



River Eden SAC

Nutrient Modelling Summary

Date: October 2026

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Introduction

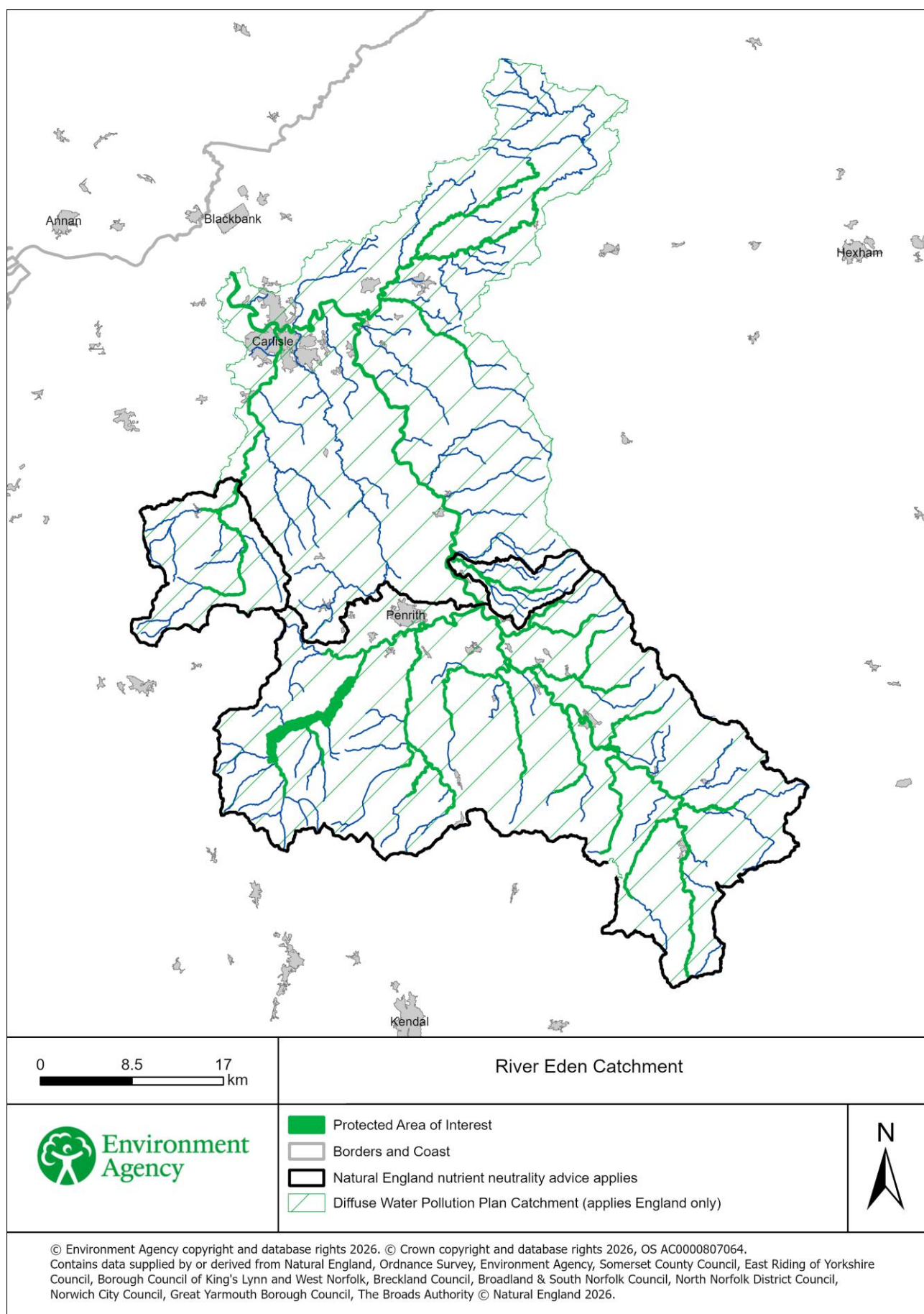
This document provides summary outputs from the Environment Agency's water quality modelling for the River Eden Special Area of Conservation (SAC) catchment (Map 1). We provide catchment-scale source apportionment information and maps showing the scale of reductions needed to achieve protected area water 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.

We used the phosphate Common Standards Monitoring Guidance (CSMG) targets applicable to the River Eden SAC. 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 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. River Eden SAC and catchment with protected area highlighted and catchment where Natural England nutrient neutrality advice applies shown.

Models used

We used the Price Review (PR) PR19 and the 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 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.

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
Actual (2014 to 2020)*	Observed discharge flow and quality (2014 to 2019). Where not available, defaults used.	Current activities as represented post model calibration.	PR24 Calibration
2030 Optimistic	Water company AMP8 quality permit limits incorporated where applicable**	Current activities as represented post model calibration.	PR24 Calibration
2030 At Permit	All discharges represented at permitted flow and quality values up to and including AMP8**	Current activities as represented post model calibration.	PR24 At Permit
2030 Full Regulation	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
2030 Theoretical Maximum	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: Percentage phosphate reductions applied to the rural land use sector in the Simcat SAGIS Scenarios, values produced through Farmscoper v5 modelling.

Scenario	Description	Reductions
Full Regulation	100% uptake of Regulatory measures, 25% uptake of Farming Rules for Water 'reasonable' Regulatory measures and 'current' uptake of voluntary measures.	17%
Theoretical Maximum	100% uptake of all measures in Farmscoper v5.	29%

River Eden modelled outputs

We estimate the phosphate input load source apportionment for the Eden catchment to be 43% point source and 57% diffuse source in the Actual (2014 to 2020) scenario. Rural land use sources dominate the diffuse sector (55%) (Table 3). 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% to 57% and 52% respectively.

We estimate the baseline (2009) sector share of the protected site target to be 72% diffuse and 28% point. This gives a diffuse sector share of 0.016mg/l and a point sector share of 0.006mg/l (Table 4). The estimated catchment average sector concentrations in the Actual (2014 to 2020) scenario exceed the sector share for both sectors (Table 4). For the sector share to be met, the diffuse sector concentrations need to reduce by an estimated 38% and point sector concentrations by 16%. With the Full Regulation and Theoretical Maximum reductions applied to the rural land use sector, the residual reductions needed to meet the diffuse sector share come down to 26% and 12% respectively (Table 4). The maps show the spatial variation in the reductions needed.

Input load source apportionment

Table 3 shows the estimated phosphate input load source apportionment figures for each scenario modelled. 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 phosphate input load source apportionment from the catchment endpoint.

Scenario	Point Sources	Rural Land Use	Urban	Septic Tanks	Other
Actual (2014 to 2020)	42.9%	54.7%	1.7%	0.5%	0.1%
2030 Optimistic	34.0%	63.3%	2.0%	0.6%	0.1%
2030 At Permit	36.4%	61.0%	1.9%	0.6%	0.1%
2030 Full Regulation	40.6%	56.5%	2.1%	0.6%	0.1%
2030 Theoretical Maximum	44.6%	52.2%	2.3%	0.7%	0.1%

Catchment average concentrations and reductions

The in-river modelled concentrations arise from the input loads, after the influence of river dilution and natural decay processes in the river have been simulated. Table 4 shows the in-river concentration as a sector catchment average to be consistent with the revised polluter pays principle methodology (v0.17) 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 river 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 4: Catchment average phosphate sector share alongside modelled catchment average concentrations (mg/l) and estimated percentage reductions across all scenarios.

Scenario and Assessment Metric	Diffuse	Point	Total
Baseline (2009) Sector Share of the target	72%	28%	
Catchment average sector share of the target (mg/l)	0.016	0.006	0.022
Actual (2014 to 2020) - modelled sector concentration (mg/l)	0.0253	0.0073	0.033
Actual (2014 to 2020) - reduction to meet sector share	38%	16%	33%
2030 Optimistic – modelled sector concentration (mg/l)	0.025	0.005	0.031
2030 Optimistic – reduction to meet sector share	38%	0%	29%
2030 At Permit – modelled sector concentration (mg/l)	0.025	0.0067	0.032
2030 At Permit – reduction to meet sector share	38%	8%	32%
2030 Full Regulation – modelled sector concentration (mg/l)	0.021	0.0067	0.028
2030 Full Regulation – reduction to meet sector share	26%	8%	21%
2030 Theoretical Maximum – modelled sector concentration (mg/l)	0.018	0.0067	0.025
2030 Theoretical Maximum – reduction to meet sector share	12%	8%	11%

Maps - modelled reductions needed

The catchment average information above provides an overview of the sector concentrations and reductions needed at the catchment scale. However, within the designated reaches there are locations where the overall reductions needed to meet the protected site targets are greater or less than the catchment average. We show this detail on the catchment maps.

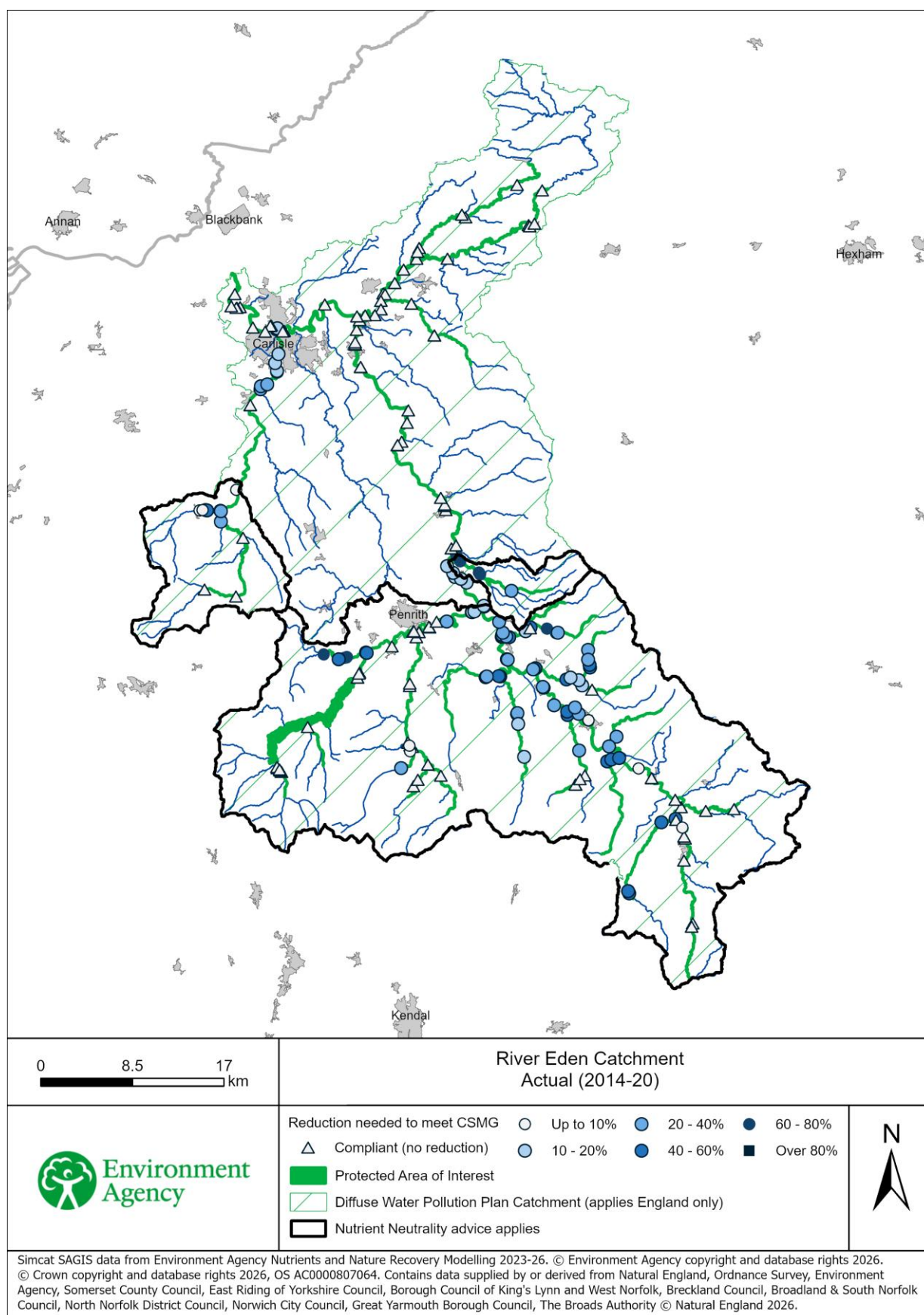
Maps 2 to 6 show the percentage reduction needed in phosphate total concentrations to meet the CSMG targets in the designated site for each scenario. Maps 7 to 9 show the percentage reduction needed in the diffuse sector concentrations after the rural land use reductions (Table 2) have been applied in the 2030 Full Regulation and the 2030

Theoretical Maximum scenarios. Data is plotted for each modelled plotting point where there is a real-world feature for example. monitoring point or discharge location.

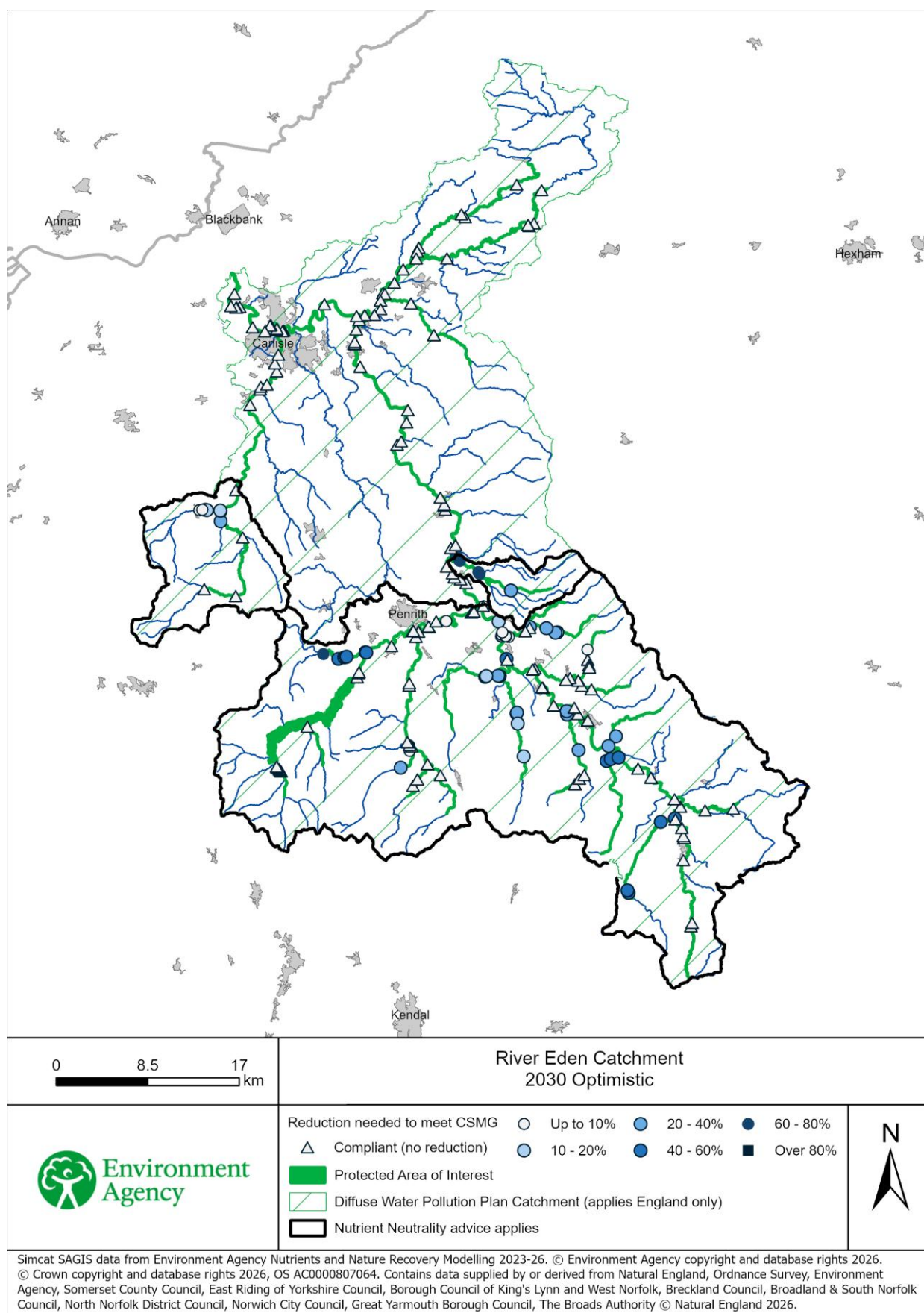
Under the Actual (2014 to 2020) scenario the majority of the northern part of the catchment and the headwaters meet the overall site targets, with no reductions estimated to be needed (Map 2). In the middle part of the catchment, closer to Penrith, concentrations are estimated to need to reduce by between 10% and 40% predominantly, but with locations where up to 80% reductions are needed. Under the same scenario, the diffuse sector reductions needed to meet the diffuse sector share of the target in the middle part of the catchment range predominantly between 20% and 60%, with some areas up to 80% (Map 7).

The 2030 Optimistic scenario estimates the concentrations after the implementation of AMP8 water company investment in the calibration model (Map 3). While this scenario indicates a greater number of locations where the site targets are met, there remain parts of the catchment that are estimated to need over 60% reductions. With the Full Regulation and Theoretical Maximum reductions applied to the diffuse sector, the estimated residual reductions required to meet the diffuse sector share remain high, over 60% in parts of the catchment (Maps 8 and 9).

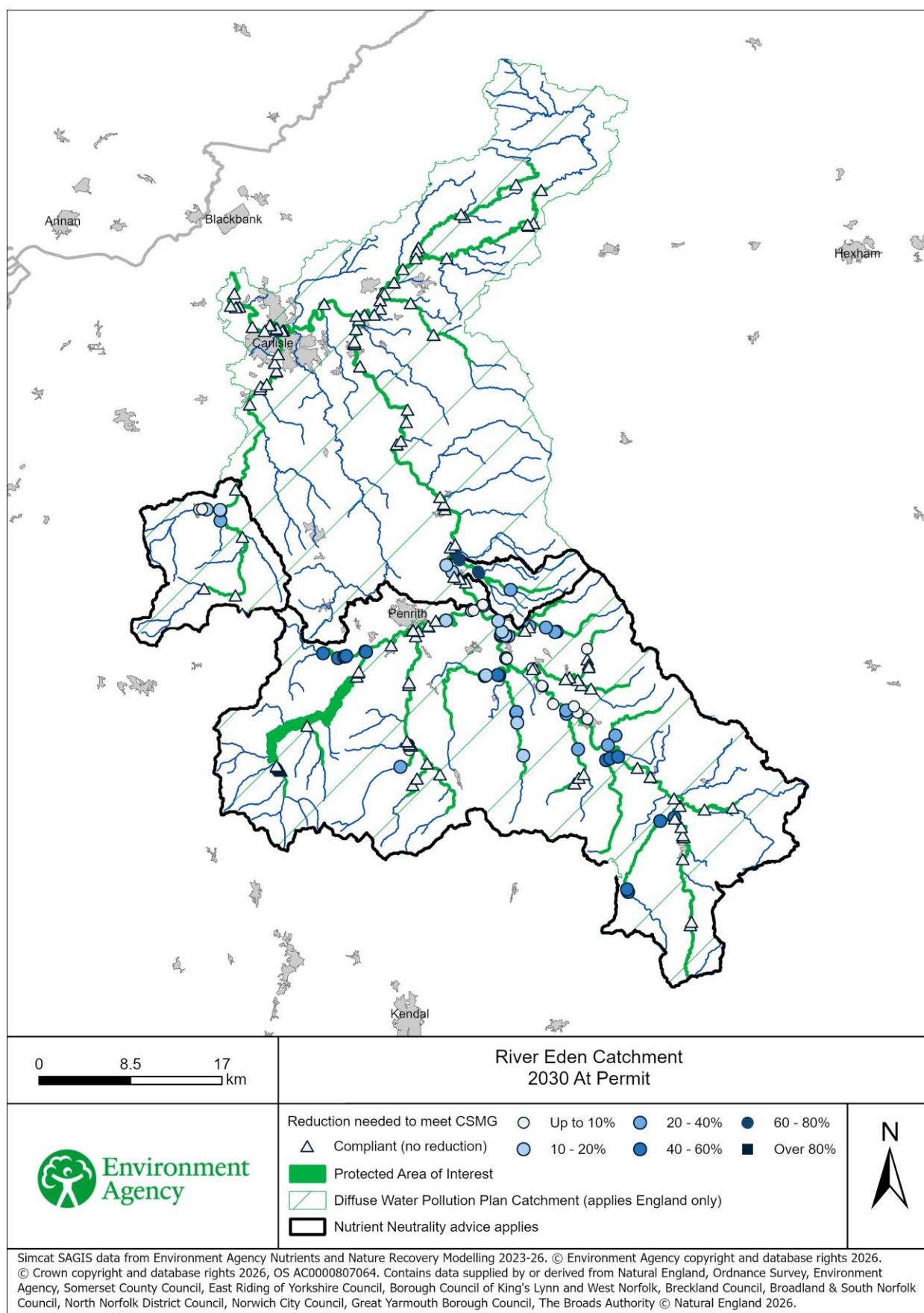
There are locations where the estimated reductions needed to meet the diffuse sector share of the target (Maps 7 to 9) are greater than the estimated reductions needed in total concentrations to meet the overall site target (Maps 2, 5 to 6). This is where the point sector concentrations are less than the point sector share of the target, which creates a degree of 'headroom' for the diffuse concentrations.



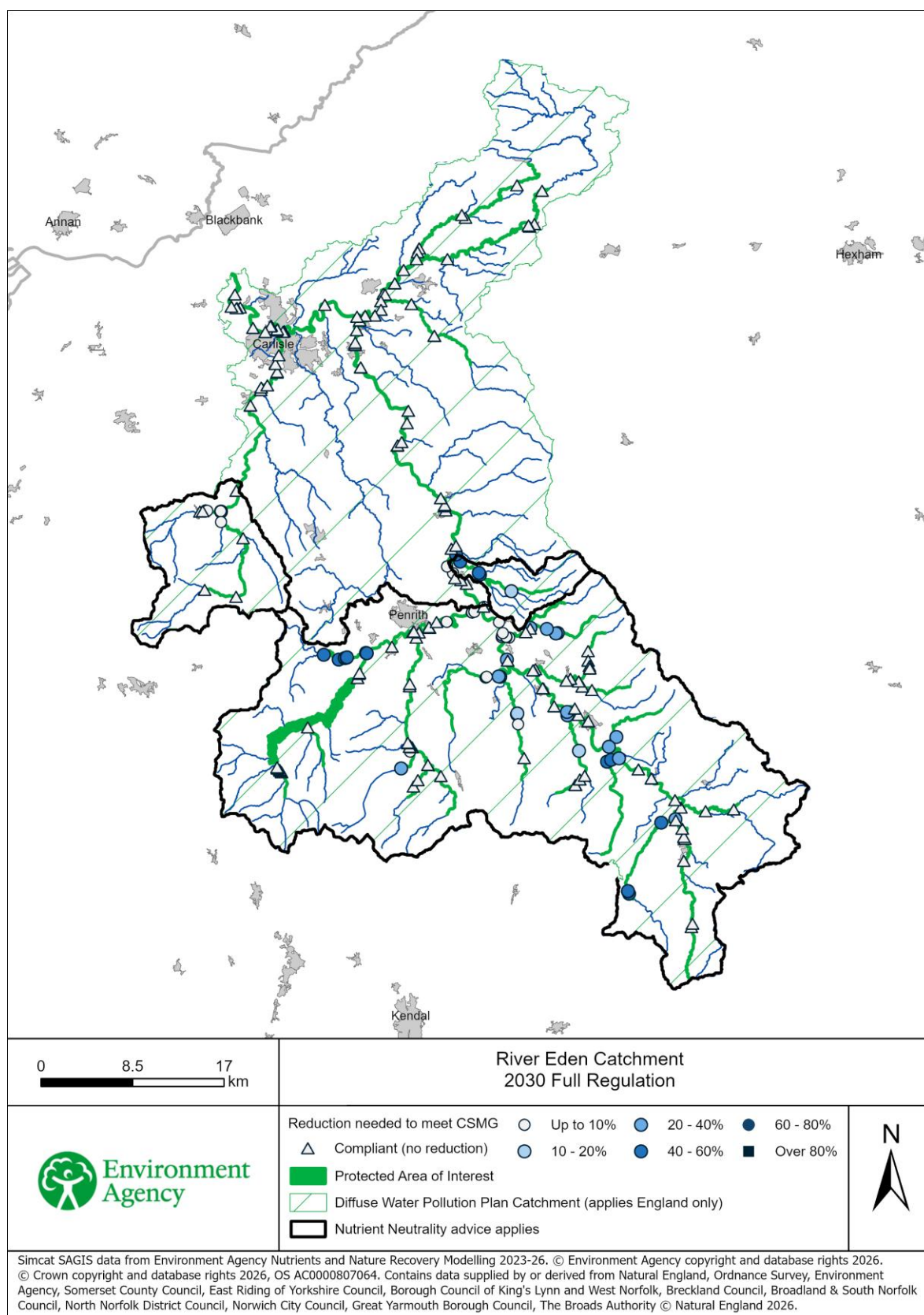
Map 2. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the Actual (2014 to 2020) Scenario. The site target is estimated to be met in the northern part of the catchment and headwaters, with no reductions estimated. In the middle part of the catchment, reductions of between 10% and 60% are needed, with up to 80% reductions estimated in some tributaries.



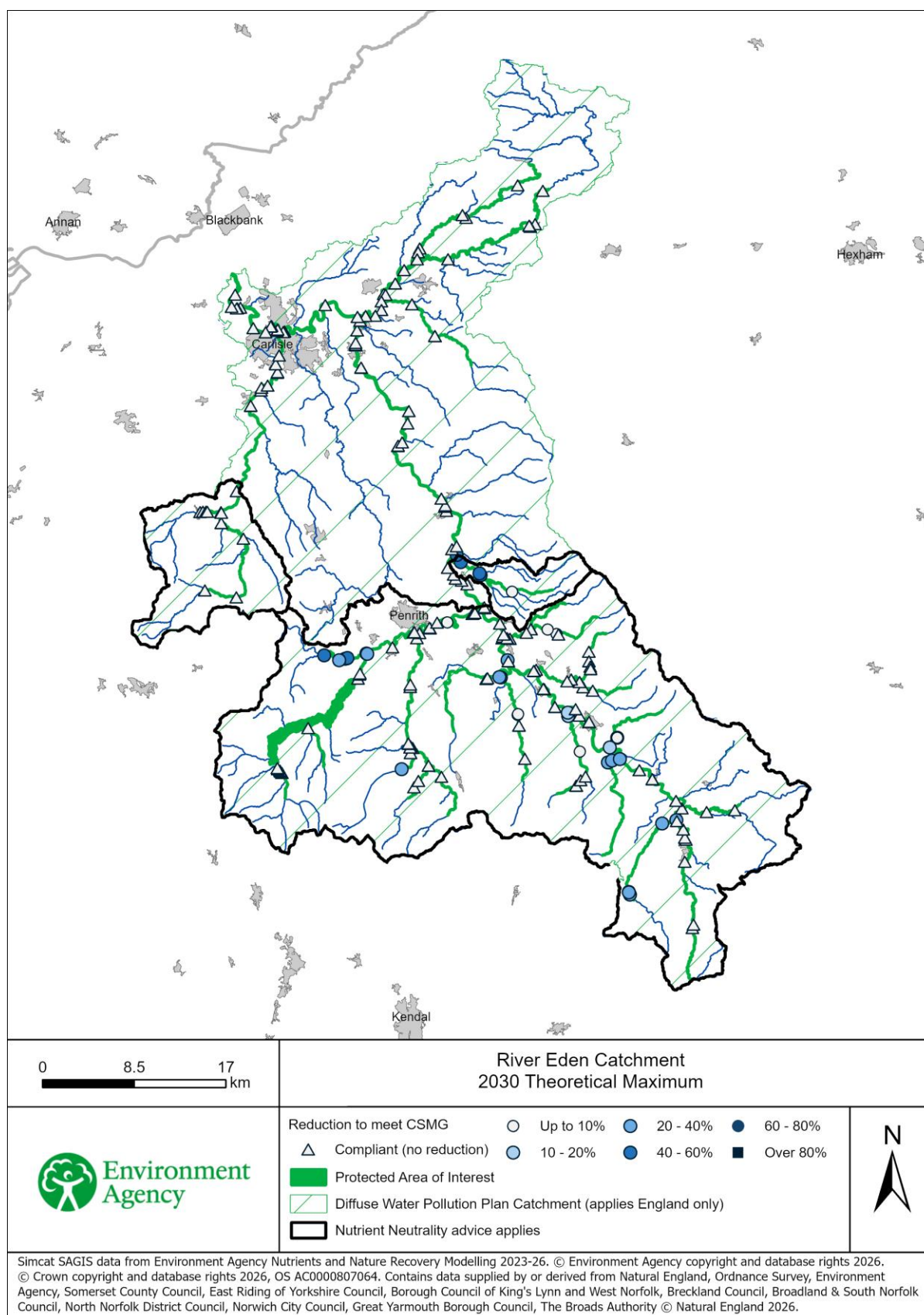
Map 3. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 Optimistic Scenario. There are a greater number of locations where the target is met when compared to the Actual (2014 to 2020) scenario. There are individual river stretches and tributaries where reductions of up to 80% are estimated to be needed.



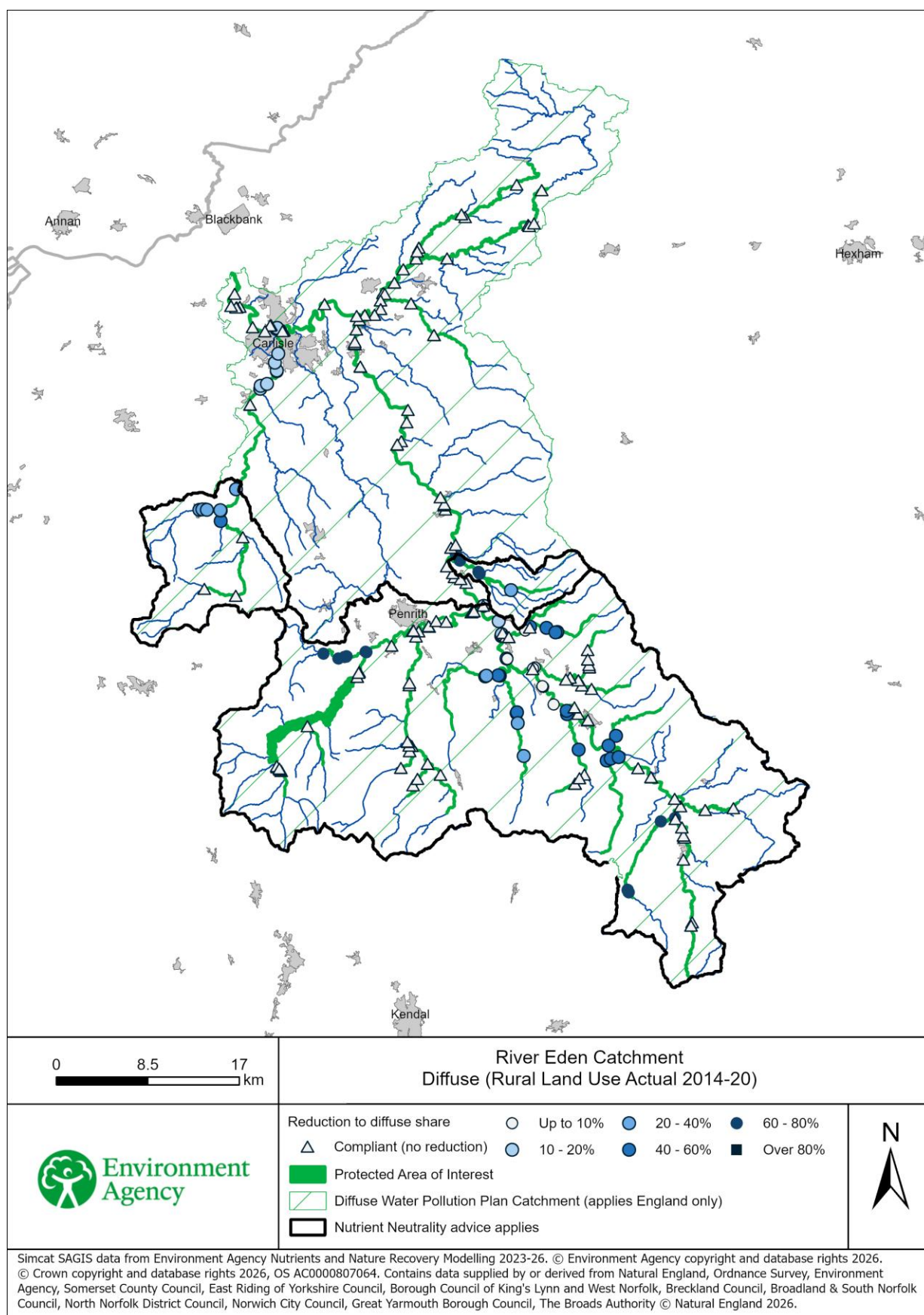
Map 4. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 At Permit Scenario. Similar estimated reductions as shown by the 2030 Optimistic scenario. There are individual river stretches and tributaries where residual reductions of up to 80% are estimated.



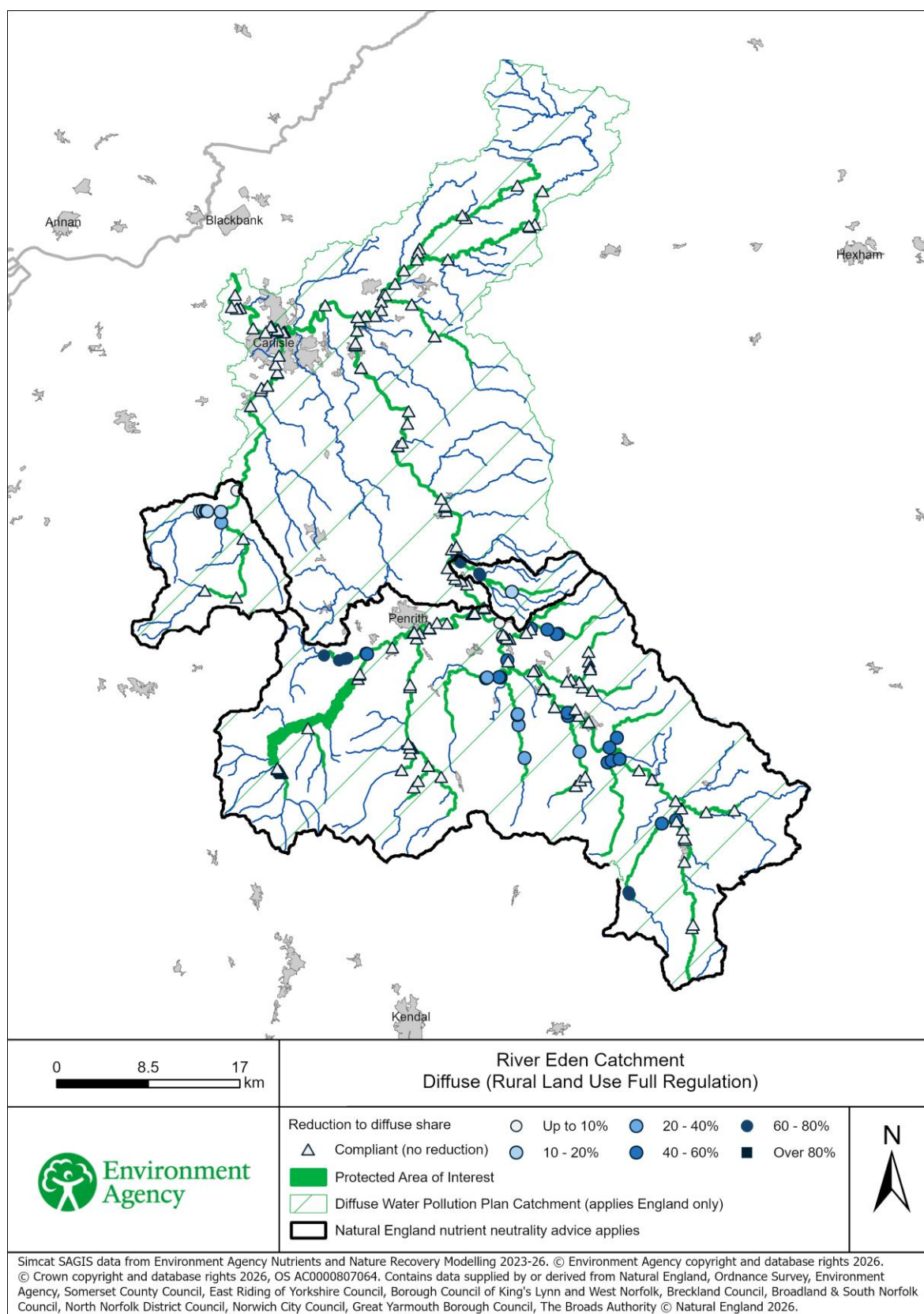
Map 5. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 Full Regulation Scenario. There are more locations in the upper (southern) reaches where the target is estimated to be met than when compared to the 2030 At Permit scenario and the reductions estimated are mainly between 20% to 60%.



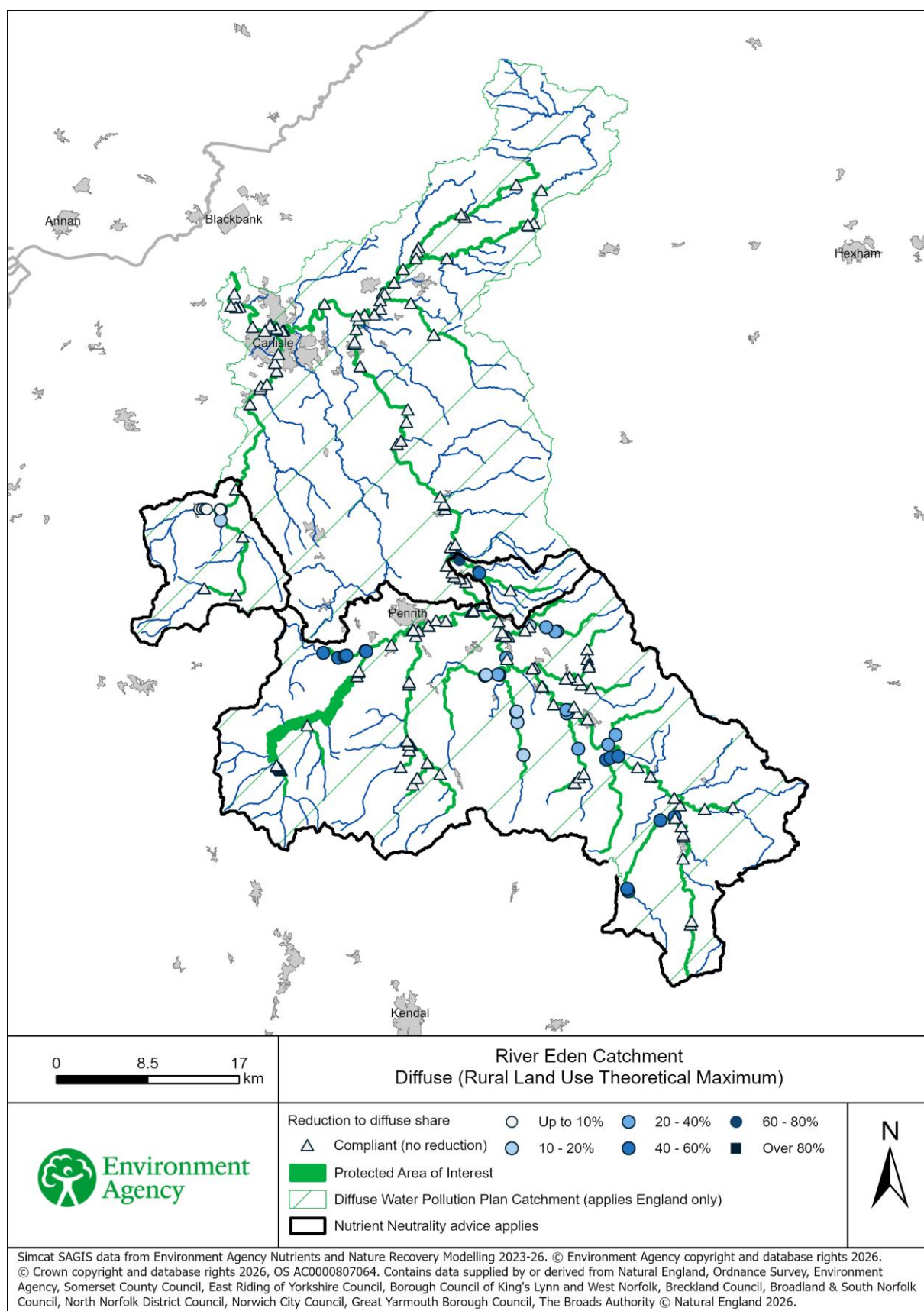
Map 6. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 Theoretical Maximum Scenario. The majority of the catchment is estimated to meet the target, with isolated locations where estimated reductions of up to 60% needed.



Map 7. Estimated reductions needed in diffuse phosphate concentrations to meet the diffuse share of the target in the Actual (2014 to 2020) Scenario. Diffuse concentrations are estimated to meet the diffuse sector share in many parts of the catchment. There are locations where reductions of up to 80% are estimated to be needed.



Map 8. Estimated reductions needed in diffuse phosphate concentrations to meet the diffuse share of the target in the 2030 Full Regulation Scenario. There are more locations where the diffuse sector share is met, particularly in the northern part of the catchment near Carlisle when compared to the Actual (2014 to 2020) scenario. The estimated reductions in parts of the southern catchment are mainly 20% to 60%, but with isolated locations where 60% to 80% reductions are needed.



Map 9. Estimated reductions needed in diffuse phosphate concentrations to meet the diffuse share of the target in the 2030 Theoretical Maximum Scenario. Estimated diffuse reductions are improved marginally when compared to the 2030 Full Regulation scenario. The estimated reductions in parts of the southern catchment are mainly 10% to 60%, but with isolated locations where 60% to 80% reductions are needed.

Input load figures used to calculate source apportionment

Table 5: Estimated phosphate input loads (kg/d) and input load source apportionment after calibration, before in-river processes.

Scenario	STW (kg/d)	Intermittents (kg/d)	Industrial (kg/d)	Rural Land Use (kg/d)	Urban (kg/d)	Septic Tanks (kg/d)	Highways (kg/d)	Point (%)	Rural Land Use (%)	Urban (%)	Septic Tanks (%)	Other (%)
Actual (2014 to 2020)	80.82	31.13	1.95	145.31	4.55	1.38	0.28	42.9%	54.7%	1.7%	0.5%	0.1%
2030 Optimistic	41.55	32.08	1.94	140.81	4.53	1.38	0.28	34.0%	63.3%	2.0%	0.6%	0.1%
2030 At Permit	53.76	31.13	1.95	145.31	4.55	1.38	0.28	36.4%	61.0%	1.9%	0.6%	0.1%
2030 Full Regulation	53.76	31.13	1.95	120.94	4.55	1.38	0.28	40.6%	56.5%	2.1%	0.6%	0.1%
2030 Theoretical Maximum	53.76	31.13	1.95	101.73	4.55	1.38	0.28	44.6%	52.2%	2.3%	0.7%	0.1%

References

Defra (2019a). A national scale assessment of current and future actions to reduce diffuse pollution of water by agriculture. [Report by ADAS for Defra project WT1594](#): 1-47.

Environment Agency (2022). Water quality: what 3 future environmental land management schemes can achieve by 2027. [Water quality: what 3 future environmental land management schemes can achieve by 2027](#).

Gooday, R. D., Anthony, S.G., Chadwick, D.R., Newell-Price, P., Harris, D., Duethmann, D., Fish, R., and A. L. a. W. Collins, M. (2014). Modelling the cost-effectiveness of mitigation methods for multiple pollutants at farm scale. [Science of the Total Environment](#) (468-469): 1198-1209.

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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