



# Esthwaite Water Ramsar

## Nutrient Modelling Summary

Date: October 2026

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# Introduction

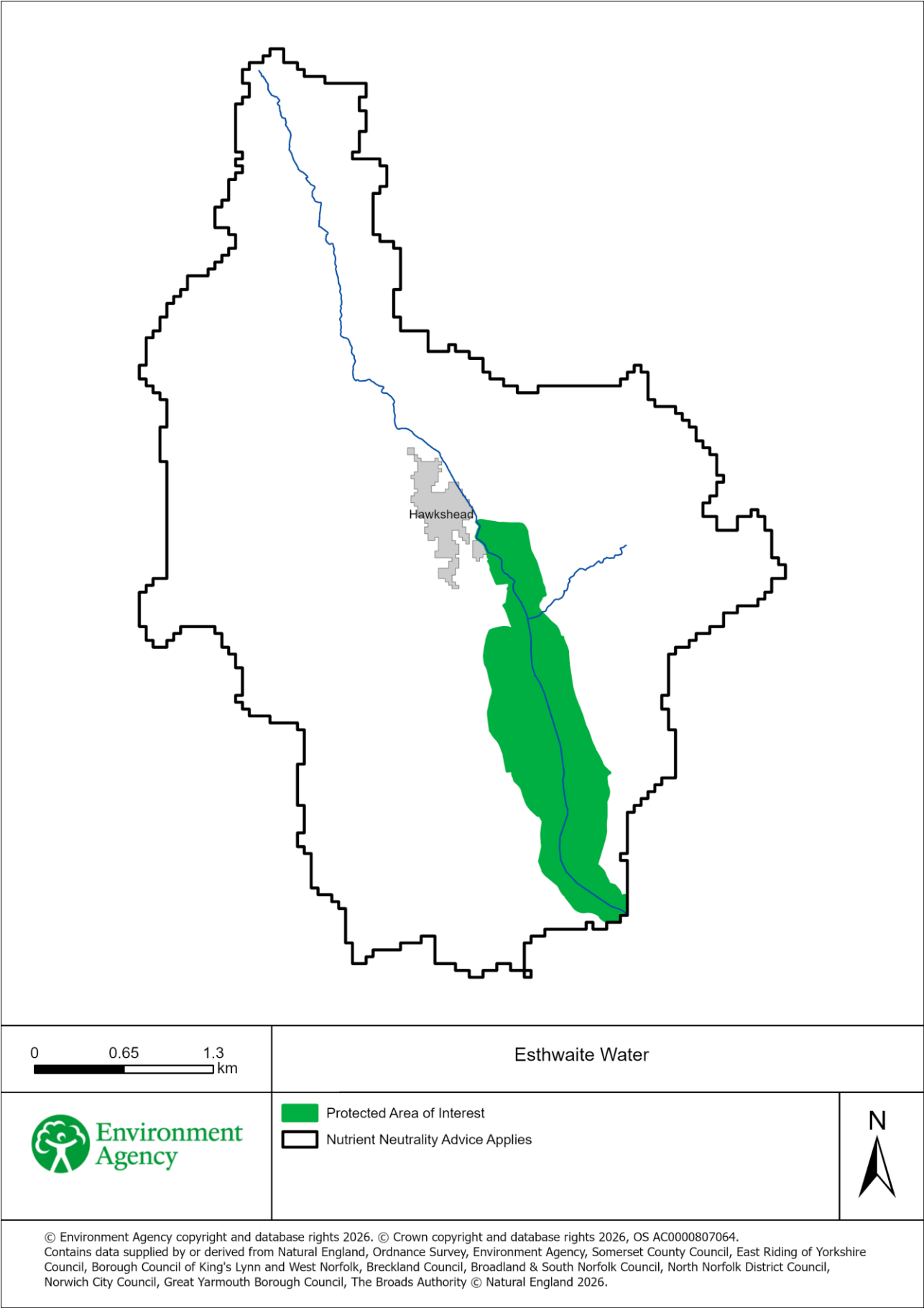
This document provides summary outputs from the Environment Agency's water quality modelling for the Esthwaite Water Ramsar catchment (Map 1). We provide source apportionment information and data to show the scale of reductions needed to achieve protected area water quality targets. Our outputs will help those working on Diffuse Water Pollution Plans (DWPPs), designing or co-ordinating nutrient mitigation schemes, and working on site restoration. We aim to support a general understanding of the catchment rather than give the level of detail needed to inform specific on-the-ground measures. Our detailed methodology is described in [Catchment statistics for nutrient pollution in protected areas](#).

We used the total phosphorus and total nitrogen Common Standards Monitoring Guidance (CSMG) targets applicable to Esthwaite Water. Natural England and the Environment Agency agree these targets for water dependent protected areas and publish them on the [Catchment Data Explorer](#).

Alongside Simcat SAGIS models, we used the Farmscoper v5 decision support tool and applied the revised polluter pays principle methodology (v0.17) used during PR24 planning to define the sector share of the targets for the point and diffuse sectors.

Our outputs highlight the dominant nutrient sources under a range of scenarios, including future estimates based on planned water company investment up to 31 March 2030 (AMP8) and the wider implementation of rural land use measures.

We have not incorporated additional nutrient contributions from any future development and growth including housing. Any additional future nutrient load will be assessed through the planning process led by the Local Planning Authority or through our permitting process.



**Map 1. Esthwaite Water catchment with protected area highlighted and catchment where Natural England nutrient neutrality advice applies shown.**

## Models used

We used the PR19 and PR24 Simcat SAGIS models for this work alongside Farmscoper v5. Simcat SAGIS (Source Apportionment Geographical Information System) integrates ArcGIS-based digital information management and visualisation with SIMCAT (Simulated Catchment), the Environment Agency's water quality model. Farmscoper is a decision support tool that can be used to assess diffuse agricultural pollutant loads and quantify the impacts of farm mitigation methods on these pollutants.

The PR19 Simcat SAGIS model is calibrated to 2010 to 2012 data, following nationally agreed model build and calibration standards across UKWIR (UK Water Industry Research). Outputs from this model are used to establish the sector share of the protected site target under the revised polluter pays principle. Similarly, the PR24 Simcat SAGIS model is calibrated to 2014 to 2020 data, following UKWIR agreed model build and calibration standards. Since publication of the Indicative Catchment Statistics Report (Version 1.2, September 2024) we recalibrated the model to improve representation of Esthwaite Water and catchment, the results presented in this report will therefore differ from those presented previously.

The calibration process optimises the agreement between measured and simulated values through reasonable and systematic adjustments to model parameters and input data. We adjust the inputs where there is least confidence, those representing diffuse sources of pollution. The associated project overview document details the datasets included in the models. To assess confidence in the models, we compare the measured and simulated values. While Simcat SAGIS provides a robust framework for decision-making in wastewater investment, we have less certainty in the diffuse load estimates. As a result, we have lower confidence when using the models to assess the outcomes of measures that target diffuse sources, including those used here and in the DWPPs.

Farmscoper has undergone external peer review (Gooday et al., 2014), and the component models and methods used within Farmscoper have been published in the external literature. The assumptions, methods and resulting conclusions are therefore based on sound scientific principles. Farmscoper was developed as an advisory tool to aid policy makers. Farmscoper is now used more extensively and for a wider range of purposes than originally intended, therefore the consequences of assumptions and other uncertainties in Farmscoper outputs need to be considered when decision-making and users need to understand the assumptions, uncertainty, and limitations at the relevant scale of interest.

We used Farmscoper v5 to assess diffuse agricultural pollutant loads and to quantify the impacts of farm scale mitigation methods for a range of scenarios. This applies the agricultural planning assumptions for RBMP cycle 3 for land management measures ([Environment Agency, 2022](#)), as well as information from Defra project WT1594 ([Defra, 2019a](#)) We present outputs for two Farmscoper scenarios in this report to provide estimates of the reduction in nutrient losses from 'full regulation' and 'theoretical maximum' uptake rates in agricultural mitigation measures (Table 2).

# Scenarios

The modelling scenarios (Table 1) evaluate the effectiveness of nutrient reductions in point and diffuse sources to meet protected site targets and the diffuse sector share of those targets. In the 2030 Full Regulation and 2030 Theoretical Maximum scenario we have applied the Farmscoper v5 reductions (Table 2) to the rural land use sector inputs. We have based the point sector measures on the AMP8 water industry national environment programme agreed in December 2024 ([PR24 WINEP](#)).

**Table 1: Summary description of the point and diffuse measures represented in the Simcat SAGIS Scenarios modelled.**

| Scenario                        | Point Sector Measures                                                                      | Diffuse Sector Measures                                                                   | Model            |
|---------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------|
| <b>Actual (2014 to 2020)*</b>   | Observed discharge flow and quality (2014 to 2019). Where not available, defaults used.    | Current activities as represented post model calibration.                                 | PR24 Calibration |
| <b>2030 Optimistic</b>          | Water company AMP8 quality permit limits incorporated where applicable**                   | Current activities as represented post model calibration.                                 | PR24 Calibration |
| <b>2030 At Permit</b>           | All discharges represented at permitted flow and quality values up to and including AMP8** | Current activities as represented post model calibration.                                 | PR24 At Permit   |
| <b>2030 Full Regulation</b>     | All discharges represented at permitted flow and quality values up to and including AMP8** | Rural land use inputs reduced by Full Regulation values from Farmscoper v5 (Table 2).     | PR24 At Permit   |
| <b>2030 Theoretical Maximum</b> | All discharges represented at permitted flow and quality values up to and including AMP8** | Rural land use inputs reduced by Theoretical Maximum values from Farmscoper v5 (Table 2). | PR24 At Permit   |

\*Previously referred to as the 'recent' scenario.

\*\*Does not include any discharge flow increases that may be required to support growth.

**Table 2: Phosphate and nitrate percentage reductions applied to the rural land use sector in the Simcat SAGIS Scenarios, values produced through Farmscoper v5 modelling.**

| Scenario                   | Description                                                                                                                                                            | Phosphate | Nitrate |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------|
| <b>Full Regulation</b>     | 100% uptake of Regulatory measures, 25% uptake of <a href="#">Farming Rules for Water</a> 'reasonable' Regulatory measures and 'current' uptake of voluntary measures. | 16%       | 7%      |
| <b>Theoretical Maximum</b> | 100% uptake of all measures in Farmscoper v5.                                                                                                                          | 42%       | 18%     |

## Esthwaite Water modelled outputs

We estimate the total phosphorus load source apportionment for Esthwaite Water to be 53% point source and 46% diffuse source in the Actual (2014 to 2020) scenario (Table 3). Rural land use (36%) dominates the diffuse sector. The source apportionment changes incrementally under the subsequent scenarios. When we apply the Full Regulation and Theoretical Maximum reductions to the rural land use sector, the contribution from the rural land use sector falls from 61% in the 2030 At Permit scenario to 57% and 49%.

The baseline (2009) sector share of the total phosphorus protected site target is estimated to be 68% diffuse and 32% point (Table 5). This means the diffuse sector share of the target is 0.01mg/l and the point sector share is 0.005mg/l (Table 5). The estimated Esthwaite Water concentrations in the Actual (2014 to 2020) scenario exceed the sector share for both sectors. For the sector share to be met, the diffuse sector concentrations need to reduce by an estimated 6% and point sector concentrations by 61%.

The 2030 Optimistic scenario estimates the concentrations after the implementation of AMP8 water company investment in the calibration model (Table 1). Under this scenario, while the diffuse concentrations are unchanged, the point sector concentrations are sufficiently low for the overall CSMG protected site target (0.015mg/l) to be met (Table 5). This is the same situation for all of the 2030 scenarios modelled.

We estimate the total nitrogen load source apportionment for Esthwaite Water to be 9% point source and 89% diffuse source in the Actual (2014 to 2020) scenario. Rural land use (36%) and other sources (46%), including atmospheric deposition, angling and background contributions, dominate the diffuse sector (Table 4). The source apportionment changes incrementally under the subsequent scenarios. When we apply the Full Regulation and Theoretical Maximum reductions to the rural land use sector, the contribution from the rural land use sector changes marginally from 44% in the 2030 At Permit scenario to 43% and 40% respectively.

We estimate the baseline (2009) sector share of the total nitrogen protected site target to be 14% diffuse and 86% point. This means the diffuse sector share of the target is 0.108mg/l and the point sector share is 0.662mg/l (Table 6). The estimated diffuse sector concentrations in the Actual (2014 to 2020) scenario exceed the sector share (Table 6), however the point concentrations are sufficiently low for the overall protected site target to be met. The total nitrogen CSMG target is estimated to be met in all scenarios (Table 6).

## Input load source apportionment

Tables 3 and 4 show the estimated load source apportionment figures for each scenario modelled for total phosphorus and total nitrogen. We have greatest confidence in the point sector loads where monitoring data is available. Confidence reduces where the contribution from the sector is based on estimates rather than observed data, such as the diffuse sectors. Apportioning the input loads gives an indication of which sector is the dominant nutrient source.

**Table 3: Estimated total phosphorus load source apportionment in Esthwaite Water.**

| Scenario                        | Point Sources | Rural Land Use | Urban | Septic Tanks | Other* |
|---------------------------------|---------------|----------------|-------|--------------|--------|
| <b>Actual (2014 to 2020)</b>    | 53.2%         | 36.5%          | 0.0%  | 5.2%         | 5.2%   |
| <b>2030 Optimistic</b>          | 19.3%         | 63.0%          | 0.0%  | 8.9%         | 8.9%   |
| <b>2030 At Permit</b>           | 20.9%         | 61.2%          | 0.0%  | 9.0%         | 9.0%   |
| <b>2030 Full Regulation</b>     | 23.0%         | 57.4%          | 0.0%  | 9.8%         | 9.8%   |
| <b>2030 Theoretical Maximum</b> | 27.7%         | 48.5%          | 0.0%  | 11.9%        | 11.9%  |

\*Includes angling and background estimates.

**Table 4: Estimated total nitrogen load source apportionment in Esthwaite Water.**

| Scenario                        | Point Sources | Rural Land Use | Urban | Septic Tanks | Other* |
|---------------------------------|---------------|----------------|-------|--------------|--------|
| <b>Actual (2014 to 2020)</b>    | 8.7%          | 44.2%          | 0.0%  | 0.7%         | 46.4%  |
| <b>2030 Optimistic</b>          | 6.7%          | 45.2%          | 0.0%  | 0.7%         | 47.4%  |
| <b>2030 At Permit</b>           | 7.8%          | 43.9%          | 0.0%  | 0.7%         | 47.6%  |
| <b>2030 Full Regulation</b>     | 7.9%          | 42.9%          | 0.0%  | 0.7%         | 48.4%  |
| <b>2030 Theoretical Maximum</b> | 8.2%          | 40.5%          | 0.0%  | 0.8%         | 50.5%  |

\*Includes atmospheric deposition, angling and background estimates.

## Input concentrations and reductions

The modelled concentrations arise from the input loads, after the influence of river and lake natural processes have been simulated. Tables 5 and 6 show the estimated concentrations in Esthwaite Water to be consistent with the revised polluter pays principle methodology (v.0.17) used in the PR24 water company price reviews.

Apportionment by concentration and by load can be different because inputs from different sources tend to occur under different flow conditions. Inputs from treatment works occur continuously while diffuse source inputs tend to occur under higher river flow conditions where there is greater dilution available in the receiving water. As a result, a kilogram of phosphorus discharged from a treatment works will have a relatively greater impact on in-river concentrations than the equivalent input from diffuse sources.

**Table 5: Total phosphorus sector share alongside modelled concentrations (mg/l) and estimated percentage reductions needed across all scenarios.**

| <b>Scenario and Assessment Metric</b>                                  | <b>Diffuse</b> | <b>Point</b> | <b>Total</b> |
|------------------------------------------------------------------------|----------------|--------------|--------------|
| <b>Baseline (2009) sector share of the target</b>                      | 68%            | 32%          |              |
| <b>Sector share of the target (mg/l)</b>                               | 0.010          | 0.005        | 0.015        |
| <b>Actual (2014 to 2020) - modelled sector concentration (mg/l)</b>    | 0.011          | 0.012        | 0.023        |
| <b>Actual (2014 to 2020) - reduction to meet sector share</b>          | 6%             | 61%          | 36%          |
| <b>2030 Optimistic – modelled sector concentration (mg/l)</b>          | 0.011          | 0.003        | 0.014        |
| <b>2030 Optimistic – reduction to meet sector share</b>                | 6%             | 0%           | 0%           |
| <b>2030 At Permit – modelled sector concentration (mg/l)</b>           | 0.011          | 0.003        | 0.013        |
| <b>2030 At Permit – reduction to meet sector share</b>                 | 4%             | 0%           | 0%           |
| <b>2030 Full Regulation – modelled sector concentration (mg/l)</b>     | 0.009          | 0.003        | 0.012        |
| <b>2030 Full Regulation – reduction to meet sector share</b>           | 0%             | 0%           | 0%           |
| <b>2030 Theoretical Maximum – modelled sector concentration (mg/l)</b> | 0.007          | 0.003        | 0.010        |
| <b>2030 Theoretical Maximum – reduction to meet sector share</b>       | 0%             | 0%           | 0%           |

**Table 6: Total Nitrogen sector share alongside modelled concentrations (adjusted from modelled nitrate) (mg/l) and estimated percentage reductions needed across all scenarios.**

| <b>Scenario and Assessment Metric</b>                                  | <b>Diffuse</b> | <b>Point</b> | <b>Total</b> |
|------------------------------------------------------------------------|----------------|--------------|--------------|
| <b>Baseline (2009) sector share of the target</b>                      | 14%            | 86%          |              |
| <b>Sector share of the target (mg/l)</b>                               | 0.108          | 0.662        | 0.770        |
| <b>Actual (2014 to 2020) - modelled sector concentration (mg/l)</b>    | 0.621          | 0.059        | 0.680        |
| <b>Actual (2014 to 2020) - reduction to meet sector share</b>          | 83%            | 0%           | 0%           |
| <b>2030 Optimistic – modelled sector concentration (mg/l)</b>          | 0.621          | 0.045        | 0.665        |
| <b>2030 Optimistic – reduction to meet sector share</b>                | 83%            | 0%           | 0%           |
| <b>2030 At Permit – modelled sector concentration (mg/l)</b>           | 0.612          | 0.051        | 0.663        |
| <b>2030 At Permit – reduction to meet sector share</b>                 | 82%            | 0%           | 0%           |
| <b>2030 Full Regulation – modelled sector concentration (mg/l)</b>     | 0.601          | 0.051        | 0.652        |
| <b>2030 Full Regulation – reduction to meet sector share</b>           | 82%            | 0%           | 0%           |
| <b>2030 Theoretical Maximum – modelled sector concentration (mg/l)</b> | 0.574          | 0.051        | 0.625        |
| <b>2030 Theoretical Maximum – reduction to meet sector share</b>       | 81%            | 0%           | 0%           |

# Input load figures used to calculate source apportionment

Table 7: Total phosphorus loads (kg/d) and load source apportionment.

| Scenario                    | STW<br>(kg/d) | Intermittents<br>(kg/d) | Industrial<br>(kg/d) | Rural<br>Land<br>Use<br>(kg/d) | Urban<br>(kg/d) | Septic<br>Tanks<br>(kg/d) | Highways<br>(kg/d) | Background<br>& Angling<br>(kg/d) | Point<br>(%) | Rural<br>Land<br>Use<br>(%) | Urban<br>(%) | Septic<br>Tanks<br>(%) | Other* |
|-----------------------------|---------------|-------------------------|----------------------|--------------------------------|-----------------|---------------------------|--------------------|-----------------------------------|--------------|-----------------------------|--------------|------------------------|--------|
| Actual (2014 to 2020)       | 0.284         | 0.975                   | 0.000                | 0.863                          | 0.000           | 0.122                     | 0.000              | 0.122                             | 53.2%        | 36.5%                       | 0.0%         | 5.2%                   | 5.2%   |
| 2030 Optimistic             | 0.113         | 0.154                   | 0.000                | 0.871                          | 0.000           | 0.123                     | 0.000              | 0.123                             | 19.3%        | 63.0%                       | 0.0%         | 8.9%                   | 8.9%   |
| 2030 At Permit              | 0.133         | 0.153                   | 0.000                | 0.836                          | 0.000           | 0.122                     | 0.000              | 0.122                             | 20.9%        | 61.2%                       | 0.0%         | 9.0%                   | 9.0%   |
| 2030 Full Regulation        | 0.132         | 0.153                   | 0.000                | 0.713                          | 0.000           | 0.122                     | 0.000              | 0.122                             | 23.0%        | 57.4%                       | 0.0%         | 9.8%                   | 9.8%   |
| 2030 Theoretical<br>Maximum | 0.133         | 0.153                   | 0.000                | 0.500                          | 0.000           | 0.123                     | 0.000              | 0.123                             | 27.7%        | 48.5%                       | 0.0%         | 11.9%                  | 11.9%  |

\*Estimate of highways, background and angling.

Table 8: Total nitrogen loads (kg/d) and load source apportionment (adjusted from modelled nitrate).

| Scenario                    | STW*<br>(kg/d) | Intermittents<br>(kg/d) | Industrial*<br>(kg/d) | Rural<br>Land<br>Use<br>(kg/d) | Urban<br>(kg/d) | Septic<br>Tanks<br>(kg/d) | Highways<br>(kg/d) | Atmospheric<br>Deposition<br>(kg/d) | Background<br>& Angling<br>(kg/d) | Point<br>(%) | Rural<br>Land<br>Use<br>(%) | Urban<br>(%) | Septic<br>Tanks<br>(%) | Other* |
|-----------------------------|----------------|-------------------------|-----------------------|--------------------------------|-----------------|---------------------------|--------------------|-------------------------------------|-----------------------------------|--------------|-----------------------------|--------------|------------------------|--------|
| Actual (2014 to 2020)       | 1.70           | 0.68                    | 0.00                  | 12.18                          | 0.00            | 0.20                      | 0.00               | 12.53                               | 0.25                              | 8.7%         | 44.2%                       | 0.0%         | 0.7%                   | 46.4%  |
| 2030 Optimistic             | 1.70           | 0.10                    | 0.00                  | 12.18                          | 0.00            | 0.20                      | 0.00               | 12.53                               | 0.25                              | 6.7%         | 45.2%                       | 0.0%         | 0.7%                   | 47.4%  |
| 2030 At Permit              | 1.97           | 0.11                    | 0.00                  | 11.80                          | 0.00            | 0.20                      | 0.00               | 12.55                               | 0.25                              | 7.8%         | 43.9%                       | 0.0%         | 0.7%                   | 47.6%  |
| 2030 Full<br>Regulation     | 1.97           | 0.11                    | 0.00                  | 11.35                          | 0.00            | 0.20                      | 0.00               | 12.55                               | 0.25                              | 7.9%         | 42.9%                       | 0.0%         | 0.7%                   | 48.4%  |
| 2030 Theoretical<br>Maximum | 1.97           | 0.11                    | 0.00                  | 10.24                          | 0.00            | 0.20                      | 0.00               | 12.54                               | 0.25                              | 8.2%         | 40.5%                       | 0.0%         | 0.8%                   | 50.5%  |

\*Estimate of atmospheric deposition, highways, background and angling.

## References

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## List of abbreviations

ADAS – UK-based independent agricultural and environmental consultancy, previously National Agricultural Advisory Service (NAAS).

AMP8 WINEP – Asset Management Plan 8 (2025 – 2030) Water Industry National Environment Programme - [Water industry national environment programme \(WINEP\) methodology - GOV.UK](#)

CSMG – Common Standards Monitoring Guidance – includes guidance on the appropriate standards and targets for designated sites [Common Standards Monitoring Guidance for Freshwater Habitats | JNCC Resource Hub](#)

DWPP – Diffuse Water Pollution Plan

NEAP-N – ADAS model providing annual 1 km grid loadings of nitrate.

PR – [Price Review https://www.ofwat.gov.uk/regulated-companies/price-review/](https://www.ofwat.gov.uk/regulated-companies/price-review/)

PSYCHIC – ADAS model providing annual 1 km grid loadings of Phosphate.

SAC – Special Area of Conservation

SAGIS – Source Apportionment Geographical Information System

SPA – Special Protection Area

SSSI – Site of Special Scientific Interest

UKWIR – United Kingdom Water Industry Research

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