform management of the whole water system
2. Deliver a clean water environment for nature and people
3. Secure a plentiful supply of water.

These are underpinned by about 100 specific actions (Appendix 4). A number of these actions could specifically benefit headwater catchments and the management of Descriptive wastewater treatment plants. These include:

- Delivery of tailored long-term catchment action plans with new funding for local groups to improve all water bodies in England including:
    - improve delivery and coordination at a catchment level with tailored long-term catchment plans that cover all water bodies – catchment plans will set out the key issues and priorities for action, including priorities identified in Local Nature Recovery Strategies
    - increase funding for catchment groups and improve their capacity to deliver improvements through the right tools, data, and approaches
    - unlock more green finance to manage water in an integrated way by removing barriers which limit investment in nature-based solutions - as outlined in our new Green Finance Strategy
- Policy and legal framework will be more streamlined, with greater join-up between water and flood planning and aligned with Local Nature Recovery Strategies.
    - better integrated water and flood planning by reforming River Basin Management Plans and flood risk management planning – ensuring integration with water company plans
    - align water and flood planning with Local Nature Recovery Strategies and the future Land Use Framework to make sure we are taking actions – especially nature-based solutions – where they will have the biggest impact
    - review the implementation of the Water Environment Regulations 2017 to improve on-the-ground water outcomes whilst retaining our goal to restore 75% of water bodies to good ecological status – we will consult on any proposed changes
- Apply funds from the new Water Restoration Fund from water company fines and penalties – taken from company profits, not customers – and reinvest this into water environment improvements, including headwater catchments. The government plans to:
    - channel the money from fines and penalties into projects which improve the water environment through the newly created central Water Restoration Fund
    - fund a wide range of projects to improve the water environment, water management, and restore protected sites, which will include activities such as re-meandering rivers; removing invasive non-native species; creating and restoring water-dependent habitats, such as wetlands; removing barriers to enable fish and other species' natural movement in rivers; and supporting catchment partnership groups in local delivery.

Nutrient neutrality policy

The nutrient neutrality policy was established by Government to tackle pollution to help meet the government's legal commitments to restore species abundance whilst enabling sustainable development of new homes.

Nutrient neutrality is a means of ensuring that a development plan or project does not add to existing nutrient burdens on Habitats Sites (designated as protected under the Conservation of Habitats and Species Regulations 2017 (as amended)), that are classified as being in 'unfavourable condition'. A development is considered 'nutrient neutral' where it can be demonstrated that it will cause no overall increase in nutrient pollution affecting specified Habitats Sites.

When a planning application is submitted in a relevant catchment a competent authority (usually the LPA or Environment Agency) must make an appropriate assessment of the implications of the development for that site, taking account of the site's conservation objectives and if damage due to nutrient pollution cannot be ruled out, mitigation to reduce or eliminate the impact should be put in place.

Mitigation can be onsite – preventing nutrient pollution directly from the development in question, or offsite – reducing nutrients from other sources that affect the site overall. Suitable mitigation measures might include constructed wetlands or changes in land management within the catchment of the impacted site(s) or may also entail the creation of new wetlands, woodland or grasslands. This provides the additional benefit of creating new spaces for nature and recreation as well as offering potential new income streams for landowners, including water companies.

Suitable mitigation may also include developers purchasing nutrient credits via a nutrient trading scheme where other landowners in the catchment have taken action to reduce their nutrient load, and this may provide opportunities for water companies, especially where they have met their fair-share obligations, to fund nature-based improvements to small works in relevant headwater catchments by selling 'credits' to developers.

6.3 Non-statutory and semi-statutory guidance and advisory processes supporting headwater catchment management

There are a number of non-statutory policy and guidance process which may support the management of headwater catchments. These include:

- **Water UK** policy guidance which provides an overview of water industry priorities and proposals, including 21st Century Rivers: Ten actions for change and Water 2050.
- **Developments of agri-environment funding (ELM scheme) and implications for headwater management**. Funding for land managers has recently been substantially increased for measures which can be widely applied in headwater catchments.
- **The Catchment-based Approach**: objectives and implications for headwater catchments.
- **Blueprint for Water: Charter for Small Waters**. The Blueprint consortium of NGOs with a special interest in water management is currently developing a Charter for Small Waters to emphasise the importance given to small waters by the NGO sector.
- **Support for priority headwater habitats.** Applying Natural England's 'Narrative for conserving freshwater and wetland habitats in England' which explains the importance of natural habitat function to freshwater-related biodiversity supported by the 'Discovering Priority Habitats in England' website and by Freshwater Habitats Trust, which supports identification of priority ponds on behalf of Natural England. Both are particularly relevant to headwater catchments where traditional policy and regulation may be less influential.
- Investing in the restoration of natural form and function of catchments and wider landscapes in which water companies operate to help contribute to the resilience of catchments and their freshwaters to the impacts of climate change (e.g. by protecting and strengthening the habitats that comprise the Freshwater Network: see https://freshwaterhabitats.org.uk/freshwater-network/).
- Improving the resilience of ecosystems is of equal importance to the management of public water and wastewater infrastructure. The long-term functioning of ecosystems, as the natural assets that the water industry and people rely on, should be protected, maintained, and enhanced.

Table 8. Definition of Government expectations
The Government has identified for water companies for the PR24 process expectations of statutory and non-statutory requirements. Expectations are categorised as either statutory (S), statutory plus (S+) or non-statutory (NS) in line with the following definitions.
Statutory obligations (S) Statutory obligations arise from legislative requirements and the need to comply with obligations imposed directly by statute or by permits, licences and authorisations granted by the Secretary of State, the Environment Agency or other body of competent jurisdiction. Other statutory obligations include ministerial directions and meeting specific planning requirements. While it is important to understand the costs and benefits of measures needed, these statutory obligations ***must*** be achieved.
Statutory plus obligations (S+) Statutory plus obligations are categorised as legal requirements where economic evidence forms part of the decision-making process, that is the balance of costs and benefits, and affordability considerations. In cases where action is considered disproportionately expensive to meet statutory plus obligations, alternative objectives, or timescales, may be set.
Non-statutory requirements (NS) Some expectations are not driven by statutory requirements. There may be a public need which may not be underpinned by a specific Act or piece of legislation. Water companies should demonstrate that there is an environmental requirement and customer support and that such investments provide best value for customers over the long term. Effective customer engagement should reveal whether customers (and which types of customers) want to see further environmental improvements, and over what timescale.

6.4 Water industry strategic environmental requirements (WISER)

The Water Industry Strategic Environmental Requirements sets out the Governments' expectations of water companies in the PR 24 process. About a third of the expectation are mandatory (see Appendix 5, listed with a S; Table 8 shows definitions of expectations).

In the PR24 process, now largely complete, a relatively small number of the Government's statutory expectations would be likely to assist headwater catchment management. A larger proportion of the more discretionary actions could help headwater catchment management.

Examples of statutory expectations that could help headwater catchments are shown in Table 9, highlighted in green; mostly those selected are statutory and Statutory+ (which means mandatory depending on funding availability). A few Non-Statutory expectations are also shown, although being non-statutory they have substantially lower priority.

Examples include:

- In drinking water protected areas, catchment actions to prevent deterioration in water quality and to reduce the need for additional treatment
- Action that contributes to meeting and or maintaining conservation objectives of Habitats sites, for example, addressing the potential impact of development and growth
- Action to prevent deterioration in current water body status.

Actions are then delivered through the WINEP process.

Table 9. The Water Industry Strategic Environmental Requirements (WISER): actions which may be relevant to headwater catchments and Descriptive wastewater treatment plants (Defra, 2022). Statutory expectations that could help headwater catchments are highlighted in green	
Objective: a thriving natural environment	
The expectations are set out under each heading and their status as Statutory (ie mandatory) or Statutory + (mandatory, depending on cost).	
Chemicals	
• Action to prevent deterioration (includes standstill measures)	S
• Action to achieve compliance with environmental quality standards	S+
Drinking Water Protected Areas	
• Catchment actions to prevent deterioration in water quality and to reduce the need for additional treatment	S
• Catchment actions to improve water quality to reduce the level of existing treatment	S+
Environment Act 2021 targets	
• Reduce phosphorus loadings from treated wastewater in line with the Environment Act's long-term environmental targets	S
Healthy and resilient fish stocks	
• Address barriers to the passage of fish	S+
• Action that supports recovery of Natural Environment and Rural Communities Act (NERC Act S.41 priority fish species (which includes salmon, brown sea trout, eels, smelt, river and sea lamprey and shad or at sites where fish form part of the conservation designation)	S+
Invasive non-native species (INNS)	
• Prevent deterioration by reducing the risk of spreading INNS and reducing the impact of INNS	S
• Reduce the impact of INNS, where INNS is a reason for not achieving conservation objectives or good status	S,S+
• Reduce pathways for the introduction and spread of INNS	S
Natural environment	
• Action that contributes to meeting and or maintaining conservation objectives of Habitats sites, for example, addressing the potential impact of development and growth	S
• Action that contributes to meeting or maintaining favourable condition targets for Sites of Special Scientific Interest	S+
• Action that contributes to the restoration and recovery of habitats and species under the NERC Act including supporting delivery of the Nature Recovery Network	S+
• Actions for biodiversity should deliver the outcomes of the relevant Local Nature Recovery Strategy, Protected Site Strategies, and Species Conservation Strategies introduced by the Environment Act	S+

Table 9. The Water Industry Strategic Environmental Requirements (WISER): actions which may be relevant to headwater catchments and Descriptive wastewater treatment plants (Defra, 2022).

Statutory expectations that could help headwater catchments are highlighted in green

Water body status (river basin management plan objectives	
• Action to prevent deterioration in current water body status	S
• Action to improve water body status	S+
• Action to ensure no river, lake or estuary is in poor or bad ecological status due to the water industry	S+
• Work with stakeholders and catchment partnerships to explore integrated solutions, including nature-based solutions, and delivery of multi-functional benefits at a catchment scale	NS

Objective: expected performance and compliance

Regulatory compliance (all regimes)	
• 100% compliance at wastewater treatment works and water treatment works with numeric limits and for storm overflows	S
• 100% compliance with environmental impact and operational performance permit conditions at wastewater treatment works and water treatment works with descriptive not numeric limits	S
• All the correct authorisations (permits and exemptions are held and 100% compliance with installation permits, waste operation permits etc)	S
• Zero serious pollution incidents (category 1 and 2)	S
• At least a 30% reduction of all pollution incidents (category 1 to 3 by 2030 on current 2025 targets). There may be some variation on our expectation depending on company performance during the current asset management plan period (2020 to 2025)	S
• Business plans include all actions identified within the WINEP and these are planned well and completed to agreed timescales and specification	S
• Action which supports Nature Recovery Networks through enhancing ecosystem resilience and ecosystem function on which nature recovery is reliant (where this goes beyond statutory obligations)	NS
• Restore and reconnect priority habitats (such as wetlands and peatlands to strengthen freshwater and marine resilience to challenges such as climate change)	S+
Future drainage	
• Ensure compliance with permitted flow to full treatment settings	S
• Continuously monitor the receiving water quality potentially affected by storm overflows	S
• Publish data on storm overflow operation on an annual basis and make spill information available in near real time	S

Partnership approaches which guide the actions of environmental NGOs and have a semi-statutory underpinning include:

- The Catchment-Based Approach: The objectives for the Catchment Based Approach are to:
    - Deliver positive and sustained outcomes for the water environment by promoting a better understanding of the environment at a local level; and
    - Encourage local collaboration and more transparent decision-making when both planning and delivering activities to improve the water environment.
- Blueprint for Water Charter for Small Waters: the Blueprint consortium of NGOs with a special interest in water management is currently developing a Charter for Small Waters to emphasise the importance given to small waters by the NGO sector.

We have also evaluated the expectations of water companies outlined by the government in WISER, and the implications of these expectations for headwater catchments including:

- Taking account of new information that has become available since PR19 including priority river habitat and lake habitat mapping and targeting, and the management needs of priority species and others at high risk of extinction.
- Applying Natural England's 'Narrative for conserving freshwater and wetland habitats in England' which explains the importance of natural habitat function to freshwater-related biodiversity supported by the 'Discovering Priority Habitats in England' website and by Freshwater Habitats Trust which supports identification of priority ponds on behalf of Natural England. Both are particularly relevant to headwater catchments where traditional policy and regulation may be less influential.
- Investing in the restoration of natural form and function of catchments and wider landscapes in which water companies operate to help contribute to the resilience of catchments and their freshwaters to the impacts of climate change (e.g. by protecting and strengthening the habitats that comprise the Freshwater Network: see https://freshwaterhabitats.org.uk/freshwater-network/).
- Improving the resilience of ecosystems is of equal importance to the management of public water and wastewater infrastructure. The long-term functioning of ecosystems, as the natural assets that the water industry and people rely on, should be protected, maintained, and enhanced.
- Restoring, re-connecting, and enhancing freshwater, estuarine and marine habitats and recovering priority species. This will ensure that natural assets used for, or impacted by, water company activities are sustainable into the future.

We have assessed both whether headwaters are disadvantaged or, conversely, have advantages in their ability to cost-effectively meet these expectations.

6.5 The Office of Environmental Protection review of implementation of the Water Framework Directive Regulations and River Basin Management Planning in England, May 2024

Background
In May 2024 The Office for Environmental Protection completed a review of the implementation of the Water Framework Directive Regulations and River Basin Management Planning in England.

As the first major evaluation of the impact of the WFD since it was transposed into British law following the UK's exit from the European Union, the review is an important marker for the success of the approach. The original intention of the Water Framework Directive was that it protected **all** freshwaters[4], and this is particularly relevant to headwater catchments and small waters generally, which are not effectively regulated by the Water Framework Directive Regulations.

In the context of the present report, on the role of small waters, headwater catchments and Descriptive works, the report is especially relevant as the WFD effectively excludes about half of the water environment, either with specific rules (for standing water less than 50 ha) or *de facto* by omitting most headwater streams from mapping and classification.

In particular, small headwaters can be omitted from WFD maps for drafting reasons:

> *"Where necessary to simplify the mapping of river water bodies, the minor tributaries that are included within the water body in accordance with this principle need not be shown (see Figure 8).*

Although in the diagrammatic example used by the UK TAG WFD Advisory Group the small streams that 'need not be shown' seem a very insignificant part of the water environment, this is very misleading. In practice, and as can be seen in the real-world case study example (see Section 3.2, Figure 2), omission of 'minor' headwaters streams leads to approximately 66% of the stream network being excluded from mapping and therefore receiving little or no attention.

Not mapping the headwater environment leads to:

- Measures not being applied specifically to the protection of these waterbodies. River Basin Management Plans contain only very generic measures for protection of waterbodies and cannot target specific headwater locations or problems because the waterbodies affected cannot be identified in any monitoring or protection programme because they are not mapped.
- Anecdotal evidence that unmapped headwaters streams are likely to be physically modified (Graham Scholey, Environment Agency Thames Region. *pers. comm.*)
- Documented effects of on-going pollution by septic tank discharges into headwaters. In the case study area, the project by Withers *et al*. (2011) found that septic tank discharges into a second order tributary of the Eye Brook flowing through Loddington village in Leicestershire, showed evidence of pollution with "profound implications for stream biodiversity". The stream affected is not mapped or monitored even though technically part of the Eye Brook waterbody.

Omission of headwaters from mapping and programmes of measures probably leads to their lower quality. Nationally, data from the Countryside Survey (2007) showed that invertebrate

[4] "…. Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water…" (see https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF).

assemblages in headwater streams were in worse ecological condition than the stream network as a whole in 2010 as measured by the Environment Agency (Figure 8a). Thus in 'all rivers' 65% of invertebrate assemblages were at High or Good status, compared to 54% in headwaters. Conversely, 35% of all rivers had invertebrate assemblages that were in Moderate, Poor or Bad condition, compared to 46% of headwaters. Although this is not conclusive evidence that omission of headwaters from maps is the cause of poorer headwater quality, it is highly likely to be implicated.

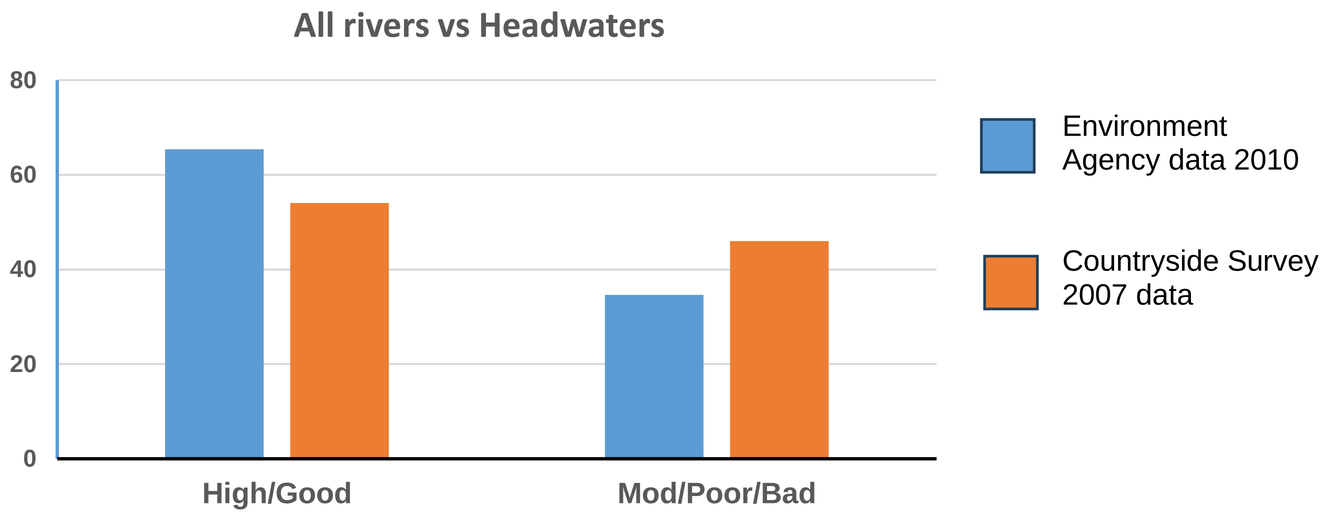


Figure 8a. Ecological quality of invertebrate assemblages all rivers monitored in England by the Environment Agency in 2010[5] compared to the results of 2007 Countryside Survey of headwaters in England (Dunbar *et al*., 2010).

Key findings
The OEP found a lack of clear coherence between the Environmental Objectives in the RBMPs and the targets and goals of the Environment Act, EIP23 and Plan for Water.

There is also a lack of integration between different water management plans and the objectives they contain. The Government has noted this in its Plan for Water and committed to 'make the whole framework more outcome focussed and fully integrated with other environmental plans and government delivery plans,' an outcome which the OEP support.

The OEP notes that more broadly, the overall water law and policy framework is complex and risks being incoherent. This may be creating barriers to achieving the Environmental Objectives and wider outcomes that depend on them.

The OEP notes that:

> "Overall [The OEP] sees a significant need to strengthen how environmental law on water is applied to increase its effectiveness and support Government's wider goals and targets. We encourage Government to pursue the major reset that we believe is required as it takes forward its 'Plan for Water.'"

As The OEP dryly notes:

> "As things stand, the 2027 Environmental Objectives [for freshwaters to be at Good status or above] appear more likely to be missed by a large margin."

Recommendations from the OEP review are highly relevant to small headwater catchments and the management of Descriptive wastewater treatment plants. We discuss these further in Chapter 11: Conclusions and Recommendations for Policy Change.

[5]Source of data: https://environment.data.gov.uk/dataset/19bd07e7-f172-44ae-9552-eda5a41b451b.

7. Review of current knowledge of the impacts of small wastewater treatment plants on headwater ecology

In this section we first summarise what is known generally of impacts on the headwater environment and the small waters it supports. We then consider the impacts of wastewater treatment plants on stream ecological quality, including water quality, and the impacts this has on plant and animal communities. These are some of the best-known environmental impacts in freshwater science and they have a long history of study dating back to the Saprobic system developed in Germany in the 1880s (Zelinka and Marvian, 1961).

7.1 The state of the headwater environment

Countryside Survey Headwater Streams survey 2007 (Dunbar *et al*., 2010) was the last GB-wide survey to focus exclusively on headwater stream ecological quality. Invertebrate and wetland plant assemblages increased in diversity compared to earlier surveys but there were no obvious water quality trends reported (although analysis of the dataset was quite limited). No conclusions were drawn about the potential influence of sewage discharges. The most notable regional difference was that in the Easterly Lowlands (EZ1) in England only 32% of headwater streams had High quality invertebrate assemblages compared to over 60% in most other areas of the country (Figure 9).

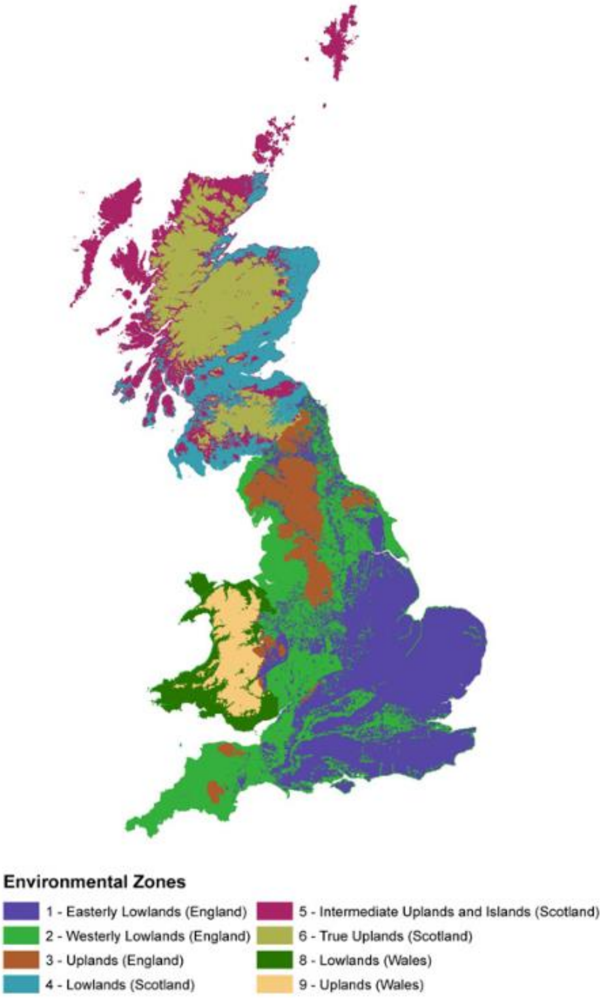


Figure 9. Environmental zones in the Countryside Survey

Treating the Countryside Survey 2007 Pond Survey as representative of the headwater landscape (most of the ponds would, by default, be in headwater catchments) some comments on nutrient can be made but, again, no specific observations were made on sewage effluents.

Despite a low baseline, there was evidence that pond quality declined significantly in the lowlands of England and Wales between 1996 and 2007. Mean plant species richness decreased by 20% during this period from 10.2 to 8.2 species per pond. The proportion of Poor or Very Poor quality ponds increased by 17%. This decline was broadly related to land use intensity and pollution risk and specifically linked to:

- high nitrogen levels in pond water
- presence of road-runoff
- presence of stream inflows, and
- increasing tree shade.

Generally, it is very rare for sewage works to discharge to ponds. The data from the Countryside Survey do not suggest that there is a strong link between small or Descriptive wastewater treatment plant effluents and pond quality, but there is no specific data with which to evaluate this effect

7.2 Overall nutrient status of headwater streams

A better picture of headwater stream nutrient (and therefore pollution) levels alone is provided by a more recent study by Jarvie *et al*. (2018) who undertook the first national-scale assessment of the nutrient status of British headwater streams. Evaluating streams in the wider river network by joint analysis of the national Countryside Survey Headwater Stream and Harmonised River Monitoring Scheme dataset, they applied a novel Nutrient Limitation Assessment methodology which showed that:

- Headwater streams showed a markedly lower degree of P and N impairment compared with the rivers: 23% of all headwater samples exceeded the upper P concentration threshold, compared with 51% of river samples; and 52% of headwater streams exceeded the upper N concentration threshold, compared with 87% of river samples.
- Nutrient impairment was generally greatest for Lowland-High-Alkalinity headwater streams and rivers: 41% of Lowland-High-Alkalinity headwater streams and 81% of Lowland-High-Alkalinity river samples exceeded the upper P concentration threshold; and 78% of Lowland-High-Alkalinity headwater streams and 98% of Lowland-High-Alkalinity river samples exceeded the upper N concentration threshold. Again, headwaters were less impaired than lower catchment waterbodies.
- Nutrient impairment was generally lowest in the Upland-Low-Alkalinity headwater streams and rivers: < 10% of Upland-Low-Alkalinity headwater stream and river samples were P impaired, while 15% of headwater streams and 61% of rivers were N impaired for the Upland-Low-Alkalinity typology.
- Levels of N impairment were consistently higher than P impairment. For all headwater stream and river typologies, a greater percentage of samples were N impaired than P impaired.

7.3 The effect of Descriptive wastewater treatment plants

In this section we review current knowledge of the impact of Descriptive wastewater treatment plants on headwater ecology including how low flow and high load effluents are likely to affect water quality. Compared to lower catchment and larger waterbodies very little information is available on the effects of wastewater treatment plants on headwater streams.

Despite this, recent Europe-wide work, including the UK, suggests that lower order streams (i.e. 3rd order and below) are the most impacted by sewage effluents, suggesting they may require more, rather than less, demanding policy goals to protect them. Using a very large pan-European Water Framework Directive dataset, Büttner *et al*. (2022) showed that there was a critical point when wastewater treatment flows exceeded 6.5% of total flow volume in small streams, with biotic impacts occurring once this threshold was exceeded. There was no similar critical point seen in higher order streams, indicating that these were less affected by effluent discharges, with effluents more adequately diluted. They concluded that where in the river network positioning of wastewater discharges occurred determined the threat to stream ecosystems, that stream ecological status declined with higher urban wastewater discharge fraction and that one third of wastewater treatment plants in Europe exceeded the critical threshold of 6.5%. In the UK about two-thirds (64%) of wastewater treatment plants exceeded the 'Safe Operating Space' threshold (Figure 10).

They conclude that new receiving water-specific strategies for wastewater management are needed.

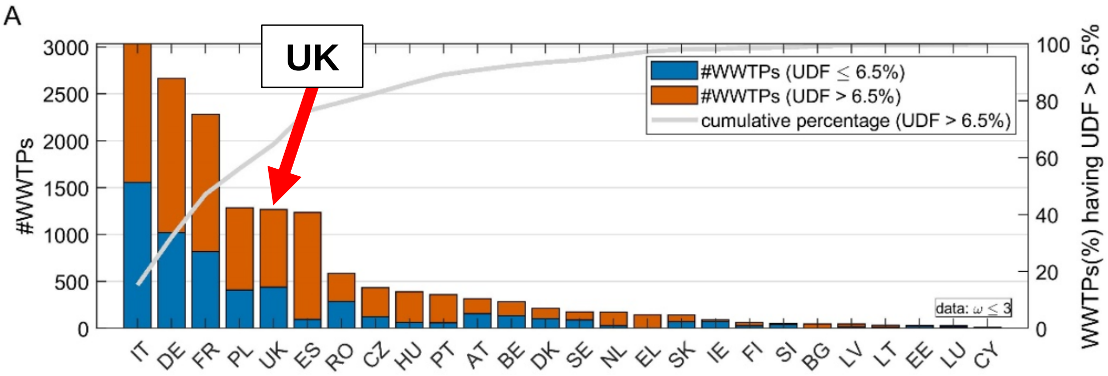


Figure 10. Proportion of wastewater treatment plants where effluent is greater than 6.5% of receiving water flow. The UK is highlighted with the red arow

There are hundreds of studies of the effects of larger sewage works on freshwaters. For example, a recent global review by Hamdhani *et al*. (2019) found over 140 studies describing the release of treated effluent into streams and the subsequent ecological impacts. These included:

- ***Invertebrates***: Taxon richness declined by nearly 50% in effluent-fed reaches (mean change ± 1 SD: −46.9 ± 23.0%, n = 13 studies), with only a single study reporting equal richness values above and below effluent outfalls. Of the 16 studies that reported Ephemeroptera, Plecoptera, Trichoptera (EPT) abundances or richness values, 94% observed a decline in EPT taxa below effluent outfalls, and 50% observed a complete loss of EPT taxa in effluent-fed reaches.
- ***Fish***: Nearly all studies on the taxonomic diversity, richness, or abundance of fish reported negative effects of effluent. Fish diversity in one U.S.A. stream was sharply depressed, with no fish species found in the site closest to the outfall and only 69% survival rates for fish observed 15 km downstream of the outfall (Birge et al., 1989). Lower fish richness was also observed in an effluent-fed stream near Tel Aviv (Israel), but fish biomass was higher than in a nearby undisturbed stream (Gafny *et al*., 2000). Four studies reported a shift in species composition from intolerant to more tolerant taxa in sites downstream of outfalls. In South Korea, >90% of fish in one effluent-fed stream were characterised as tolerant, compared to unpolluted stretches.

In the UK, the work of Johnson *et al*. (2019) provides a well-documented and probably fairly typical example of both the impacts, and the effects of upgrades to generate improvements, to larger streams – in this case the fourth order R. Ray in Wiltshire. This receives the wastewater from the town of Swindon (population c,220,000). At the point where the wastewater plant discharges, 80% of the flow is sewage effluent. At the confluence with the Thames, the mean annual flow of the River Ray still comprises 65% effluent (Balaam *et al*., 2010).

Considering macroinvertebrate and water quality parameters, the only long-term data available, Johnson *et al.* (2019) found that from 1991, when the wastewater treatment process changed from trickling filter to activated sludge, to 2016:

- biological oxygen demand was nearly halved (90^{th} percentile from 8.1 to 4.6 mg/L), ammonia peaks dropped more than 7-fold (90^{th} percentile from 3.9 to 0.53 mg/L)
- dissolved oxygen climbed consistently above 60% saturation (10th percentile from 49 to 64%)
- A sustained increase in the number of macroinvertebrate species was evident from that point.
- River flow did not change, temperature rose slightly, and the major metal concentrations declined steadily over most of the monitoring period.
- Unsurprisingly, the introduction of phosphate stripping in 1999 and tertiary granular activated charcoal from 2008 to 2014 had little effect on subsequent macroinvertebrate diversity. More surprising, however, is that, in 2023, phosphorus remained at Poor status and macrophytes and algae at Moderate status, according to the Environment Agency Catchment Data Explorer.
- By 2014 macroinverterbrates reached Good status but did not improve further in subsequent years.

These results probably echo many studies around the world as invertebrates recover to a reasonable degree from sewage pollution but plants, which are more sensitive to nutrients, do not.

In contrast, the ecological impacts of smaller discharges on receiving waterbodies have rarely been investigated with most previous research concentrating on works with a design capacity > 3000 PE (see Hamdhani *et al*. 2019 for a review). Similar studies on smaller decentralized wastewater treatment works (from <50 to 500 PE) are limited or mainly focus on water quality elements rather than biological ones.

7.4 Effects of the ‘Imhoff plants’

At present the number of studies of small waters is modest and generalisation needs to be cautious. We are not aware of any peer-reviewed published data concerning sewage impacts on small streams in the UK and in the absence of such data it is worth looking further afield. In Italy, Sabatino *et al.* (2024) concluded that studies of headwater streams affected by small so-called ‘Imhoff plants’ - a simple septic tank-like wastewater treatment system, with only primary treatment confirmed - showed results similar to research conducted on larger wastewater treatment plants.

They found that the structure and composition of freshwater invertebrate communities was substantially affected causing:

- a reduction in taxa richness, EPT richness and abundance
- an increase in more tolerant taxa.
- negative effects on the most sensitive macroinvertebrates and possible negatively affect the ecological status of receiving waterbodies.

They concluded that discharges from small Imhoff plants with only a primary treatment can considerably affect the structure and composition of freshwater communities. These effects were more evident when wastewater was discharged into streams with moderate ecological status and with a lower self-depurative capacity.

A note of caution is needed in reading too much into this small numbers of studies. Thus, in the study of ecological impacts of Imhoff plants, receiving waters were only assessed just below their discharge point where there would be most impact. Downstream recovery was not assessed.

7.5 Swiss headwater streams

In a contrasting study from Switzerland wastewater impacts were assessed on 23 headwater streams across a broad land use gradient, with samples collected up and downstream of the wastewater outfall. In this study the response to treated wastewater was less obvious when it discharged downstream of more intensive agricultural land-uses. This probably reflected the well-designed and maintained nature of the wastewater plants. Overall there was a strong suggestion that the regional context – the amount of agricultural land upstream – had a bigger effect than the wastewater plants, although these did cause some local impacts.

Currently there is too little data available on headwater streams wastewater plants to reach definitive conclusions about the scale of their impact; example of both impacts due to the works (admittedly a more basic system than is normal for the UK) and impacts where landuse and pesticides have more effects than sewage effluent.

7.6 The effects of other non-wastewater treatment stressors

The causal factors in the multiple stressor environments of streams and rivers in cultivated landscapes are controversially debated (Woodward et al., 2012; Birk et al., 2020), with potential contributions from nutrient loading (Greaver et al., 2016), urban land use, agricultural land use, flow alteration (Palmer and Ruhi, 2019), and micropollutants (Rice and Westerhoff, 2017). Clearly all are implicated to some degree. In the UK, Riley *et al*. (2018) characterised the headwater stream environment as:

- Experiencing more physical modification (Figure 11) than lower catchments

and

- Exposed to a range of chemical, pesticide, acidification and micropollutant pressure, although available evidence (e.g. Jarvie *et al*. 2018) suggests this may be less than further down catchments.

Controlling multiple stressors in any freshwater environment is difficult. For example, the present project's case study, the Water Friendly Farming project, found that pesticides often could not be effectively mitigated by land management practices, leading to them needing to be withdrawn if they were to be reduced to regulatory levels (Villamizar *et al*., 2020). This has implications for 'fair shares' approaches to water quality improvement noting that, based particularly on research in Germany, levels of pesticides in small streams (and potentially also ponds) are frequently likely to be biologically damaging (see for example Vormeir *et al*., 2023).

The example from Switzerland described above (Section 7.5) obviously has important implications here for smaller wastewater treatment plants which will often be discharging into waterbodies dominated by water flowing from intensive agricultural land. Pesticide impacts may be particularly important in this respect.

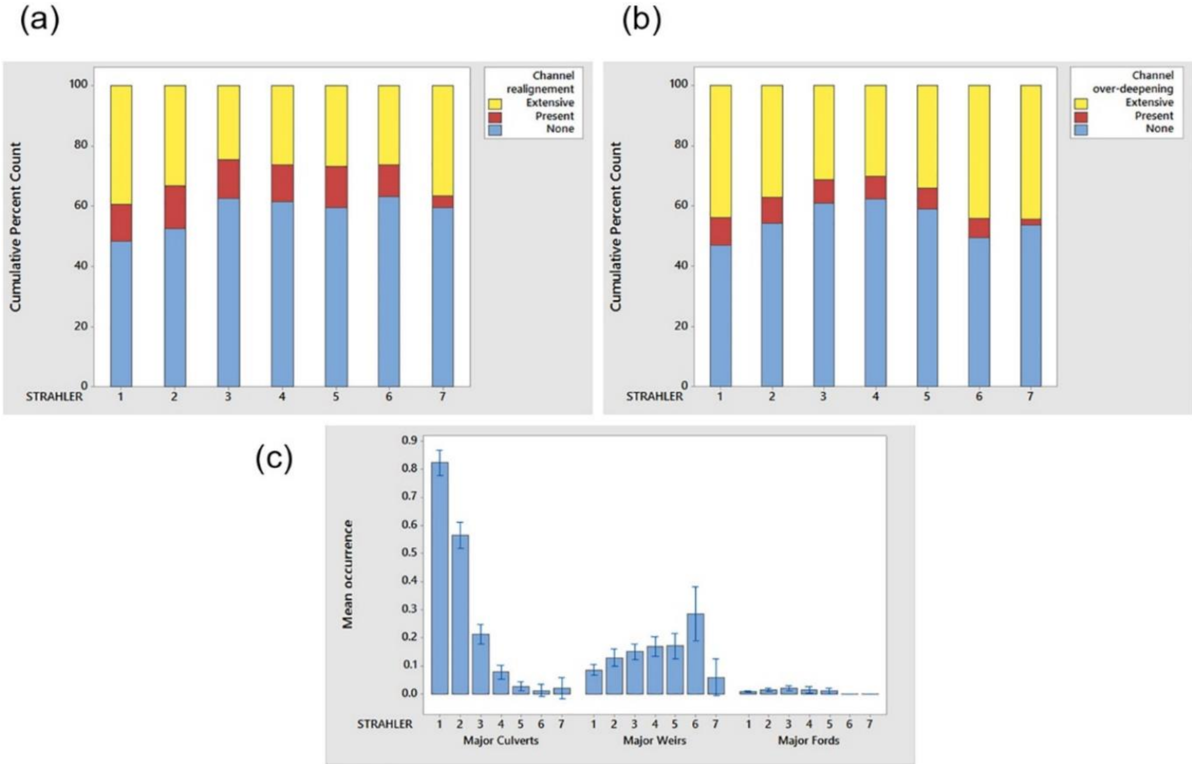


Figure 11. Channel modifications based on River Habitat Survey (RHS) data. Headwater streams (Strahler (1957) orders 1 and 2) have higher proportions of channel modifications.

a) channel planform modifications through realignment; b) cross-section modification through dredging; c) major in-channel structures (bars are 95% CI for the mean).

7.7 Mitigating the impact of small wastewater treatment plants with traditional engineered and nature-based solutions

Small wastewater treatment plants use a wide range of engineered and, increasingly, nature-based solutions to reduce impacts on the water environment. These include:

- Enhancing pollution prevention (i.e. by reducing the quantities of contaminants entering the water waste stream at source).
- Spatial optimization and reallocation of discharge points (i.e. evaluating the cost effectiveness of pumping to larger wastewater treatment plants). This is likely to require a whole system approach to the design of the effluent discharge network, as suggested by Büttner *et al*. (2022) – see Section 7.3 above.
- Post-processing of technically treated wastewater with nature-based solutions. For example, the R. Ingol treatment wetland at Ingoldisthorpe in Norfolk has reduced the nutrient loads leaving the wetland during its first years of operation (Figure 12). Note that the wetland system is specifically designed for ammonia reduction and, although it does also reduce phosphorus effluents, to be effective for phosphorus reduction it would need to be larger (Chris Gerrard, Anglian Water, *pers. comm.*). The R. Ingol was classified as Poor status for phosphorus in 2009, Bad from 2010 to 2013 and Poor from 2014 to 2022.
- There is an extensive scientific literature on wetland treatment plants which indicate a wide ranges of effectiveness, including wetlands acting as pollutant sources. Most treatment wetlands reduced export of target pollutants.

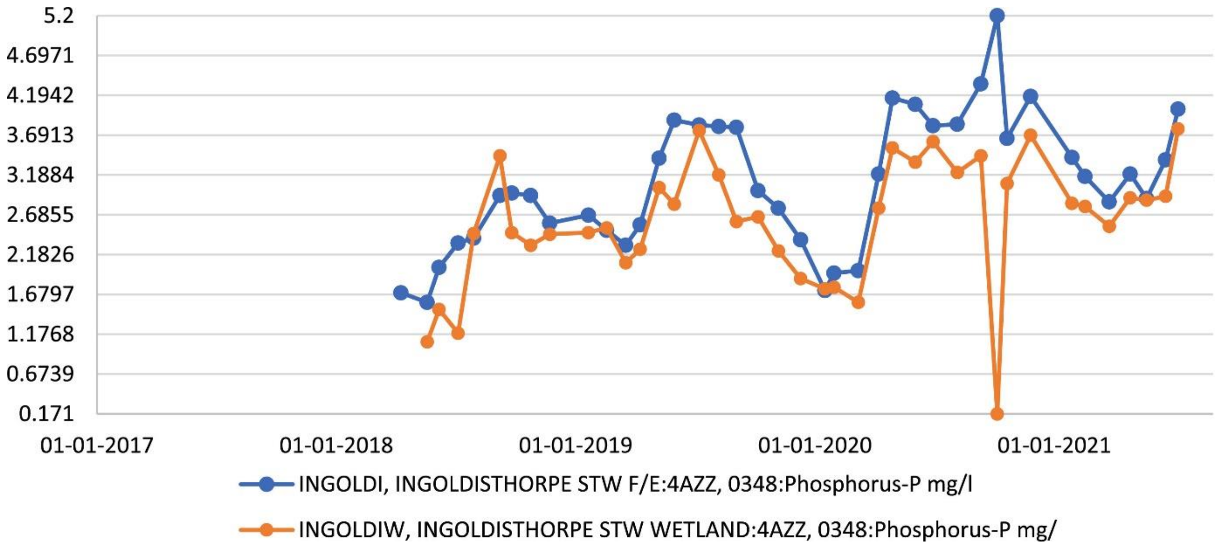


Figure 12. Phosphorus-P concentrations (mg L) in the inflow and outflow of the Ingoldisthorpe wetland, Norfolk. Source: Souliotis and Voulvoulis, 2022.

7.8 Nature-based solutions

Nature-based solutions for wastewater treatment are already widely used worldwide, the most common being various types of treatment wetlands, waste stabilization ponds, and soil infiltration. These are engineered systems that mimic functioning ecosystems and take advantage of their benefits with minimal reliance on power and chemicals. Nature-based solutions integrate plants, porous media, soil, microorganisms, and other natural elements and processes to remove pollutants such as organics, suspended solids, nutrients, pathogens, and various contaminants of emerging concern such as personal care products, pharmaceuticals, and hormones.

In Western Europe, constructed wetlands are the most widely used nature-based treatment system, as they comprise a well-established technology (Figure 13). Their use is supported by numerous freely available implementation and operation manuals and the scientific literature (see for example Dotro et al., 2017; Langergraber, et al., 2020). Recent technical reviews of the design and effectiveness of nature-based solutions for wastewater treatment which could be applied in headwater catchments provide a range of potential benefits. For example, in Central and Eastern Europe, with many small rural settlements of less than 2000 Person Equivalents, thousands of constructed wetland systems are in use (Istenič, et al., 2023). For the UK, the Constructed Wetlands Hub now provides a central point of contact.

Other nature-based solutions listed in Table 10 are more concerned with maintaining the integrity of the whole water environment and maintaining options (*sensu* Nature's Contributions to People) for the future. These can be grouped into two categories: those intended to reduce other water pollutants in the waterbodies that small wastewater treatment plants are discharging into (e.g. buffer strips, reduced fertiliser inputs) and those which are restoring the natural environment to make the whole network of freshwater habitats more resilient.

We provide a qualitative assessment of cost-effectiveness of the non-treatment nature-based solutions on a five-point scale based on evidence of technical effectiveness and relative cost (1=little evidence effectiveness to 5=high levels of evidence of effectiveness including large-scale field trials). We have not attempted to cost the different techniques as this would require a separate programme of research.

Figure 13. Before and after views of a new constructed wastewater treatment system in Lixnaw, Co. Kerry which cost £1.72 million.

Table 10. Checklist of nature-based measures which can be used in association with Descriptive wastewater treatment plants. **The first two lines of the table are measures specifically intended for effluent treatment. Remaining measures are intended to reduce other pollutant sources or maintain overall ecosystem quality.**
For wastewater treatment plants
Constructed wetlands
Alternative methods classed as nature-based solutions include: soil infiltration, evapotranspirative willow systems, waste stabilization ponds, aerated ponds, treatment wetlands, and sludge drying reed beds.
For reducing other pollution sources
Create new areas of properly clean (i.e. High status) running water Not much evidence of success so far, and not much attempted, though probably best option for running waters.
Maintain non-intensive land use Perhaps best evidenced measure for maintaining freshwater biodiversity
Creating 'low input' land
Creating clean water ponds (directly adds new unpolluted habitat to landscape)
Agri-environment mitigation measures (e.g. reducing fertiliser use, arable to grass conversion, low input options)
Buffer strips
Woodland creation
Add SuDS schemes Individual waterbodies sometimes good quality; little evidence of large-scale benefits
Measures to reduce diffuse pollution in rural arable landscapes (cropping, buffer strips, interceptions wetlands etc etc) Modelling suggests likelihood of substantial diffuse pollutant reduction without large-scale landuse change is optimistic.
Reducing organic pollution in grassland farming systems Evidence of nutrient (P) reduction; not much evidence of biodiversity improvement
For maintaining ecosystem quality
'Stage 0' river restoration; other types of river restoration
Manage wetlands by grazing, cutting, preventing succession Good evidence of success. Important freshwater biodiversity hotspots; perhaps most successful freshwater biodiversity management method.
Create wetland habitat (e.g. reedbed, fen, bog, wet grassland)
Manage wetlands by grazing, cutting, preventing succession Good evidence of success. Important freshwater biodiversity hotspots; perhaps most successful freshwater biodiversity management method.
Create wetland habitat (e.g. reedbed, fen, bog, wet grassland)
Create new areas of properly clean (i.e. High status) running water Not much evidence of success so far, and not much attempted, though probably best option for running waters.

Table 10 (cont). Checklist of nature-based measures which can be used in association with Descriptive wastewater treatment plants. The first two lines of the table are measures specifically intended for effluent treatment. Remaining measures are intended to reduce other pollutant sources or maintain overall ecosystem quality.
Beaver re-introduction Don't change landuse in catchment so little impact on diffuse pollution can be expected. Where beavers dam streams which are mostly polluted, the ponds they make will usually be constrained by pollution. No landscape scale studies so far (i.e. assessment of impact at whole freshwater landscape scale).
Physical management to reverse pond succession. Leads to dramatic short-term change and can reduce pollution burden short-term but may not affect long-term water quality (unless catchment also modified). Evidence of landscape scale benefits currently lacking. Many ponds have less grazing than traditionally.
Leaky dams and other natural flood management measures Not much evidence of freshwater biodiversity benefits to dates.
Re-meander river channels (and similar physical manipulations of channels) Without pollution control, limited impacts; in clean water, probably helps fish. Very large body of evidence showing only modest or no benefits for biodiversity.
Add wood to running water Modest evidence of benefits; probably has most impact where water unpolluted.
Restore floodplains Better evidence of success than for channel work, though pollution from river may be problematic.
Re-wet peatlands. Limited evidence of landscape scale freshwater biodiversity improvements. Not clear whether regional freshwater biodiversity enhanced, although rewetted pools may be like pre-existing pools.
De-intensifying land use Non-intensive landuse is best method for maintaining clean water; not much evidence of benefits of landuse change improving water quality, but likely to be high.
Controlling alien species Largely a question of making sure stable door is well-bolted and locked before species escape. Shutting stable door usually ineffective. Modest evidence of benefits resulting from control; efforts mainly thwarted by difficulty of actually effecting control of most alien species.
Solutions that are not nature-based but control pollution
Remove sources of sewage pollution Highly effective, and good evidence, if other pollution sources minimal / absent.
Make sewage effluent cleaner, less polluting Extensive evidence of river improvements; less evidence that this has led to biodiversity benefits except in spread of organic pollution intolerant invertebrates. Some recovery of salmonid fish.
Improve septic tanks Known problem but not much evidence of effect of preventing/controlling.
Stop using, or reduce, pesticides Usually the only way to stop pesticide contamination; limited effect when done in isolation (usually lots of other pollutants come with pesticides).

7.9 How much impact do the smallest works have?

It is difficult to estimate the extent of the water environment that is affected by small wastewater treatment plants as there is insufficient monitoring data with the granularity of the Water Friendly Farming case study landscape with which to evaluate these impacts.

However provisional indications of the scale of the impact can be made using the following data:

- there are approximately 3000 small wastewater treatment plants in England and Wales, just under half of the total number of all works, according to Ofwat.
- using data on stream chemical quality from the Water Friendly Farming case study area, the typical length of headwater streams affected by each Descriptive wastewater treatment plants was calculated, giving a value of 6.7 km for the average length of stream affected by each wastewater plant. To be conservative we rounded this length down to 5 km.

Using these two values a rough national estimate of the proportion of stream length affected was made using data on stream length from Brown *et al*. (2006). This gives an estimate of the stream length in each of the 10 Defra land classes calculated by these authors (Figure 14; Table 11), which indicates a total stream length in England and Wales of 94,950 km. Note that the length of rivers is additional to this.

With 3000 small wastewater treatment plants each affecting 5 km of headwater stream this suggest a plausible worst-case impact of 18,000 km, **representing about 20% of this stream network**.

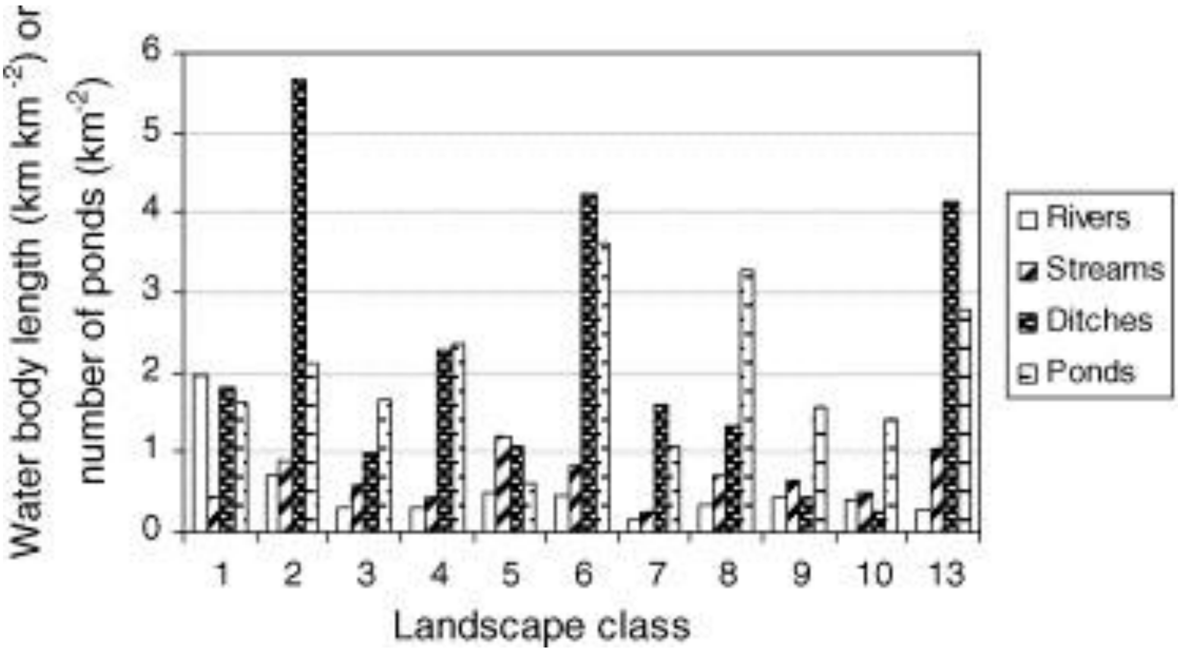


Figure 14. Length of rivers, stream and ditches, and number of ponds in the 11 agricultural landscape classes that make up the landscape of England and Wales (Brown *et al*., 2006).

Table 11. The length of streams in each of the 11 Defra landscape classes in England and Wales (calculated from Brown et al., 2006).	
Defra Land Class	**Stream length (km)**
River floodplains and low terraces	2334
Warplands, fenlands and associated low terraces	7214
Sandlands	5436
Till landscapes	6645
Till landscapes	18539
Pre-Quaternary Clay landscapes	3941
Chalk and Limestone plateaux and coombe valleys	9938
Pre-Quaternary 'Loam' landscapes	6547
Mixed, hard, fissured rock and clay landscapes	6742
Hard rock landscapes	9337
Non-agricultural	79690

7.10 Septic tanks

Given the paucity of data on the effects of small wastewater treatment plants there is some value in considering the effects of another small source: septic tanks.

The study by Withers *et al.* (2011) is one of the few to have been undertaken in the UK. The study area is very close to the Water Friendly Farming case study area, the work having been undertaken at Loddington, Leicestershire.

The septic tank-affected stream network at Loddington also feeds into Eye Brook, just below the Water Friendly Farming catchment area. The landscape is undulating glacial till dominated by mixed arable and livestock farming on heavy-textured, underdrained, chalky boulder clay soils (Denchworth Association). Denchworth soils are characterised as having an impermeable clay horizon at about 25 cm depth and a high proportion of rainfall generates surface runoff (Soil Survey of England and Wales, 1983).

Three sites were monitored approximately weekly for just over 12 months. At one site (Whitehorse Creek), septic tank effluent from older houses in the main Loddington village (exact number not known) was discharged via a pipe directly into a stream. At a ditch site (Village East), samples were taken upstream and downstream of a cluster of four houses (ca. 8 people) and a small but regularly used visitor centre (estimated visitor numbers of 600–1100 per year) with two offices at the eastern end of the village (Figure 15).

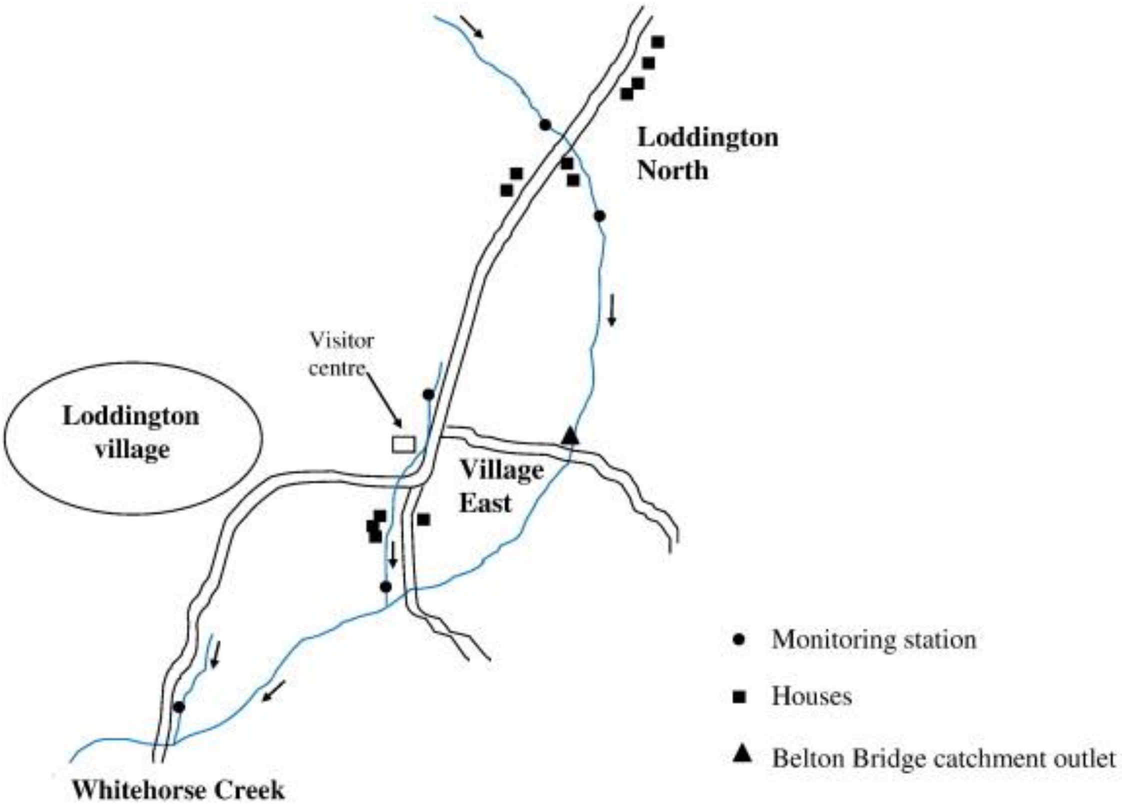


Figure 15. Septic tank study area just outside the project case study area at Loddington, Leicestershire.

At a stream site (Loddington North), samples were taken upstream and downstream of a cluster of eight houses (ca. 14 people) located in the Belton Bridge catchment monitored by Jarvie *et al.* (2010). The septic tanks serving the houses and visitor centre at Village East and Loddington Village mainly discharge to the streams via soakaways and ditches. Runoff from nearby roads may also contribute to downstream concentrations during major storm events.

Septic tank effluent discharging via a pipe directly into one stream was highly concentrated in soluble N (8–63 mg L^{-1}) and P (< 1–14 mg L^{-1}) and other nutrients (Na, K, Cl, B and Mn) typical of detergent and household inputs. Ammonium-N (NH_4N) and Soluble Reactive P (SRP) fractions were dominant (70–85% of total) and average concentrations of nitrite-N (NO_2N) were above levels considered harmful to fish (0.1 mg L^{-1}). Lower nutrient concentrations were recorded at the ditch and stream sites, but range and average values downstream of rural habitation were still 4 to 10-fold greater than those in upstream sections.

At the ditch site, where flow volumes were low, annual flow-weighted concentrations of NH_4N and SRP increased from 0.04 and 0.07 mg L^{-1}, respectively upstream to 0.55 and 0.21 mg L^{-1} downstream. At the stream site, flow volumes were twice as large and flow-weighted concentrations increased much less; from 0.04 to 0.21 mg L^{-1} for NH4N and from 0.06 to 0.08 mg L− 1 for SRP. At all sites, largest nutrient concentrations were recorded under low flow and stream discharge was the most important factor determining the eutrophication impact of septic tank systems.

The very high concentrations, intercorrelation and dilution patterns of SRP, NH_4-N and the effluent markers Na and B suggested that soakaways in the heavy clay catchment soils were not retaining and treating the septic tank effluents efficiently, with profound implications for stream biodiversity. The potential impacts of septic tank effluents on water quality may lead to eutrophication and toxicity to aquatic ecosystems during summer low flow periods.

8. Regulatory and policy factors that restrict investment in the Descriptive wastewater treatment plants, headwater catchments and small waters

8.1 Regulatory and policy barriers: general observations

Discussion with regulators and policy makers indicates that the main barriers to investment in Descriptive wastewater treatment plants, headwater catchments and smaller waters are ultimately concerned with the primacy of legislation. In practice, there are a small number of measures which are effectively mandatory, in that they are specified in primary legislation and are treated by Government as mandatory. Many other measures have legal support, including measures that involve practically all parts of the headwater environment and smaller wastewater plants, but their application is qualified by their position in the legal/financial hierarchy. This can be seen, for example, in the WISER guidance where actions are divided into Statutory, Statutory+ (which, slightly idiosyncratically, means it requires additional financial justification) and Non-statutory, for actions which are supported by government but not mandated.

Even when legislation is mandatory it can still be derailed by the ineffectiveness of delivery. For example, there was a legal requirement for waterbodies to achieve Good status by 2027 but this target is highly unlikely to be achieved, mainly because of delivery difficulties. In addition, in the cost-benefit analysis, the disproportionate cost rule disallows investment to improve ecological status.

With specific reference to headwaters and Descriptive wastewater treatment plants, underlying approaches to their regulation seem ultimately to reflect the perception that small streams are not very important, a situation probably exacerbated by cost-benefit assessment methods in which the benefits are widely dependent on numbers of people affected, which tends to favour more populated areas.

8.2 Regulatory and policy factors that restrict investment in Descriptive wastewater treatment plants

Building on Sections 4.1, 6.1 and 7.3 of the project (current water industry regulatory framework, the value of small waterbodies in headwater catchments, the impacts of Descriptive wastewater treatment plants and desirable quality outcomes), we identify the following main regulatory barriers that restrict investment in Descriptive wastewater treatment plants and the headwater catchment environment.

8.2.1 Cost:benefit limitations

Small wastewater treatment plants probably have a disproportionate impact on their receiving waters if these are also small, and many are probably operating outside their ‘Safe Operating Space (see Section 7.3).

There is potential to apply an ***‘ecological correction factor’*** to cost:benefit analyses based on a quantification of the relative importance of headwater catchments for biodiversity compared to lower catchment areas, further downstream. At present cost:benefit analyses lead to actions being focused on areas of high population as these generate lower per person costs. One option for adjusting this approach to better protect headwater catchments would be to adjust the cost:benefit analysis of small works which are currently below the 250 PE threshold, when they automatically qualify for investment, in terms of the volume of effluent compared to flows in the receiving water.

An alternative approach would be to explore the potential for quantifying the value of headwaters by physical habitat area (although small, the abundance of headwaters means that they occupy a substantial area) and by relative biodiversity value (headwaters catchments overall support at least as diverse assemblages as lower catchments). Cost-benefit analyses would then be subject to a correction based on biodiversity value. This 'ecological correction factor' would be analogous to the adjustments applied in the Biodiversity Net Gain calculator to describe Strategic Significance which essentially applies a policy adjustment to the habitats' quality and extent measures.

8.2.2 Water Framework Directive monitoring limitations

Constraints created by the Water Framework Directive for headwater catchment protection, enhancement of freshwater biodiversity and investment in Descriptive wastewater treatment plants fall into two broad categories:

- Constraints due to the structure of monitoring networks which mean that waterbodies affected by Descriptive works may not be routinely monitored or lack sufficient monitoring sites to assess benefits effectively. Although in theory all waterbodies reported in WFDR / River Basin Management Plans will have at least one monitoring point, these may not be located near to Descriptive works so may not provide information on the specific impacts of these facilities. Certainly in the case study area (Section 11) in the R. Welland catchment, monitoring points are not specifically located to reflect the impact of the catchments numerous Descrptive works (Simon Bonney, Environment Agency, *pers. comm.*).
- Restriction of the WFD programme to running waters which means that no data are collected on the condition of the standing water network, despite their importance for biodiversity and ecosystem services. There is a growing body of evidence internationally, particularly in the United States, that the condition of the running water network is affected by the whole network of freshwater habitats, whether they are physically directly connected to a specific running water or not.

8.2.3 Fair shares apportionment

The policy recommendations made in Environment Agency (2022) broadly conclude that catchment-specific optimisation of wastewater and agricultural phosphorus sources should continue as the preferred approach. Although this approach has the benefit of being apparently fair it is often counter-productive because only one party (water companies) has sufficient control over its pollution impacts to act effectively.

Briefly, the strengths and limitations of the Source Apportionment Geographical Information System-SIMulation of Catchment (SAGIS-SIMCAT) model modelling approach for assessing fair-share apportionment are:

- Strengths:
  - comparatively simple to apply with low data and modelling power requirements
  - produces technically credible answers for larger waters and whole catchments
- Limitations:
  - takes no account of the ecological importance of small waters
  - drives an approach based on total volumes of P retained, rather than length or area of waterbody
  - may not predict sources correctly for smaller waters.

It is clear that new catchment specific phosphorus apportionment approaches could help prioritise Descriptive works and headwaters more generally. For example, in the case study catchment, previous work by the Water Friendly Farming project partnership showed that of the headwater streams in the Eye Brook study area, most were High status for phosphorus except for the sub-catchment affected by Tilton-on-the-Hill Descriptive wastewater treatment plant (see Figure 16). This suggests that prioritisation would be beneficial in this case because it would not be compromised by diffuse pollution impacts from agricultural runoff, with landuse in these catchments dominated by grassland and with stream networks often having substantial (20 m+) wooded buffer strips. SAGIS modelling is not able to take account of these factors and a finer scale modelling approach could overcome this limitation.

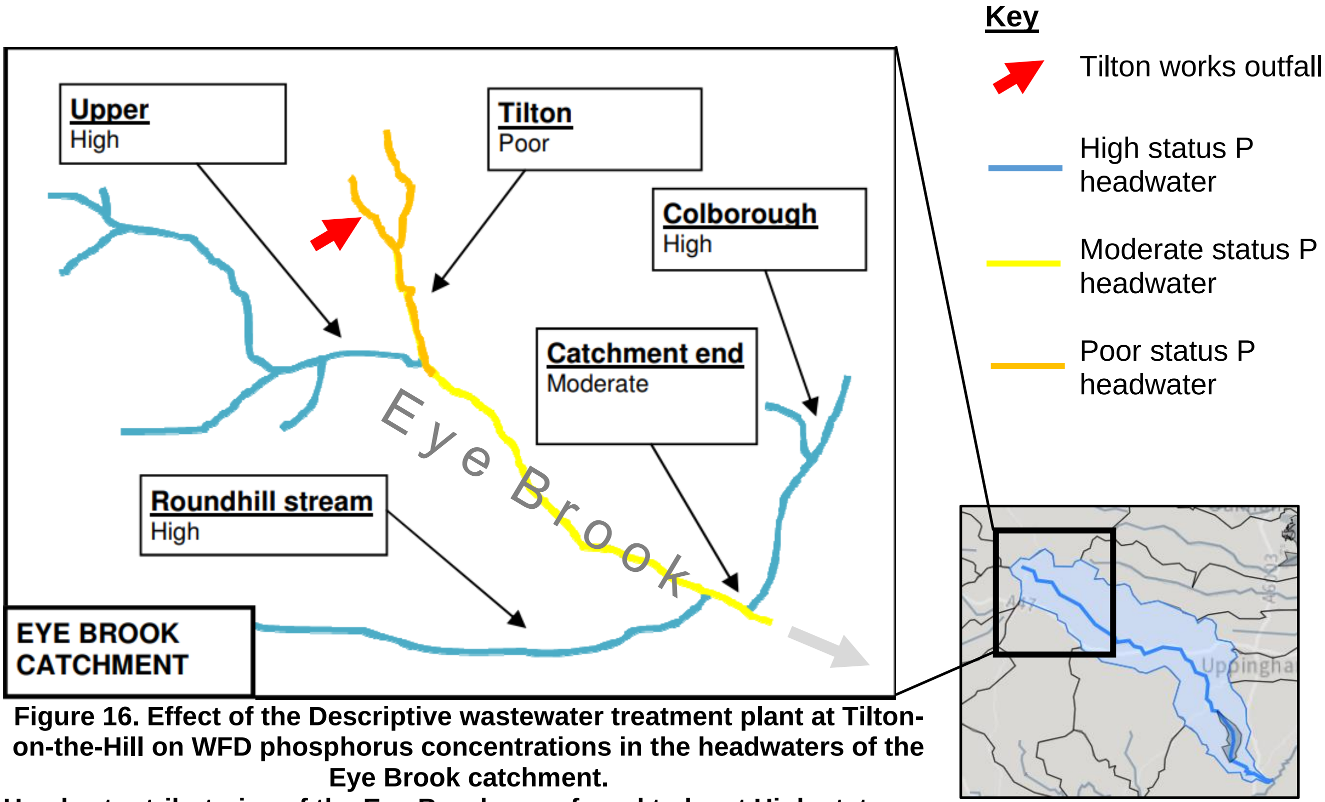


Figure 16. Effect of the Descriptive wastewater treatment plant at Tilton-on-the-Hill on WFD phosphorus concentrations in the headwaters of the Eye Brook catchment.
Headwater tributaries of the Eye Brook were found to be at High status for phosphorus except where impacted by Tilton wastewater treatment plants. Reducing phosphorus loads here is likely to be cost-effective because there would be little or no constraint from agricultural phosphorus sources. At this site the WFD classification treats all of the headwater tributaries shown in Figure 2 as a single waterbody (see inset) whereas the true situation is considerably more nuanced.

8.2.4 New legislative challenges particularly Environment Act, Environmental Improvement Plan and the Plan for Water.

Potential regulatory ***barriers and constraints*** could still discourage investment in Descriptive wastewater treatment plants following the introduction of the Environment Act 2021, the Environmental Improvement Plan 2023 and the Plan for Water because even though there is greater acknowledgment of small waters than in earlier legislation, many of the targets in the Environment Act are based on earlier legislation, limiting their value for small waters. Thus, targets for nutrient reduction (as a proportion of total load discharged) will naturally focus on larger works which produce most phosphorus, rather than assessing sites case-by-case. Similarly, clean and plentiful water targets will still use WFD waterbodies, largely excluding abundant and diverse smaller waters.

The levels of phosphorus reduction proposed for agriculture are substantially less than those already achievable for wastewater plants but are probably the critical limiting step on the overall effectiveness of phosphorus reduction measures. This presents a constraint on the overall effectiveness of measures to control sewage pollution and, therefore, the outcome of investments in wastewater treatment plants phosphorus reduction generally. However, in contrast to lower catchments this problem may be less severe in upper catchments because of the larger number of locations with protected, less intensively managed, catchments, such as those seen in the case study area, where drainage from grassland has low nutrient levels. This suggests that Defra or Ofwat should ask water companies to further consider optimal approaches to improving the water environment in the round. i.e. rather than solely focusing on wastewater treatment plants, formalise programmes of work in headwater catchments with farmers to restore the whole system. This approach is already being tested in some pilots and is ready for wider application.

Further potential barriers created by other new targets (e.g. mandatory targets to halt the decline in species abundance by 2030 and ensure that species abundance in 2042 is greater than in 2022, and at least 10% greater than 2030). Although such targets can seem automatically to be positive, in headwaters such a focus could be problematic. For example, in many smaller streams in the Anglian Water region freshwater species abundance is severely modified by Signal Crayfish and actions to improve water quality in support of species abundance targets may be largely negated by the presence of crayfish.

8.2.5 Non-statutory barriers.

Non-statutory regulatory/policy factors that could restrict investment in Descriptive wastewater treatment plants include:

- technical difficulty of nutrient reduction methods, although recent progress on methods to control phosphorus are reducing this problem
- lack of tradition in the UK of working to very low nutrient levels in wastewater effluents (c.f. Denmark, USA)
- the traditional view amongst wastewater engineers that large wastewater treatment plants/sources are the most important pollutant sources simply because they are the largest sources.

8.3 Reputational issues

There are reputational issues affecting the water industry which may present a barrier to headwater investment. For example, attention on pollution from storm overflows in larger waters currently has very high levels of public awareness whereas smaller works remain largely below the radar. This leads to substantial public emphasis, driven by media attention, on the more visually obvious problems associated with large works.

9. Desirable quality outcomes

Desirable quality outcomes for headwaters catchments are provided as an annotated checklist based on Environment Act goals, focusing on those most relevant to the headwater catchments for Goals 1, 3, 7 and 10.

9.1 Desirable outcomes

A checklist of desirable outcomes for headwater catchments focusing on freshwater biodiversity and, also taking account of benefits for people and society, is given below.

- **Goal 1: Thriving plants and wildlife**

The management plan for headwater catchments should embed the principles of the Freshwater Network, placing catchments in the context of nationally significant Important Freshwater Landscape and regionally significant Important Freshwater Areas (Figure 17). There should be evidence of long-term, landscape wide, gains in freshwater biodiversity. This means, for example, at least 1% per annum increase in species until the regional species maximum is at least 90% established - replicating gains seen in the case study area - and at least doubling the area of priority freshwater and wetland habitat.

Specifically:

- 90% of protected headwater catchment freshwater sites and priority habitats are in Favourable condition
- Environment Act freshwater indicators (habitat and species) are shown to be changing in a positive direction in the light of regular monitoring
- 90% of Priority habitats are under management and maintaining or improving towards Favourable condition
- The extent of priority habitats in Favourable condition is at least double the 2023 level. This includes:
  - Priority ponds, established by management and particularly by creating new high quality ponds, to at least double pond numbers
  - Freshwater habitat extent and condition meet the targets of the Freshwater Network[6] which, up to 2035, are to:
    - Double the area or numbers of freshwater and wetland habitats that are at High or Good status and / or in Favourable condition
    - Ensure that Species of Conservation Concern are on an upward trajectory i.e. those which contribute to Environment Act targets for endangered species (addresses Environment Act long-term biodiversity target on species' extinction risk)
    - Freshwater species contributing the Environment Act abundance target are on an upward trend, with modelling proving an underlying objective assessment of expected expansion (addresses Environment Act long-term biodiversity target on species' extinction risk)

Programmes should be underpinned by credible monitoring programmes which can provide suitable data to assess progress.

[6] An introduction to the concepts of the Freshwater Network, which is being developed by Freshwater Habitats Trust and partners, is shown here: https://freshwaterhabitats.org.uk/freshwater-network/.

- **Goal 3: Clean and plentiful water**

Biological and chemical water quality targets should be used as outcome measures for determining desirable outcomes in headwater catchments. These should include:

- At least 75% of the of the freshwater environment has water which is chemically at High status in WFDR terms, which is likely to be a more achievable target in headwater systems than further downstream.
- At least 75% of freshwaters in headwater catchments are close to their natural state. In practice, in headwater catchments this would mean:
  - Ensuring that headwater stream quality is at High or Good status in WFDR terms
  - Other standing freshwaters are in Good ecological condition (e.g. 75% of ponds and small lakes meet the PSYM Good status category); priority freshwaters and wetlands are in Favourable condition and are increasing in extent or area
  - Levels of critical pollutants should be falling, especially nitrogen or phosphorus, as evidenced by regular monitoring programmes targeted and funded to provide credible data on pollutant levels
  - The extent of 'clean water' (equivalent to WFD High status) should be on an upward trajectory measured catchment of landscape wide in terms of waterbody area (hectares) of clean water. The upward trajectory can be obtained by either cleaning up pollution or creating new habitats (especially ponds) that can instantly bring new area of clean water to the landscape.
- The extent of impacts of Descriptive wastewater treatment plants, which may affect 30% of the stream network, is better understood.
- Descriptive wastewater treatment plants no longer damage headwaters; no small waste water treatment plants should be discharging to waters which are outside the Safe Operating Space (sensu Büttner *et al*., 2022).
- Sufficient monitoring is undertaken to ensure that the desirable outcomes noted above can be evaluated.
- Catchment management plans should:
  - Identify all headwater catchments and waterbodies to ensure they are properly considered and managed
  - Catchment plans should embed the targets and plans which are specific to the headwater environment.

- **Goal 7: Mitigating and adapting to climate change**

A wide range of measures which could be undertaken in headwater catchments that will help to mitigate and adapt to climate change.

Most of the measures not in Goal 1 and Goal 3 have benefits for the climate (e.g. alkaline spring-fed fen restoration, reduced use of fertilisers, pond creation to make species populations more resilient).

In addition, headwater catchments should be areas where:

- There are opportunities to allow forest and woodland to develop providing protection for freshwaters and good freshwater habitat creation locations, whilst sequestering carbon in trees
- Soil management should as far as possible be climate friendly in headwater catchments e.g. by using cultivation techniques which encourage accumulation of soil carbon.

Headwater catchment monitoring programmes should, as far as possible include some locations where credible data on climate change mitigation evidence can be obtained.

- **Goal 10: Enhanced beauty, heritage, and engagement with the natural environment**

Headwater catchment will often be locations where there are opportunities to explore, enjoy and protect the natural environment.

For each headwater catchments opportunities to deliver Goal 10 should be explored including:

- Improve access to nature: creating new routes, more green and blue spaces and increasing their accessibility to people of all backgrounds.
- Protect our landscapes and their heritage: recognising the pride in place that comes with embracing shared histories in communities across the country, and particularly the role that farmers play as the original custodians of the land.
- Connecting with nature as a way of improving physical and mental health.
- Connecting children and nature: boosting the number of young people who can connect with nature.

Desirable outcomes for the remaining Environment Act goals should be developed. These are likely to be more generic whilst remaining focused on the headwater environment.

- Goal 2: Clean air: reduced nitrogen fertiliser application, which could be part of the Clean and Plentiful Water goal, is likely to contribute to the Clean air goal through reduced ammonia production.
- Goal 4: Managing exposure to chemicals and pesticides: efforts to encourage reduced pesticide usage are likely to be part of the Clean and Plentiful Water goal.
- Goal 5: Maximise our resources, minimise our waste: reducing waste is a general aspiration.
- Goal 6: Using resources from nature sustainably: using resources sustainably is a general aspiration in all headwater catchments.
- Goal 8: Reduced risk of harm from environmental hazards: creating natural flood management projects can contribute to reducing risk.
- Goal 9: Enhancing biosecurity

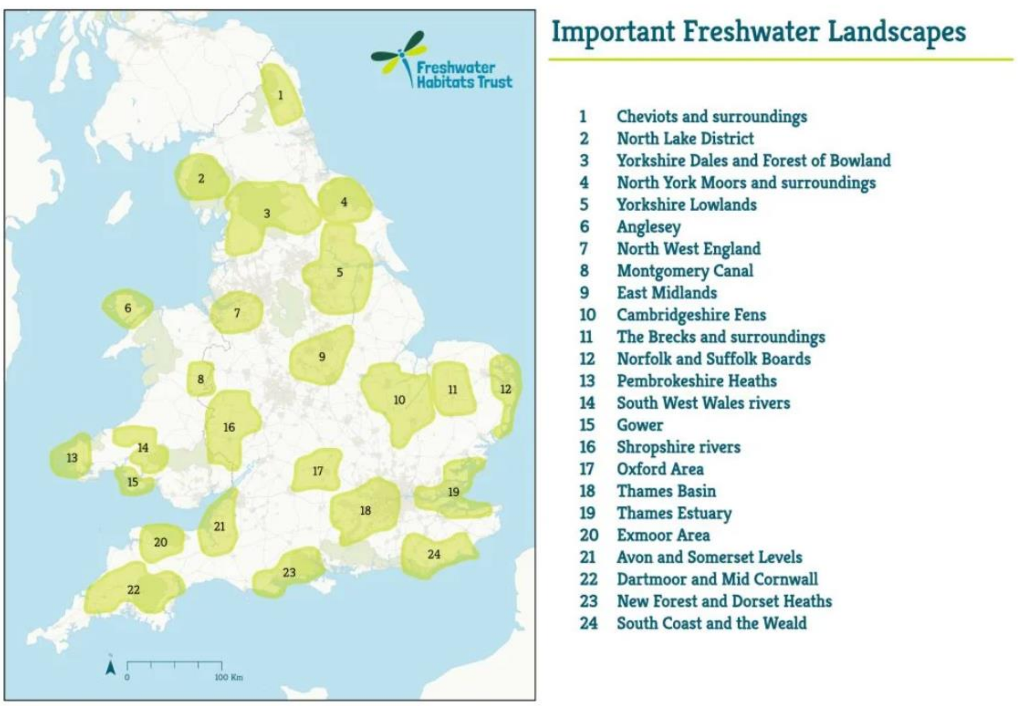


Figure 17. Important Freshwater Landscapes in England and Wales

9.2 Indicators of desirable quality outcomes

Where relevant, indicators that underpin the Environment Act goals will be applied to the headwater environment. For example, for the Clean and Plentiful Water goal we would expect to collect data that could identify desirable quality outcomes in headwater catchments for indicators B1, B2, B3, B6 and B7.

A similar process will be applied to the three other targets most relevant to the water environment (Thriving plants and wildlife, Climate change, Enhance beauty, heritage and engagement).

Indicators likely to be useful in assessing the condition of the headwater environment may include:

- Indicators that can be considered drivers or pressures on natural capital assets are:
  - A1: Emissions for five key air pollutants
  - A2: Emissions of greenhouse gases from natural resources
  - A6: Exceedance of damaging levels of nutrient nitrogen deposition on ecosystems
  - A7: Area of land exposed to damaging levels of ammonia (NH3) in the atmosphere
  - B1: Pollution loads entering waters
  - B2: Serious pollution incidents to water
  - E3: Volume of inputs used in agricultural production
  - H1: Abatement of the number of invasive non-native species entering and establishing against a baseline
  - H2: Distribution of invasive non-native species and plant pests and diseases
- Indicators that can be considered extent or condition of natural capital assets are:
  - B3: State of the water environment
  - B6: Natural functions of water and wetland ecosystems
  - B7: Health of freshwater assessed through fish populations
  - D1: Quantity, quality and connectivity of habitats
  - D2: Extent and condition of protected sites – land, water and sea
  - D3: Area of woodland in England
  - D4: Relative abundance and/or distribution of widespread species
  - D5: Conservation status of our native species
  - D6: Relative abundance and distribution of priority species in England
  - D7: Species supporting ecosystem functions
  - E1: Area of productive agricultural land
  - E7: Healthy soils
  - G1: Changes in landscape and waterscape character
  - G2: Condition of heritage features including designated geological sites and scheduled monuments
  - G3: Enhancement of green/blue infrastructure
- Indicators that can be considered services or benefits associated with natural capital assets are:
  - E8: Efficient use of water
  - F3: Disruption or unwanted impacts caused by drought
  - G4: Engagement with the natural environment
  - G5: People engaged in social action for the environment
  - G6: Environmental attitudes and behaviours
  - G7: Health and wellbeing benefits

10. Barriers to policy change and routes to overcome any barriers identified

10.1 Barriers to policy change

Barriers to policy change that can affect the management of Descriptive wastewater treatment plants and headwater catchments fall into the following broad categories:

- Scientific bias towards larger water**s**
- Lack of information about the status of headwater catchments
- Technological barriers
- Legislative and regulatory barriers

10.2 Scientific bias towards larger waters

Headwater catchments and small waters have long been neglected in freshwater science so that there a number of evidence gaps that present barriers to catchment management generally, and headwater systems specifically. The overt recognition of this bias has only come recently (van Rees *et al.*, 2020), only being specifically mentioned in the scientific literature for the first time in 2020, although growth in the interest in small waters worldwide had tacitly acknowledged this issue for some years.

Van Rees et al (2020), a group of European freshwater specialists, noted that:

> "*Within the freshwater realm, new strategies should address the bias in research, management, and policy principally focused on rivers and lakes, largely excluding other freshwater habitats"*

10.2.1 Lack of Information

Monitoring of freshwater is heavily biased towards running waters. This bias has been continued into the Environment Act for freshwater as many of the species in the Environment Act statute are freshwater invertebrates selected from river monitoring programmes. However, it is notable that 65% of the species listed also occur in ponds and lakes (a reflection of the richness and heterogeneity of ponds in particular), rising to a total of 85% of the Environment Act species, if headwaters are also included. This suggests that the new Environment Act targets could help to generate datasets that are relevant to whole landscapes, providing better understanding and representation of headwater catchments.

However, despite recent progress on the development of monitoring networks, which are increasingly encompassing smaller waters, there is still no co-ordinated national monitoring programs of ponds and headwaters, wetlands or springs.

Recent attempts to develop new monitoring and prediction paradigms for freshwaters also fall into the bias trap. For example, Wilkes et al, 2024 show the development of a new modelling tool for predicting freshwater species recovery but, although this work presents a valuable new idea about freshwater monitoring approaches, it is created from existing data (i.e. from rivers) leading to an intellectual circularity where ideas can only be derived from the existing information on rivers, producing more conclusions only relevant to part of the water environment.

10.2.2 Development of new monitoring programmes

Lack of monitoring of smaller waters has been a substantial barrier to engaging with headwater catchments, and by implication measures to control pollution sources like small wastewater treatment plants.

However, recent developments in monitoring approaches by statutory agencies are benefitting smaller water and could support policy interest. For example, the Environment Agency is revising its monitoring networks nationally to be more representative of small waters. Likewise, Natural England is now including a national monitoring programme for ponds in the England Ecosystem Assessment, which started in 2023 and aims to replicate the approach of the Countryside Survey which undertook national pond, stream and ditch surveys in 1996, 2000 and 2007.

Both these organisations' approaches, if adequately linked, will help to provide better understanding of headwater catchments, thereby driving policy action in these areas.

10.3 Uncertainty about the effectiveness of measures

Work on headwater catchments, including work on small wastewater treatment plants, is hampered by uncertainty about the effectiveness of measures to control pollution from the land. There is an extensive scientific literature showing that the effectiveness of measures to reduce the nutrient burden from diffuse agricultural and urban runoff in freshwater has been modest.

Thus, despite clear evidence of reduced nutrient (and other pollutant) inputs from wastewater treatment, many freshwaters are still damaged by diffuse pollution. Greater certainty in 'what works' in land management would remove some constraints on prioritising Descriptive wastewater treatment plants as gains from improving wastewater treatment will be more likely to be matched by gains in reduced agricultural pollution.

The main sources of phosphorus and nitrates in rivers and lakes in the UK are sewage effluent and run-off from agricultural land (Environment Agency, 2022). However, at present there is no up-to-date data on the exact contribution of these sources to the nutrient load in UK waters and to nutrient pollution (Rankl, 2023). In considering potential strategies for managing P at river catchment level, the Environment Agency (2022) suggests considering the relative priority for action of two scenarios which are relevant to the prioritisation of headwater catchments:

- **Scenario 1 High P concentrations**, often in high alkalinity lowland rivers, due to sewage and agricultural sources, with good local evidence of ecological harm (eutrophication), high confidence that some reduction in concentration/load will be achieved but low likelihood it will be sufficient to achieve P standards and thus uncertainty over ecological improvement. Tackling P from sewage treatment works is an essential starting point in these situations but agricultural sources are increasingly important.
- **Scenario 2 Low P concentrations**, often in sensitive low alkalinity or headwater river reaches, where local evidence of eutrophication is likely to be weaker, but deterioration needs to be prevented and measures for agriculture, small STWs and rural sewage sources might reduce P concentrations from just failing to levels that will deliver ecological improvement or prevent impacts.

10.4 Technological barriers

Descriptive wastewater treatment plants can be difficult to manage using the approaches that are straightforward in larger population centres (e.g. restrictions on access, restrictions on the telecommunications needed for wastewater treatment plants management, transport costs).

In practice, water companies are able to manage these technical issues as can be seen in the mechanisms which are already in place for upgrading Descriptive works once they cross the 250 PE threshold.

However, there remain some technical issues particularly for processes for removing phosphorus, which have been described by the Environment Agency (2022). This means that further trials of processes for small wastewater treatment plants may still be needed to optimise the choice of treatment methods. Currently these comprise the following options where ([C] denotes a current measure in the UK and [F] denotes a possible future measure, little or not yet used in the UK):

- Chemical (iron or aluminium) dosing – the current UK norm (using iron) [C]
- Biological phosphorus removal – not much used in UK [C/F]
- As 1st two bullets with effluent polishing to achieve very low P (for example 0.1 mg/l) [F]
- Getting the best we can from current treatment plants [F]
- Membrane filtration, reverse osmosis and other novel technologies [F]
- Reed beds with adsorption media for tertiary P polishing at rural STWs [F]
- Free surface water treatment wetlands [C]
- Sludge recycling to agricultural land, or sludge to landfill, or to incineration [C]
- Phosphorus recovery from sludge or effluent for example to produce fertiliser pellets [F]
- Trade effluent control [C]

10.5 Legislative and regulatory barriers

10.5.1 Long-term barriers in legislation

Multiple legislative barriers to investing in headwaters remain, often rooted in the long traditions of freshwater biology overlooking small waters of all kinds. This will inevitably take time to be corrected as younger more recently qualified biologists, engineers and managers learn a new language of freshwaters which encompasses both large and small waters and wetlands.

The importance of barriers in restricting improvement to headwater catchments was evaluated in discussions with stakeholders. The discussion focussed mainly on:

1. The extent to which recognition of smaller waters as ‘waterbodies’ constrained action.
2. The potential to consider the whole water environment: a non-traditional approach but potentially a route to be taken in the implementation of the Environment Act
3. The legal requirements – relevant to both water and ‘nature’
4. The need to ensure public acceptance of measures
5. The role of alternative approaches – wetlands
6. Sharing experience
7. The complexity of the wastewater process and water pollution more generally: it’s about more than the storm overflows
8. There’s no shortage of legislation: you can find a workaround if you’ve got one of the primary pieces of legislation supporting your aims – that’s the key
9. Fair shares and affordability rules
10. Opportunity for knowledge gaps and new approaches.

11. The role of the catchment and, for water companies, how far outside the traditions of asset focused work can or should the organisation go.

These are discussed in more detail in Section 10 on the identification of mechanisms for policy change.

In 2027, when waterbodies are intended to be at Good status under Water Framework Directive Regulations, there may be an opportunity to adjust the current framework for achieving Good status for freshwaters to better represent headwater systems.

10.5.2 Systems-led approaches

Amongst options for the future is the potential for developing a more ***systems-led approach*** to managing the man-made and nature-based assets. At present, such thinking is in the early stages of development, and is probably part of longer term solutions. There is potential for systems-led approaches to enhance outcomes and encourage investment in Descriptive wastewater plants, particularly alongside nature-based solutions.

A starting point for this is the work of Liu et al. (2023) who have begun testing systems approaches for the Environment Agency, and also worked in the Anglian Water region.

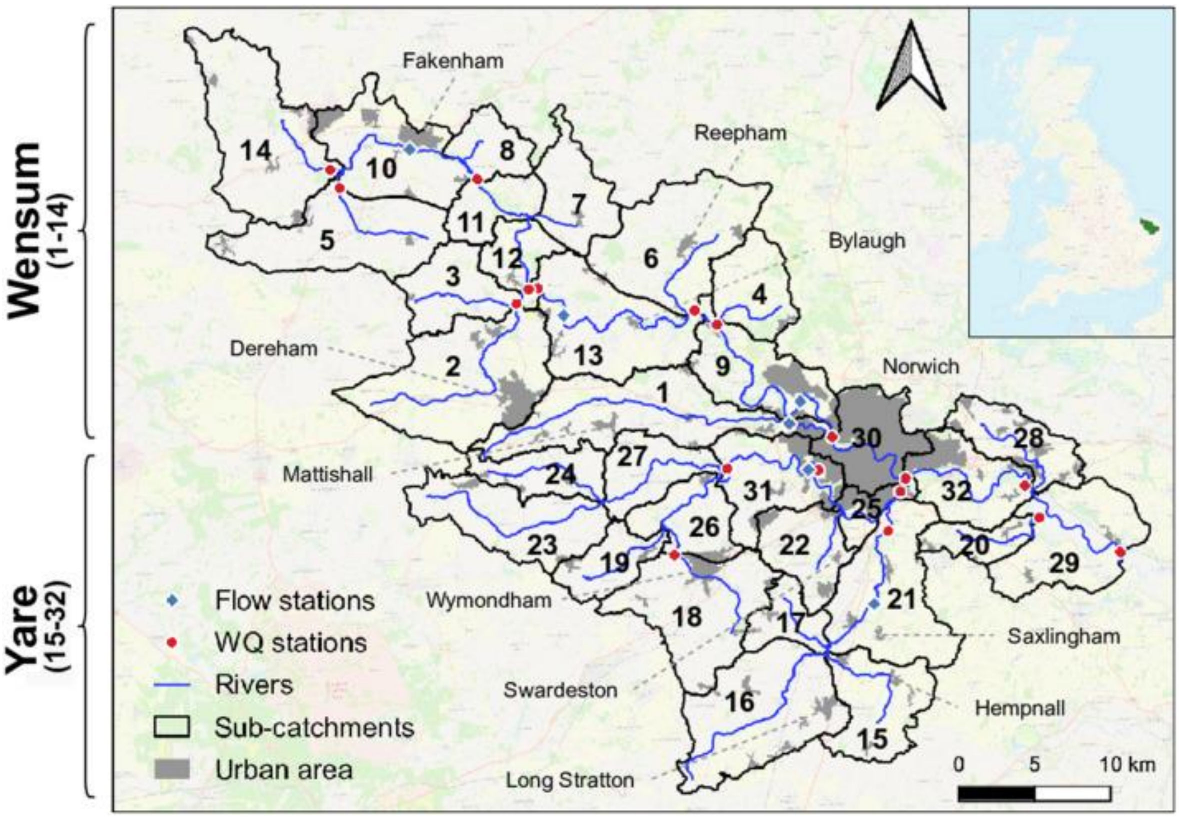


Figure 18. Area used by Liu *et al*. (2023), the catchment of the Yare and Wensum, to develop systems-led approaches to catchment management with nature-based solutions.

Other modelling frameworks may also be valuable for developing a system-led approach including:

- SWAT (used in the case study area)
- HYPE - A New National Water Quality Model to Evaluate the Effectiveness of Catchment Management Measures in England
- INCA - Integrated Catchment Model

- QUESTOR - Quality Evaluation and Simulation Tool for River Systems
- FARMSCOPER - Farm Scale Optimisation of Pollutant Emission Reductions
- LUCI - Land Utilisation & Capability Indicator
- SIMCAT - SIMulation of CATchments
- SEPARATE - Sector Pollutant Apportionment for the Aquatic Environment

More information about a number of these models is available on the CEH Catchment Management Modelling Platform.

'Digital Twin' catchments are also providing new approaches to the complexity of catchment management and may be particularly valuable for new situations, such as the R. Stiffkey twin catchment.

10.5.3 Legislation

At present water law essentially aims for all waters to be protected from uncontrolled pollution and to be at least at 'Good' status *sensu* Water Framework Directive, with deterioration prevented. Conservation law, which is concerned with a subset of valuable sites (but see discussion in Section 6.1.2), has similar objectives. This approach has never been underpinned scientifically to assess 'What is the *right* amount of unpolluted (High or Good status) water?'. A more objective assessment of the 'correct' amount of unpolluted water would place this general aim to stop pollution on a more rigorous footing. Nature law - also fairly arbitrarily - suggests that all important habitats should be in good condition, without identifying what the 'right amount' is, beyond the obvious: 'a lot more than now'. Neither system deals very well with a critical problem of freshwater management: that a large proportion of freshwater habitats are not in good condition and may not be for some time.

Although the general objective of legislation in aiming for a large proportion of freshwaters to be in Good condition is an apparently simple and desirable concept, supporting positive change, it has several specific shortcomings in headwater catchments. Specifically:

- Small running waters (first and second order streams), although technically covered by multiple strands of legislation (e.g. as controlled waters, as parts of WFDR water bodies, as priority habitats) are in practice largely overlooked (see discussion in Section 6.5).
- Small standing waters (small lakes, ponds) are specifically excluded from major water legislation and practice (e.g. River Basin Management Plans).
- Other freshwater habitats, such as springs, flushes, ditches, and wetlands that are not designated as SSSIs or SACs, have little or no protection or monitoring.

Focusing on freshwater biodiversity and headwater catchments, the desirable legislative outcomes would be headwater landscapes and catchments where:

- a certain extent of 'clean water'[7] is maintained in the landscape. Several options are available for deciding what this extent should be. For example, the extent required could be pragmatically aligned with the 30x30 initiative, so that 30% of all surface waters in catchments would have 'clean water'. Alternatively, more rigorous analytical approaches could be used with Species Distribution Modelling used to identify the proportion of a freshwater network need to maintain populations of specific species, giving an understanding of the *actual* extent of habitat needed to maintain populations of sensitive species
- all smaller freshwater habitats are in High or Good status and / or Favourable condition

[7]In this report 'clean water' means water which has the characteristics of High status waterbodies as defined in the Water framework Directive i.e. minimally impaired or at the reference condition, or equivalent for those waterbodies not covered by the WFD Regulations. Although uncommon in larger waters, this status can be widely seen in smaller waters.

- the abundance of freshwater Environment Act species is increasing
- the number of Red Data Book Environment Act species and other protected species is increasing
- landscape level diversity is increasing to a plateau which is close to the undisturbed, near natural, background for the region. That would conveniently be assessed on a 10x10 km square basis.

10.6 Routes to overcoming barriers to policy change

An overview with examples of ways in which barriers to policy change can be overcome is given in Table 12 (Scientific bias towards larger waters, Lack of information about the status of headwater catchments, Technological barriers, Legislative and regulatory barriers).

10.6.1 Support for policy change

A central requirement of policy change is that ideas are broadly agreed and supported by multiple actors.

In the case of headwater catchments there is now a good basis of support for change with many examples of regulators, water companies, NGOs, private landowners and the public supporting the need for better protection of the headwater environment. Mobilising such consortia is a key component of developing legislative change.

10.6.2 Routes to overcoming barriers to policy change

This section identifies mechanisms for policy change and the barriers to these changes. In the second part of the chapter we describe the results of the project round table and detailed discussions with practitioners involved in water management for overcoming those barriers.

The key barriers for small waters, headwater catchments and small Descriptive wastewater treatment plants are:

- How current policy leads to small waters being downplayed (e.g. exclusion of ponds and small lakes from WFD, although these are the richest part of the water environment at landscape scale), even though existing policy supports the protection and management of small waters (e.g. identification of small waters, both still and flowing, as Priority habitats including headwaters and high ecological value ponds)
- How cost:benefit procedures focused on Person Equivalents can distort ecological outcomes as this inevitably skews investment towards larger water bodies where costs are distributed across larger numbers of people but do not necessarily provide greater ecological benefits when assessed at landscape scale.
- Despite recent policy developments (e.g. new targets in the Environment Act 2021), River Basin Management Plans, which guide large parts of investment in the water environment, still effectively exclude a large proportion of waterbodies in headwater catchments.

Mechanisms for policy change can be grouped into three classes of change which increase in difficulty:

- New practices that develop within existing policy frameworks (e.g. amendments to River Basin Management Plans, activities built into Local Nature Recovery Strategies).
- Formal policy guidance from The OEP and / or government departments which have actual or near legal force (e.g. the Environment Improvement Plan)
- New primary or secondary legislation: generally requires high level of public awareness (e.g. new regulations on Storm Overflows).

Table 12. Summary of barriers to policy change and routes to overcome any barriers identified

Barrier **Scientific bias towards larger waters**

How barrier can be overcome:

- Provide information about the importance of smaller waters (textbooks, scientific papers, technical manuals, websites)
- Encourage and support research on smaller waters
- Ensure that opportunities to exploit current policy which supports work on small waters and headwater catchments are taken up

Barrier **Technological barriers**

How barrier can be overcome:

- Pilot test and implement existing technologies (e.g. treatment wetlands)
- Encourage development of new solutions which can be applied specifically to smaller waters and Descriptive wastewater treatment plants
- Ensure there is credible technical monitoring of small waters (e.g. in the case study area a previously Descriptive works is now scheduled for conversion to a numeric consent providing the opportunity to evaluate the impact of this change)

Barrier: **Lack of Information**

- Monitoring programme should be supported and further developed for smaller waters: schemes are currently developing so there is now a good foundation to build on
- New data collection and monitoring methods should be optimised and explored; for example, the status of Great Crested Newts in ponds is now monitored nationally and regionally using eDNA in a way that was impossible before 2015 when the technique was developed (Biggs et al., 2016).
- Optimised approaches to whole catchment monitoring should be piloted in upper catchments building on techniques developed in the case study area. These provide more complete whole landscape level understanding of ecosystem quality and should also include use of citizen-science approaches being developed in CaSTCo.

Barrier: **Long-term barriers in legislation covering headwater catchments**

- Ensure that existing legislation is exploited as much as possible, particularly by developing programme based on currently statutory requirements which are mandatory (e.g. protection of controlled waters, ensuring they are included in WFDR waterbodies).
- Seek options to modify existing legislation to increase relevance to headwater catchments (e.g. adopting System A of WFDR waterbody classification)
- Develop new legislation specifically creating duties to protect small waters and facilitate restoration and creation (including specific and realistic legal target)

10.6.3 Conclusions

Barriers to investment in headwater catchments and Descriptive wastewater treatment plants are mainly the result of the tradition of overlooking smaller waters generally and treating small wastewater treatment plants as insignificant (i.e. those below 250 Population Equivalents).

The main barrier to investment in headwater catchments has been the absence of strong statutory drivers, particularly the exclusion of smaller waters that originated in the classification scheme of the Water Framework Directive (i.e. excluding standing waters less than 50 ha in area and minimising the importance of headwaters). Although this is to some extent compensated for by recognition of small waters and wetlands as Priority Habitats, this does not translate into effective protection, because protection mechanisms for priority habitats have generally been weaker.

The main barrier to investment in work on Descriptive wastewater treatment plants is the lack of data on their effects on receiving waters, linked to the assumption that headwaters are a comparatively minor part of the water environment. This barrier can be resolved into three main problems:

- Lack of data on the impacts of smaller works and the length of the stream network impacted.
- Lack of standard modelling approaches to predict the effect of solutions (at present modelling is bespoke).
- Lack of evidence of the benefits of improving works in terms of ecology of headwater streams and delivery of other ecosystem services.

Overcoming the barriers to investment in headwater catchments and small wastewater treatment plants are comparatively straightforward and can also be resolved into three key issues:

- Recognition of the importance of small waters in primary legislation; this can be done in the short term by simple administrative changes and guidance from the Government that small waters are important. In the longer term, new legislation to recognise freshwater as a network of interdependent and interconnected habitats, managed at the whole landscape scale, is necessary to properly manage catchments. This would also be a logical progression in the development of truly integrated catchment management, a process which has been ongoing for 30 years.
- Effective trials of benefits to provide confidence that investments are effective.
- Monitoring programmes that can detect stresses and effects on waterbodies of all sizes, from small ponds to large rivers.

An example to overcoming these problems can be seen in the project case study area where information about the extent of the impact of small wastewater treatment plants on headwaters, modelling techniques to evaluate impacts and practical solutions to the management of headwater catchments are all being demonstrated.

Short, medium and long-term policy and regulation changes that will help to increase benefits from the headwater environment are described in Section 11: Conclusions and Recommendations.

10.7 Results of consultations with stakeholders

We held discussions under the Chatham House rule with stakeholders from water companies, public bodies, the Environment Agency, NGOs and the private sector. Many other people have been informally consulted about the barriers and opportunities discussed here.

The importance of barriers in restricting improvement to headwater catchments was evaluated in discussions with stakeholders. Although conversation was wide-ranging at the time, we have focussed on 12 key issues which were:

1. The extent to which recognition of smaller waters as 'waterbodies' constrained action.
2. The potential to consider the whole water environment: a non-traditional approach but potentially a route to be taken in the implementation of the Environment Act
3. The legal requirements: relevant to both 'water' and 'nature'
4. The need to ensure public acceptance of measures
5. The role of alternative approaches e.g. wetlands for sewage treatment
6. Sharing experience
7. The complexity of the wastewater process and water pollution more generally: it's about more than the storm overflows
8. There's no shortage of legislation: you can find a workaround if you've got one of the primary legislative drivers supporting your work - that's the key
9. Fair shares and affordability rules
10. Opportunity for knowledge gaps and new approaches.
11. The role of the catchment and, for water companies, how far outside the traditions of asset focused work on should/can go.
12. You can do quite a lot now; there is almost nothing stopping any action to improve the water environment except prioritisation of funding.

The key points relating to each of these areas of discussion are summarised below.

1. **The extent to which recognition of smaller waters as 'waterbodies' constrained action.**

The implementation of the Water Framework Directive and now the WFD Regulations seems to exclude many headwater streams from the system. Although this may be a problem in some areas, in practice existing laws can be used to include small streams as part of 'waterbodies' even when they are not shown on WFD maps. As controlled waters, all headwaters can potentially be included in pollution control measures. However, this practice seems not to be widely adopted; there seems to be little or no monitoring of these sites so assessing their condition remains difficult.

At present small standing waters are not included in WFDR, with the exception of a small subset which were lobbied for by NGOs and have been retained in the system. Strangely, for most of these sites no meaningful data are collected. For example, Black Pond, Esher is part of Esher Commons SSSI and the pond, and associated species, are part of the SSSI designation. Stakeholders agreed that small standing waters were not covered by WFD Regulations.

2. **The potential to consider the whole water environment: this may be possible in the implementation of the Environment Act 2021**

At present, no legislation supports the management and protection of the whole water environment, as a unified network. Technically the majority of running waters, and many standing waters (those connected to other running or standing waters directly) are controlled waters and should legally be protected from pollution and, through land drainage consent processes, physical modification. River Basin Management Planning should protect the whole running water network but quirks of the mapping and management process have led to less emphasis on smaller waters. Although legislative protection of running waters is all-encompassing and theoretically comprehensive, in practice the process is overwhelmed by the shear extent of pollution and small-scale physical modifications and by the generic and non-specific nature of measures to protect many small running waters. Present legislative mechanisms generally provide less protection for small standing waters (small lakes and ponds) from pollution and physical damage. This is largely a reflection of their effective exclusion from River Basin Management Plans.

New approaches to water protection in the Environment Act and the Plan for Water may provide opportunities to protect the whole water environment, the plan noting that "*when in a healthy and naturally functioning state, rivers, streams, ponds, lakes, wetlands, estuaries, and coasts deliver multiple benefits for society*".

3. The legal requirements - relevant to both 'water' and 'nature' legislation

Stakeholders discussed the importance of legislation, how it was applied and the support it provided for practical actions. There was general agreement that the 'strongest' legislation (i.e. measures regarded by Government as 'Statutory' - see Table 9) was most useful in achieving practical outcomes.

4. The need to ensure public acceptance of environmental measures

The process by which environmental improvements are made by the Water Industry, in processes co-developed and agreed with the statutory agencies and Ofwat, have a considerable degree of flexibility to incorporate environmental enhancements.

Stakeholders noted that, although the Water Companies are encouraged to be as innovative as possible in developing environmental solutions, a critical component of this process is that water company customers support these activities.

5. The role of alternative approaches – wetlands

There was discussion amongst stakeholders about the use of alternative approaches to treatment of effluents, particularly using constructed wetlands. Stakeholders included those who were strong supporters of this approach and there was little doubt that further experimentation in this area would be valuable as experience grows.

6. Sharing experience

Water companies, because they operate in essentially non-overlapping geographic areas, may be isolated from each other, their operations and experiences. Unlike regulators, they are not part of single national organisations, except through their representative body, Water UK. Several stakeholders supported the idea that further collaboration between water companies would be valuable, sharing knowledge, skills and idea where this helped better to protect the environment.

7. The complexity of the wastewater process and water pollution more generally: it's about more than the storm overflows

There was a clear sense amongst stakeholders, coming from a number of different perspectives that, while it was important that storm overflows were better managed, there was a danger of storm overflows becoming 'the only show in town'. This was a very challenging problem to deal with given that actions to deal with storm overflows have high priority and will require very substantial expenditure and may produce only modest environmental gains. Some stakeholders felt that it would be valuable to treat work on small waters as an economical 'quick win', likely to produce benefits far sooner, and for much less money, than the legally prioritised work on storm overflows.

8. There's no shortage of legislation: you can find a workaround if you've got one of the primary legislative drivers – that's the key

Stakeholders noted that there is a lot of legislation to work with: there's nothing to say that you can't do something, other than its degree of legal priority and the funding to do it. Others noted that, if you wanted to get something done (perhaps particularly if it was a nature conservation objective) it was vital to have the action underpinned by one of the statutory legal duties.

9. Fair shares and affordability rules

Stakeholders spent quite a bit of time discussing how the 'fair shares' approach can hamper their work. Water companies have very straightforward control over their assets, and can control how well they are working (though perhaps storm overflows are a salutary reminder that that may not be so simple). In contrast land managers have traditionally had much less control over the pollution they generate – perhaps because it is by definition more diffuse and generally not so apparent to the naked eye (though the spill from the silage clamp, slurry store or milk tank can be just as obvious as the sewage overflow).

This led to discussion about water companies extending activities out into the wider landscape and working more with others – something most now do. There is always a degree of tension in this process at present because in one sense it is 'not their problem' and the fair shares approach builds this into policy. In another sense it is quite perverse for water companies to spend billions of pounds of customers money making improvements which don't lead to much environmental improvement because they have much less influence on what the other polluters are doing.

10. Opportunity for knowledge gaps and new approaches

Stakeholders commented that there were opportunities to evaluate and attempt to fill knowledge gaps and generate new approaches. In our discussions we had a strong sense that water companies were enthusiastic about making the environment better and working collaboratively to do that. We suspect that many of their customers might find this surprising and perhaps be ready to hear a more nuanced story than the one that has become embedded in popular thinking.

11. The role of the catchment and, for water companies, how far outside the traditions of asset focused work can/should they go.

There was some discussion about the extension of the catchment approach – generally stakeholders agreed with this idea and would probably like to see it used as much possible. Quite probably current legislation will not allow water companies and others to go as far as they would like in seeing the water environment as a whole. By developing new approaches slowly and feeling their way it has been possible to make change – but more legislative change may be needed to get the maximum benefit from the catchment approach.

12. You can do quite a lot now; there is almost nothing stopping any action to improve the water environment except prioritisation of funding.

The stakeholders we met were resourceful people and often at the cutting edge of developing new ideas – perhaps that was inevitable when discussing something that is a bit beyond business as usual. Several stakeholders were able to find legally supported routes for doing things which, were it not for their personal powers of persuasion, would not otherwise have happened. It seemed likely that some approaches could be more widely implemented if they weren't dependent on that distinctive class of advocate who blazes trails – not a role everyone feels comfortable in. This was another area where tidying up legislation with the backing of a Ministerial statement could go a long way to doing some good.

11. Conclusions and recommendation for policy change

We make recommendation on policy and regulation changes to achieve positive outcomes for headwater catchments in (a) the current regulatory environment and (b) with changes to policy and legislation in the short (12-24 months), medium (up to 5 years) and longer term (5 years+).

11.1 Overall conclusions

Water management is in long-term transition from being separated into 'water' and 'nature conservation', to becoming a unified concept: the 'water environment'. This process has seen duplication, overlaps and separation become less of a barrier to efficient and effective action to protect the water environment. Further changes creating a truly unified 'water environment' in policy terms can be made without the need for primary legislation. However, given the major problems facing the water environment, highlighted by many, including recently The Office for Environmental Protection, it is possible that further legislative changes will also be necessary. This is because the water environment has probably never been more in need of transitioning from a resource to be exploited to an environmental system to be nurtured if that environment is to go on providing essential services.

The OEP has recently noted substantial problems in the management of the water environment. In Table 13 we highlight recommendations made by The OEP which have a substantial bearing on the management of headwaters. We suggest ways in which recommendations made by The OEP could facilitate new approaches to headwater management which could help people, society and the environment more widely.

11.2 Policy and regulation changes in the current context

Using information from the reviews and discussion in earlier sections of the report we first identify and recommend practical programmes and investigations that could be made relatively easily within current policy frameworks. These include:

- Developing and testing the Safe Operating Space concept for small wastewater treatment plants on first and second order streams as the basis for 'ecological corrections' to the process of prioritising upgrades on smaller wastewater treatment plants.
- Evaluating the quality of all streams that are receiving effluents from Descriptive works to assess their quality and the length of stream sections that are impaired; use this information to prioritise headwater streams which are discharging into chemically and/or biologically High status headwaters.
- Develop a pilot programme to identify High status first and second order headwater stream catchments combing data review and field investigations, including use of citizen science techniques.
- Provide guidance for Catchment Partnerships and Local Nature Recovery Strategy Responsible Authorities on the role and importance of headwater catchments.
- Plan and prepare programme of works to pilot headwater catchment restoration and recovery projects building on practical demonstration programmes (e.g. Water Friendly Farming, water company projects such as Catchment Nutrient Balancing in the Tone, Parrett and Dorset Stour).
- Develop a headwater catchment prioritisation advice programme with Ofwat and the statutory agencies, working on sites which are underpinned by statutory legal requirements (e.g. areas where small wastewater treatment plants intersect with Drinking Water Protected areas and 'Habitats' sites such as alkaline headwater fens).

- Develop a small wastewater treatment plant data programme to obtain key information about effects of, and benefits of upgrades to, small wastewater treatment plants. Identify learning opportunities from on-going projects e.g. the upgrade of Tilton-on-the-Hill Water wastewater treatment plant which is inside the project's case study area and is now programmed for upgrading to a standard numeric permit.

Additionally, we specifically recommend that:

- Water companies are required to provide evidence that wastewater plants discharging into first, second and third order streams are not outside the ecological 'Safe Operating Space' (i.e. effluent volume great than 6.5% of flow).
- Water Companies are required to identify all Descriptive wastewater treatment plants discharging into High or Good status headwater streams (Tilton-on-the-Hill is an example of this – though now it is getting a numerical permit).

11.3 Short, medium and long-term policy and regulation changes

We identify a range of short, medium and longer term policy and regulation changes that will help to increase benefits we obtain from the headwater environment.

11.3.1 Short term change in policy (12-24 months)

The following changes are recommended:

- Government provides guidance to Responsible Authorities managing Local Nature Recovery Strategies (LNRSs) to take account of small waters, making consideration of small waters a binding target in LNRSs as part of the Plan for Water. At present LNRS guidance notes that responsible authorities should consider 'improvements to the water environment' and take account of 'plans such as river basin management plans and related plans for water management'. A simple word change, so that 'improvements to the water environment' becomes 'improvements to the water environment, including small waters' would be sufficient, along with a glossary of terms of what constitutes small waters (see Section 3.2).
- Through the Catchment-based Approach, provide support for catchment partnerships to take account of small waters by (a) making Ordnance Survey mapping of all small standing waters freely available and (b) identifying the catchments of all first to third order streams, and labelling national maps defining steam order.
- Develop a land manager version of WISER to provide assurance to the water industry about what is 'in-scope' for catchment management to support the work done on company wastewater treatment plants.
- Incorporate the Important Freshwater Landscapes and Important Freshwater Areas concepts into water and nature planning (e.g. RBMPs, LNRSs).
- Develop a 'small waters' guidance manual and other materials dealing practically with all aspects of small waters to raise awareness of their importance.
- Defra provides guidance on measures to highlight mechanisms already available to protect small waters; this would provide a pilot for the simplification and updating of Water Framework Directive Regulations and River Basin Management Plan programmes of measures.
- Work with The OEP Recommendation on the WFD (see examples in Table 13) to develop areas where easy wins could be achieved in delivery of WFDR goals through work on headwaters, ensuring they are widely adopted. These include:

- structural adjustment to RBMPs, which should include advice to include headwater streams, ponds and small lakes in future RBMP objectives.
- Catchment Partnerships are given a clear role in the protection, management and creation of small waters.
- development of an integrated programme of monitoring of small waters, already in part implemented by partnerships of statutory agencies and NGOs, and used as a test case for this more coherent approach
- incorporating mechanisms for protecting, managing and creating small waters would provide an ideal pilot for improving the implementation of the WFD Regulations.
- Including small waters explicitly in further developments of the Plan for Water.

- Support updating of WFD Regulations (The OEP notes 'the government can modify, replace or revoke the WFD Regulations') to:
  - include small standing waters in the regulatory system
  - clarify the approach to headwater streams so both are assessed and managed in River Basin Management Plans as was originally intended in the goals of the Directive.

Additionally, we specifically recommend that:

- Water companies prioritise upgrading of Descriptive works discharging to headwater streams inside Important Freshwater Landscape if there is evidence of stream quality impairment.

11.3.2 Medium term change in policy (up to 5 years)

In the medium term we recommend the following five changes:

- Modify Water Framework Directive Regulations to adopt System B (i.e. including standing water less than 50 ha in area) for monitoring and management of freshwaters in River Basin Management Plans so that small standing waters are included in practical regulation.
- Update definition of Controlled waters to ensure that it unambiguously offers protection to smaller waters; provide guidance that headwater streams are specifically recognised on River Basin Management Plans.
- Extend and modify Environment Act water and habitats targets to be more outcome focused, including biological targets to integrate with EIP including:
  - Extent, in hectares, of WFDR 'clean water' (i.e. Good and High status)
  - Extent, in hectares, of High and Good status biological assemblages
  - Refine targets for habitat creation in Environment Act to specifically recognise creation of small waters and small wetlands; despite their small size (making limited contribution to overall area-based targets) policy should specifically drive their creation.
- Build on existing catchment pilots in the WINEP programme to test headwater and small water catchment programmes in each water company region.
- Develop a specific programme of headwater investigation and piloted demonstration projects in the WINEP to underpin advice and guidance from Ofwat to the water companies.
- Create integrated 'all-waterbody' catchment plans as part of development and revision of Plan for Water.

Additionally, we specifically recommend that:

- 10 pilot catchments are identified where measures to manage whole upper catchment water environment are trialled, the recommendations identified here.

11.3.3 Long-term change in policy (5 years+)

In the longer term, the following five changes are recommended to enhance the integration of policies on the headwater environment with water policy more generally, and address mismatches between 'water' and 'nature' law in the way the freshwater environment is protected, benefitting headwater catchments.

Practically, headwater catchments are more manageable than lower catchments because they are small. Individual landowners and managers can have a substantial impact, with many examples of this already occurring. Similarly, the water companies are able to apply solutions to smaller works; the main reason for under-prioritisation is that policies embed the concept that they are not significant.

Specifically we recommend:

- Establishing a new 'Freshwater Act' developing the proposal made by Water UK in '21st Century Rivers Ten Actions for Change (WaterUK, 2021). Linked to the NGO proposed 'Charter for Small Waters' this could provide an important long-term driver for investment in headwater catchments, clarify and simplify overlaps in water management and ensure a 'water focused' approach to land management.
- Freshwater Priority Habitats are given equal status in law to Habitats Regulation sites and SSSIs. Stronger protection for freshwater Priority habitats (formally known as 'habitats of principal importance) is needed because:
    - A large proportion of freshwater priority habitats support species under severe threat such as Atlantic Salmon (especially juvenile stages), European Eel, Great Crested Newt, various bats, Water Vole and many red-listed species which are critical to the maintenance of the UKs biodiversity.
    - In terms of their physical size, Priority freshwater habitats, especially those in headwater catchments, are biologically disproportionately important. Increasing their protection, thereby driving greater allocation of finances to these habitats, is cost-effective because they are small, so require less money spent on them than larger areas of habitat.
    - Because of their small size, priority freshwater habitats are especially vulnerable to damage. As can be seen in the case of headwater streams there is evidence that they are in generally poorer condition than the network of larger rivers.
    - The protection level for freshwater habitats of Principal Importance should be raised from requiring public bodies to 'have regard to', to a legal duty to protect priority habitats, which are the bedrock if England habitat conservation.

  Additionally, for running waters a biologically-led approach to identification of priority headwater streams should be introduced, using a similar approach to identification of priority ponds. This will ensure better protection for freshwater biodiversity than approaches based on 'natural processes' which, paradoxically, downplay the importance of the biodiversity which is the objective of protection.
- Create a 'small waters' fund targeted on measures to protect High status small waters (i.e. first and second order streams, ponds and small lakes). The aim of the fund would be to redress the imbalance in water management created by the long history of bias against all kinds of small waters.

- Landuse intensity is the key to the quality of freshwater habitats: adjust primary legislation to include a programme of Water Environment Protection Zones to protect existing high quality small standing and running water catchments with an ambitious programme to extend this network of sites, starting at the top of catchments and in areas with high concentrations of important standing waters, working downstream (running waters) and linking up sites (standing waters).
- 'Small waters'-proof existing water management policy generally to ensure that the century long imbalance in priorities is corrected.

Additionally, we specifically recommend that:

- Water companies identify and prioritise upgrades to Descriptive work discharging into biologically important headwaters. This could include catchments that would qualify as 'Water Environment Protection Zones.'

Note that although all 'Headwaters' are in theory priority habitats (i.e. habitats of principal importance), to support the delivery of Environment Act species targets this should focus on those that fulfil quality criteria that are initially prioritised biologically or in terms of water quality (e.g. have Red-listed or protected species, have biological assemblages of High or Good ecological status, have diverse assemblages).

Table 13. Analysis of The OEP recommendation in "A review of implementation of the Water Framework Directive Regulations and River Basin Management Planning in England" and implications for headwaters

"There is also potential for change to existing water law and policy. Government has powers to modify, replace or revoke the WFD Regulations under the Retained EU Law (Revocation and Reform) Act 2023. Without changing the law, Defra and the EA can also adjust how it is applied to maximise effectiveness." (OEP, 2024)
The Plan for Water, published in April 2023, aims to build on the EIP23 by outlining additional actions to support the 'clean and plentiful water' goal and Environment Act targets. Government states in this plan that there to be opportunities to improve the regulatory system through reviewing implementation of the WFD Regulations.
OEP Recommendation 5: We recommend that Defra and the EA adjust the structure, presentation and content of RBMPs for future cycles. ***We recommend that this structural adjustment should include advice to include headwater streams, ponds and small lakes in future RBMP objectives.***
OEP Recommendation 7: We recommend that Government, in seeking to extend the reach of Catchment Based Approach partnerships, more clearly define their role and functioning, and then organise and fund them so they can deliver as intended. ***We recommend that Catchment Partnerships are given a clear role in the protection, management and creation of small waters.***
OEP Recommendation 9: We recommend that Defra develop and implement a coherent and nested monitoring and evaluation framework for the state of the water environment and progress on measures to improve it. ***We recommend that the development of an integrated programme of monitoring of small waters, already in part implemented by partnerships of statutory agencies and NGOs, is used as a test case for this more coherent approach***.
OED Recommendation 10: We recommend that Government retain the fundamental underlying structure and approach of the WFD Regulations, while also consulting on proposals to improve the legal and governance framework to produce a regime that is stronger and includes mechanisms for better implementation. ***We recommend that the incorporating mechanisms for protecting, managing and creating small waters would provide an ideal pilot for improving the implementation of the WFD Regulations***.
OEP Recommendation 12: We recommend that, in further developing the Plan for Water and reviewing implementation of the WFD Regulations, Defra: i) clarify how the WFD Regulations' objectives and the goals and targets of the Environment Act, EIP23 and Plan for Water relate and contribute to each other for both surface water and groundwater……. ***We recommend that small waters are included in further developments of the Plan for Water.***

12. Case study

12.1 Introduction to the case study area

The landscape of the Water Friendly Farming project in Leicestershire was used as the case study for the project. The case study area comprises three adjacent headwater catchments in the Eye Brook, the Stonton Brook and the Barkby Brook. The first two are in the Anglian Water region, draining to the Wash, and the Barkby Brook is in Severn-Trent region, draining to the Humber (Figure 19).

Water Friendly Farming is concerned with the effect of land and water management measures on freshwater biodiversity, water quality and flows. It is a Before:After:Control:Impact (BACI) design study. An introductory overview of the project and its characteristics is provided in Biggs *et al*., (2014).

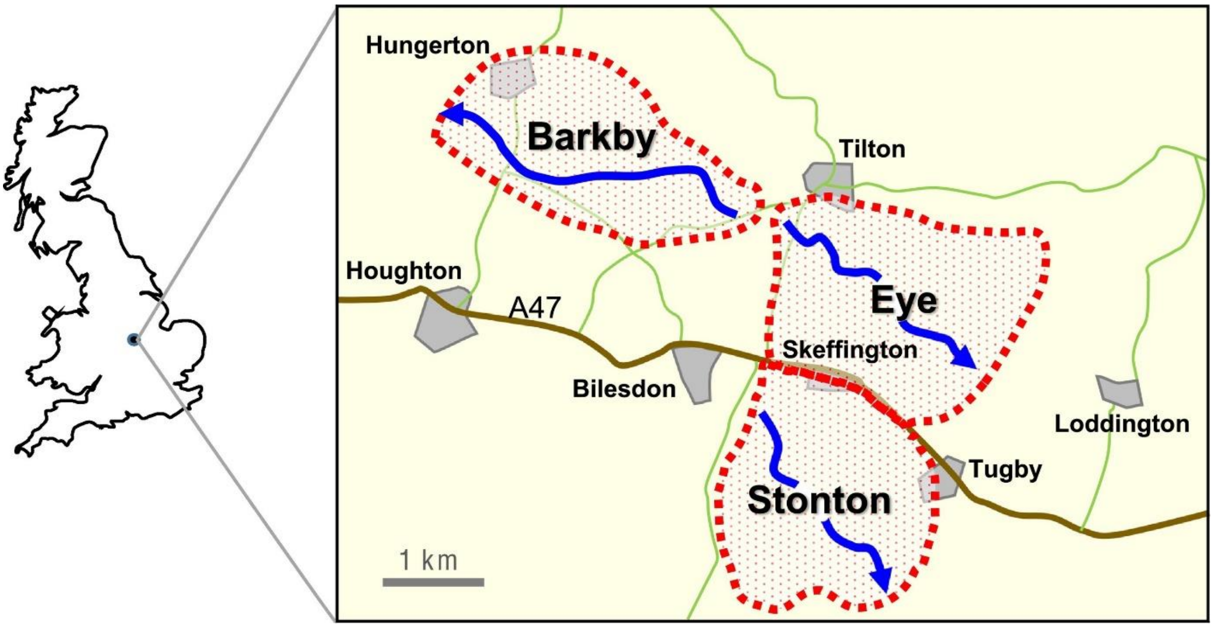


Figure 19. The location of the case study area: the Water Friendly Farming project, Leicestershire (Source: Williams *et al*., 2020).

This area has the only freshwater monitoring programme in the UK that, as far as we are aware, takes account of the whole of the water environment i.e. in this case headwater streams (first to third order), ditches and ponds. The project area has no waterbodies large enough to be rivers or lakes, following the definitions of Brown *et al.* (2008), which have widely applied in the UK.

The water environment in the area is exemplified by the upper part of the Eye Brook catchment which comprises ponds, streams and ditches. These occupy about 0.5% (5 ha) of the total project area (1072 ha) (Figures 20, 21).

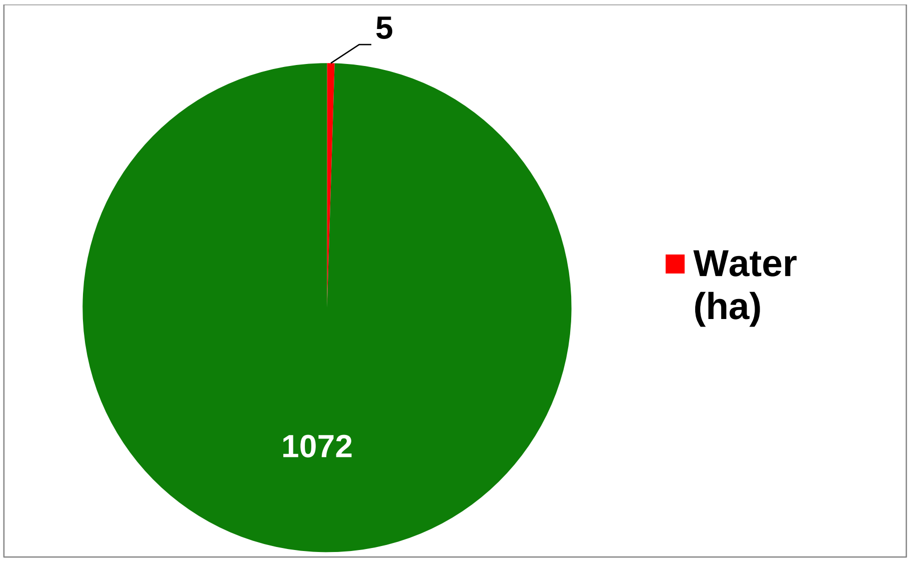


Figure 20. The total area of land and water in the Eye Brook catchment, part of the Water Friendly Farming study area.

The extent of the water environment is probably typical of large parts of England where there are few lakes and large rivers. Note that the total proportion of the England landscape that is water is estimated at 0.8% (Marston *et al*., 2023).

Water Friendly Farming started in 2010. For monitoring purposes, the most detailed data collection has focussed on wetland plants because these can be quickly collected in considerable detail, including a census survey of all waterbodies in all years since 2010. This means that the complete extent of the areas habitats has been surveyed i.e. biological data are not based on a sample of sites so that changes measured are absolute and do not need to be estimated statistically. Other data on macroinvertebrates, fish and diatoms are also collected but there is insufficient funding to maintain the same intensity of survey work. However, there is a range of evidence from other sites indicating that patterns seen in wetland plant data broadly reflect those seen in monitoring with aquatic invertebrates. Water Friendly Farming also has an intensive programme of water quality assessment based on 'continuous' monitoring of catchment outfalls.

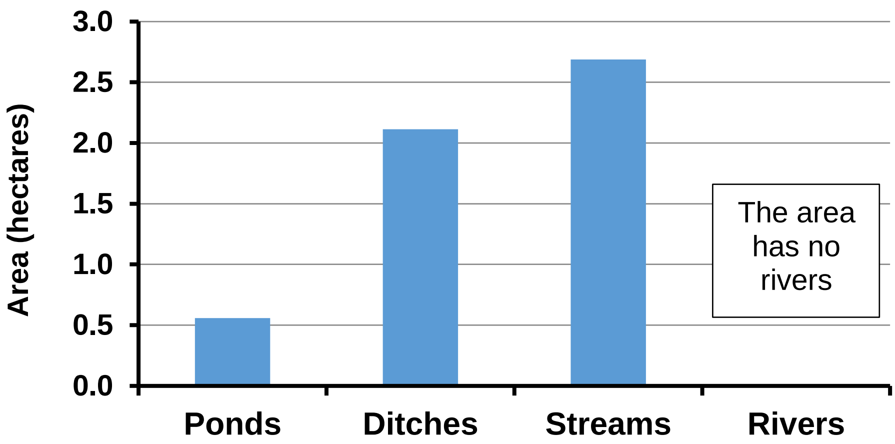


Figure 21. The area (hectares) of different freshwater habitats in the Eye Brook catchment in the Water Friendly Farming project.

The project area provides a number of important demonstrations of key principles of the water environment which are not currently well-known, or embedded in policy, including:

1. The comparative richness of different waterbody types, showing the exceptional importance of ponds
2. The heterogeneity of the headwater environment, with sites varying from highly impacted to near pristine, even within the constraints of an intensively farmed landscape (Figure 23)
3. A long-term decline in whole landscape biodiversity
4. Evidence of the effectiveness at landscape scale of certain habitat management measures. Specifically:
   - creation of clean ponds which led to striking increases in freshwater biodiversity
   - more polluted habitats intended to add ecosystem services have some biodiversity benefits but do not add to overall landscape diversity, so do not reverse whole landscape biodiversity declines.

These points are described in detail in Williams *et al*., 2020. More recent updates are referred to below.

The Water Friendly Farming landscape also provides clear evidence of the heterogeneity of small waters, particularly ponds and ditches, in the headwater environment. As is typical for freshwaters generally, running waters (the streams) show more uniformity in water quality (Figure 23).

12.2 Importance of ponds for freshwater biodiversity

The Water Friendly Farming landscape closely replicates the results of the widely cited paper by Williams *et al*. (2004) that first demonstrated the richness of ponds compared to other freshwaters. Results from the project are summarised in Figure 22, below, which shows gamma (whole landscape) diversity of wetland plants for ditches, ponds and streams, and for all habitats combined ('all catchments') over the first 9 years of results of the project. Note that there are no data for 2013 when mitigation measures were installed.

There are three key features to note:

1. Ponds are consistently the richest habitats in all years, supporting roughly two to three times more species than ditches or streams.

2. Streams are only slightly richer than ditches overall

3. About 90% of species can be found in ponds.

There was also a significant general decline in wetland plant richness across the whole landscape over the course of the project, which is discussed further below.

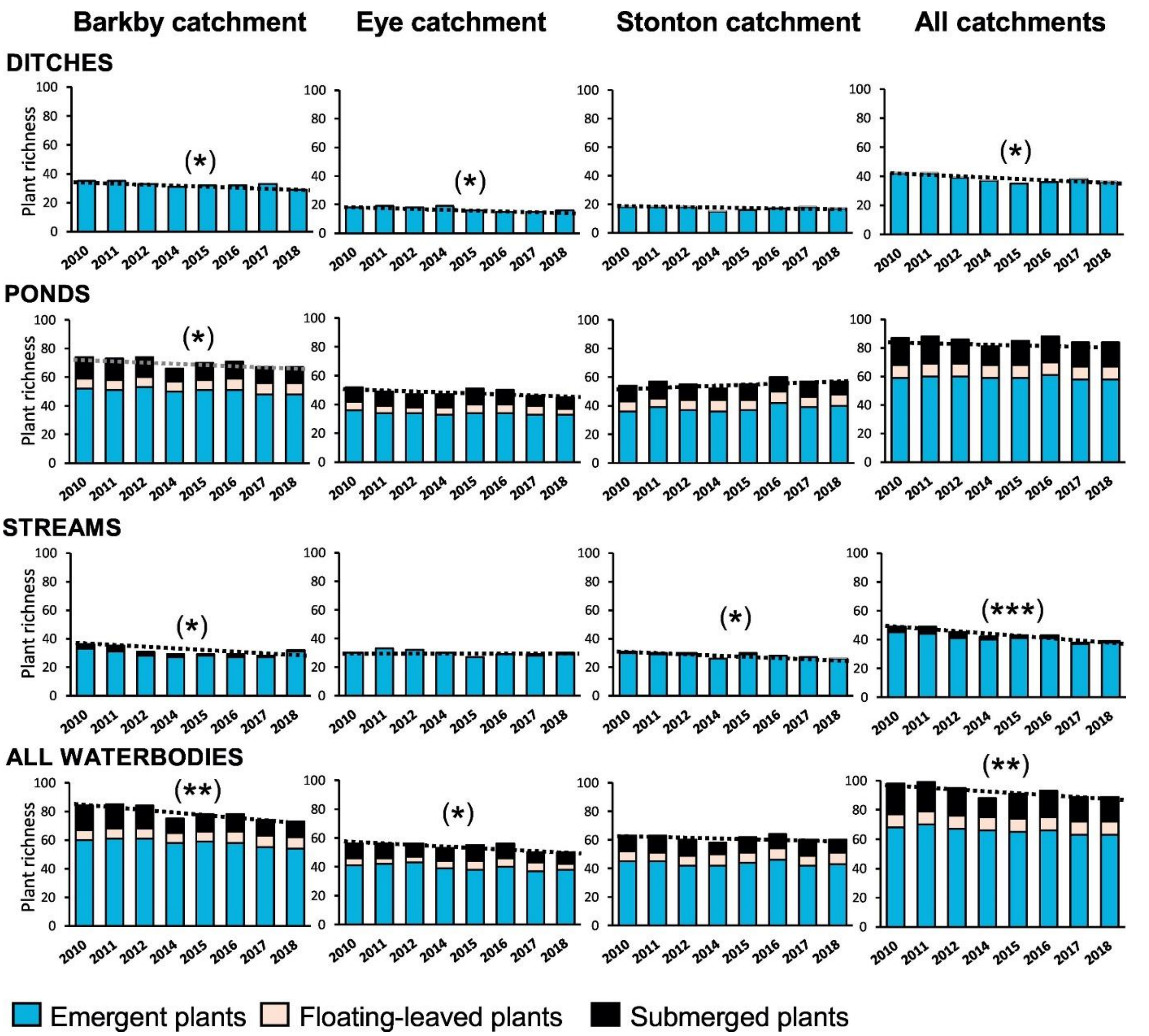


Figure 22. Plant gamma richness for all ditches, ponds and streams in each of three catchments, shown with a line of best fit. No data were collected in 2013 when measures were being implemented. The graphs do not include new waterbodies or features added after 2014, and hence show underlying trends in the absence of nature-based measures. Dotted lines show the simple linear regression for total plant richness in each waterbody and catchment. Asterisks denote the statistical significance of the regression equation: p-value <0.05 (**), <0.01 (**), <0.001 (***).

12.3 Heterogeneity of the headwater environment: water quality in the Water Friendly Farming landscape

12.3.1 Water Friendly Farming heterogeneity data

Chemically, headwaters (streams, ponds, ditches) in the Water Friendly Farming landscape, measured with single snapshot samples collected in annual whole catchment surveys, showed a wide range of chemical quality (Figure 23). Using the Eye Brook as a demonstration case, we found that:

- Streams were chemically the *least* heterogeneous habitats
- In 17 out of 20 cases, ditches and ponds showed the largest differences between the minimum and maximum values for the 20 determinands measured. Only for ammoniacal nitrogen, nitrite as N, sodium and copper were ranges greater for streams than other habitats.
- Differences between minimum and maximum values were sometimes substantial: for example, the difference between the lowest and highest values seen for total oxidised nitrogen was 47 mg/L, a very substantial difference.

More information about the results is given in Biggs *et al.* (2014).

12.3.2 High and low water quality in the same landscape

The case study area is also notable for showing how very good water quality can occur in the same quite small area as very poor water quality in smaller headwater systems. This is most noteworthy in the case of phosphorus. Two lines of evidence from the case study area show how streams with very low phosphorus levels can be found even in apparently intensive landscapes: (a) Water Friendly Farming project data and (b) results of phosphorus research undertaken by Palmer-Felgate *et al*. (2009).

Water Friendly Farming data showed that streams in both the Eye Brook and Stonton Brook catchments included watercourses that had phosphorus concentrations that were similar to High status under WFD, as well as much more polluted at Moderate or Poor status.

In addition to the data collected during Water Friendly Farming, an intensive study of phosphorus pollution undertaken for Defra by Palmer-Felgate *et al*. (2009) also showed that the upper Eye Brook was an area with low, near background, phosphorus levels.

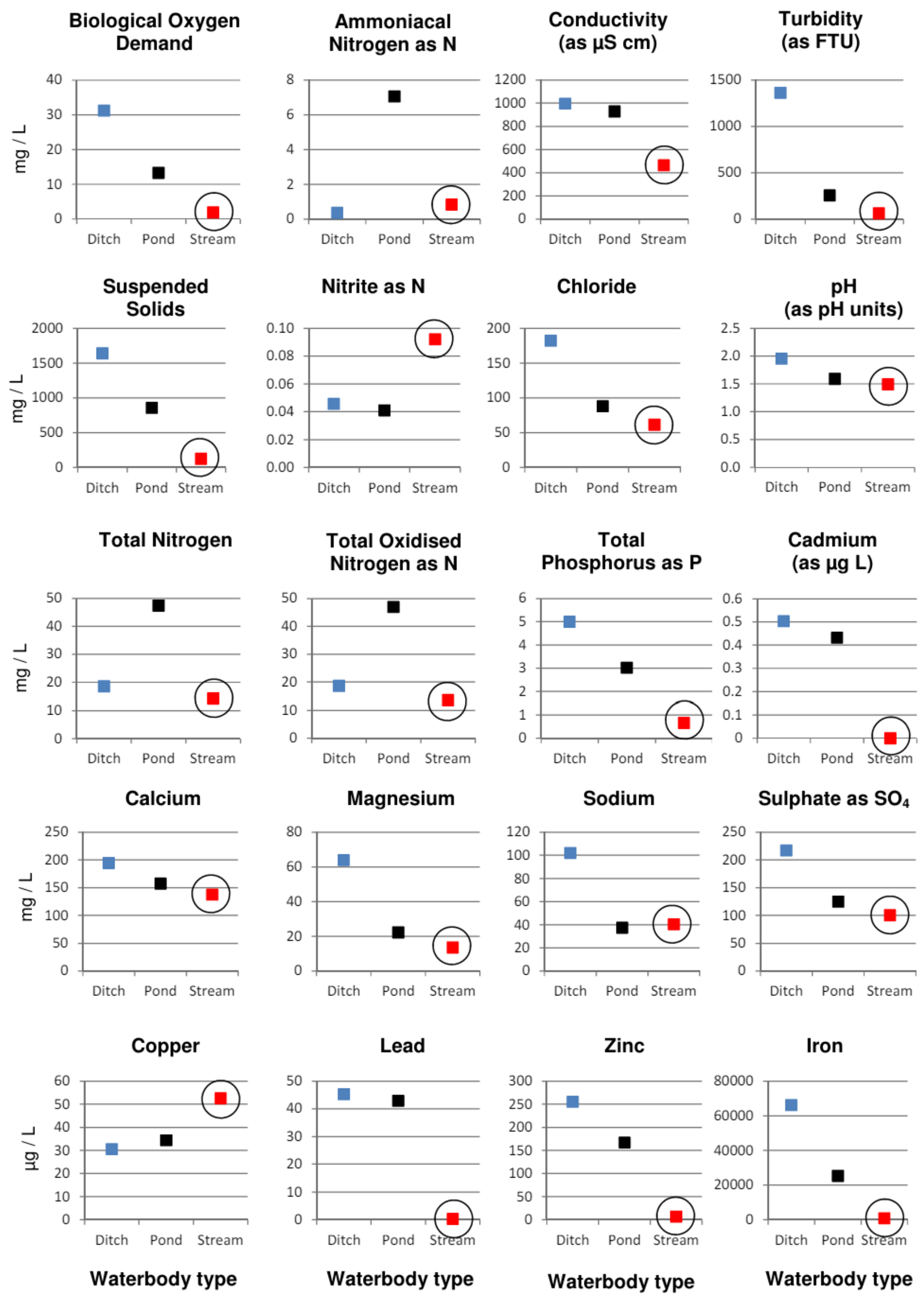


Figure 23. Chemical variability of freshwater habitats (ponds, ditches and streams) at the landscape scale.

Graphs show range from minimum to maximum values for each determinand in the three waterbody types present in the Water Friendly Farming Landscape: ponds, ditches and streams. Data from all three catchments combined; n=60 for each habitat in all figures. Values are mg/L, unless stated in caption above graph, except metals which are µg/L. Streams are circled for clarity.

Working at Digby Farm in the upper sections of the Eye Brook (Figure 24) Palmer-Felgate *et al.* (2009) found that, in this low intensity hilltop grass catchment, there were very low Soluble Reactive Phosphorus concentrations (falling below analytical detection limits of <7 µg-P L^{-1}) between April and September, with highest concentrations (typically 10–25 µg-P L^{-1}) during the winter months. In both seasons these values are equivalent to WFD High Status and are substantially below the values seen further down the catchment and in other catchments studied by Palmer-Felgate *et al*. (2009). For instance, in the Wye catchment at Kivernol, Herefordshire, Soluble Reactive Phosphorus levels peaked over 1000 µg L^{-1} (Figure 25).

Digby Farm has chalky boulder clay soils; seasonally waterlogged clayey and fine loamy soils. Most fields have under-drainage and ditches are common. The landscape is permanent pasture (beef, sheep, silage production) and there are no major wastewater discharges. At the time of the study, all 4 residents (1 farm) were served by a septic tank which was not in direct connectivity to the stream.

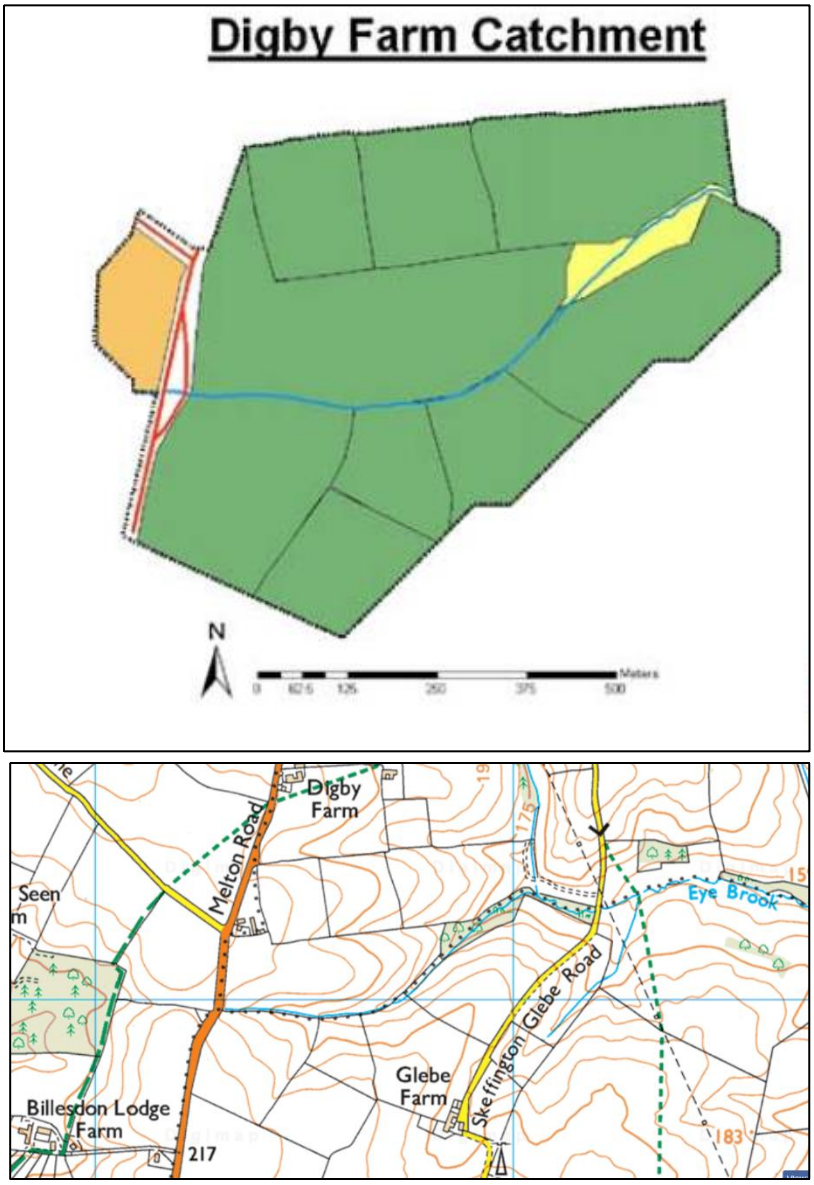


Figure 24. Digby Farm at the start of the Eye Brook, a location with very low, near natural, stream phosphorus concentrations. Source: Palmer-Felgate, et al., 2009.

Kivernoll in contrast, in the Wye catchment, had intensive arable cultivation (winter cereal, oilseed rape, sugar beet, potato and poultry farming. There was a small village wastewater treatment plant (discharging directly to the stream) and 190 residents (ca. 27% of the population of 709) relying on septic tanks.

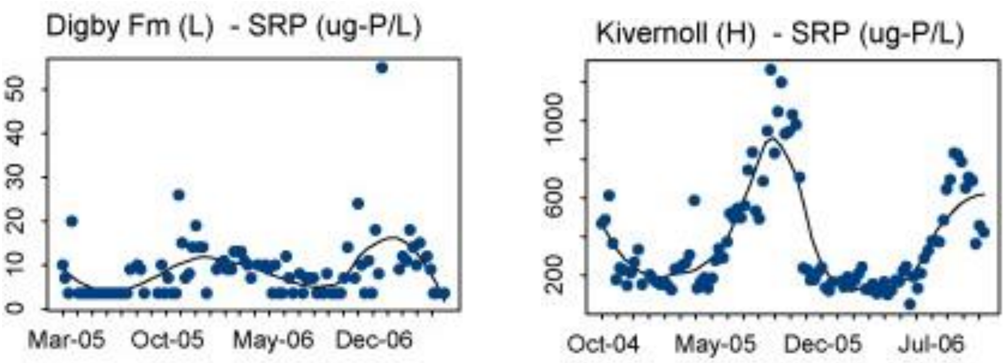
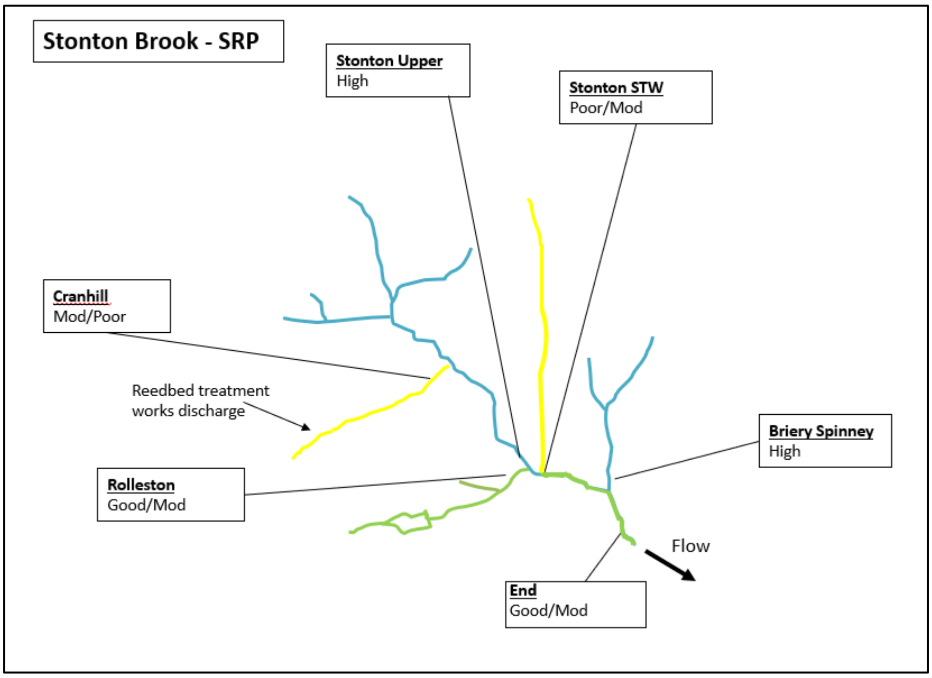


Figure 25. Comparison of the near natural phosphorus levels at Digby Farm in the case study area with Kivernoll, an arable and small wastewater treatment plant dominated stream in the Wye catchment (from Palmer-Felgate *et al*., 2009). Note that phosphorus concentrations are approximately 100 times lower at Digby Farm.

1. There are two practical implications of these observations. It is possible that wastewater treatment plants in rural areas could be discharging into waters otherwise very little polluted. This contrasts with the suggestion from some work that headwaters are most likely to be dominated by agricultural pollution; clearly this is not always the case.

Water was mostly High status for phosphorus except for the sub-catchment affected by Tilton-on-the-Hill Water wastewater treatment plant (see Figure 29).

2. This illustrates the diversity of headwater systems and how this is not captured by standard WFD-type monitoring. The Environment Agency currently describes both the Eye Brook and Stonton Brook as Moderate status for phosphorus, reflecting the way that measurements further down the catchment integrate the whole landscape stressors and hide the inherent diversity that exists.



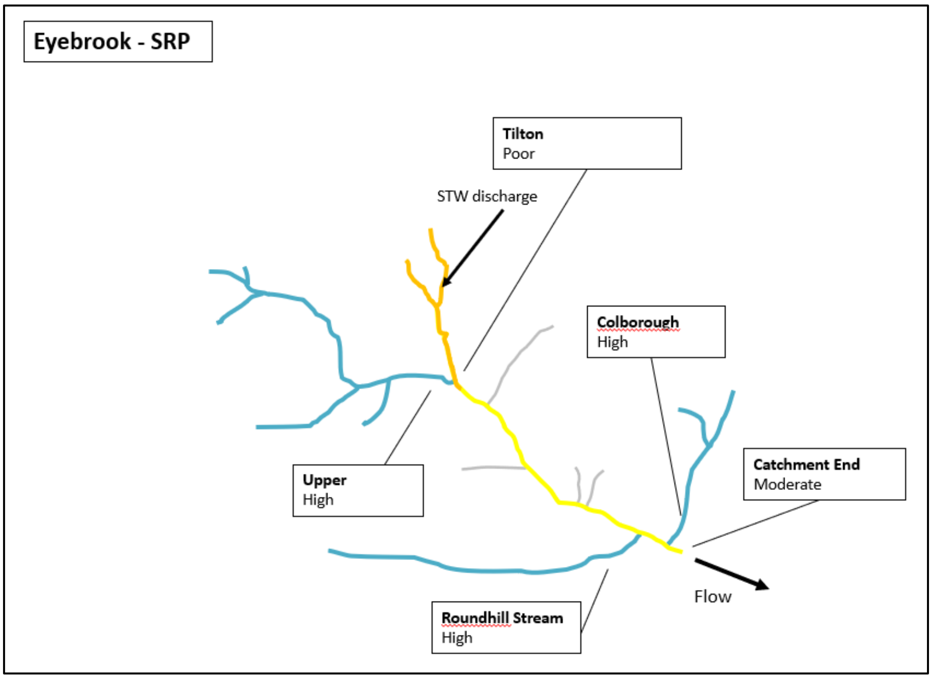


Figure 26. Variations in Soluble Reactive Phosphorus levels in the Stonton Brook and Eye Brook catchments showing the co-occurrence in the same landscape of streams with phosphorus levels equivalent to Poor, Moderate, Good and High status under WFD classifications.

12.3.3 Resilience, quality and diversity

The data collected from the case study area, and from other studies of small waters suggests three important features of these waterbodies:

Resilience. The richness of the small waters in the case study area suggests that they are likely to contribute to the overall resilience of freshwater ecosystems in these landscapes.

Quality. Data from the case study area also support the idea that high quality waterbodies can exist even in generally intensely used landscapes, if those waterbodies have small catchments protected from stressors.

Diversity. Small waters are highly diverse habitats at the whole landscape scale.

12.3.4 Practical implications of small water heterogeneity for small wastewater treatment plants

Current monitoring programmes do not provide data on water quality heterogeneity at landscape scale because they focus on larger running waters.

However, in the case study area, data suggest that prioritisation of improvements to small wastewater treatment plants would be beneficial because improvements would not be compromised by diffuse pollution impacts from agricultural runoff. In these small catchments, with landuse dominated by grassland and stream networks often having substantial (20 m+) wooded buffer strips, the benefits of cleaning up wastewater plants would be maximised.

12.4 Descriptive works in the Eye Brook and Stonton Brook catchments within the Water Friendly Farming project area.

Like many rural areas, the landscape in the case study area is served by a number of small Descriptive wastewater treatment plants.

In the Eye Brook, Tilton-on-the-Hill works is scheduled for upgrading as it has been approaching the 250 PE level for some time. Anglian Water collects more data about these sites in preparation for the upgrade that works exceeding 250 PE will require. A second works at Belton has a Descriptive permit.

In the Stonton Brook there are five wastewater treatment plants, all with Descriptive permits.

Data on these wastewater plants are provided by Anglian Water to the Environment Agency as part of their permit compliance for the Eye Brook and Stonton Brook. Since 2009, Anglian Water are only required to provide the data for the chemicals listed on their permit as part of Operator Self-Monitoring (OSM).

The following data were available:

(i) for Tilton on the Hill, monitoring data for effluent quality from Jan 2000 to April 2024.

(ii) for Belton wastewater treatment plant (AW5NF594) from Jan 2000 to April 2024.

(iii) from 5 works in the Stonton Brook catchment: Skeffington, Goadby, Glooston, Shangton and Thorpe Langton wastewater treatment plant with limited data as all works have descriptive permits. Jan 2000 to today.

Data for effluents at Tilton on the Hill are indicative of levels which could reduce water quality with nutrient concentrations well above levels likely to affect nutrient sensitive ecosystems (although this rule would not apply on the Eye Brook). Other determinands are closer to normal standards. In the Stonton Brook levels of orthophosphate and ammonia seem to be well above levels normally permitted in effluents.

Tilton-on-the-Hill

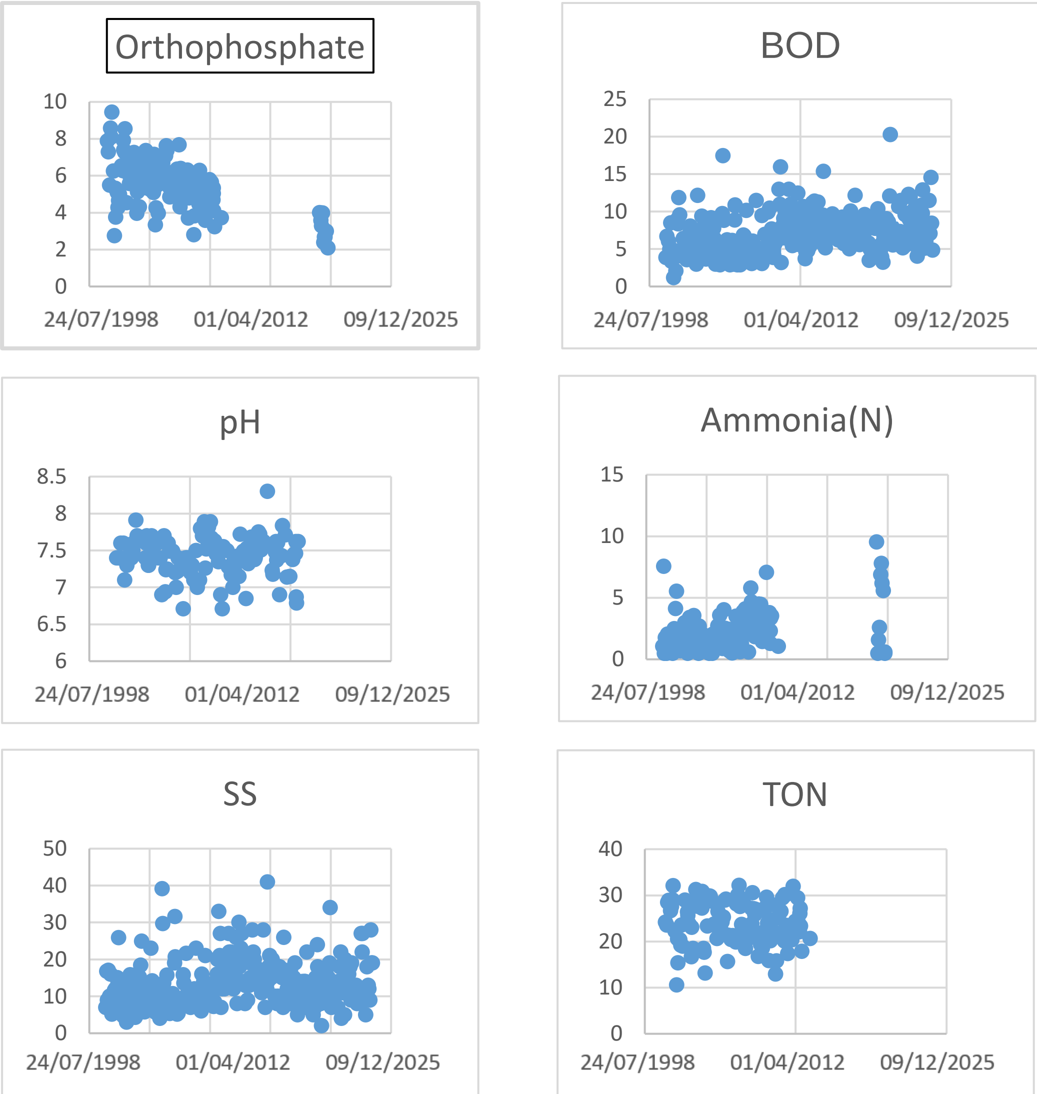


Figure 27. Effluent chemical quality for the Tilton-on the Hill Water ecycling Centre which discharges into the Eye Brook.

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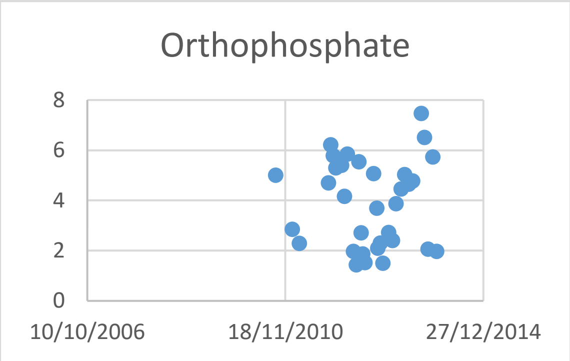
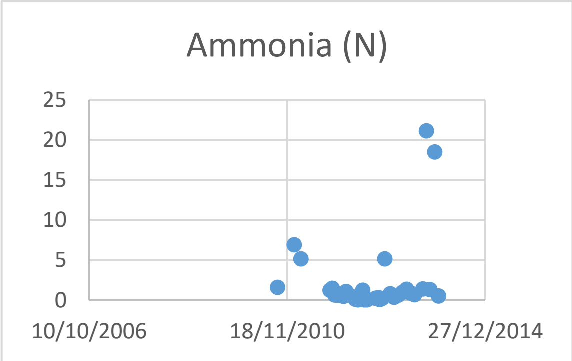
Skeffington





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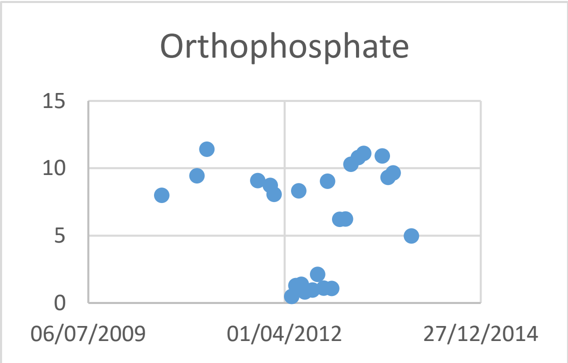

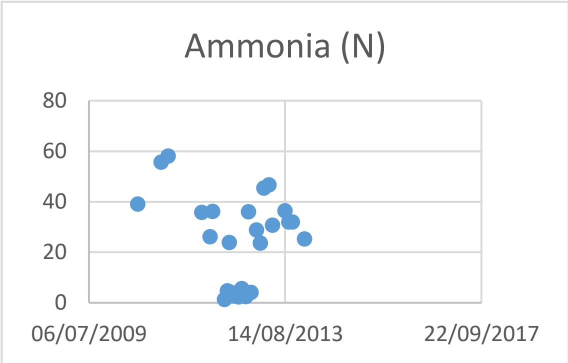

Thorpe Langton

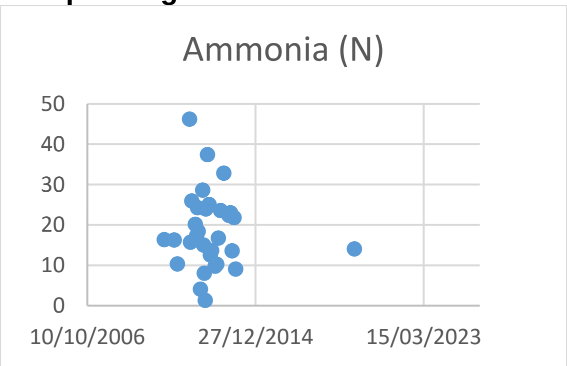

Figure 28. Examples of occasional data collected for the Descriptive permits of the small wastewater treatment plants discharging into the Stonton Brook.

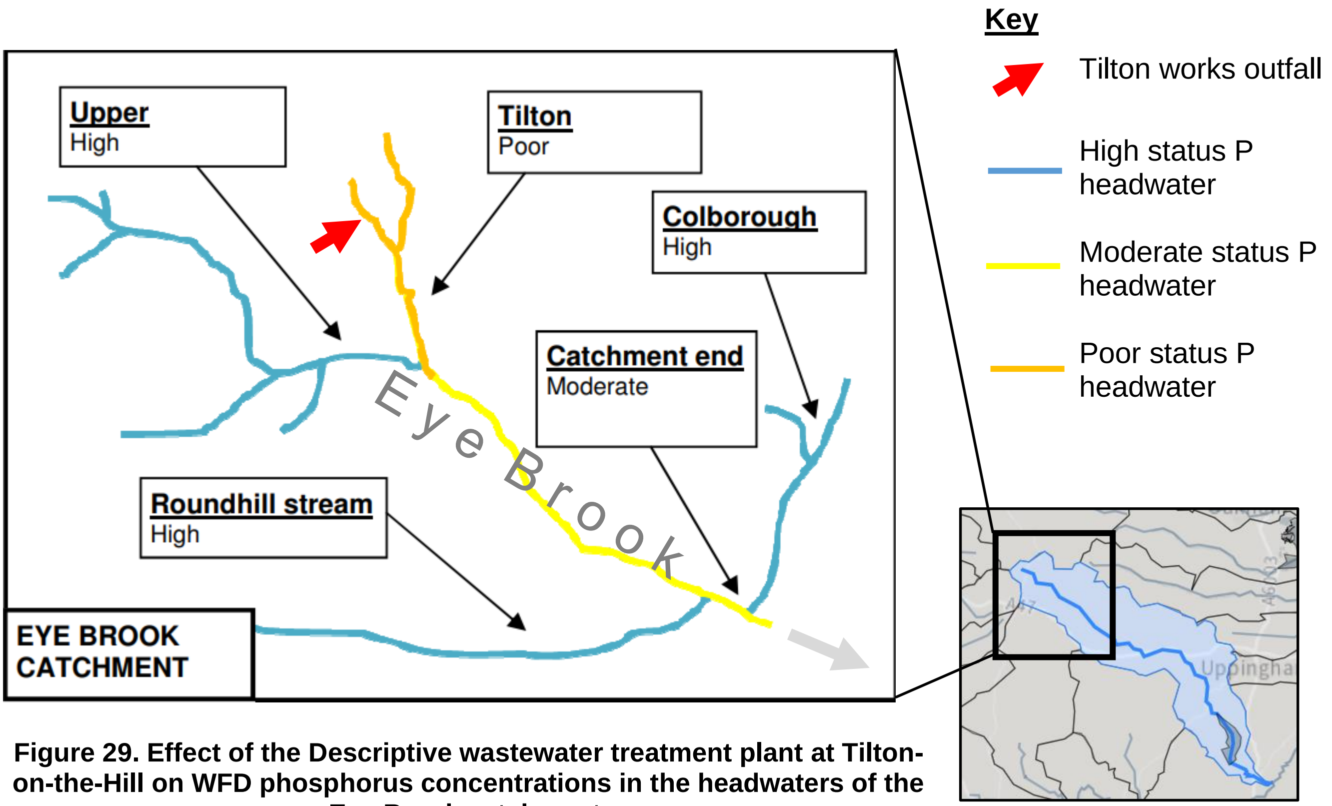

Figure 29. Effect of the Descriptive wastewater treatment plant at Tilton-on-the-Hill on WFD phosphorus concentrations in the headwaters of the Eye Brook catchment.

Headwater tributaries of the Eye Brook were found to be at High status for phosphorus, except where impacted by Tilton wastewater treatment plant. Reducing phosphorus loads here is likely to be cost-effective because there would be little or no constraint from agricultural phosphorus sources. At this site the WFD classification treats all of the headwater tributaries shown in Figure 29 as a single waterbody (see inset) whereas the true situation is considerably more nuanced.

The Eye Brook wastewater treatment plant at Tilton-on-the-Hill has now passed the 250 PE threshold and is due to be upgraded. This works has a pronounced effect on the ecological quality of the Eye Brook with catchment monitoring undertaken in the Water Friendly Farming project showing that above the works tributaries of the Eye Brook were high status for phosphorus whereas below the tributary headwater into which the works discharged phosphorus levels were raised substantially.

Table 14. Typical sewage effluent standards for the UK	
Biochemical Oxygen Demand (BOD):	around 20 mg / L
Total Suspended Solids (TSS):	20 to 30 mg / L
Ammonia:	1 to 5 mg / L
Total Phosphorus	0.5 to 1.0 mg / L.

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Appendix 1 Agenda and questions used to guide discussion in one-to-one interviews with water sector stakeholders

Agenda

Roundtable workshop and discussion (facilitated by Freshwater Habitats Trust)

14.30-15.00 Session 1: How do legislative barriers prevent the protection of upper catchment freshwater ecosystems?

15.00-15.30 Session 2: What are the optimum outcomes for headwater catchments if current legislative and cost:benefit approaches were not a limiting factor?

15.45 – 16.15 Session 3: To what extent do current approaches restrict improvement of Descriptive water recycling centres and other parts of the water environment

16.15 – 16.45. Roundup and summary

Questions used to guide workshop and discussion in one-to-one interviews with water sector stakeholders

We will be seeking your views on three broad themes (1 to 3 below):
1. How do legislative barriers prevent the protection of upper catchment freshwater ecosystems?
2. What are the optimum outcomes for headwater catchments if current legislative and cost:benefit approaches were not a limiting factor?
3. To what extent do current approaches restrict improvement of Descriptive wastewater treatment plants and other parts of the water environment?
The subsidiary questions are prompts to help us get discussion going. We don't expect to cover all the questions today and will pick many of them up in the one-to-one sessions.
1. How do legislative barriers prevent the protection of upper catchment freshwater ecosystems?
• What policies / legislation do you think drive the management of freshwaters in upper headwater catchments?
• How much effect do you think policy has on: (a) running waters (b) standing waters?
• Which of these policies has greatest force/are most likely to be acted on?

- Are you aware of actual sites/places we could use as examples of specific policies opera headwater catchments in practice? For this project they don't have to be in Anglian Wate
- When financial push comes to shove, what is prioritised?
- Are there existing mechanisms that encourage integration of objectives to stop freshwat pollution and loss of freshwater habitat quality? For example, does improving sewage works effluents in headwater catchments influence or take account of measures to reduc farmland runoff?
- Is cost:benefit analysis simply a matter of the number of people benefitting? Can CBA take account of other factors?

2. What are the optimum outcomes for headwater catchments if current legislative and cost:benefit approaches were not a limiting factor?

- What do you think would be the ideal outcome for freshwater in headwater catchments?
- Should we be taking account of more of the water environment in headwaters than a present?

  In this question 'we are following IPBES (the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) definition which notes that: "Freshwater habitat includes streams, rivers, lakes, ponds (temporary or not) and also their sources (glaciers, aquifers or rainfall)".
- What about freshwater wetlands like fens, wet grasslands or bogs?
- In the ideal situation, should we be concerned about protection, restoration and creation or does one have more priority than the other?
- What's the ideal approach to stopping water pollution in headwater catchments (there will be multiple examples)?
- Do you think we should focus on pollution (i.e. water quality) or physical habitat structure or other stressors?

3.	**To what extent do current approaches restrict improvement of Descriptive wastewater treatment plants and other parts of the water environment?**
	These questions are about getting everyone on the same page with Descriptive wastewater treatment plants and thinking about the policy restrictions that affect them.
	• To what extent is it simply a matter of funding? Would you **prioritise** headwater catchments over lower catchments in some cases? Would some actions get us more '**bang** for our buck' than others?
	• What's the ideal approach to stopping water pollution in headwater catchments (there will be multiple examples)?
	• Should Nature-based solutions by the main technique for improving Descriptive wastewater treatment plants?
	• Is fixing small sewage works the only show in town in headwater catchments? Are there other activities we should be undertaking to improve the water environment? Can we name example?
	• As well as upgrading Descriptive wastewater treatment plants what else would be worth doing in headwater catchments to improve the water environment?

Appendix 2. Legislation and policies affecting the water environment

The **Water Industry Act 1991** underpins all activities carried out by water companies, but “the Act’s provisions on sewage are outdated and focus on protecting public health rather than the environment.” (Water UK, 21st Century Rivers: Ten Actions for Change). Water companies should take opportunities to improve the landscape, heritage, access and recreation outcomes linked to their duties under the Water Industry Act 1991 which includes general environmental and recreational duties “to further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological or physiographical features of special interest together with a further requirement to take into account “the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or object” when enacting proposals.

[The **Environment Act 1995** includes general provisions with respect to water. “It shall be the duty of an appropriate agency], to such extent as it considers desirable, generally to promote— (a) the conservation and enhancement of the natural beauty and amenity of inland and coastal waters and of land associated with such waters; (b) the conservation of flora and fauna which are dependent on an aquatic environment; and (c) the use of such waters and land for recreational purposes.”]

Natural Environment and Rural Communities Act 2006 places a duty on public bodies, including water companies, to "have regard", so far as is consistent with the proper exercise of their functions, to conserve and enhance biodiversity. The action which may be taken by the authority to further the general biodiversity objective includes, in particular, action taken for the purpose of— (a) conserving, restoring or otherwise enhancing a population of a particular species, and (b) conserving, restoring or otherwise enhancing a particular type of habitat.

Environment Act 2021 ***“****makes provision for targets, plans and policies for improving the natural environment. This includes air quality, biodiversity, water, and waste reduction and resource efficiency. Under the Act, government is developing new, legally binding targets for water environment improvement…The Environment Act 2021 introduced Local Nature Recovery Strategies (LNRSs) in England. It is anticipated water companies will need to have regard to the priorities set out in the LNRSs covering their operational area when agreeing PR24 priorities. LNRSs support the achievement of mandatory biodiversity net gain. They also provide a focus for a strengthened duty on all public authorities to conserve and enhance biodiversity. They will underpin the Nature Recovery Network (NRN). The Environment Act 2021 amends the NERC Act 2006 placing a duty on public authorities including water companies to further, so far as is consistent with the proper exercise of their functions, the conservation and enhancement of biodiversity. The Environment Act 2021 includes legal duties to tackle storm overflow discharges and their impact to help protect our waters including duties on water companies to inter alia: reduce the frequency, duration and volume of storm overflow discharges in line with future government directions, progressively reduce the adverse impacts storm overflows have on the environment and public health.”*

The Environmental Targets (Water) (England) Regulations 2023 set the long-term targets in respect of four matters within the priority area of water under section 1 of the Environment Act 2021 (c. 30). The Regulations specify the target to be achieved in respect of each matter and the date by which each target must be achieved. The *Agriculture Water Target* applies to total nitrogen, total phosphorus and sediment entering the water environment through agricultural diffuse pollution from human activity undertaken on agricultural land in England. The *Waste Water Target* applies to relevant discharges into freshwaters in England from sewerage systems of sewerage undertakers whose areas are wholly or mainly in England at sewage disposal works in England. Part 3 ('Waste Water Target') makes provision in relation to a target to reduce the levels of total phosphorus discharged into freshwaters from relevant discharges from sewerage systems of sewerage undertakers. Regulation 10 sets the target to reduce such levels by at least 80% (compared with the baseline) by 31st December 2038. Regulation 11 provides that the load of total phosphorus to be compared with the baseline is to be measured by determining the load of total phosphorus discharged into freshwaters in the year from 1st January 2038 to 31st December 2038. The baseline is the load discharged into freshwaters from relevant discharges in the year 2020. (The other two priority water matters relate to *abandoned metal mines* and *water demand*).

[There is a *"lack an overarching (apex) target for water in the Environment Act. The 4 water targets are siloed, not sufficiently ambitious, and there is still no clear evidence or explanation of how they will be met or what the environmental outcomes will be - e.g. achieving the nitrogen pollution target assumes a huge boost in landowner compliance, yet offers no explanation or evidence on how this will be achieved. Beyond the Environment Act, there is a lack of clear detail on interim targets in the EIP. Without an overall target for water health, the Government lacks a driver of holistic action; progress could be made against the 4 discrete water targets whilst the overall state of things does not improve, or even declines."* – Blueprint for Water, policy tracker]

Environmental Improvement Plan (EIP) 2023 is the first revision of the 25 Year Environment Plan (25YEP). It builds on the 25YEP vision with a new plan setting out how Government will work with landowners, communities and businesses to deliver each of the goals for improving the environment, matched with interim targets to measure progress.

Includes goal of *Clean and plentiful water*:

- Long term target: Reduce nitrogen, phosphorus and sediment pollution from agriculture into the water environment by 40% by 31 December 2038, compared to a 2018 baseline.
- Interim target 1: Reduce nitrogen, phosphorus and sediment pollution from agriculture to the water environment by 10% by 31 January 2028
- Interim target 2: Reduce nitrogen, phosphorus and sediment pollution from agriculture to the water environment by 15% in catchments containing protected sites in unfavourable condition due to nutrient pollution by 31 January 2028
- Long term target: Reduce phosphorous loadings from treated wastewater by 80% by 31 December 2038, against a 2020 baseline
- Interim target: Reduce phosphorous loadings from treated wastewater by 50% by 31 January 2028, against a 2020 baseline.

"The target to halt the decline of species by 2030 is [the] apex target."

Goal *Thriving plants and wildlife*

- Long term targets: • By the end of 2030, we will halt the decline in species abundance. • By the end of 2042, we will increase species abundance so that it is greater than in 2022 and at least 10% greater than in 2030. • By the end of 2042, we will restore or create in excess of 500,000 hectares of a range of wildlife-rich habitats outside protected sites, compared to 2022 levels. • By the end of 2042, we will improve the GB Red List Index for species extinction compared to 2022 levels.
- Interim targets: • To restore or create 140,000 ha of a range of wildlife-rich habitats outside protected sites by 31 January 2028, compared to 2022 levels. • All SSSIs will have an up-to-date condition assessment by 31 January 2028. • 50% of SSSIs to have actions on track to achieve favourable condition by 31 January 2028.

The **Office for Environmental Protection (OEP)'s 'Progress in improving the natural environment in England 2022/2023'** published in January 2024 indicates Government remains largely off track to meet its environmental ambitions and progress in achieving outcomes for clean and plentiful water is poor:

"The current state of the water environment is not satisfactory. Despite historic improvements, the pace of change has now stalled. Only 16% of surface waters are at least at good ecological status or potential, levels of pollution are still problematic, and per capita water consumption has increased in the short term. The recent scale of investment to drive delivery is commendable, and there are broadly comprehensive plans in place to deal with some issues. However, progress in achieving outcomes is poor. The slow pace of progress is largely due to a lack of specific measures and investment to achieve government's main environmental objectives and the focus of efforts and investments not addressing all major pressures." (p.58)

"we do not see a clear path or plan for achievement of the commitments listed in EIP23 or the objectives set out in the WFD Regulations. Prioritisation of investment and action does not appear to be adequate or sufficiently balanced to address all major pressures." (p.63)

Table 4.1. Clean and plentiful water – summary assessment.

Past trends	Water pollution is still problematic. While the water industry has reduced pollution loads from wastewater treatment discharges, pollution incidents are not reducing. The ecological status and potential of water bodies in England has remained largely static.	**Trends show a mixed picture**
Progress	The scale and pace of effort does not prioritise all major pressures. For example, whilst sewer overflows and sewage treatment are receiving attention, detailed and specific plans to address wider pollution sources, other pressures and reductions in water use are not demonstrably adequate.	**Mixed**
Overall prospects of meeting ambitions, targets and commitments	The scale and pace of delivery of actions is not aligned with the objective to achieve good ecological status or potential by 2027. The River Basin Management Plans indicate low confidence in achieving this.	**Largely off track**
Robustness	The assessment has primarily used publicly available monitoring data and evidence along with expert judgement. It has also been informed by our current, ongoing scrutiny of the implementation of the Water Framework Directive Regulations.	

Water industry national environment programme (WINEP) methodology
The primary role of the WINEP (Water Industry National Environment Programme) is to provide information to water companies on the actions they need to take to meet the environmental legislative requirements that apply to water companies in England. WINEP represents a set of actions that the Environment Agency have requested all 20 water companies operating in England, to complete between 2020 and 2025, in order to contribute towards meeting their environmental obligations.

WINEP actions will come from other strategic plans, such as water resource management plands, river basin management plans and drainage and wastewater management plands.

WINEP is designed to:

- focus delivery on outcomes including the WINEP wider environmental outcomes
- have a longer-term focus
- aid adoption of a more systems and catchment-oriented approach that furthers more innovation and company collaboration, including facilitating a greater use of nature-based solutions
- support co-design, co-delivery, and co-funding of solutions
- make the best use of, and improve available data

The Environment Agency and Natural England translate legislation and UK government priorities into WINEP drivers each of which is described by supporting WINEP driver guidance specifying what actions are statutory (S), statutory plus (S+) and non-statutory (NS):

Statutory obligations

Statutory obligations (S) arise from legislative requirements and the need to comply with obligations imposed directly by statute or by permits, licences and authorisations granted by the Secretary of State, the Environment Agency or other body of competent jurisdiction. While it is important to understand the costs and benefits of actions needed water companies must complete WINEP actions to fulfil statutory obligations.

Statutory plus obligations

Statutory plus (S+) obligations are set out in primary or secondary legislation and can include an assessment of benefits and, in some cases, an additional step of affordability testing. Where an action is considered disproportionately expensive to meet statutory plus obligations, alternative objectives, or extended timescales to meet the objectives, may be set.

Non-statutory requirements

Non-statutory (NS) requirements enable water companies to go beyond the minimum legal requirements to deliver an environmental need where there is customer support. Actions to meet non-statutory requirements may be required to meet the UK government's environmental ambition.

Water industry strategic environmental requirements (WISER)
Expectations of water companies with relevant to management of headwater catchments:

- Water companies must comply with permits set to prevent further deterioration of waterbodies resulting from wastewater emissions and, where cost beneficial, deliver local improvements in water quality.
- Water companies <u>should</u> consider how reducing storm overflows, the use of nature-based solutions and sustainable drainage systems could all contribute to reduced loads of chemicals entering the environment.
- Water companies <u>should</u> include actions or investigations to contribute to or meet conservation objectives for Habitats sites. Water companies <u>must</u> take account of predicted growth in housing development in their business plans and have a duty to maintain and upgrade their wastewater systems. Water companies are also required to meet permit limits set to prevent exceedance of, or deterioration towards, the relevant quality standards downstream of wastewater discharges.

- Managing the introduction and spread of invasive non-native species (INNS) are key to delivering improvements and preventing deterioration in water body status and achieving conservation objectives.
- Water companies have a role in tackling diffuse pollution from their land and improving the connectivity between designated sites. They can do this through the national NRN. Water companies can:
    - restore and enhance habitats
    - create habitats
    - expand designated sites and linking them up

  This will:

    - support biodiversity recovery
    - support naturally functioning ecosystems resilient to climate change and other pressures
    - increase the population of species

  When operating their assets and undertaking their activities, water companies should consider actions under non-statutory initiatives.
- We expect water companies to develop actions during PR24 to contribute to biodiversity priorities and obligations carried out on land they own, the catchment in which they operate, and other areas in which they exercise their functions.
- Water companies should have particular regard to the needs of priority habitats and priority species as set out in legislation
- New information since PR19 that should be taken into account by water companies includes priority river habitat and lake habitat mapping and targeting, and details on the management needs of priority species and others at high risk of extinction. **Natural England's 'Narrative for conserving freshwater and wetland habitats in England'** explains the importance of natural habitat function to freshwater-related biodiversity and is supported by the 'Discovering Priority Habitats in England' website
- Water companies are expected to contribute to maintaining or achieving SSSI favourable condition both on land they own, **the catchment in which they operate**, and other areas in which they exercise their functions.
- Water companies have a key role in achievement of nature recovery including the government's 25 Year Environment Plan commitment to restore 75 per cent of our one million hectares of terrestrial and freshwater protected sites to favourable condition alongside improving the water quality of the coastal environment and securing their wildlife value for the long term.
- Water companies should assess and develop a programme to meet river basin management plan requirements by 2027. They should base it on a consistent methodology for assessing costs and benefits across the sector…No river, lake or estuary should be in poor or bad ecological status due to water company activities. The programme for PR24 must include actions to improve water body status to ensure 'moderate' status as a minimum is achieved by 2030 and improve further where technology allows…In addition, where new evidence shows actions to get to good status are now technically feasible, and best value, they should be implemented as soon as possible after Ofwat's final determination. Water companies should work with stakeholders and catchment partnerships to explore integrated solutions and to achieve multi-functional benefits at a catchment scale.
- Water companies should consider ways to contribute to the mitigation of rising water temperatures such as tree planting to increase shading. Water companies should also consider actions that contribute to mitigating the impact of low flows and rising temperatures on water quality.

- Water companies are expected to adopt nature-based solutions as much as possible. This provides opportunities to maximise carbon storage and sequester carbon and promotes resilience and adaptation to future climate impacts.
- Water companies are expected to monitor the success of nature-based solutions and share learning with partners to build the evidence base. Water companies are encouraged to work with others to overcome challenges around sharing and accepting risk around nature-based solutions, such that they can be promoted and adopted more widely.
- Water companies should invest in the restoration of natural form and function of the catchments and wider landscapes in which they operate to help contribute to their resilience to the impacts of climate change.
- Water companies should consider sustainable drainage systems as a default option to reduce the pressure on sewerage networks, supporting wider environmental objectives such as biodiversity and local amenity
- Water companies have an important role to play in preventing further damage to the environment, as well as enabling its recovery and enhancement. The status of water-dependent biodiversity is linked to the health of the wider catchment.
- Improving the resilience of ecosystems, alongside public water and wastewater systems is equally important. The long-term functioning of ecosystems, as well the natural assets the water industry and people rely on, should be protected, maintained, and enhanced.
- Water company activity should restore, re-connect, and enhance freshwater, estuarine and marine habitats and recover priority species. This will ensure that natural assets used for, or impacted by, water company activities are sustainable into the future. This is both in terms of ecological functions and processes and in terms of their ability to continue to provide (or offer more) benefits to people - ecosystem services resilience.
- Water companies are expected to set out in their business plans priority actions for ensuring existing and new assets, and systems, are resilient for the long term. Business plans must be based on a clear and systematic understanding of service and system risks and include a range of options for reducing the likelihood of future service failures.
- The use of sustainable drainage systems and nature-based solutions should be considered wherever possible to reduce reliance on grey infrastructure and to provide multiple benefits

….

The Environment Act 2021 introduced **Local Nature Recovery Strategies (LNRSs)** in England. *"LNRSs are a new system of spatial strategies for nature, covering the whole of England. They are tools designed to achieve a more coordinated, practical and focused action to recover nature. Water companies contribute to shaping and supporting nature recovery through LNRSs and using nature-based solutions. In turn this contributes to wider socio-economic benefits.*

*LNRSs support the achievement of mandatory **biodiversity net gain**. They also provide a focus for a strengthened duty on all public authorities to conserve and enhance biodiversity. They will underpin the Nature Recovery Network (NRN), alongside work to develop delivery partnerships and to integrate nature into incentives and land management actions. It is anticipated water companies will need to have regard to the priorities set out in the LNRSs covering their operational area when agreeing PR24 priorities. Water companies should explore opportunities to work with others where their ambitions overlap with NRNs and LNRS."* [*from* WISER: Technical Document]

The **Ofwat PR24 final methodology** reflects Ofwat's statutory duties and the strategic policy statements (SPSs) from the UK government and Welsh Government that they must act in accordance with when they set price controls at PR24.

"Despite improvements in some areas, the sector is not where it needs to be – and it must take urgent action to deliver better service for customers, communities and the environment. The challenges before us are clear: • meeting rising expectations about what water companies need to deliver for their customers and communities; • protecting and enhancing our environment, including sustainably managing our natural resources, and making rapid progress on the operation of storm overflows; • adapting to climate change and meeting net zero emissions; and • delivering affordable bills, in the context of increasing cost of living challenges. Addressing these challenges will require companies to transform performance and embrace new ways of working…. Taking these factors into account, we have identified four interrelated ambitions for PR24:
• delivering greater environmental and social value;
• reflecting a clearer understanding of customers and communities;
• driving improvements through efficiency and innovation; and
• increasing focus on the long term
We want companies to deliver greater social and environmental value, so they can deliver more for the funding that customers provide. This includes making a step change increase in the use of nature-based rather than traditional solutions. Our expenditure assessment will promote best value and take more explicit account of environmental and social factors. We will provide a 10-year allowance for non-traditional opex-based schemes, and reward companies that reduce costs by delivering wider benefits, for example through partnerships. […]
We are introducing new performance commitments for biodiversity, river water quality and to reduce the impact of storm overflows. The ***biodiversity performance commitment*** *will provide incentives to improve habitats including increasing the use of nature-based solutions and catchment management approaches. The river water quality performance commitment incentivises companies to reduce the amount of phosphorus discharged from their treatment works - including reductions delivered in partnership or through catchment-management approaches. Companies will also be incentivised to reduce the frequency of discharges of wastewater from their storm overflows (the number of spills). It will therefore help to incentivise companies to make quick and efficient progress towards UK government and Welsh Government ambitions. […]*
Companies should deliver best value, so that they can deliver more for the funding that customers provide. This will require companies to take account of wider environmental and social benefits, costs, risks and affordability of customers' bills when developing their enhancement proposals. […]
We also want companies to make a step change increase in the use of nature-based solutions at PR24. We have introduced a suite of changes to our methodology to facilitate this step-change. We summarise these policy changes in section 6.4.2 of Appendix 9: Setting expenditure allowances. These changes include our consideration of wider environmental and social benefits in our assessment of enhancement expenditure; new performance commitments in areas where nature-based solutions tend to perform better than traditional solutions, such as GHG emissions and biodiversity; and our quality and ambition assessment of business plans which will make rewards available to those companies which show (among other factors) more ambition in relation to i) delivering stretching performance from base expenditure allowances and ii) using best value solutions to deliver requirements."

From ***Creating tomorrow, together: Our final methodology for PR24: Appendix 7: Performance Commitments***

Table 4.1 – Proposed PR24 environmental common performance commitments

Water and wastewater	Water only	Wastewater only
Biodiversity Serious pollution incidents Discharge permit compliance	PCC (per capita consumption) Leakage Business demand Operational greenhouse gas emissions - water	Total pollution incidents Bathing water quality River water quality (phosphorus) Storm overflows Operational greenhouse gas emissions - wastewater

*"The **biodiversity performance commitment** will measure the change in biodiversity on company owned land and third-party land on which it is working in partnership as part of its statutory functions. Companies will work with stakeholders to consider which land is most appropriate to monitor… To protect customers and the environment we will also expect companies to provide assurance that overall biodiversity across sites which are not included in the performance commitment is not deteriorating in order to receive outperformance payments" (pp.31-32)*

The performance commitment will be based on the metrics developed in Defra and Natural England, 'Biodiversity metric' July 2021 and Defra, 'Biodiversity Terrestrial and Freshwater Targets - Detailed Evidence report', April 2022, p. 24.

As well as a performance commitment, Ofwat also expect to set price control deliverables (PCDs) to ensure that companies deliver the biodiversity benefits of the WINEP and NEP programmes – many of which will emerge after 2030. Their approach to PCDs is explained in Appendix 9

River Basin Management Plans
["River basin management plans establish an integrated approach for the protection and sustainable use of the water environment. They set the environment quality objectives for groundwater and surface waters (including estuaries and coastal waters) and summarise the programmes of measures needed to meet these objectives. Water companies must ensure that current and future activities, such as abstraction or the return of treated wastewater, support the achievement of these objectives and prevent deterioration in water bodies". – from WINEP]

"The 2022 river basin management plans will set out the legally binding objectives for groundwater and surface waters, including estuaries and coastal waters. The plans summarise the programmes of measures needed to meet those objectives. Where evidence supports a change in the water body objective, water companies will only be able to confirm detailed actions once the Secretary of State has approved the 2022 river basin management plans. Water companies must make sure that their activities will support achieving the water body objectives set out in the 2022 river basin management plans, including:

- *current and future abstraction*
- *return of treated wastewater*
- *physical infrastructure and associated maintenance activities*
- *preventing deterioration*

Water companies should take an adaptive management approach to make sure their actions are resilient to the likely impacts of extreme weather and climate change (2 to 4oC), as well as population growth. Under Regulation 33 of the WFD Regulations public bodies must, in exercising their functions so far as affecting a river basin district, have regard to the river basin management plans for that district. 'Have regard to' includes taking account of and considering the environmental objectives and summary of measures contained within the

2022 plans when exercising any of their functions. Water companies are 'public bodies' for the purposes of Regulation 33. Water companies should assess and develop a programme to meet river basin management plan requirements by 2027." – from WISER technical document]

Delivering Clean and Plentiful Water: Actions to transform the management of the whole water system ('Plan for Water') published by Defra in April 2023 sets out measures to transform and integrate England's water system, address sources of pollution, and boost water supplies through more investment, tighter regulation, and more effective enforcement subsequent to the Environmental Improvement Plan (EIP23) which set out the first steps in the Government's reform programme for the water system. Plan is built around a catchment approach to managing the water system with 3 broad objectives:
1. Transform management of the whole water system,
2. Deliver a clean water environment for nature and people,
3. Secure a plentiful supply of water.

Plan will take an approach that considers all pressures in the round, rather than in isolation - and claims an integrated approach to water management is the foundation of [the] plan for water.
A new Water Restoration Fund will also be created to further boost investment in the natural environment which will be made up of money from water company environmental fines and penalties which come from water company profits. This will be additional to the money water companies must already pay to clean up the impact of pollution incidents that breach their permit conditions.
The Plan for Water provides a summary of government's integrated approach, rather than a detailed and specific delivery plan.

Water UK's **21st Century Rivers: Ten Actions for Change (2021)** calls for a new deal for rivers in England- asking everyone — from river users and customer groups, to environmental NGOs, to work with Water UK on a new approach that responds to challenges. *"Crucially, with other industries responsible for three-quarters of the reasons for harm in rivers, this needs a new, combined, national endeavour that does things differently. The recommendations in this document are intended to bring a more effective, evidence-based way of tackling all sources of pollution."*

Restoration of natural habitats and catchment resilience should be embedded across all legislation, frameworks and funding priorities to remove barriers to water companies, local authorities, NGOs, community groups, farmers and landowners working together to deliver solutions." This should include:
• A clear view from Government on the contribution it expects the water environment to make by 2030 toward the new State of Nature species abundance target to be set under the Environment Bill. • A more holistic approach to targets set under the Environment Bill and the Water Industry National Environment Programme, to ensure sufficient weight on the full breadth of environmental ambitions from carbon to climate adaptation to biodiversity. The risk is that billions of pounds of investment is otherwise narrowly targeted at removing nutrients from the ends of pipes, while causing other kinds of environmental harm and ignoring goals like habitat and species restoration.
• Options for further expanding and accelerating recent tentative proposals to improve the water industry's environment programme through more partnerships and catchment-based approaches. […]
• Recognising the importance of the water industry to the nature recovery network, with rivers as a natural wildlife corridor linking dispersed habitats together. We need an easier way of identifying and agreeing the benefits of those corridors, and of investing in schemes to grow them.

• Use of Government's new powers under Clause 101 of the Environment Bill to ensure Local Nature Recovery Strategies take full account of the needs of aquatic and wetland habitats and species within each strategy area.

Environmental Land Management scheme (ELMS)

Farmers and land managers will be able to benefit from and work across 3 new Environmental Land Management schemes:

- Sustainable Farming Incentive
- Local Nature Recovery
- Landscape Recovery

These schemes will pay farmers and land managers in return for providing environmental outcomes including:

- habitat protection and creation
- natural flood management
- water quality
- carbon capture
- biodiversity recovery

Defra have started the piloting and rolling out Environmental Land Management schemes in advance of live offers in 2024. These schemes will also be joined up other interventions such as Biodiversity Net Gain.

https://www.gov.uk/government/publications/environmental-land-management-update-how-government-will-pay-for-land-based-environment-and-climate-goods-and-services/environmental-land-management-elm-update-how-government-will-pay-for-land-based-environment-and-climate-goods-and-services#waterbodies

Nutrient Neutrality

Nutrient neutrality aims to enable developers to demonstrate they will cause no additional nutrient damage to Habitats Sites already in 'unfavourable condition'. Local mitigation will enable developments to proceed alongside the potential to provide multiple added benefits for biodiversity and recreation.

We will also assess the context of partnership approaches which guide the actions of environmental NGOs and have a semi-statutory underpinning including:

- **Catchment-based Approach objectives** and implications for headwater catchments
- **Blueprint for Water Charter for Small Waters**: the Blueprint consortium of NGOs with a special interest in water management is currently developing a Charter for Small Waters to emphasise the importance given to small waters by the NGO sector.

'A narrative for conserving freshwater and wetland habitats in England: Natural England Research Report NERR064 provides an overview of circumstances relating to the conservation of freshwater and wetland habitats in England, considering their ecological function, the natural and anthropogenic factors affecting them, the management principles that can be drawn from the evidence, and the respective roles of the main policy mechanisms involved in their conservation [and] aims to provide an ecological explanation of why natural ecosystem function is important to our freshwater and wetland wildlife, and a rationale for how we can recognise this importance in the steps we take to conserve these habitats and their associated species.

Stresses the value of natural habitat/ecosystem function & that restoring natural catchment processes (hydrology, hydrochemistry) is a fundamental part of restoring freshwater and wetland ecosystems:
"Natural habitat function needs to be considered at a range of spatial scales, but good progress cannot be made without consideration of whole catchments. This necessitates integration with planning measures for conserving other habitats and their associated species, and for the provision of wider ecosystem services such as flood risk management and water resources [...] The strategic goal, as far as it is feasible, is naturally functioning freshwater and wetland habitat mosaics situated in locations within catchments most suited to their self-maintenance, as part of a wider habitat mosaic with terrestrial habitats that caters for all characteristic assemblages of the locality including their priority species." p.83

"Headwater streams make up nearly 70% of total stream length in Great Britain (based on the estimated length of first and second order streams in Smith and Lyle 1979), so in ecological terms they should be seen as the essential foundation for healthy functioning river systems. They are vital both as habitat in their own right and as a support system for larger rivers downstream." p.7

General binding rules
https://www.gov.uk/guidance/general-binding-rules-small-sewage-discharge-to-a-surface-water

Appendix 3. The WISER policy framework (Defra, 2022)

Objective: a thriving natural environment	
The expectations are set out under each heading and are given a category or categories in brackets.	
Bathing waters	
action to improve waters with a current planning class of poor	S
action to improve waters at risk of deterioration to a planning class of poor (more than 20% risk of failing sufficient	S
action to improve waters to good or excellent where there is evidence of customer support	NS
action to improve waters failing their baseline class	S
action to improve non-designated waters where there is evidence of customer support	NS
action to communicate to the public the location and quality of designated bathing waters and actions they can take to support bathing water quality	NS
Chemicals	
action to prevent deterioration (includes standstill measures)	S
action to achieve compliance with environmental quality standards	S+
develop and implement operating targets for chemical removal for existing and upgraded wastewater treatment works as part of assessing performance in reducing chemical loads to the environment	NS
review and strengthen management of trade effluent, tankered waste and sludge transfers to improve effluent and sludge quality	S
investigate existing and emerging substances occurring in sewerage systems, inform and work with consumers, businesses and other stakeholders to develop innovative approaches to reduce loads entering sewerage systems or treatment techniques to improve the environment	NS
Drinking Water Protected Areas	
catchment actions to prevent deterioration in water quality and to reduce the need for additional treatment	S
catchment actions to improve water quality to reduce the level of existing treatment	S+
Environment Act 2021 targets	
reduce phosphorus loadings from treated waste water in line with the Environment Act's long-term environmental targets	S
reduce the use of public water supply in England per head of population in line with the Environment Act's long-term environmental targets	S
Healthy and resilient fish stocks	
screen abstractions and outfalls to prevent the entrainment of eels, salmon, sea trout and to resolve Water Framework Directive fish failures	S, S+
address barriers to the passage of fish	S+

action that supports recovery of Natural Environment and Rural Communities Act (NERC Act S.41 priority fish species (which includes salmon, brown sea trout, eels, smelt, river and sea lamprey and shad or at sites where fish form part of the conservation designation	S+
Invasive non-native species (INNS)	
prevent deterioration by reducing the risk of spreading INNS and reducing the impact of INNS	S
reduce the impact of INNS, where INNS is a reason for not achieving conservation objectives or good status	S, S+
reduce pathways for the introduction and spread of INNS	S
Natural environment	
action that contributes to meeting and or maintaining conservation objectives of Habitats sites, for example, addressing the potential impact of development and growth	S
action that contributes to meeting or maintaining favourable condition targets for Sites of Special Scientific Interest	S+
action that contributes to the restoration and recovery of habitats and species under the NERC Act including supporting delivery of the Nature Recovery Network	S+
action that contributes to the achievement of conservation objectives of Marine Conservation Zones and (when designated the desired state of the environment within Highly Protected Marine Areas	S, S+
actions for biodiversity should deliver the outcomes of the relevant Local Nature Recovery Strategy, Protected Site Strategies, and Species Conservation Strategies introduced by the Environment Act	S+
contribute to actions under non-statutory initiatives including the England Peat Action Plan, England Tree Action Plan and the National Pollinator Strategy	NS
action that contributes to the conservation and enhancement of landscape character and sense of place, so that landscapes are alive for nature and beauty, and provide opportunities that benefit people's health and wellbeing (where this goes beyond statutory obligations	NS
action that delivers inclusive public access to water company land and water of natural beauty, amenity or recreational value and allow public access for the widest possible range of activities	S+
Shellfish waters	
action to prevent deterioration of shellfish water protected areas	S
action to achieve shellfish water protected area objectives	S
Urban wastewater	
reduce the frequency and volume of sewage discharges from storm overflows in line with the Storm Overflow Discharge Reduction Plan	S
action to protect newly identified Sensitive Areas	S
action to improve wastewater treatment where population thresholds are exceeded and, in line with Defra policy, provide secondary treatment where water company owned septic tanks discharge to surface water	S
maintain sewers to minimise sewer leakage especially in source protection zones	S

provision of first-time sewerage schemes	S
action to increase flow to full treatment and storm tank capacity at wastewater treatment works where the Urban Waste Water Treatment Regulations requirements are not being met	S
Water body status (river basin management plan objectives)	
action to prevent deterioration in current water body status	S
action to improve water body status	S+
action to ensure no river, lake or estuary is in poor or bad ecological status due to the water industry	S+
work with stakeholders and catchment partnerships to explore integrated solutions, including nature-based solutions, and delivery of multi-functional benefits at a catchment scale	NS

Objective: expected performance and compliance	
The expectations are set out under each heading and are given a category or categories in brackets.	
Regulatory compliance (all regimes	
achieve 4-star status on the Environmental Performance Assessment	NS
100% compliance for all licences and permits	NS
100% compliance at wastewater treatment works and water treatment works with numeric limits and for storm overflows	S
100% compliance with environmental impact and operational performance permit conditions at wastewater treatment works and water treatment works with descriptive not numeric limits	S
100% compliance with abstraction and impoundment licences	S
all the correct authorisations (permits and exemptions are held and 100% compliance with installation permits, waste operation permits and waste exemptions	S
100% compliance with flow conditions, including dry weather flow, flow to full treatment, maximum daily volume and flow rates, MCERTS certification, at wastewater treatment works and water treatment works	S
100% compliance with ultra-violet dose conditions	S
zero serious pollution incidents (category 1 and 2	S
at least a 30% reduction of all pollution incidents (category 1 to 3 by 2030 on current 2025 targets. There may be some variation on our expectation depending on company performance during the current asset management plan period (2020 to 2025	S
high levels of self-reporting of pollution incidents with at least 90% of incidents self-reported by 2030. More than 95% of incidents self-reported for wastewater treatment works and pumping stations	NS
business plans include all actions identified within the WINEP and these are planned well and completed to agreed timescales and specification	S
either good or excellent rating of self-monitoring provisions under Operator Monitoring Assessment. Compliance with self-monitoring conditions, including data quality and providing data on time for Operator Self-Monitoring, Urban	S

Waste Water Treatment Regulations and flow monitoring, event duration monitoring and ultra-violet disinfection	
sustainable management of sludge treatment and onward sludge use so as not to cause regulatory breaches or pollution to land, surface water or groundwater by implementation. Including modernisation of the regulatory controls through delivery of the Environment Agency's sludge strategy, which moves sludge from Sludge (Use in Agriculture Regulations to Environmental Permitting Regulations	S
100% compliance with satisfactory use of sludge on agricultural land	S

Objective: resilience for the environment and customers	
The expectations are set out under each heading and are given a category or categories in brackets.	
Climate change	
report on understanding of risks from climate change and how they are being addressed through Adaptation Reporting Power reports	S
contribute to the sector's ambition to achieve net zero carbon by 2030 as set out in Water UK's 'Net Zero 2030 Routemap'; to meet the government's 2050 net zero target, the sector will need to go beyond the stated net zero ambition as currently scoped 1 and 2 greenhouse gas protocol to account for, and reduce, existing indirect emissions greenhouse gas protocol Corporate Value Chain (Scope 3 Standard, that result from: future asset management plan delivery; new national requirements; and measures taken in adapting to and addressing climate change impacts	NS
apply adaptive planning for a range of future climate change scenarios	NS
safeguard services and ensure risks are proactively identified and actions implemented using an adaptive planning approach	NS
deliver actions to restore form and function of the natural environment to improve resilience of ecosystems to warmer water temperatures, more frequent flooding and drought, and rising sea level (where this goes beyond statutory obligations	NS
deliver actions that help to mitigate rising water temperatures	NS
deliver actions that mitigate the impact of low flows and rising temperatures on water quality (where this goes beyond statutory obligations	NS
Ecosystem and natural function	
action that contributes to restoring natural function to allow capacity for growth and development and to allow nature recovery	NS
action which supports Nature Recovery Networks through enhancing ecosystem resilience and ecosystem function on which nature recovery is reliant (where this goes beyond statutory obligations	NS
restore and reconnect priority habitats (such as wetlands and peatlands to strengthen freshwater and marine resilience to challenges such as climate change	S+
Flood risk management	

act in a manner consistent with the National Flood and Coastal Erosion Risk Management Strategy for England and have regard to Local Flood Risk Management Strategies	S
co-operate with other risk management authorities and Regional Flood and Coastal Committees in improving flood resilience and exercising water company flood risk management functions	S, NS
co-ordinate and share data and information with risk management authorities to deliver flood resilience, and with category 1 and 2 responders to manage incidents	S
comply with statutory reservoir safety requirements	S
engaging with stakeholders to understand service and system risks and implement solutions to improve flood resilience	NS
reduce sewer flooding of homes and businesses trending towards zero	NS
contribute to reducing the number of properties at risk of all sources of flooding through co-funded or co-delivered schemes with other risk management authorities and other parties, including by using nature-based solutions	NS
deliver sustainable drainage systems and nature-based solutions, for example by promoting these solutions through the drainage and wastewater management plan process and business plans	NS
Future drainage	
PR24 business plans should reflect the requirements including the extent and pace of these reductions as set out in the Secretary of State's "Storm Overflow Discharge Reduction Plan" to be published by 1st September 2022	S
water and sewerage companies drainage and wastewater management plans should provide the evidence base for reducing spills from current and future baselines to meet the requirements of the Storm Overflow Discharge Reduction Plan	NS
improve and monitor networks and wastewater treatment works to reduce the number of failures	NS
ensure compliance with permitted flow to full treatment settings	S
PR24 business plans should address the Environment Act duties on water and sewerage companies to:	
continuously monitor the receiving water quality potentially affected by storm overflows	S
publish data on storm overflow operation on an annual basis and make spill information available in near real time	S
Water resources – security of supply	
demonstrate that the government expectations for water companies' water resources planning have been met	NS
ensure water resource management plans reflect the relevant regional water resource plans and show how strategic scale solutions are implemented to meet long term water supply needs and environmental destination	NS
abstractions and operations meet current regulatory requirements to support the achievement of environmental objectives	S, S+
incorporate sustainability changes into supply forecasts	NS

deliver solutions to meet the need identified in final water resource management plans for 2030 and the long term	NS
commitment to reduce demand and per capita consumption in line with the Environment Act target and set out in the Meeting our future water needs: a national framework for water resources	NS
set challenging targets for leakage informed by water company customers' views and the potential for innovation	NS
water companies in seriously water stressed areas may implement wider water metering programmes where it is shown within their water resource management plans that there is customer support and it is cost effective to do so. Using the latest evidence provided by the Environment Agency, additional areas in the South, East and the Midlands were designated as in serious water stress by the Secretary of State in July 2021. Smart meters should become the standard meter installed, given the wider benefits or there should be justification for using older technology	S+
implement solutions to meet the needs identified in the final water resource management plan aiming for resilience to a 1-in-500 year drought by 2039 (or by 2050 where costs are exceptionally high locally in comparison to benefits	NS
ensure agreed and up to date plans are in place to manage a drought and minimise environmental impacts	S

Appendix 4. Selected recommendations from the OEP review of implementation of the Water Framework Directive Regulations and River Basin Management Planning in England" relevant to headwater catchments.

Recommendations
There is also potential for change to existing water law and policy. Government has powers to modify, replace or revoke the WFD Regulations under the Retained EU Law (Revocation and Reform) Act 2023.38 Without changing the law, Defra and the EA can also adjust how it is applied to maximise effectiveness. p28 OEP
The Plan for Water, published in April 2023, aims to build on the EIP23 by outlining additional actions to support the 'clean and plentiful water' goal and Environment Act targets. Government states in this plan that it considers there to be opportunities to improve the regulatory system through reviewing implementation of the WFD Regulations. It does not make specific proposals but commits to consulting on any changes. There have been no such consultations to date. p28 OEP
Recommendation 4: We recommend that Defra and the EA review and improve how exemptions are justified and presented in the RBMPs to ensure they are appropriate, clear and transparent. We recommend specifically that RBMPs should include at least an outline of the substantive justifications for individual exemptions at the water body level. The approach to how exemptions are determined, justified and presented should also be subject to greater oversight by Defra before the RBMPs are approved by the Secretary of State.
Recommendation 5: We recommend that Defra and the EA adjust the structure, presentation and content of RBMPs for future cycles. For each RBD, the RBMP should provide the 'driver-pressure-state-impact-response' information for the RBD as a whole and each water body. It should be clear in the RBMPs how the measures will achieve the Environmental Objectives at the water body level. The RBMPs should also be adjusted to make the next cycle of plans and supporting documents clearer, and more reader- and user-friendly, including through the provision of a non-technical summary.
Recommendation 6: We recommend that Defra and the EA improve the approach to public consultation on the draft plans for future cycles. This should ensure that it supports full, active and informed public consultation including in relation to Environmental Objectives, at the RBD and water body levels, measures to achieve those objectives, and the review and justification of exemptions.
Recommendation 7: We recommend that Government, in seeking to extend the reach of Catchment Based Approach partnerships, more clearly define their role and functioning, and then organise and fund them so they can deliver as intended. This will require a closer alignment with the contents of the Programmes of Measures, relating to individual water bodies and catchments, and clarification of the role of partnerships in identifying and supporting the implementation of those measures where appropriate. We also recommend that Government determine how best to further develop partnership working in conjunction with other plans covering water, nature, land use and other development
Recommendation 9: We recommend that Defra develop and implement a coherent and nested monitoring and evaluation framework for the state of the water environment and progress on measures to improve it. This should include a clear relationship between monitoring for individual water bodies, catchments and river basin districts under the WFD

Regulations through to wider monitoring and evaluation of the water-related goals and targets of the EIP23.
Recommendation 10: We recommend that Government retain the fundamental underlying structure and approach of the WFD Regulations, while also consulting on proposals to improve the legal and governance framework to produce a regime that is stronger and includes mechanisms for better implementation. Central aspects of the WFD Regulations that we consider should be retained include: • Integrated protection of all water body types to cover aquatic ecosystems as a whole. • Ambitious Environmental Objectives based on strong scientific underpinnings and evidence. This should include retention of the 'No Deterioration' principle and targets for the ecological, chemical and quantitative health of surface water and groundwater. • An integrated, multi-element approach to classifying water bodies and determining if overall Environmental Objectives are met, while providing for assessment and reporting of progress towards these objectives at a more detailed level for the various individual elements monitored.
Recommendation 12: We recommend that, in further developing the Plan for Water and reviewing implementation of the WFD Regulations, Defra: i) clarify how the WFD Regulations' objectives and the goals and targets of the Environment Act, EIP23 and Plan for Water relate and contribute to each other for both surface water and groundwater, including chemical status; (ii) review their coherence with other water law and policy and broader environmental and sectoral law; and (iii) review and rationalise the overall wider suite of relevant plans and measures, including their timings and plan periods, to ensure that their alignment and sequencing serves to optimise outcomes.
Recommendation 13: We recommend that, in reviewing implementation of the WFD Regulations, Defra assess current levels of understanding of and compliance with the general duty on public authorities to have regard to the RBMPs (Regulation 33). The assessment should prioritise public authorities with functions that are key to delivering the Environmental Objectives.
Recommendation 14: We recommend that Defra and the EA issue guidance to all public authorities with functions that may affect RBDs on a standardised process for WFD assessment. This should take account of any relevant evidence and information gathered through the implementation of Recommendation 13 above. We also recommend that the EA engage with public authorities concerning implementation of the guidance, prioritising those with functions that are key to delivering the Environmental Objectives. Defra should also itself adopt and apply a standardised process for WFD assessment in relation to its own decision-making.
Recommendation 15: We recommend that, in reviewing implementation of the WFD Regulations, Defra consider: (i) strengthening the wording of the 'have regard to' duty for RBMPs; (ii) introducing a free-standing duty on all public authorities to consult with the EA when WFD assessment identifies risks to water bodies; and (iii) increasing transparency concerning mechanisms to ensure and monitor the implementation of all measures in the approved Programmes of Measures. The EA should also provide more detailed information in its report describing progress in the implementation of each planned Programme of Measures, to support scrutiny and transparency concerning their delivery