



River Dee SAC

Nutrient Modelling Summary

Date: October 2026

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

www.gov.uk/environment-agency

© Environment Agency 2026

All rights reserved. This document may be reproduced with prior permission of the Environment Agency.

Further copies of this report are available from our publications catalogue: www.gov.uk/government/publications or our National Customer Contact Centre: 03708 506 506

Email: enquiries@environment-agency.gov.uk

Contents

Introduction	4
Models used	6
Scenarios.....	7
River Dee modelled outputs.....	8
Input load source apportionment	8
Catchment average concentrations and reductions.....	8
Maps - modelled reductions needed.....	9
Input load figures used to calculate source apportionment.....	19
References	20
List of abbreviations	20
Would you like to find out more about us or your environment?	21
incident hotline.....	21
floodline	21
Environment first.....	21

Introduction

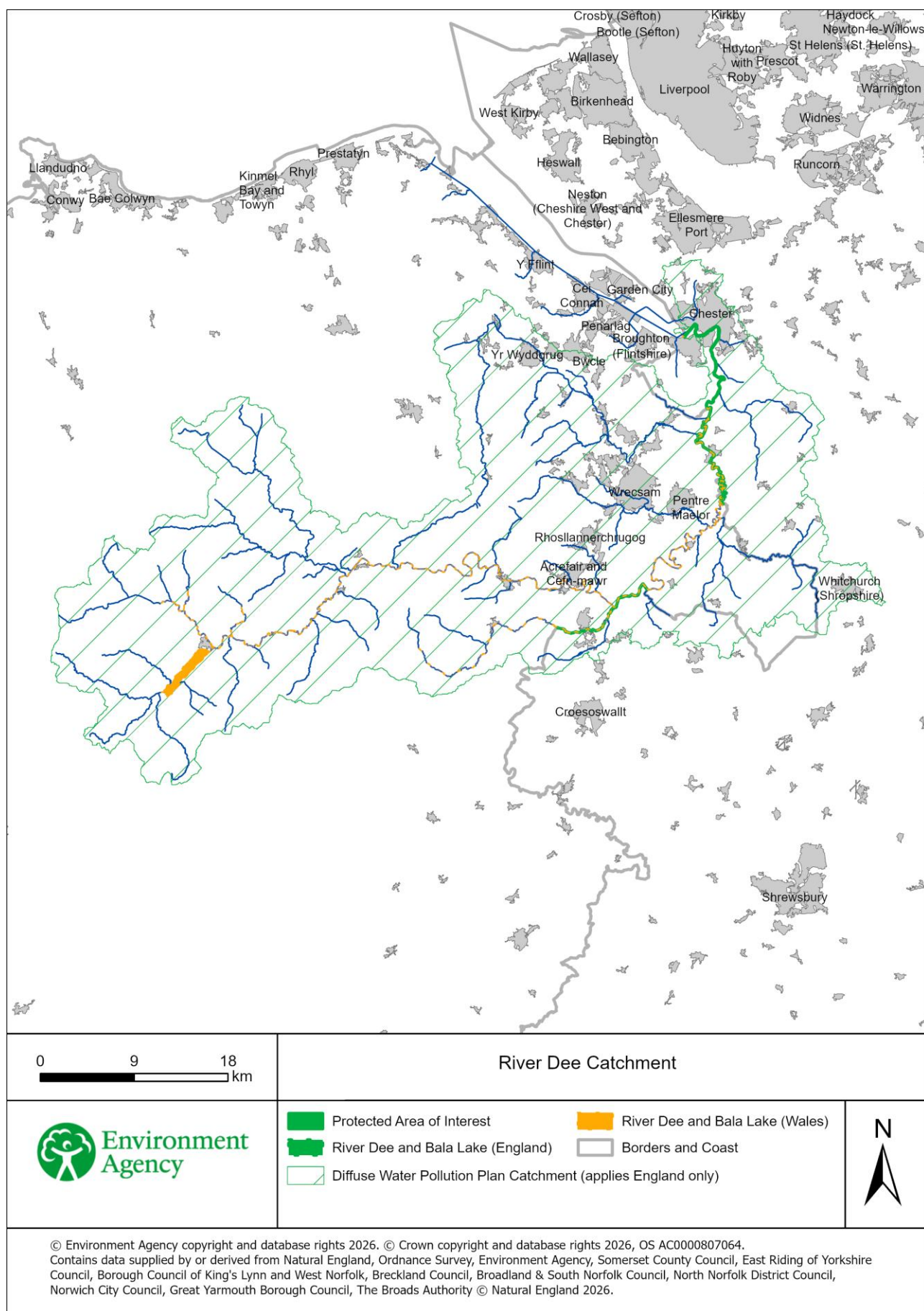
This document provides summary outputs from the Environment Agency's water quality modelling for the River Dee Special Area of Conservation (SAC) (Map 1). We provide catchment-scale source apportionment information and maps showing the scale of reductions needed to achieve protected area water quality targets in England only. Our outputs will help those working on Diffuse Water Pollution Plans (DWPPs) 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 phosphate Common Standards Monitoring Guidance (CSMG) targets applicable to the River Dee SAC in England. 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 Dee SAC and catchment with protected area highlighted. Modelling results presented for the English reaches only.

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. Since publication of the Indicative Catchment Statistics Report (Version 1.2, September 2024) we recalibrated the Dee model to incorporate additional catchment data and to improve representation of the Dee 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 4) 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 (Tables 5 and 6) 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 main 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 (see 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 (see 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 English reaches only 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.	16%
Theoretical Maximum	100% uptake of all measures in Farmscoper V5.	28%

River Dee modelled outputs

We estimate the phosphate input load source apportionment for the River Dee to be 32% point source, 69% diffuse source in the Actual (2014 to 2020) scenario, with rural land use (63%) dominating the diffuse sector sources (Table 3). The source apportionment changes incrementally under the subsequent scenarios. When we apply the Full Regulation and Theoretical Maximum reductions to the diffuse sector, the contribution from rural land use reduces from 64% in the 2030 At Permit model to 63%. The small change is due to the rural land use reductions being applied only to modelled reaches in England.

We estimate the base (2009) sector share of the protected site target to be 50% diffuse and 50% point. This gives a sector share of 0.01mg/l for both the diffuse and point sectors (Table 4). The estimated catchment average sector concentrations in the Actual (2014 to 2020) scenario exceed the sector share of the target (Table 4). For the sector share to be met, the diffuse sector concentrations need to reduce by an estimated 82% and point sector concentrations by 71%. With both the Full Regulation and Theoretical Maximum reductions applied to the rural land use sector, the residual reductions needed to meet the diffuse sector share remain high, over 70% as a catchment average (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)	31.7%	62.8%	4.6%	0.8%	0.0%
2030 Optimistic	19.3%	74.3%	5.4%	1.0%	0.0%
2030 At Permit	30.0%	64.4%	4.7%	0.9%	0.0%
2030 Full Regulation	30.6%	63.8%	4.8%	0.9%	0.0%
2030 Theoretical Maximum	31.1%	63.1%	4.9%	0.9%	0.0%

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: Diffuse and Point Sector catchment average phosphate sector share, modelled concentrations and percentage reductions for each scenario.

Scenario and Assessment Metric	Diffuse	Point	Total
Baseline (2009) Sector Share of the target	50%	50%	
Catchment average sector share of the target (mg/l)	0.010	0.010	0.020
Actual (2014 to 2020) - modelled sector concentration (mg/l)	0.053	0.034	0.088
Actual (2014 to 2020) - reduction to meet sector share	82%	71%	78%
2030 Optimistic – modelled sector concentration (mg/l)	0.053	0.022	0.075
2030 Optimistic – reduction to meet sector share	82%	55%	74%
2030 At Permit – modelled sector concentration (mg/l)	0.052	0.045	0.098
2030 At Permit – reduction to meet sector share	81%	78%	80%
2030 Full Regulation – modelled sector concentration (mg/l)	0.048	0.045	0.093
2030 Full Regulation – reduction to meet sector share	79%	78%	79%
2030 Theoretical Maximum – modelled sector concentration (mg/l)	0.044	0.045	0.089
2030 Theoretical Maximum – reduction to meet sector share	77%	78%	78%

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 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 e.g. monitoring point or discharge location.

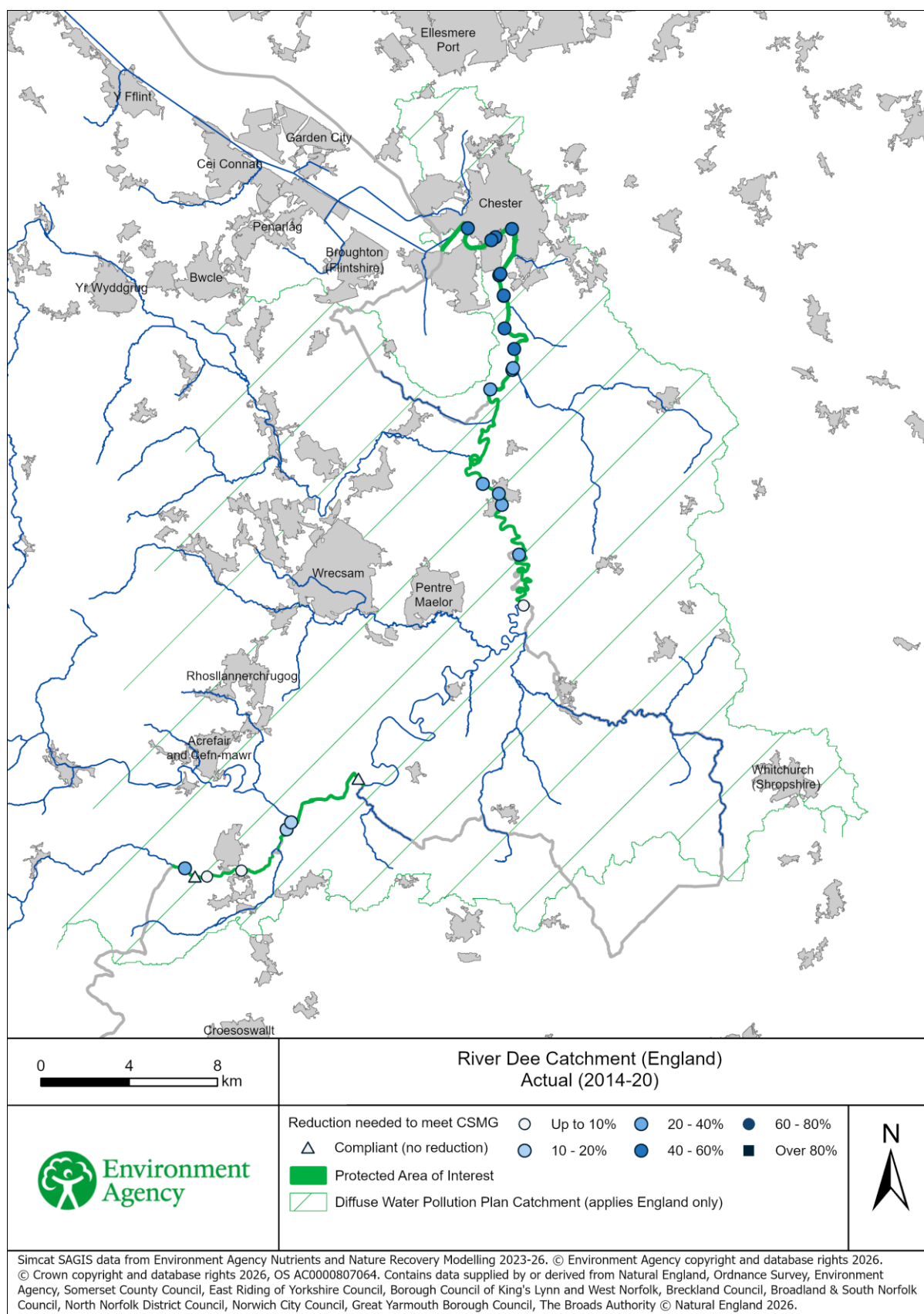
Under the Actual (2014 to 2020) scenario there is a single location in the Ceiriog tributary, the southern-most designated reach in England, that meets the site targets (Map 2). The estimated reductions needed are up to 20% in parts of the Ceiriog tributary, between 20 and 40% in the middle reaches of the catchment and between 40 and 60% in the lower reaches close to Chester. Under the same scenario, the estimated diffuse sector reductions needed to meet the diffuse sector share of the target are broadly the same in the Ceiriog tributary but greater in the main river Dee, with reductions needed up to 80% at the lower end of the catchment (Map 7).

The 2030 Optimistic scenario (Map 3) estimates the concentrations after the implementation of AMP8 water company investment in the calibration model. The 2030 At Permit scenario represents the same investment in the At Permit model (Map 4). We estimate the CSMG target to be met in the Ceiriog tributary in both these scenarios (Maps 3 and 4). To meet the CSMG target in the middle reaches, the estimated reductions needed are between 20 and 40% and in the lower reaches, between 40 and 60%, in both scenarios (Maps 3 and 4).

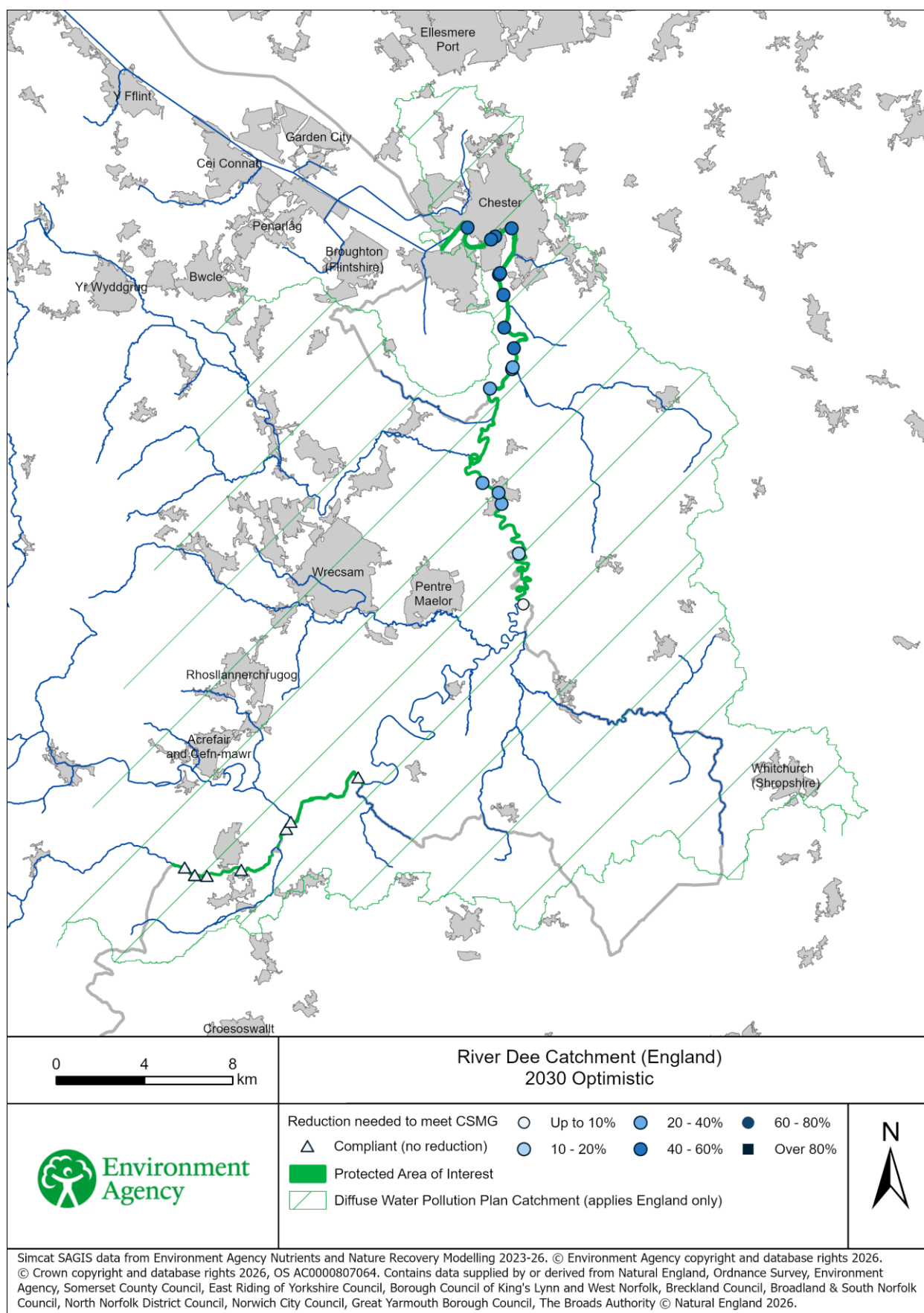
With the Full Regulation and Theoretical Maximum reductions applied to the rural land use sector in the English reaches only (Table 2), the estimated reductions needed to meet the CSMG targets are the same (Maps 5 and 6).

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 targets (Maps 2, 5 to 6). This is because the point sector concentrations are less than the point sector share of the target, which creates a degree of 'headroom' for the diffuse concentrations. In the Ceiriog tributary for example, the overall site targets are estimated to be met when the AMP8 investment is in place (Maps 3 and 4), despite the diffuse sector share of the target being exceeded (Maps 8 and 9).

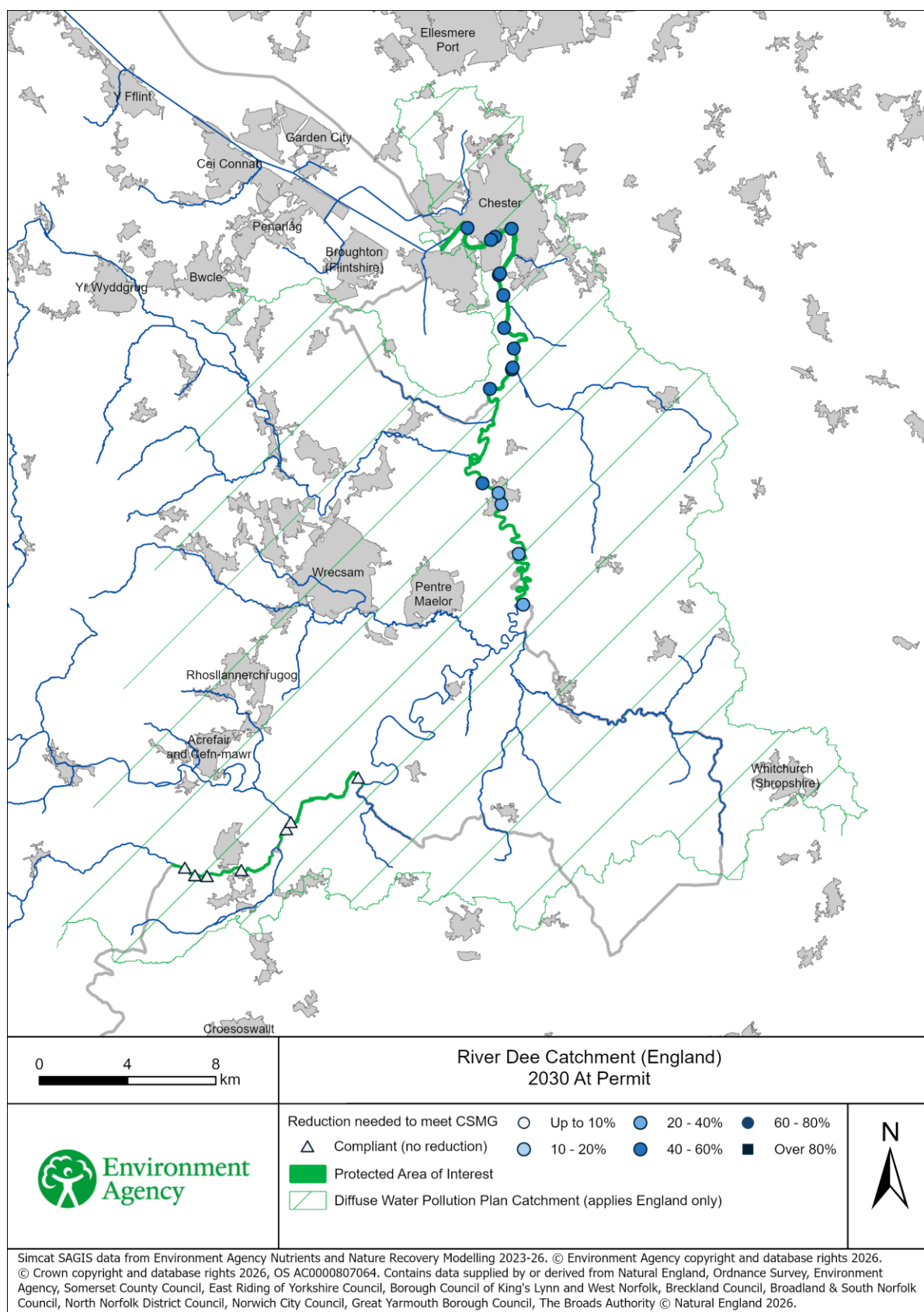
When we apply the Full Regulation and Theoretical Maximum reductions to the diffuse sector in the English modelled reaches, the diffuse reductions needed to meet the diffuse sector share are estimated to be between 40 and 60% in the middle reaches and up to 80% in the lower reaches of the catchment.



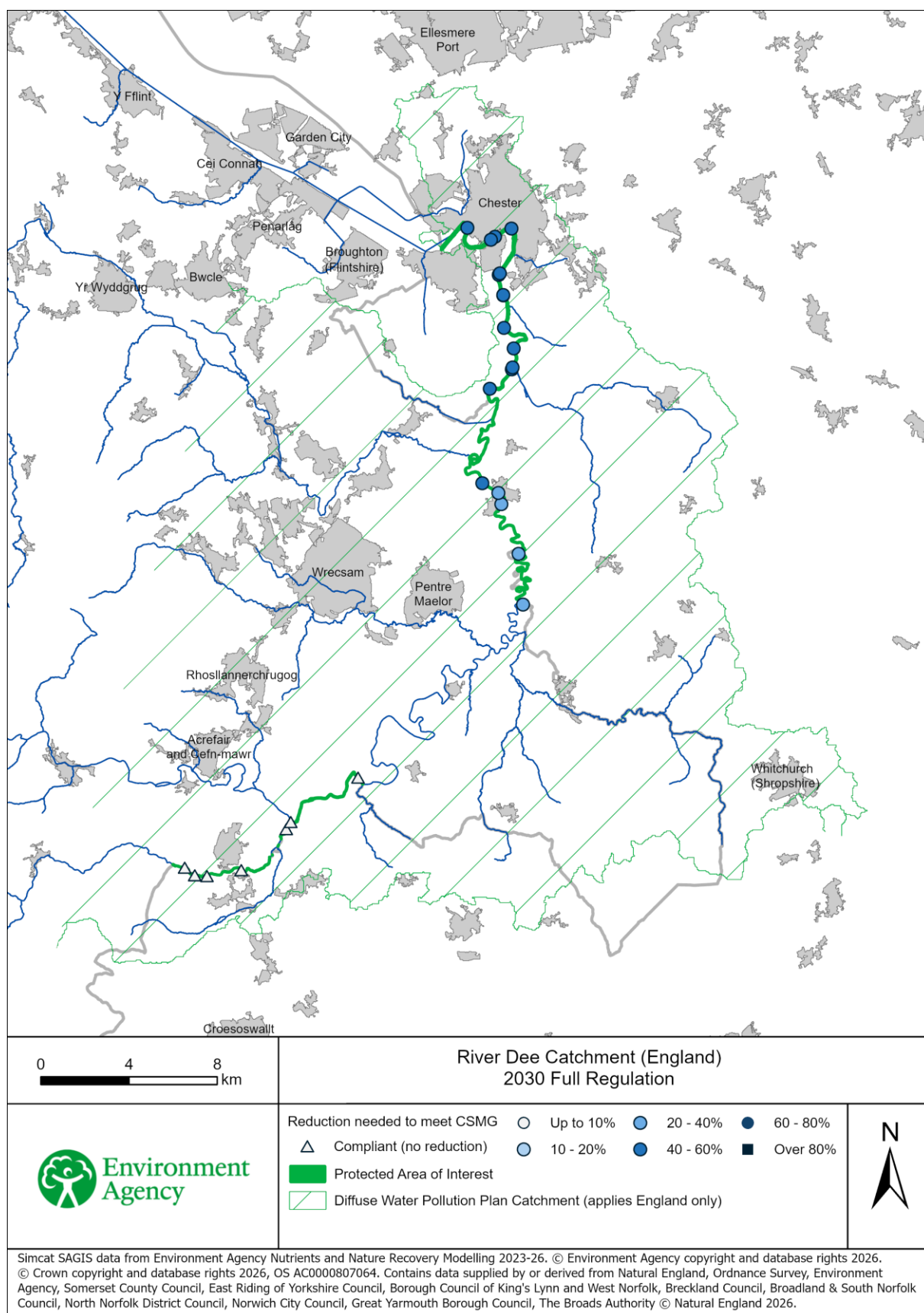
Map 2. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the Actual (2014 to 2020) scenario. Concentrations in the Ceiriog tributary (the southern most designated reach) are less than those in the main river Dee towards Chester. Reductions needed in the Ceiriog tributary are up to 20%, they are between 20% and 40% in the middle part of the catchment, and up to 60% in the lower reaches close to Chester.



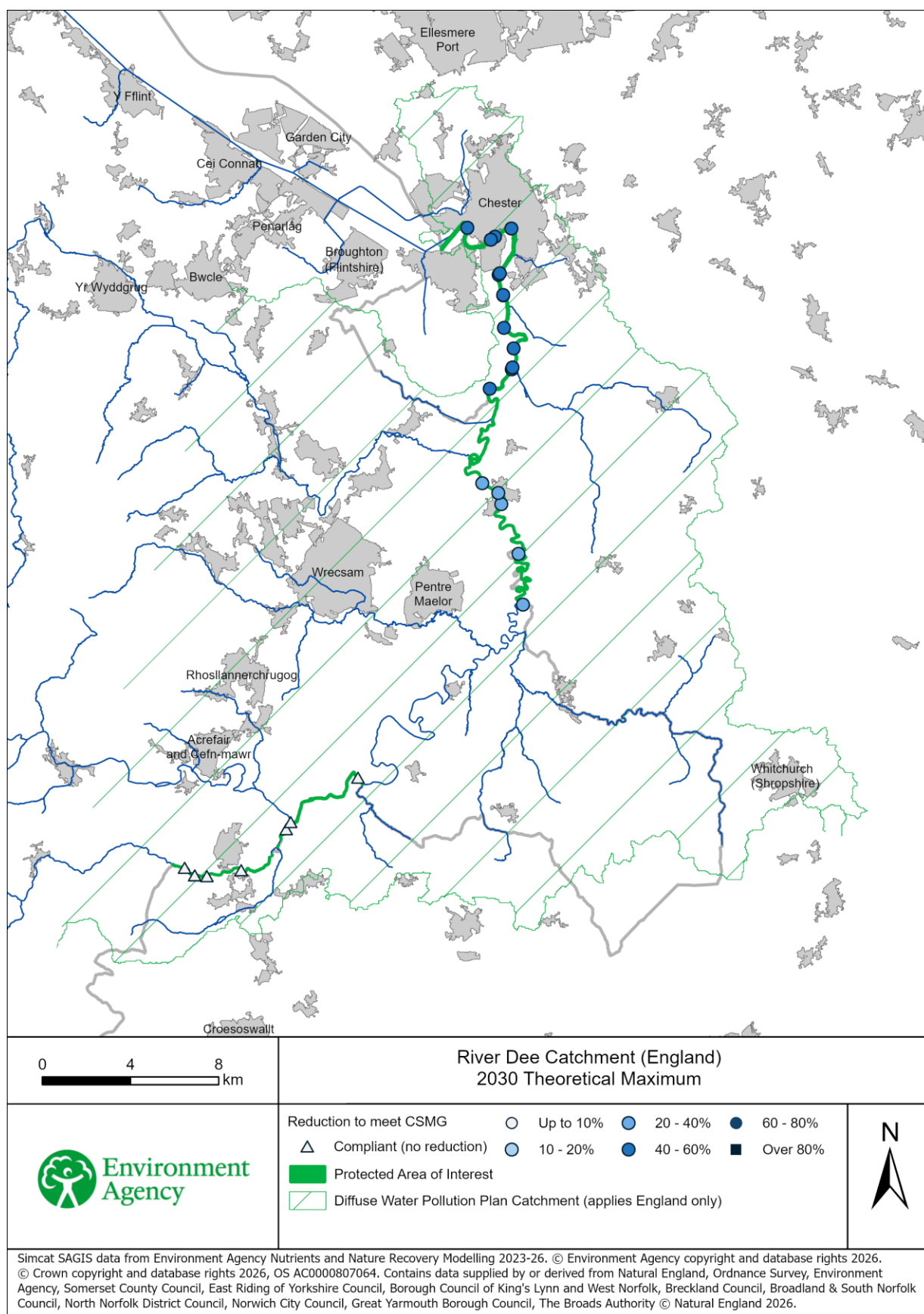
Map 3. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 Optimistic scenario. Concentrations in the Ceiriog tributary are estimated to be meet the target. Concentrations in the lower reaches of the main river Dee towards Chester need to reduce by up to 60% for the target to be met.



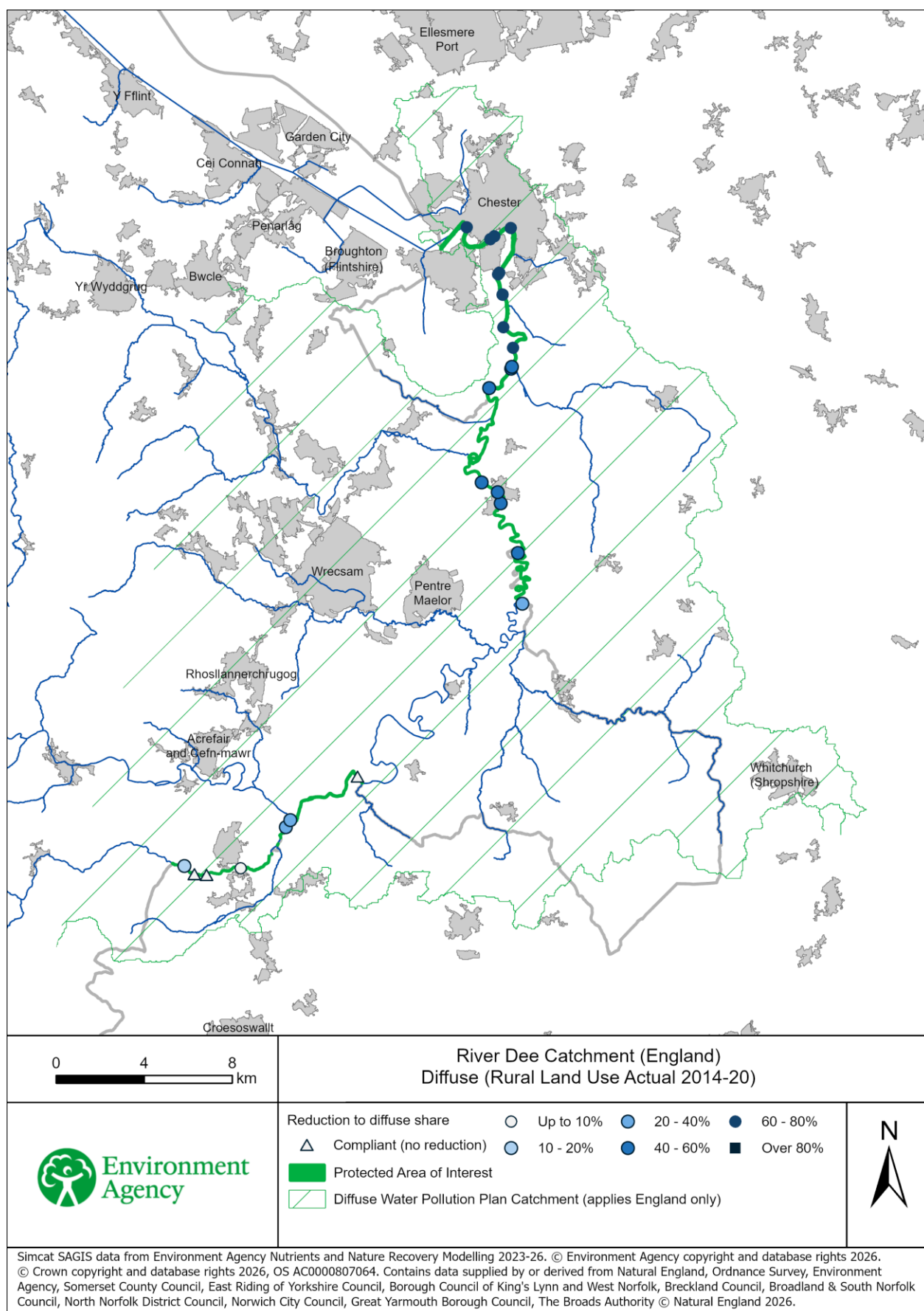
Map 4. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 At Permit scenario. Broadly the same as the 2030 Optimistic scenario. Concentrations in the Ceiriog tributary are estimated to meet the target. Concentrations in the lower reaches of the main river Dee towards Chester need to reduce by up to 60% for the target to be met.



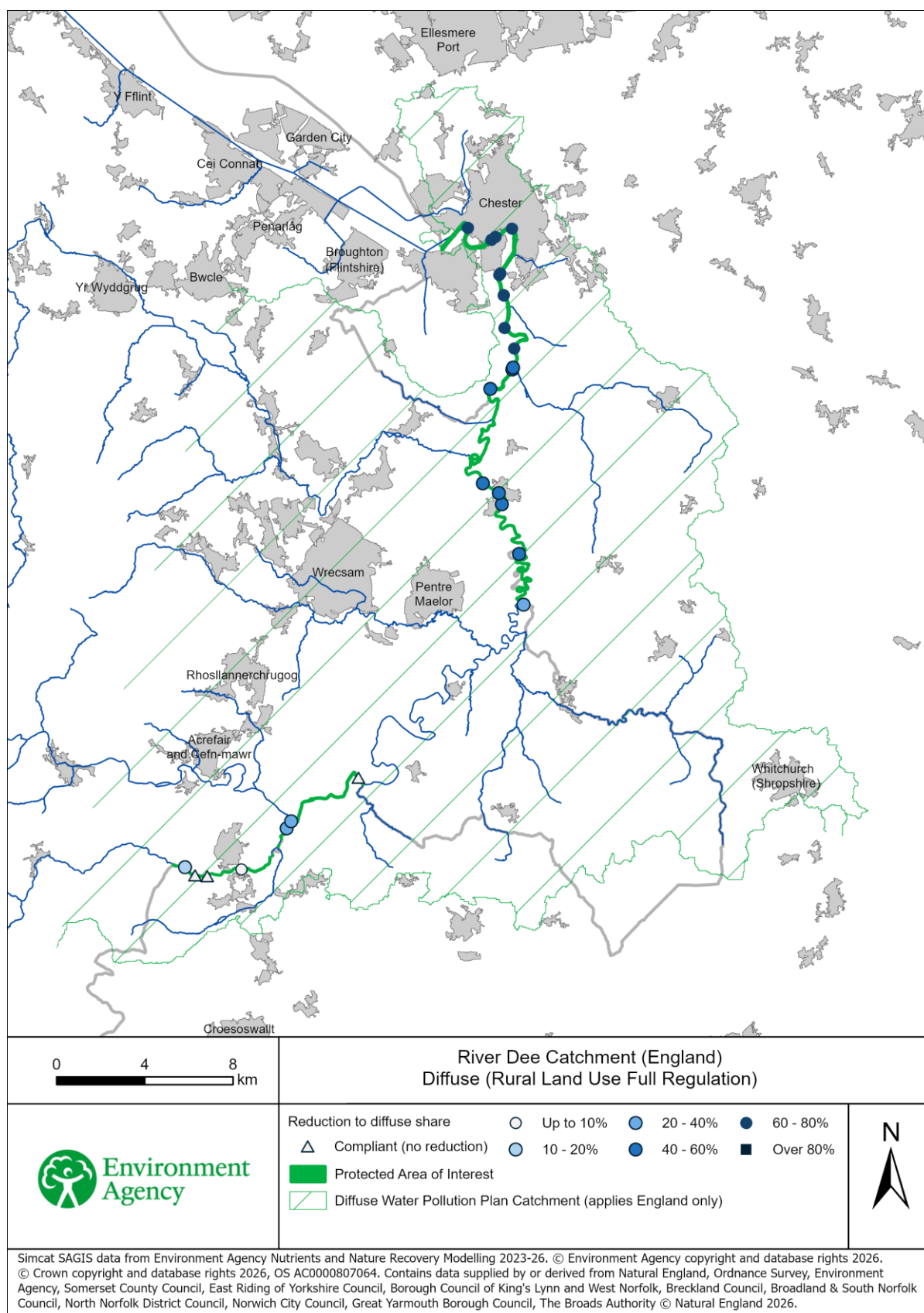
Map 5. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 Full Regulation scenario. The reductions needed are broadly the same as the 2030 At Permit scenario.



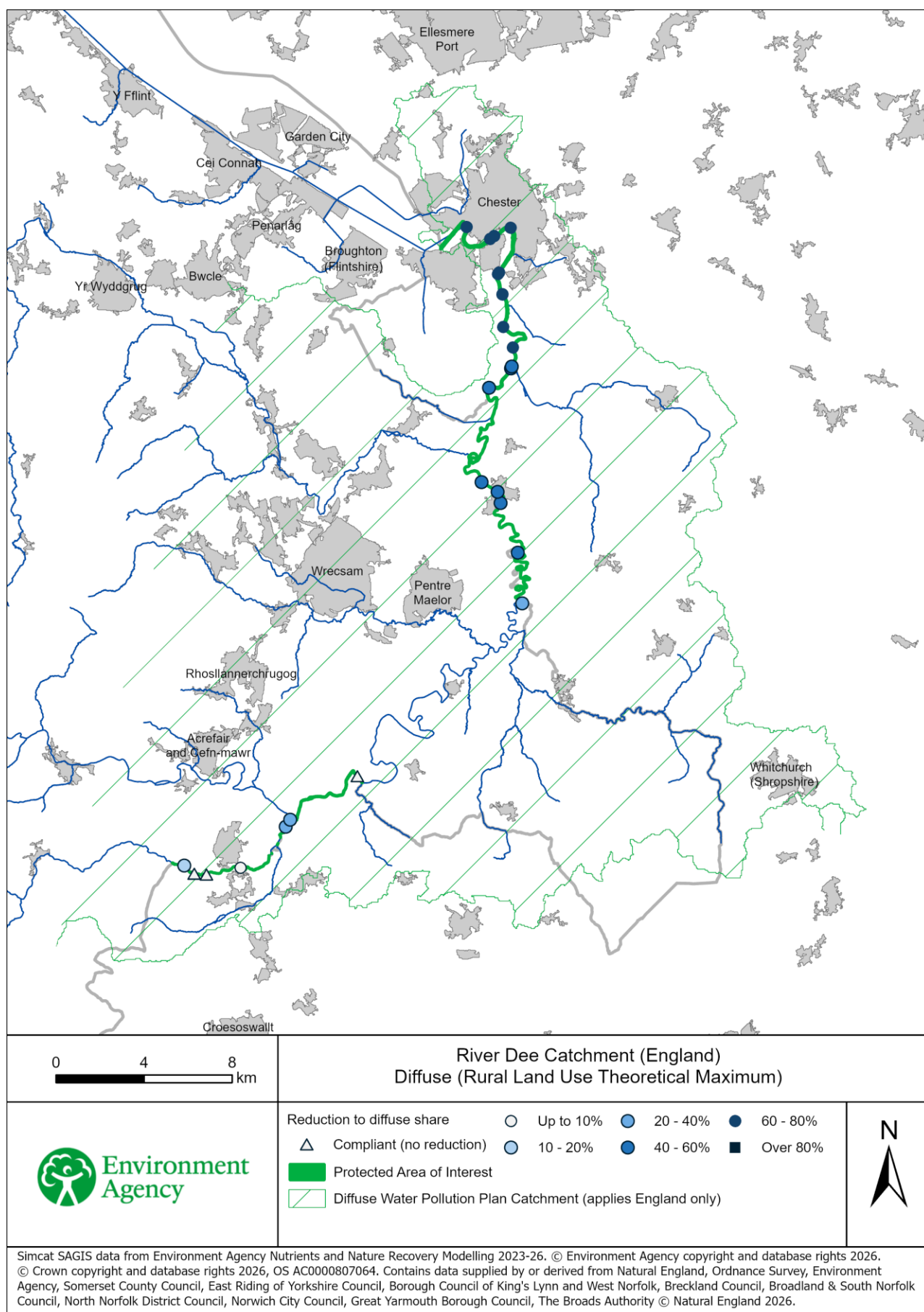
Map 6. Estimated reductions needed in phosphate total concentrations to meet the CSMG target in the 2030 Theoretical Maximum scenario. The reductions needed are broadly the same as the 2030 At Permit scenario.



Map 7. Diffuse sector reductions needed in diffuse phosphate concentrations to meet the diffuse sector share of the target in the Actual (2014 to 2020) scenario. Diffuse concentrations need to reduce by up to 40% in the Ceiriog tributary, and up to 80% in the lower reaches of the Dee towards Chester.



Map 8. Diffuse sector reductions needed in diffuse phosphate concentrations to meet the diffuse sector share of the target in the 2030 Full Regulation scenario. This scenario outputs are the same as the Actual (2014 to 2020) scenario.



Map 9. Diffuse sector reductions needed in diffuse phosphate concentrations to meet the diffuse sector share of the target in the 2030 Theoretical Maximum scenario. This scenario outputs are the same as the Actual (2014 to 2020) scenario.

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)	88.04	2.49	0.70	180.70	13.17	2.41	0.07	31.7%	62.8%	4.6%	0.8%	0.0%
2030 Optimistic	43.79	2.49	0.70	180.70	13.17	2.41	0.07	19.3%	74.3%	5.4%	1.0%	0.0%
2030 At Permit	81.04	2.49	0.70	180.70	13.17	2.41	0.07	30.0%	64.4%	4.7%	0.9%	0.0%
2030 Full Regulation	81.04	2.49	0.70	175.75	13.17	2.41	0.07	30.6%	63.8%	4.8%	0.9%	0.0%
2030 Theoretical Maximum	81.04	2.49	0.70	171.10	13.17	2.41	0.07	31.1%	63.1%	4.9%	0.9%	0.0%

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

Would you like to find out more about us or your environment?

Then call us on

03708 506 506 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Or visit our website

www.gov.uk/environment-agency

incident hotline

0800 807060 **(24 hours)**

floodline

0345 988 1188 **(24 hours)**

Find out about call charges (<https://www.gov.uk/call-charges>)

Environment first

Are you viewing this onscreen? Please consider the environment and only print if absolutely necessary. If you are reading a paper copy, please don't forget to reuse and recycle.