Catchment Nutrient Balancing (CNB) Approach

An example for the water industry

United Utilities

Water for the North West

Contents

1. Introduction

Nutrient pollution by phosphorus (P) and nitrogen (N) is one of the reasons waterbodies commonly fail to achieve Water Framework Directive (WFD) water quality objectives. To achieve these objectives, wastewater treatment works (WwTW) permit limits are becoming increasingly stringent, technically challenging and difficult to achieve.

Traditional and emerging advanced P removal technologies are designed to address the economies of larger, urbanised WwTWs. When tighter P permits are proposed for small sites under different drivers (e.g. WFD, protection of European sites etc.), P removal can be practically challenging and excessively expensive. Further, in some rural catchments, the apportionment of P pollution can be greater from agricultural runoff, as well as other diffuse sources, such as septic tanks. The challenge of meeting the requirements of watercourses to deliver their WFD objectives often goes beyond water company activities, providing significant opportunities to deliver activities in catchments to reduce nutrient load at source and deliver other multiple benefits, offsetting this load reduction against treatment works performance.

Innovative permitting approaches such as Catchment Nutrient Balancing (CNB) have been introduced as an alternative to conventional permitting to address specific catchment needs in a more sustainable and holistic way. This approach unlocks the potential for innovation, integrated solutions, risk-sharing, cost efficiencies, and the delivery of wider benefits.

CNB provides an opportunity for water companies to offset some or all of their obligations at a wastewater treatment works by helping another sector such as agriculture to deliver beyond their own obligations. This provides a sustainable way to improve and protect the environment through a natural capital approach. As per the paid ecosystems services approach, CNB can be used by one sector to pay others to change behaviours and implement measures to reduce nutrient.

Building on our learning from delivering the first catchment flexible permit and our use of CNB, we identified significant complexities in how to put this into action. As this approach is new to the water industry, we have developed our knowledge as an example to share with wider industry. This document provides information that will enable other water companies to make appropriate choices both now and in the future when they utilise a CNB approach and through this we hope to increase the uptake of this method benefiting customers across the country. This CNB document is acknowledged and approved by the Environment Agency.

1.1 Environment Agency principles for CNB delivery

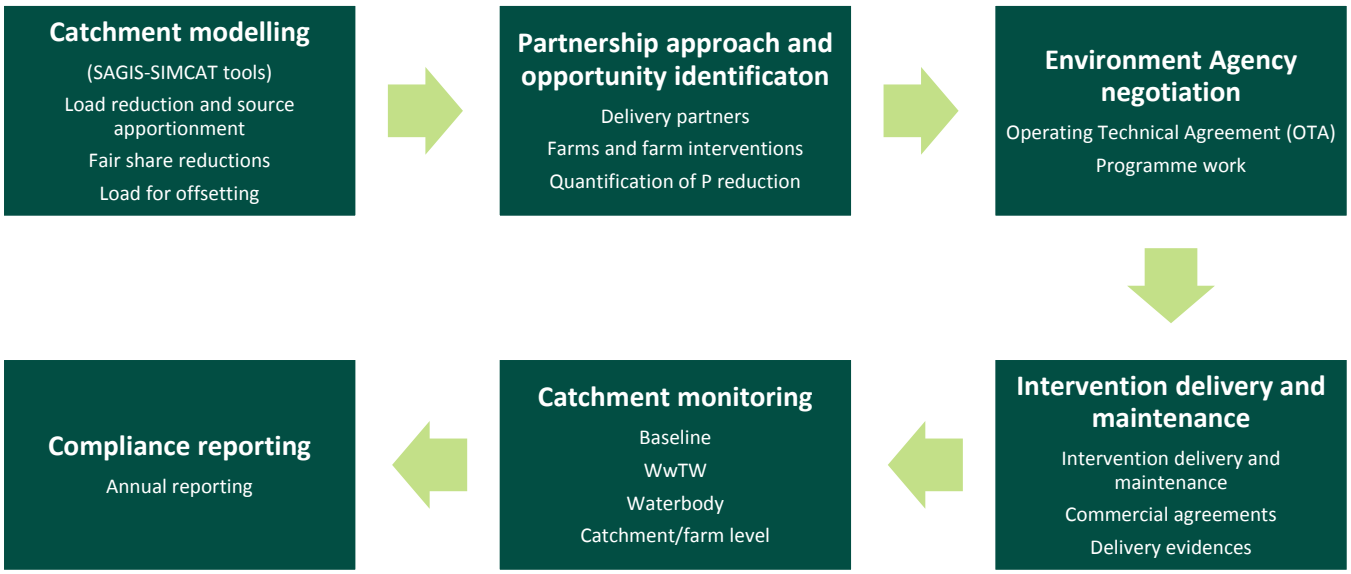
The Environment Agency (EA) issued “Catchment Nutrient Balancing Criteria position statement” in Oct 2018, and then issued “Agriculture Fair share interim position statement” in Feb 2021. The recent “PR24 WINEP supporting guidance – Permitting innovative solutions” details the EA principles for CNB delivery.

In summary:

- Environment Agency approach is to exclude the worst Environmental performers from innovative permitting opportunities. The worst performers are those who have a 1* or 2* EPA rating for 3 out of the last 4 years, plus any other significant evidence such as enforcement action.
- When developing water company proposals for CNB measures, any proposed measures should be over and above the measures that the agricultural sector must complete to meet their fair share obligations and should not replace their fair share.
- Bespoke Operating Technical Agreements (OTAs) are developed for each CNB proposal and agree with Environment Agency. Proposals will be initially trialled over an agreed defined time period (usually 3 years) and reviewed at the end of the trial.
- The water company accepts full ownership of the measure and the risks, including the obligation to reduce the nutrient load as well as all other obligations contained within the permit.

- The Catchment Based Solutions must take place in the same geographical location as the conventional treatment solution, i.e. the measures must be in the same catchment as the conventional treatment, preferably upstream of the receptor.
- The Catchment Based Solutions must be evidence-based and measurable. Each proposal will be assessed on a case by case basis to determine the appropriateness and effectiveness of proposed measures.
- Permits will be bespoke environmental permits under the Environmental Permitting Regulations 2016 (EPR) and include standard permit conditions as well as a bespoke 'operating techniques' agreement. An Operating Techniques Agreement (OTA) will set out how the discharge and catchment measures are to be managed to achieve the overall nutrient reductions, as required by the operating techniques conditions.
- There will be a single OTA for a catchment which will be referenced in the permits of all participating WwTWs and will include all the catchment measures that will be undertaken and the expected nutrient reduction.
- The overall P reduction target against the baseline as well as obligations to monitor both the discharge and the environment. CNB can be carried out as a stand-alone solution, a hybrid solution or with another permitting solution.

Key steps of CNB approach:



2. Catchment modelling

Catchment modelling is undertaken using the latest version of SAGIS-SIMCAT modelling tools. These models are calibrated from existing flow and quality data for rivers and wastewater discharges. It is possible to update a SIMCAT model using newly collected discharge and/or river data either to recalibrate the model or to validate the results of the existing model. Ideally, data should be daily flow measurements and/or monthly water quality sampling results taken over a three-year period, but as a minimum should cover the whole seasonal variation of a 12-month period. Sufficient data is required to enable statistical distributions of the flow and quality of the river or discharge to be produced and should account for any step changes or unusual occurrences in the data. It is beneficial to validate the model anecdotally with stakeholders such as CaBA and if there are reasonable grounds to believe it is inaccurate then it is advisable to update the model.

Modelling is carried out using SIMCAT, which is a stochastic[1] deterministic model that predicts the impact of discharges on river quality along the entire length of a river network. SIMCAT gives statistical results of river flow and quality along the river network (-GIS1 file), along with source apportionment of various point and diffuse sectors (-D files) and of all modelled discharges into the rivers (-P files). These results are then exported into an Optimiser spreadsheet tool to calculate the P reductions required from point and diffuse sources on a fair share basis in order to meet in-river targets. The Optimiser tool can also be used to calculate the effect of 'beyond fair share' measures (doing more at the WwTW) on the required diffuse removal or the potential for doing less at a WwTW through additional catchment interventions, known as offsetting. An assumption is currently being made that 10% of the diffuse load remaining after fair share reductions will be available for offsetting.

Key steps:

- Run SIMCAT-SAGIS to identify load reduction and source apportionment
- Optimise across the catchment
- Identify fair share reductions across sectors
- After agricultural fair share delivered, apply 10% to remaining load (this gives the likely achievable load for offsetting etc.)
- Identify the potential impact these offsets have on future permit requirements

In optioneering the potential solutions, the baseline (fair share) requirements should be considered along with any alternative requirements, e.g. relaxed permit limits with diffuse offsetting, in order to determine the potential WwTW and catchment interventions and their relative costs and wider benefits. The SAGIS-SIMCAT suite of tools includes a multi-variate Decision Support Tool (DST) that can be used to determine the cheapest or most effective overall solution for a catchment where multiple discharges are impacting on the river quality. The need to deliver the required status across the water body may result in being able to deliver activity within the catchment, but could be at the water body level, this should be agreed with Environment Agency.

[1] Stochastic refers to random values. SIMCAT takes random (but correlated) values from the statistical distributions of the discharge flow and concentration (and hence the discharge load, which is flow x concentration) and the upstream river flow and concentration (and upstream river load) and enters them into a mass-balance equation to calculate the downstream river flow, concentration and load. It does this hundreds of times, taking different random picks for each 'shot', to create statistical distributions for the downstream river.

3. Partnership approach and opportunity identification

One of the key elements of CNB delivery is partnership approach. It is important to gain local knowledge, make joint decisions and challenge assumptions. Collaboration unlocks the potential for innovation, integrated solutions, risk-sharing, cost efficiencies, and the delivery of multiple benefits. The potential stakeholders could be other local businesses, farming communities, volunteers, local environmental groups, local authorities, Natural England, The National Farming Union (NFU) and the Environment Agency.

The CNB approach and the catchment-based solutions can attract wide partnership attention as it can address a wider range of issues identified across the landscape. The catchment-based solutions can deliver additional ecological benefit beyond target nutrient reductions. In terms of water quality improvements, reduction of sediment and FIO (faecal indicator organisms) will be a key advantage besides major nutrients. Outside water quality, adopting a catchment-based approach can also deliver flood benefits, carbon reduction, biodiversity improvement and wider natural capital benefits.

Working across catchments with nutrient trading also allows the opportunity to align interests with other partners to increase delivery. This helps water company findings to go further and also delivers greater benefit for customers.

3.1 Farms and farm interventions

The catchment interventions should take place in the same geographical location as the conventional treatment solution, i.e. the measures must be in the same catchment as the conventional treatment preferably upstream of the receptor as agreed locally with the EA. Water companies can use a partnership approach to find appropriate farms. An initial visit for potential farms with a farm expert is recommended to assess the suitability and identify possible interventions.

The agricultural sector is required to meet all the requirements of the Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018 (Farming Rules for Water) as well as other relevant legislative requirements, for example the Silage, Slurry and Agricultural Fuel Oil (SSAFO) Regulations 2010, the Nitrate Vulnerable Zones (NVZ) Regulations 2015, the Environmental Permitting Regulations 2016, and the Water Resources Act 1991, prior to engaging in any CNB approach. Any delivery of CNB interventions must be above and beyond that which is expected of agriculture through regulation and fair share.

If the agricultural sector has not met its fair share obligations through current regulatory measures, the Environment Agency would expect them to use additional measures to ensure they achieve this, and these should not be funded through a CNB approach. However, market led approaches and joint funding mechanism can be applied as long as it would not double count the measures included in CNB approach. Potential joint funding partners could be for example, developers, water companies, commercial businesses and farmers who use their own funding or funding acquired via catchment sensitive farming scheme etc. The potential double counting for such schemes could be avoided though creating a mechanisms such as nutrient trading platforms.

3.2 Quantification of nutrient reduction

It is crucial to understand the interventions that are being delivered and their likely benefit in terms of nutrient reduction for CNB approach. The Environment Agency recommendation is to use the ADAS Farmscoper model to quantify the potential phosphorus savings that can be made from farms. Farmscoper is a decision support tool that can be used to assess diffuse agricultural pollutant loads on a farm and quantify the impacts of farm mitigation methods on these pollutants. The farm systems within the tool can be customised to reflect

management and environmental conditions representative of farming across England and Wales. The tool contains over 100 mitigation methods, including many of those in the Defra Mitigation Method User Guide. Farmscoper was originally developed under a Defra project and latter version has been revised with Environment Agency support.

Farmscoper tool consist of couple of key workbooks. Farmscoper-Create workbook is used to create a farm. Initial step allows to select general information such as rainfall zone, soil type, farm type etc. and determines the pollutant loads for the specific farm type and environment. Then, it allows to customise the farm and build the specifics of the farm. Followed by Farmscoper _Evaluate workbook is used to select the mitigation method to implement and to determine their cost and impact. This allows to select the priors' already in place and then select the intervention deliver post scheme completion to allow the difference in load between priors and new interventions to be calculated.

The assessment should be performed by Farmscoper experts with the support of catchment delivery partners and farmers. A farm visit is recommended to assess the current situation of the farm and review the capacity, condition and suitability of infrastructure for managing and storing slurry/manure/effluent to reduce the risk of point source pollution and improve efficiency of use, resulting in a reduction in diffuse pollution particularly focussing on losses of nutrient. The assessments are focused on the baseline, fair share requirement and the interventions over and above fair share that could be delivered to improve the farms' nutrient performance. The reasonable precautions under FRFW, cross-compliance or NVZ regulations cannot be funded by water companies unless the farmer is already meeting fair share requirements. To evidence that a farmer is already meeting fair share requirement, the Environment Agency guidance is to use 2009 baseline and work out the required fair share reduction and if they are meeting that level now then these measures can be funded.

The farm management data is collected and fed into a Farmscoper model by the assessor. Two separate Farmscoper workbooks ("Create" and "Evaluate") are produced for each farm. A copy of both workbooks are recommended to be kept as evidence.

Farmscoper "Baseline" losses is the scenario with no mitigation measures implemented. "Prior Implementation" is an estimate of the present uptake of a method, which is normally expressed as a percentage of the applicable area or number of livestock ("With Priors"). If a mitigation method is applied in a scenario, then its implementation will be raised from the "Prior Implementation" value up to the intended implementation value (which is Set1).

Ideally the prior and maximum implementation values to be used would be derived at the farm scale through a site visit and reflect the actual farm operation. However, this is not always possible particularly when looking at a number of farms in a catchment. As such, if the Farmscoper model has pre-set baseline/prior values, then the Environment Agency would agree to use them. There are maximum likely levels for certain measures that are lower than 100%. For such measures, the Environment Agency suggests reducing the max implementation values to 85% to avoid being overly optimistic in the modelling. These values could then be increased based on actual farm specific information. The exception to this is capital items that are either present or absent such as covering slurry cover stores.

Key steps:

- Collect and input farm data to develop the "baseline",
- Input prior measures to develop the "with priors",
- Input the proposed additional measures to develop the "set 1".

In the standard procedure, we calculate the difference between the priors and the set 1 and that is the reduction water companies can claim under CNB approach. If the farm requires intervention to bring it up to the regulatory standard these activity's should not be included in the benefits delivered by water companies and so set 1 should detail this activity and a new set 2 created to represent the additional measures above these that water companies are delivering. In this case the calculated benefit would be the difference between set 1 and set 2.

Farmscoper evaluate report example:

General Farm information

Farmscoper Evaluate: Sets of methods
07/07/2021

File Information	
Create File:	FARMSCOPER4_Createfarm1.xls
Cost File:	FARMSCOPER4_Cost.xls
Evaluate File:	REvised mitigation methods farm 1.xls
Climate:	900 - 1200 mm
Soil Type:	Impermeable - Drained for Arable & Grass

Environmental Benefit	Unit	Value (£)
Nitrate	£ kg^{-1} N	0.97
Phosphorus	£ kg^{-1} P	33.16
Sediment	£ kg^{-1} S	0.39
Ammonia	£ kg^{-1} N	2.79
Methane	£ kg^{-1} CO_2-e	0.06
Nitrous Oxide	£ kg^{-1} CO_2-e	0.06
Pesticides	£ dose unit^{-1}	0.00
FIOs	£ 10^9 cfu^{-1}	0.00
Energy Use	£ kg^{-1} CO_2-e	0.06

Wider environmental benefit summary

Display Options
☑ Show Values for Methods
☑ Show Impacts for Methods

	Fixed Cost	Variable Cost	Total Cost	Environmental Benefit	Nitrate	Phosphorus	Sediment	Ammonia	Methane	Nitrous Oxide	Pesticides	FIOs	Soil Carbon	Energy Use	Production	Biodiversity	Water Use	Soil Quality
Values	£	£	£	£	kg	kg	kg	kg	kg	kg	Units	10^9 cfu	t	kg	£	-	-	-
Baseline	0	0	0	-	11,398	561	197,956	13,041	59,847	3,634	4.8	36,520	40,733	570,112	841,470	-	-	-
With Priors	8,601	-10,464	-1,863	3,225	11,006	542	197,956	12,942	59,847	3,548	4.8	31,782	40,733	566,858	841,470	0.0	0.0	0.0
Set 1	23,814	-10,645	13,169	4,162	10,789	521	197,956	12,990	59,847	3,539	4.8	27,894	40,733	567,013	841,470	0.0	0.0	0.0
Impacts (Change relative to Prior)	£	£	£	£	%	%	%	%	%	%	%	%	%	%	%	-	-	-
Set 1	15,214	-181	15,033	937	2.0	3.9	0.0	-0.4	0.0	0.2	0.0	12.2	0.0	0.0	0.0	0.0	0.0	0.0

"Baseline", "With priors" and "Set 1" values

Method lists for each set

Method IDs: Set 1	Description
52	Increase the capacity of farm slurry stores to improve timing of slurry applications
571	Minimise the volume of dirty water produced (sent to slurry store)
61	Store solid manure heaps on an impermeable base and collect effluent
62	Cover solid manure stores with sheeting
63	Use liquid/solid manure separation techniques
76	Fence off rivers and streams from livestock

List of farm interventions included in Set 1

3.3 Farm interventions that can be funded by water companies

A. The agricultural measures that can be managed using Farmscoper:

Measure	Benefit claimable under CNB	EA comments	Measure Reference from Farmscoper	Measure name in Farmscoper
Fencing	**May-be**	This is a reasonable precaution under FRFW so should not be funded by water companies unless the farmer is already meeting fair share requirements. Minimum level of prior from ADAS report (Project WT1594, 2019) was 39% for this measure.	76	Fence off rivers and streams from livestock
Settlement ponds	**Maybe**	Settlement ponds for lightly fouled water slurry systems should not normally be funded as these are part of SSAFO. Polishing water from 'clean farm yards would normally be acceptable. Specific circumstances will need to be considered.	81	Establish and maintain artificial wetlands - steading runoff
Cover crops	**No**	Cover crops should not be funded by water companies as these are required by cross compliance and FRFW.	4	Establish cover crops in the autumn

Wetland / pond creation	**Maybe**	These are not a legal requirement and can be funded by water companies except for where they are used as part of slurry treatment.	81	Establish and maintain artificial wetlands - steading runoff
Woodland planting	**Yes**	Not a legal requirement so can be funded by water companies.	102, 83	Management of woodland edges/Establish tree shelter belts around livestock housing
Hedgerow planting	**Yes**	Not a legal requirement so can be funded by water companies.	80	Establish new hedges
Buffer strips	**Maybe**	Buffer strips are normally a 'reasonable precaution' required under FRFW or cross compliance and should not be funded by water companies. 10 metre no spreading strips (or 6 metre for precision spreading) are required under FRFW and NVZ regs. This includes buffer strips around boreholes, wells and springs. None of these should be funded by water companies. Protective strips which are above 'reasonable precaution' can be considered for funding if this categorisation can be justified.	13, 14	Establish in-field grass buffer strips; Establish riparian buffer strips
In-field biodiversity strips	**Yes**	Not a legal requirement so can be funded by water companies.	13	Establish in-field grass buffer strips
Under-sowing	**No**	This is a reasonable precaution under FRFW so should not be funded by water companies.	113	Undersown spring cereals
Advice on nutrient management	**No**	Appropriate nutrient management is required under FRFW so advice to achieve this should not be funded by water companies.	22, 23, 25, 26	Use a fertiliser recommendation system, Integrate fertiliser and manure nutrient supply, Do not apply manufactured fertiliser to high-risk areas, Avoid spreading manufactured fertiliser to fields at high-risk times

Increase the capacity of farm slurry stores to improve timing of slurry applications	**Yes**	Farmer should meet SSAFO regs and water companies can pay capacity extension over and above SSAFO requirement. (SSAFO farmer requirement is a minimum of 4-months for SSAFO outside of a Nitrate Vulnerable Zone (NVZ) but 5 or 6 months for stores built inside an NVZ. Provision should ensure the same proportion of storage is maintained so this is not just used to increase herd size.	52	Increase the capacity of farm slurry stores to improve timing of slurry applications
Install covers to slurry stores	**Yes**	Not a legal requirement so can be funded by water companies.	54	Install covers to slurry stores
Minimise the volume of dirty water produced (sent to slurry store)	**Yes**	Not a legal requirement so can be funded by water companies.	570, 571	Minimise the volume of dirty water produced (sent to dirty water store)/Minimise the volume of dirty water produced (sent to slurry store)
Use liquid/solid manure separation techniques	**Yes**	Not a legal requirement so can be funded by water companies.	63	Use liquid/solid manure separation techniques
Farm track management	**Yes**	Not a legal requirement so can be funded by water companies.	79	Farm track management
Reduce field stocking rates when soils are wet	**Maybe**	This is a reasonable precaution under FRFW so should not be funded by water companies unless the farmer is already meeting fair share requirements.	37	Reduce field stocking rates when soils are wet
Loosen compacted soil layers in grassland fields	**Maybe**	This is a reasonable precaution under FRFW so should not be funded by water companies unless the farmer is already meeting fair share requirements.	15	Loosen compacted soil layers in grassland fields
Store solid manure heaps on an impermeable base and collect effluent	**Yes**	Not a legal requirement so can be funded by water companies.	61	Store solid manure heaps on an impermeable base and collect effluent
Cover solid manure stores with sheeting	**Yes**	Not a legal requirement so can be funded by water companies.	62	Cover solid manure stores with sheeting

Ditch management on arable land	**Yes**	This is beyond regulatory requirement In ditch management, the practices such as controlled drainage, appropriate connectivity, establishment of vegetation, sediments removal can contribute to reduce P losses.	180	Ditch management on arable land
Ditch management on grassland	**Yes**	This is beyond regulatory requirement In ditch management, the practices such as controlled drainage, appropriate connectivity, establishment of vegetation, sediments removal can contribute to reduce P losses.	181	Ditch management on grassland
Construct troughs with concrete base	**Yes**	This is beyond regulatory requirement	39	Construct troughs with concrete base
Washing down of dairy cow collecting yards	**Yes**	This is beyond regulatory requirement	44	Washing down of dairy cow collecting yards
Construct bridges for livestock crossing rivers/streams	**Yes**	This is beyond regulatory requirement	77	Construct bridges for livestock crossing rivers/streams
Re-site gateways away from high-risk areas	**Yes**	This is beyond regulatory requirement	78	Re-site gateways away from high-risk areas
Management of in-field ponds	**Yes**	This is beyond regulatory requirement This can bring wider Biodiversity benefit though undamaged/improved habitat	103	Management of in-field ponds
Management of arable field corners	**Yes**	This is beyond regulatory requirement This can bring wider Biodiversity benefit though undamaged/improved habitat	105	Management of arable field corners
Management of grassland field corners	**Yes**	This is beyond regulatory requirement This can bring wider Biodiversity benefit though undamaged/improved habitat	114	Management of grassland field corners
Capture of dirty water in a dirty water store	**Yes**	This is beyond regulatory requirement	120	Capture of dirty water in a dirty water store

B. Agricultural measures that is outside the scope of Farmscoper:

Some farm measures suggested by the Environment Agency are not an option in Farmscoper. For such interventions, Water Company should agree a methodology with Environment Agency how to account the benefit these measures would bring – e.g. Use RB209 to do manual calculation (Appendix 1 details a manual calculation methodology and example for such measures).

Measure	Benefit claimable under CNB	EA comments
Curb stone apron around slurry store reception pit	**Yes**	Any measure that prevents clean water entering a slurry store could be funded by water companies.
Repair to weeping wall of the slurry store	**Yes**	Impermeable walls and bases to slurry tanks are required by SSAFO and so we consider that maintenance and repairs to these are also a SSAFO requirement. Repairs to weeping walls can be funded by water companies as these are not designed to be impermeable so are not covered by the SSAFO regs.
Cover feeding yard	**Yes**	Not a legal requirement so can be funded by water companies.
Concrete open yard	**Yes**	Not a legal requirement so can be funded by water companies.
Arable reversion to species rich grassland	**Yes**	Not a legal requirement so can be funded by water companies.

4. Environment Agency negotiation

The water company should agree measures with the Environment Agency. The spatial scale of any proposal is defined on a case by case basis and an Operating Techniques Agreement (OTA) developed and agreed between the Environment Agency and the responsible water company. The programme of work document should be developed and sign off along with the relevant OTA.

4.1 Operating Technical Agreement

The OTA sets out how the discharge and catchment measures are to be managed to achieve the overall nutrient reductions targets. A single OTA can include all the participating wastewater treatment works in the catchment and this would be referenced in each permit. The OTA should include; permit details, operator details; waste water treatment work details, OTA effective dates and any other key information. Two authorised persons; one on behalf of Environment Agency and one on behalf of water company should be identified for final sign off. Then, the overall aim and the objectives can be summarised. The OTA should contains the detail of baseline load calculation, the target P load reduction for each WwTW and other sectors apportionment of the target load reduction and the date the target load will apply. The agreed monitoring regime, locations, start date and frequency (e.g. 24 per annum) details should be included in OTA.

The OTA should contain the detail of the calculation methodology for annual nutrient loads and reductions.

e.g. Calculation of annual total P loads

WwTW loads

1. The concentration of total P from the spot sample can be multiplied by the mean flow over the same 24 hour period to obtain the mean load for the sampling day.
2. Each of the daily loads for the calendar year can be added together and then divided by the number of sampling days to obtain the mean daily load for the WwTW.
3. The mean daily load can be multiplied by 365 to obtain the mean annual load (kg/year).

Total catchment load reduction

The total catchment load reduction can be calculated as follows:
Baseline load – the annual total P load at the WFD sample point

The baseline total P load has been calculated from the baseline ortho P load from the SAGIS model at WFD sample point with a 1.2 uplift based on sampling data as agreed with Environment Agency.

The annual total P load at the WFD sample point is calculated using the mean annual total P concentration multiplied by the mean flow from the SAGIS model (Ml/day).

It should include sampling programme and how and when the operator should report compliance against the target catchment annual total P load reduction (kg/year). Any other concerns such as discharge flow increases and decreases events and the process to follow should be agreed with environment Agency and detailed in OTA.

4.2 The programme of work

The programme of work document details the interventions that are scheduled to take place at each farm within the selected catchment to meet the requirements of the associated Operating Techniques Agreement. The below table can be used as a guide to capture the farm information and intervention details.

Farm Name		**Farm Address**		**Farm Grid Reference**	
Existing Water Quality Issues at the Farm					
Proposed Interventions					
Location of Trend Monitoring Point					
Number of Trend Monitoring Samples per year (No.)					
Intervention No.	**Description of Intervention**		**Expected date of Completion**	**Expected annual load reduction (kg/year Total P)**	**Evidence of completion**
			Total load reduction from farm		

5. Intervention delivery and maintenance

Once the OTA and programme of works is agreed and signed off by both parties, the water company should develop the delivery and maintenance agreement with appropriate catchment partners. Catchment partners could be farmers or other 3rd party organisations and the water company should closely engage with them and collate appropriate evidence for intervention delivery (e.g. photographic evidence). The water company is responsible for the installation and maintenance of all the improvement measures listed in Programme of work document. Any changes should be communicated and agreed with the Environment Agency.

6. Catchment monitoring

The water company should agree an appropriate monitoring regime, start date and frequency (e.g. 24 per annum) with the Environment Agency. The sampling regime could be a combination of monitoring at WwTW, waterbody and catchment/fam level. The water company ensures that the monitoring is ongoing and sample frequency is unchanged except by agreement. Baseline sampling should be agreed with the Environment Agency as appropriate for the agreed programme.

- Baseline sampling – baseline sampling should be undertaken prior to any treatment or catchment interventions being implemented, over a period of at least 12 months, although two or three years of data would be better. Sampling should be carried out fortnightly (and no less than monthly) and should cover the entire calendar year to take into account any seasonal variation.

- WwTW – following the completion of treatment interventions, the wastewater treatment works' final effluent should be sampled in line with the Operator Self-Monitoring (OSM) requirements of the works' Environmental Permit, although additional sampling should be considered and may be required by the Environment Agency as part of the Operating Techniques Agreement e.g. fortnightly rather than monthly sampling.

- Waterbody – the watercourse should be sampled downstream of the wastewater treatment works' discharge at the same frequency and on the same days as the discharge sampling. The default location for the sampling of the watercourse will be the compliance monitoring point for the waterbody (one location for a catchment that has multiple linked treatment works), as these will be safe and accessible and will be comparable to the EA's WFD compliance sampling, although alternative locations can be agreed with the EA where necessary.

- Catchment/Farm level sampling – trend monitoring points should be identified for catchment or farm levels interventions to demonstrate that those interventions have achieved the required reductions in P and/or N. These will typically be on small streams or drainage ditches, so ideally locations will be identified where samples can be taken at all times, e.g. avoiding sites that may run dry during dry weather. Where a larger number of widespread interventions are included, the trend monitoring points should be selected so as to cover the most significant of the catchment interventions, as identified by the Farmscoper model.

7. Compliance reporting

At the end of each calendar year, the water company should report sampling results and compliance against the target catchment annual total nutrient load reduction (kg/year) agreed within OTA. The report should calculate the total catchment load reduction from the WwTW and catchment based solutions and compare this with the target catchment annual load reduction. The water company is compliant with its Operating Techniques Agreement if the target catchment annual total nutrient load reduction (kg/year) is achieved for the preceding calendar year.

In the event, the target catchment annual total nutrient load reduction is not achieved, the operator must investigate the reasons why either the WwTW or the catchment based solutions or both did not achieve their target annual total nutrient load reductions and report these to the Environment Agency within 28 days of the end of the reporting period.

In the event that the target catchment annual total nutrient load reduction was not achieved as a result of third party action, the water company should report these to the Environment Agency and explain how the third party action has affected the reduction target.

In the event that the target catchment annual total nutrient load reduction (kg/year) is not achieved during the trial, the operator has three years to improve the performance. If at the end of the agreed trial period the target catchment annual total nutrient load reduction (kg/year) is not achieved a revision of this Operating Techniques Agreement will be required.

Glossary of terms

Traditional permitting – revised permit limits based on fair share contribution, assessed using catchment models.

Flexible permitting – alternative permitting options; utilise the flexibility within existing legislation and permitting process, open to new ideas and proposals.

Catchment Permitting – stretch and backstop limits set with operating agreements to deliver fair share load reduction across multiple WwTWs.

Catchment Nutrient Balancing – operating agreement with stretch and backstop limit including nutrient trading to offset traditional permitting requirements.

Seasonal permitting – less stringent treatment is required at certain times of the year e.g. winter

Variable permitting – treatment is varied in response to changes to flows and concentrations in the receiving watercourse.

Appendix 1

Agricultural measures that is outside the scope of Farmscoper

Farm intervention load reduction calculations

1. Introduction

This protocol details the methodology developed by United Utilities (UU) to calculate the assumed Nitrogen (N) and Phosphate (P) input load reduction on a watercourse as a result of farm based interventions. All calculations are based on the N and P figures detailed in the Defra fertiliser manual RB209 as shown in Table 1 and 2.

For all calculations, United Utilities have used the stated dirty water figure as this best matches all installed intervention types, is usable 12 months a year and makes less assumptions on the benefits of the interventions (see figure 1.). Although a conservative approach to the calculations, dirty water figures represent a more realistic target.

Slurry figure assumptions:

1. All rainwater that falls on a slurry store displaces an equal amount of slurry
2. The displaced slurry is 6% dry matter with no dilution effect.
3. Commonly used during the cattle housing period of October to March
4. Not able to be used during the months of April-September periods due to potentially high rainfall.

Dirty water assumptions:

1. By covering a yard and setting out clear rainfall pathways away from the yard this will prevent the washing of dirt into the waterway.
2. There are no seasonal restrictions based around the housing of livestock it is a 12 months a year figure
3. Makes no assumptions about dry matter content.
4. The Bio-available figure of 0.05 is used

Figure 1. Slurry and dirty water assumptions

Type of slurry		Dry matter (%)	Phosphate		
			Total phosphate (kg P_2O_5/m^3 or /t)	Availability (%)	Available phosphate (kg P_2O_5/m^3 or /t)
Slurries/ liquids	Cattle	2	0.6	50	0.3
		6[b]	1.2[b]	50[b]	0.6[b]
		10	1.8	50	0.9
	Dirty water	0.5	0.1	50	0.05
Separated cattle slurries (liquid portion)	Strainer box	1.5	0.3	50	0.15
	Weeping wall	3	0.5	50	0.25
	Mechanical separator	4	1.2	50	0.6
Separated cattle slurry (solid portion)		20	2.0	50	1.0

Table 1. Phosphate nutrient content

Type of slurry		Dry matter (%)	Total nitrogen[a] (kg N/m³ or /t)
Slurries/liquids	Cattle	2	1.6
		6[b]	**2.6[b]**
		10	3.6
	Dirty water	0.5	0.5
Separated cattle slurries (liquid portion)	Strainer box	1.5	1.5
	Weeping wall	3	2.0
	Mechanical separator	4	3.0
Separated cattle slurry (solid portion)		20	4.0

To convert kg/m³ to units/1,000 gallons, multiply by 9.

a. Cattle slurry and the liquid portion of separated cattle slurry are high readily available nitrogen manures, typically with greater than 30% of their total nitrogen content present as readily available nitrogen and will be subject to closed-spreading periods in Nitrate Vulnerable Zones. The crop-available nitrogen supply from manures will depend on the application timing, application method and the delay between application and incorporation.

b. Typical dry matter and nitrogen contents of cattle slurry are shown in bold.

Table 2. Nitrogen nutrient content

2. Calculation methodology

- Obtain the monthly/yearly average rainfall data for the catchment/geographical area that the farm affects. This can be obtained under licence from the EA database.
- There are 1000 rainfall gauges available throughout the UK from the EA database. Use the closest geographically to the area of interest.
- Installation of a specific site rain gauge is an option but this must be undertaken by a certified flow monitoring company.
- Information with regards to the intervention installed is required, specifically the total surface area of rainwater separation affected in m^2.
- Using the obtained data the calculated rainwater separation is achieved by using the formula in Equation 1:

$$(\boldsymbol{Area\ of\ Rainwater\ Separation\ (m2)} \times \boldsymbol{Average\ Rainfall\ (mm)}) \div \mathbf{1000}$$

- The obtained result from Equation 1 gives you an assumed volume of rainwater that is prevented from washing in to the watercourse via the farm yard area.
- Using the above result and nutrient figures from Table 1 or 2, you can calculate a best case load prevented from entering the watercourse, and therefore, the total load reduction in that same watercourse as a result of the interventions.
- For example: *to calculate the total nitrogen load prevented from entering the watercourse in the month of May (rainfall average 22.4 mm), by covering a farm yard area of 1200 m^2, using the dirty water total nitrogen load figure in Table 2 (0.5 kg/m^3), the calculation is:*

((1200 x 22.4)/1000) x 0.5 = 13.44 kg
Nitrogen prevented from leaching into the watercourse in May

- A load reduction is calculated for each farm within the catchment; these are then added together to give a total load reduction across the catchment.
- An assumed 50% risk of failure scaling factor is applied to allow for the uncertainty in the assumptions made in the calculation. This is based on the % risk of failure used by the EA on their RBMP cost-benefit analysis methodology.

3. Example

- Interventions were delivered at farm A and farm B. Nutrient N and P load reductions from interventions were calculated by using the methodology described in the previous sections of this report.

- The calculations are based on 12 months of data, collected October 2021 to September 2022. The parameters used to calculate the load reduction for the farms are shown in Table 3 and a breakdown calculation month by month, for each farm, is shown in Table 4.

Parameter	Farm A	Farm B
Yard surface area (m^2)	591	1122.9
Total N load based on dirty water (kg/m3)	0.5	
Bio avail. P load based on dirty water (kg/m^3)	0.05	
Average monthly rainfall (mm) October 2021 – September 2022	See table 4	

Table 3: Parameters used to calculate load reductions at Farm A and Farm B

Month	Rainfall monthly average (mm)	P load reduced based on dirty water (kg/m^3)			N load reduced based on dirty water (kg/m^3)		
		Farm A	Farm B	Combined total P load reduction *(both farms)*	Farm A	Farm B	Combined total N load reduction *(both farms)*
Oct-21	44.42	1.31	2.49	3.81	13.13	24.94	38.07
Nov-21	92.95	2.18	5.22	7.40	21.84	52.19	74.03
Dec-21	119.62	2.81	6.72	9.53	28.11	67.16	95.27
Jan-22	66.57	1.56	3.74	5.30	15.64	37.38	53.02
Feb-22	49.24	1.16	2.76	3.92	11.57	27.65	39.22
Mar-22	73.73	1.73	4.14	5.87	17.33	41.39	58.72
Apr-22	36.45	0.86	2.05	2.90	8.57	20.47	29.03
May-22	22.40	0.53	1.26	1.78	5.26	12.58	17.84
Jun-22	60.47	1.42	3.39	4.82	14.21	33.95	48.16
Jul-22	45.60	1.07	2.56	3.63	10.72	25.60	36.32
Aug-22	67.09	1.58	3.77	5.34	15.77	37.67	53.44
Sep-22	43.99	1.03	2.47	3.50	10.34	24.70	35.04
Total P reduction over 12 months				**57.82**	**Total N reduction over 12 months**		**706.58**
P reduction with 50% risk of failure				**28.91**	**N reduction with 50% risk of failure**		**353.29**

Table 4: Breakdown of monthly rainfall and nutrient load reduction based on dirty water figures

In order to assess the benefits and the impact of the interventions on water quality, comprehensive monitoring programme should be agreed through Operating Techniques Agreement.

References

- Agriculture Fair share interim position statement, 2021 - Environment Agency
- Catchment Nutrient Balancing Criteria position statement, 2018 - Environment Agency
- Fertiliser Manual RB209, 2022 Edition – Department for Environment and Rural Affairs (Defra
- PR24 WINEP supporting guidance – Permitting innovative solutions, 2022 - Environment Agency

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