Afonydd Cleddau Nutrient Management Board

Afonydd Cleddau Nutrient Management Plan

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CONTENTS

Tables

Figures

Acronyms and Abbreviations and Technical Terms

Term	Meaning
Anadromous	Animals that ascend from marine to riverine environments to spawn for example salmon and eels.
CTW	Constructed Treatment Wetlands an artificial wetland to treat sewage, greywater, stormwater runoff or industrial wastewater
Determinands	When a sample is analysed to determine one or more properties of the sample or of the associated environment, the properties measured are formally called determinands.
DCWW	Dŵr Cymru Welsh Water is a not-for-profit regulated water and sewerage companies, is the sixth largest of the ten in England and Wales responsible for providing three million people with drinking water in 1.4 million homes and businesses.
EIA	Environmental Impact Assessment is a systematic process that evaluates the potential environmental impacts of a proposed development project or activity. The process can help identify strategies to mitigate or avoid negative impacts and enhance positive outcomes.
HRA	Habitats Regulations Assessment is a process that determines whether or not development plans could negatively impact local plans on a recognised protected European site beyond reasonable scientific doubt.
Intermittent	SO's are classified as an "intermittent" source of phosphorus, often termed simply intermittent.
JNCC	Joint Nature Conservation Committee a public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation.
LPA	Local Planning Authority is the local government body that is empowered by law to exercise urban planning functions for a particular area
NMB	Nutrient Management Board voluntary body focused on a catchment based approach to phosphate and nutrient mitigation
NNR	National Nature Reserve were set up to conserve and to allow people to study their wildlife, habitats or geological features of special interest or geological features of special interest.
NRW	Natural Resources Wales core purpose is to pursue the Sustainable Management of Natural Resources (SMNR) as set out in the Environment (Wales) Act 2016.

Term	Meaning
LoD	Limit of Detection means the minimum concentration of phosphorus that the sampling method is able to register.
LDP	Local Development Plan sets out each local planning authority's proposals for future development and use of land in their area
PRAM	Phosphate Reduction and Mitigation is a Ceredigion County Council led initiative for phosphate mitigation in the Afon Teifi catchment funded by the Heritage Lottery Funding (HLF)
SAC	Special Area of Conservation
SAGIS	Source Apportionment Graphical Information System
SFS	Sustainable Farming Scheme is the primary source of Welsh government’s funding for farmers with universal, optional and collaborative layers.
SG	Stakeholder Group any interested party engaged with the NMB
SO	Storm Overflow, an outlet from the public sewer that is designed to spill excess rainwater and sewage into the environment if sewers become inundated with excess water
SOEfW	Storm Overflow Evidence for Wales
SSSI	Site of Special Scientific Interest nationally designated site for biodiversity or geology
STW	Sewage Treatment Works
SuDS	Sustainable Urban Drainage Systems are nature-based drainage solutions that provide an alternative to the direct channelling of surface water through networks of pipes and sewers to nearby watercourses
TAG	Technical Advisory Group, stakeholders selected to provide their technical expertise to the NMB
TP	Total Phosphorus
WFD	Water Framework Directive statutory instrument for implementing overall water quality targets
WwTW	Wastewater Treatment Works

1 Foreword

This Nutrient Management Plan (NMP) has been prepared on behalf of the Afonydd Cleddau Nutrient Management Board (NMB). The main objective of the Board is to identify and deliver actions that achieve the phosphorus conservation target of the riverine Afonydd Cleddau Special Area of Conservation (SAC). This NMP is the latest step on the journey in facilitating the NMB achieving its objective.

Nutrient management within West Wales has evolved rapidly. In early 2021, new Natural Resources Wales (NRW) phosphorus targets and compliance reporting led to the halting of Local Development Plans (LDPs) where developments were proposed within the Afon Teifi, Tywi and Cleddau SACs.

In June 2022, Carmarthenshire County Council developed a 'Nutrient Budget Calculator' allowing developers to quantify the potential impacts of new housing on nutrients. In June 2023, this was followed by Mitigation Guidelines which highlighted the potential solutions within West Wales.

Furthermore, significant work has been undertaken by Ceredigion and Pembrokeshire Councils in exploring potential mitigation measures, such as the Phosphate Reduction and Mitigation (PRAM) project in Ceredigion. This NMP represents an effort to synthesise the works underway within the catchment and develop targeted actions for stakeholders in addressing the issue of nutrient management within the catchment.

The NMP including the associated action plan will serve three purposes:

- First, it will facilitate the removal of phosphorus to support the delivery of new development impacted by nutrient neutrality and to deliver the phosphorus conservation targets within the riverine portions of the Afonydd Cleddau SAC.
- Secondly it will monitor the situation regarding other nutrient pressures, such as nitrate and ammonia in addition to future pressures; while marine management is not currently addressed within this document, this NMP may expand in the future to cover this element.
- Thirdly, while management of phosphorus in the riverine SAC is the main objective, the NMP offers an important opportunity to consider overall river restoration, including healthy populations of flagship species and the delivery of wider environmental benefits where possible.

- The NMP for the Cleddau demonstrates that to achieve the target for compliance, the currently established mitigation is insufficient. The need for reliance on riparian buffers and other NbS highlights that current regulatory measures including CoAP, SFS and voluntary farm control measures alone are not sufficient to meet compliance. Furthermore, particularly in this catchment, the legacy P issue is likely to be a factor in continued high levels of P leaching into the Cleddau. Further analysis of this impact is underway and will be included in future iterations of the Plan.
- It is likely not practical for the significant volume of NbS to be delivered, focusing purely on interception of surface runoff. This requires therefore a catchment scale approach, and a focus on the long-term sustainability of agricultural practices in the catchment delivering reductions at source. The holistic actions focusing on legacy P and soil health will be one such key step required to help secure the future compliance of this catchment.

The intention is that the NMP evolves under the governance and support of the NMB and the engagement with the many stakeholders to deliver the actions in the NMP.

The NMP has been prepared by Arcadis and developed with the generous support of and consultation with the following stakeholders: Natural Resources Wales (NRW), Dŵr Cymru Welsh Water (DCWW), Carmarthenshire County Council (CCC), Ceredigion County Council (CeCC), Pembrokeshire County Council

(PCC), Pembrokeshire Coastal Forum (PCF), Pembrokeshire Coast National Park (PCNP), Afonydd Cymru, West Wales Rivers Trust (WWRT), World Wildlife Fund (WWF), NMB Technical Advisory Group (TAG), NMB Stakeholder Group, Achub y Tywi, Save the Teifi, The Cleddau Project, and other interested individuals.

2 Introduction to the Nutrient Management Board

2.1 What is a Nutrient Management Board

The Local Authorities in West Wales have responded proactively to the publication of the status of phosphorus compliance in the SAC rivers. Three NMBs have been formed in West Wales; the Afon Tywi NMB, the Afon Cleddau NMB and the Afon Teifi NMB. The purpose of the NMBs is to put a plan in place to improve the ecological condition of the rivers whilst also helping to facilitate responsible development that fully considers the environmental impacts. The NMBs allow members of the Boards to work on a catchment basis, as many rivers flow through several county boundaries.

The Nutrient Management Board (NMB) operates on a voluntary basis, drawing on the commitment and expertise of its members to address the complex issue of nutrient management in the region. The success of the NMP relies heavily on collaborative and constructive efforts among various stakeholders, including local authorities, environmental groups, and regulatory bodies. By fostering a spirit of cooperation and shared responsibility, the NMB aims to implement effective strategies that not only improve the ecological health of the rivers but also support sustainable development initiatives.

2.2 Who Comprises the Nutrient Management Board

The three NMBs have senior members from Carmarthenshire, Ceredigion and Pembrokeshire County Councils as well as representatives from the Pembrokeshire Coast National Park and Bannau Brycheiniog (Brecon Beacons) National Park, and representatives from Natural Resources Wales and Dŵr Cymru Welsh Water. The NMB will collaborate with the Technical and Stakeholder Groups drawn from a wider range of partners to facilitate plans supporting feasibility and implementation of solutions as well as being a focal point for the drawing together of existing and future data relating to the SAC improvements.

2.3 What is a Nutrient Management Plan?

The goal of a NMP is to identify sources of excess nutrients, calculate the necessary nutrient removal, and suggest reduction measures, with clear outputs and timeframes. An NMP will also identify any information gaps. That is, a clear plan of action with targets to achieve and deadlines to meet. The NMPs will provide strategic opportunity areas to align with the quantity of nutrient removal required along with the potential wider benefits that could be provided. It will be a live document that is updated as new information is provided.

2.4 Delivering Wider Environmental Benefits

While phosphorus is the key focus, due to existing pressing targets, additional environmental benefits will be sought where possible. For example, nature-based solutions (NbS) such as constructed wetlands, and buffer strips can provide significant biodiversity enhancements. In certain settings these can also improve habitat connectivity and deliver recreational benefits. Solutions identified will require monitoring to ensure they are working as planned, opening opportunities for educational benefits, as well as research and citizen science.

2.5 Evolution of the Afonydd Cleddau NMP

Figure 2-1~~Figure 2-1~~ illustrates the nutrient management evolution journey within West Wales to date, along with anticipated milestones through to 2030.

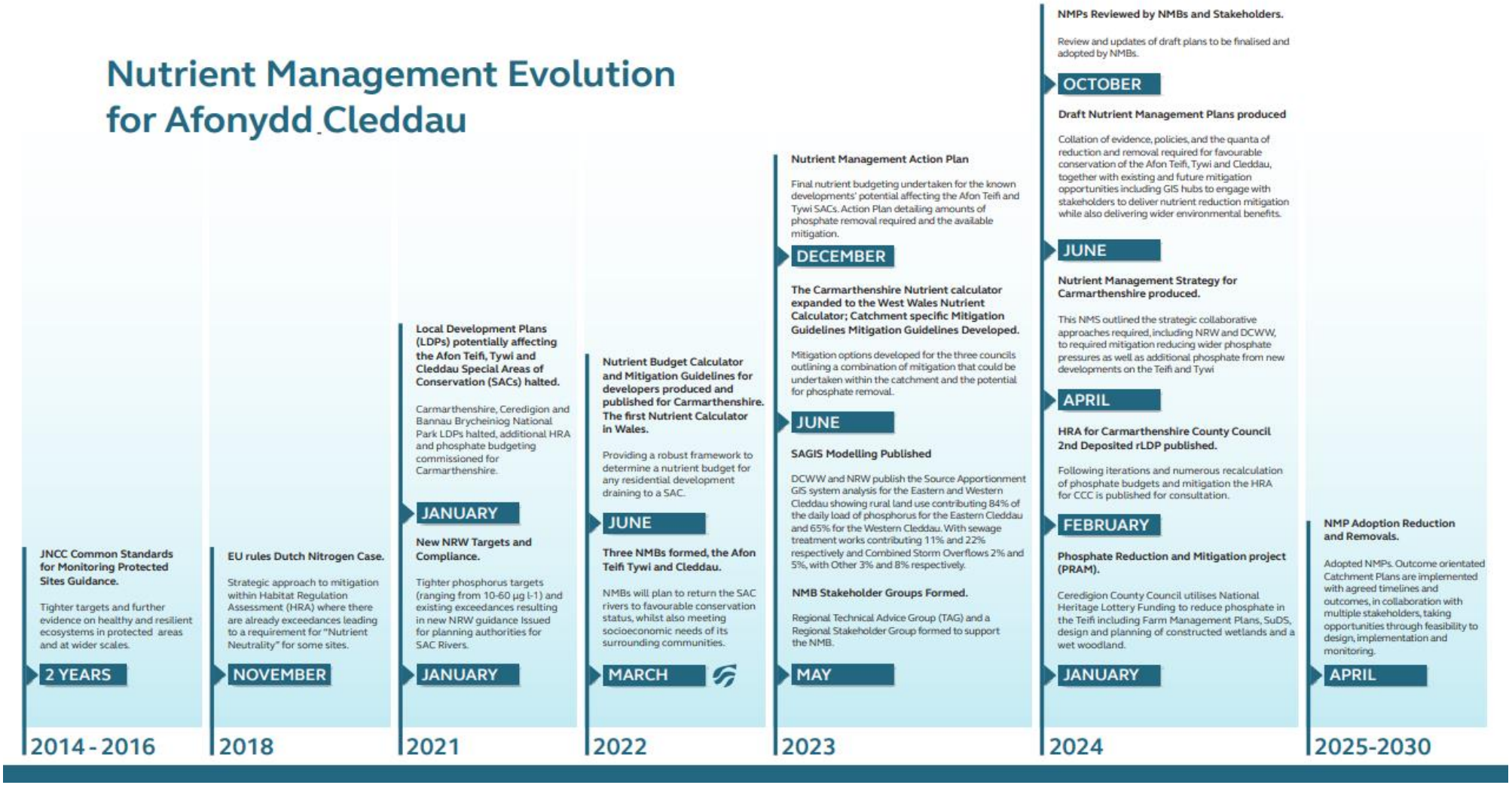

Figure 2-1: Nutrient Management Evolution in West Wales (potential future scenarios)

3 Afonydd Cleddau Catchment Profile

This NMP covers the riverine Afonydd Cleddau SAC which falls within the wider Cleddau catchment. This section provides an overview of the Cleddau catchment and its characteristics. It will introduce the catchment geography and hydrology, the important features of the river including its ecological importance and the current and future pressures on the river with respect to phosphorus.

3.1 Geography & Hydrology

The Afonydd Cleddau comprises of Eastern and Western arms:

3.1.1 Eastern Cleddau River Overview

The river flows 26 km from the foot of the Preseli Hills of north Pembrokeshire south across an ancient valley wetland to its tidal limit at Blackpool Bridge, where it discharges into the Milford Haven Waterway SAC.

The boundary for the upper reach of the Eastern Cleddau River and Afon Wern abuts the Mynydd Preseli SSSI. The gradient of the river increases producing a turbulent flow during its journey south through narrow wooded valleys. In its lower reaches the river meanders through a wide valley floodplain.

The Eastern Cleddau has 76 km of tributaries; main tributaries included within the Eastern Cleddau are the Afon Wern, Llanycefn, Rhydafallen, Afon Syfynwy, Rhyd-y-Brown Brook, Ty-llosg Brook, Deepford Brook, Cotland Brook, Afon Conin, Pont Shan and Narberth Brook.

3.1.2 Western Cleddau River Overview

The main channel stretches for 30 km between its source at Mathry to the tidal limit of the Daugleddau Estuary at Haverfordwest, flowing over sands and gravels deposited as the ice sheets from the last glaciation retreated.

In its upper course, the river flows over soft substrates across a marshy valley bounded by the extensive mire of Corsydd Llangloffan National Nature Reserve (NNR) / Site of Special Scientific Interest (SSSI). In its lower reaches, the river meanders through a wide valley floodplain bordered to its tidal limit at Haverfordwest where the Western Cleddau discharges into the Pembrokeshire Marine SAC.

Main tributaries of the Western Cleddau included within the Western Cleddau are the Afon Cleddau, Nant-y-bugail, Afon Anghof, Nant-y-coy Brook, Spittal Brook, Rudbaxton Water, Camrose Brook and Cartlett Brook.

3.1.3 Land use

The Cleddau catchment is predominantly agricultural land with significant areas of permanent pasture, broadleaved woodland and other semi-natural vegetation. Most of the soils are of clay-rich acidic brown earth type, developed under former and surviving woodland cover, although there are also peaty deposits and peaty soils in some areas.

Within the catchment, the largest urban centre is the market town of Haverfordwest near the Western Cleddau and serves as Pembrokeshire's administrative and commercial hub.

Parts of the Cleddau and Pembrokeshire catchment are underlain by major aquifers that are divided into groundwater management units. These units include Bosherston, Park Springs, Milton and Pendine. Groundwater is used extensively throughout the area to support large numbers of small domestic and agricultural abstractions.

The Cleddau has high amenity value as a tourist destination for walking and hiking, fishing, canoeing and other water sports. Rivers in a clean and healthy condition creates a more pleasant location for undertaking recreational activities. The West Wales River Basin Management Plan (RBMP) outlines that water quality improvements for Cleddau waterbodies will improve the water environment for recreation, tourist use, and aquaculture.

An overview of the Afonydd Cleddau SAC can be seen in Figure 3-1~~Figure 3-1~~.

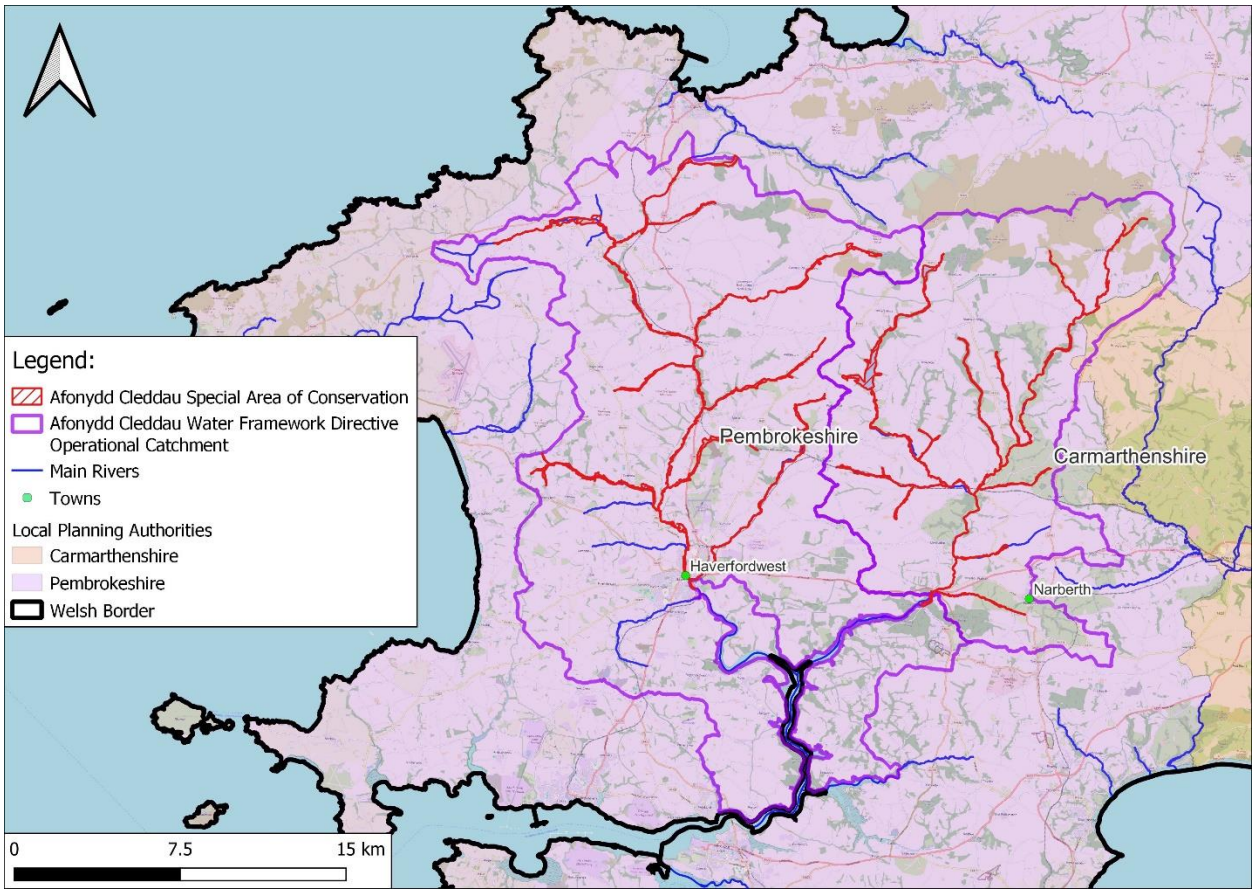

Figure 3-1 - Catchment Overview

3.2 Afonydd Cleddau SAC

3.2.1 Afonydd Cleddau SAC Overview

The Afonydd Cleddau SAC is one of the westernmost rivers in Wales and is divided into Eastern and Western arms, Figure 3-1~~Figure 3-1~~. It is one of the UK National Sites Network sites designated and protected via many mechanisms but primarily the Conservation of Habitats and Species Regulations 2017 as amended.

It is a 751.7 ha SAC that flows southwards and cuts across the structural orientation in the underlying rocks, which are of Precambrian to Silurian age (650- 395 million years ago). There are also Sites of Special Scientific Interest (SSSIs) within the SAC that overlap with the SAC boundaries, including: Afon Cleddau Dwyreiniol (Eastern Cleddau River) SSSI; Afon Cleddau Gorllewinol (Western Cleddau River) SSSI; Esgyrn Bottom SSSI; Corsydd Llangloffan SSSI; and Wallis Moor SSSI. The SAC therefore has the highest conservation value in terms of its national and global significance. This NMP covers only the Afonydd Cleddau SAC and does not include the SSSIs present within the SAC boundary.

3.2.2 Regulatory Drivers

The Afonydd Cleddau is designated under the implementation of the Habitats Directive and thus must be managed, conserved and protected in accordance with all the provisions of Article 6 of the said Directive. Whereas Article 6(1) and 6(2) concern the day-to-day management and conservation of the SAC site, Articles 6(3) and 6(4) lay down the permit procedure to be followed in cases where a plan or project, not directly connected with or necessary to the management of the site, is likely to have a significant effect thereon, either individually or in combination with other plans or projects.

These requirements have been incorporated into Welsh law and the following tables outline these and other mechanisms for regulatory enforcement that regulatory bodies and the Welsh government have for enforcing better water quality (Table 3-1~~Table 3-1~~).

Table 3-1: Regulatory drivers of phosphorus reduction in the Afonydd Cleddau SAC

Conservation of Habitats and Species Regulations 2017	
Regulation 16A(1) is a new duty, introduced in the EU Exit version of the Regulations upon Welsh Ministers to manage the national site network, with a view to contributing to the achievement of the management objectives.	Further details are provided under paragraphs (2) to (6) of regulation 16A. The 'management objectives' are to maintain or restore habitats and species to a favourable conservation status and considerations which Welsh Ministers must 'have regard' to in complying with regulation 16(A)(1) include the threats of degradation or destruction to which sites are exposed. Regulation 16(A) therefore provides a driver for the Welsh Ministers to exercise powers under other legislation to support the delivery of strategic solutions to achieve the conservation objectives of SAC rivers.
Regulation 27 gives Welsh Ministers the power to make a special nature conservation order in respect of operations which appear to Welsh Ministers to be of a kind which, if carried out in certain circumstances or in a particular manner, would be likely to destroy or damage protected features.	This power is one which is anticipated to be targeted and specific. Depending on the nature and location of potential measures identified which might be relied upon to secure phosphorus reductions, it is possible that this power might be appropriate at a future time.
Regulation 20 of the Habitats Regulations enables NRW to make a management agreement with a person who has an interest in land within or adjacent to a European site. Management agreements may be made for the purpose of the management, conservation, restoration or protection of the site, or any part of it.	Unlike regulation 16 of the Environment (Wales) Act, a management agreement under Regulation 20 can be binding on persons with an interest in such land and can impose obligations upon that person in respect of the use of the land and exercise of rights over the land. A management agreement under regulation 20 is enforceable by NRW under regulation 20(4)(b). A management agreement can provide for the making of payments to either party (refer regulation 22). This tool could be relied upon to deliver reductions in phosphorus entering the river through restrictions / controls on certain activities on land within a defined distance of the river. Likewise, a management agreement might provide payments for the planting and maintenance of woodland on such land or other land use changes.
Regulation 32 of the Habitats Regulations enables NRW to make bylaws for the protection of a European site.	Regulation 32(3) specifies that such bylaws may prohibit or restrict 'the taking of, or interference with, vegetation of any description in the site, or the doing of anything in the site which will interfere with the soil'. Regulation 32(4) extends the prohibition or restrictions of

	activities referred to in 32(3) within such area surrounding or adjoining a site as appears to NRW necessary for protecting the site. Regulation 32(6) specifies that byelaws can be made so as to relate to either the whole site or to any part of the site, of any surrounding or adjoining area of land. This tool could be relied upon to secure reductions in phosphorus entering the river as a result of adjacent land uses.
Environmental Permitting (England and Wales) Regulations 2016	
Regulation 12 of the Environmental Permitting Regulations and the need for an environmental permit, and offences under regulation 38.	NRW has an enforcement role to take action where a person causes or knowingly permits a water discharge activity except under, and to the extent authorised by, an environmental permit. Part 4 of the Regulations includes various enforcement and offences powers. Where there are known incidences of unconsented discharges which will be causing deterioration to water quality and NRW can exercise necessary powers in this regard.
Regulation 34 of the Environmental Permitting Regulations. Statutory periodic review of environmental permits.	NRW Regulatory Guidance Series, No EPR 12 sets out how NRW will meet their statutory duty to periodically review environmental permits. Para 1.2 refers to Welsh Assembly Core Guidance which says that "permit reviews are required to check whether permit conditions continue to reflect appropriate standards and remain adequate in light of experience and new knowledge. Reviews should guard against permits becoming obsolete as techniques develop."
Environment (Wales) Act 2016 Regulations	
Regulation 16 – Powers to enter into land management agreements[1]	NRW may make an agreement with a person who has an interest in land in Wales about the management or use of the land (a "land management agreement"), if doing so appears to it to promote the achievement of any objective it has in the exercise of its functions. A land management agreement may, among other things: • impose on the person who has an interest in the land obligations in respect of the use of the land; • impose on the person who has an interest in the land restrictions on the exercise of rights over the land; • provide for the carrying out of such work as may be expedient for the purposes of the agreement by any person or persons; • provide for any matter for which a management scheme relating to a site of special scientific interest provides (or could provide); • provide for the making of payments by either party to the other party or to any other person; • contain incidental and consequential provision.
The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021	
Regulatory measures to address agricultural pollution in Wales, will apply from 1 April 2021 for an initial set of measurements. The remainder will be phased in over a period of 3 years.	The Regulations focus on those farms where the environmental risk from poor manure management is greatest. In summary, the regulations include the following requirements: • Nutrient management planning; • Sustainable fertiliser applications linked to the requirement of the crop;

[1] https://www.legislation.gov.uk/anaw/2016/3/section/16/enacted

Regulation 46-Breach of any currently in-force provisions of the Regulations	• Protection of water from pollution related to when, where and how fertilisers are spread; and
	• Manure and silage storage standards. Natural Resources Wales (NRW) is responsible for assessing compliance and it will do this by inspecting farms and checking records. If a breach of the Regulations is confirmed actions will be taken according to the Natural Resources Wales Enforcement and Prosecution policy and procedures. Possible actions depend on the seriousness of the breach and impact on the environment. They include:
	  • Advice on remedying a minor breach;
	  • Warning letter noting the breach, which may be taken into account in the event of a future breach;
	  • Legal notice; •
	  • Formal caution; or
	  • Prosecution

Regulation 12 - Controlling the spreading of nitrogen fertiliser	• An occupier who intends to spread nitrogen fertiliser must first undertake a field inspection to consider the risk of nitrogen getting into surface water. • No person may spread nitrogen fertiliser on that land if there is a significant risk of nitrogen getting into surface water taking into account the factors listed under Regulation 12(2). • No person may spread nitrogen fertiliser if the soil is waterlogged, flooded, snow covered, frozen or has been frozen for more than 12 hours in the previous 24 hours.
Regulation 13- Controlling the spreading of nitrogen fertiliser	• No person may spread manufactured nitrogen fertiliser within 2 metres of surface water.
Regulation 14 -Control of the spreading of organic manure	• No person may spread organic manure within 10 metres of surface water (unless using precision spreading equipment in which case no person may spread organic manure within 6 metres of surface water) • No person may spread organic manure within 50 metres of a borehole, spring or well.
Regulation 16 – Incorporation of manure	• Any person who applies organic manure onto the surface of bare soil or stubble must ensure that it is incorporated within 24 hours.
Regulation 22 – Closed periods for spreading manufactures nitrogen fertiliser	• On grassland; from 15 September to 15 January • On tillage land; from 1 September to 15 January
Regulation 24– Storage of manure and silage	• Requirements for the storage of manure and silage
Regulation 32– Summary Only Offence	• A person who proposes to have custody or control of silage or slurry that is to be kept in a new or improved store must give notice at least 14 days before construction begins - (this change applies from 28 April 2021).
Town and Country Planning Act 1990	

Part VII – Enforcement Powers of Local Planning Authorities	• Under Part VII of the Town and Country Planning Act 19902, Local Planning Authorities have a range of enforcement powers to address breaches of planning control.
	• Local Planning Authorities may need to consider taking enforcement action against unauthorised development or a breach of any conditions imposed as part of a planning permission.
	  • Enforcement actions include:
	  • Enforcement Notice
	  • Breach of Conditions Notice
	  • Stop Notice
	  • Injunctions

Flood and Water Management Act 2010	
Schedule 3 – Sustainable Drainage SuDS approving bodies	• Schedule 3[3] to the Flood and Water Management Act 2010 (the 2010 Act) establishes SABs in local authorities. The legislation gives those bodies statutory responsibility for approving and in specified circumstances, adopting the approved drainage systems. • Under Schedule 3 to the 2010 Act, local authorities as the SuDS Approving Body (the SAB) have a duty to approve SuDS which follow the national statutory Standards for SuDS (SuDS Standards). With the exception of single curtilage sites, the SAB also has a duty to adopt the system • Under the terms of the Flood and Water Management Act 2010, the Lead Local Flood Authorities (LLFAs) are responsible for managing local flood risk which includes that from surface water.[4] • The responsibility for delivery of the SAB functions rests with the Local Authorities in Wales alongside their duties as LLFA.
Environment (Wales) Act 2016 Regulations	
Regulation 12 – Welsh ministers' directions to implement area statement[5]	The Welsh Minister (WM) may direct a public body to take such steps as appear to them to be reasonably practicable to address the matters specified in an area statement (AS) under Section 11 (3). Each AS must explain why the statement has been prepared and refer to the natural resources in the area, the benefits which the natural resources provided and the priorities, risks and opportunities for the sustainable management of natural resources which need to be addressed.
Regulation 13 – Guidance about implementing area statements[6]	In exercising its functions, a public body must have regard to any guidance given to it by the Welsh Minister about steps that should be

[2] https://www.legislation.gov.uk/ukpga/1990/8/part/VII/enacted
[3] https://www.legislation.gov.uk/ukpga/2010/29/schedule/3
[4] https://gov.wales/sites/default/files/publications/2019-06/statutory-guidance.pdf
[5] https://www.legislation.gov.uk/anaw/2016/3/section/12/enacted
[6] https://www.legislation.gov.uk/anaw/2016/3/section/13/enacted

	taken to address the matters specified in an area statement under Section 11(3).
Regulation 10 – Meaning of public body in sections 11 to 15[7]	The Welsh Minister may by regulation amend subsection (1) by adding, removing or amending a description of a person and or public body. It is noteworthy that water companies are not a public body according to Regulation 10 and it is reasonable to anticipate that, depending on the measures which might be identified to reduce phosphorus levels in SAC rivers, it may be relevant to consider adding Welsh Water to the list of public bodies.
Well-being of Future Generations (Wales) Act 2015[8]	
Sets out seven goals. • A prosperous Wales • A resilient Wales • A healthier Wales • A more equal Wales • A Wales of cohesive communities • A Wales of vibrant culture and thriving Welsh language • A globally responsible Wales	The national Well-being of Future Generations (Wales) Act 2015 requires public bodies in Wales to think about the long-term impact of their decisions and includes a goal of 'A resilient Wales' for a nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change) and includes: • biodiversity and soil - Maintain and enhance the natural environment through managing land appropriately to create healthy functioning ecosystems • natural green space – support a social resilience and community well-being • Knowledge of Nature – increased awareness of the importance of a biodiverse natural environment with healthy functioning ecosystems • Water quality and air quality – support ecological resilience making the environment healthier for wildlife and people • Using natural resources – be adaptive to a changing environment where there is a need to use resources efficiently
Agriculture (Wales) Act 2023[9]	
A statutory framework for Sustainable Land Management (SLM) in Wales.	The Act establishes the SLM objectives as the overarching framework for agricultural policy, by imposing a duty on the Welsh Ministers to exercise certain functions in the way they consider best contributes to achieving those objectives. The Act also: • gives the Welsh Ministers a power to provide support for agriculture, and in connection with agriculture; • provides agricultural tenants with access to arbitration procedures, in certain circumstances; • changes the way felling licenses operate; • prohibits the use of snares and glue traps.

[7] https://www.legislation.gov.uk/anaw/2016/3/section/10/enacted
[8] Well-being of Future Generations (Wales) Act 2015 – The Future Generations Commissioner for Wales
[9] Agriculture (Wales) Act 2023 | Law Wales

3.2.3 Phosphorus Status Overview

It is worth noting the specific terminologies to describe phosphorus (P) in various contexts. There are three common forms of river P concentrations:

- Soluble Reactive Phosphorus (SRP): This is the dissolved form of phosphorus that is readily available for biological uptake. It is often synonymous with orthophosphate-P.
- Total Dissolved Phosphorus (TDP): This includes all forms of dissolved phosphorus, both reactive and non-reactive.
- Total Phosphorus (TP): This encompasses all forms of phosphorus, including dissolved and particulate forms. TP is used synonymously with elemental P.

Regulatory agencies typically set river P concentrations as orthophosphate-P, which is considered a representative measure of SRP. In discussion around regulatory compliance, we will discuss concentrations of P in line with the definition of the regulatory agency. However, for the purposes of considering inputs and mitigation, we adopt the term TP to provide a comprehensive understanding of phosphorus presence and its impacts within the catchment.

3.2.3.1 NRW Phosphorus Compliance Report 2021

Tightened phosphorus targets were set in 2021 by NRW, their assessment report in 2021 found that over 60% of the rivers and streams assessed in Wales failed to meet the revised water quality targets for phosphorus. Samples were taken from NRW water quality data covering a three-year period from January 2017 to December 2019. The report's conclusions regarding the SAC were that, on the Western Cleddau, none of the 10 waterbodies passed its phosphorus targets, with eight failures and two not assessed due to data quantity and an inadequate detection limit for P. For the Eastern Cleddau, five waterbodies passed their targets, with two failing and two not assessed due to data quantity and an inadequate detection limit for P.

3.2.3.2 Afonydd Cleddau Core Management Plan

The Afonydd Cleddau Core Management Plan (CMP), published by NRW in 2022[10] contains the water quality targets (discussed in Section 3.2.3.1) as part of its conservation objectives. The plan was last updated in 2022 and includes the phosphorus targets published by NRW in 2021 as well as more recently updated phosphorus targets by NRW in 2022, discussed further in Section 3.2.3.3. However, it does not include the water quality attributes (those other than phosphorus) updated in January 2024[11].

3.2.3.3 2022 Phosphorus Targets

In 2022, NRW reviewed the waterbodies for SAC targets, and also made changes to the phosphorus targets for six waterbodies. The additional waterbodies and waterbodies with revised targets were re-assessed for compliance, using data from the same time period as the original phosphorus compliance report (2017-2019).[12]

[12] NRW (August 2023) Update to phosphorus targets for water bodies in Special Area of Conservation (SAC) rivers in Wales.

The target of one watercourse within the Cleddau was relaxed, however, the waterbody still failed against its new target (further discussed in Section 4.1).

3.2.4 Qualifying features and their Core Management Plan[13] condition status

Of the following qualifying features, the only one in a favourable condition in the core management plan is otter. These features are largely dependent on water quality and the P compliance targets have been set as this is one of the current pressures that is considered to have exceeded the ecosystem resilience levels. Elevated phosphorus levels interfere with competitive interactions between higher plant species and between higher plants and algae, leading to dominance by attached forms of algae and a loss of characteristic plant species (which may include lower plants such as mosses and liverworts). The respiration of artificially large growths of benthic or floating algae may generate large diurnal sags in dissolved oxygen and poor substrate conditions (increased siltation) for fish and invertebrate species. Details of the status of each qualifying feature is presented in the subsequent sections.

3.2.4.1 Primary qualifying features are the key reasons for the SAC designation, their status is as follows:

- Brook lamprey *Lampetra planeri,* are a primitive, jawless fish resembling an eel. Although it is not anadromous species, it has similar freshwater requirements and threats to sea lamprey. They build nests through picking up rocks and creating pits in the stream bed wherein eggs are subsequently deposited. They live exclusively in freshwater and spawns mostly in area of river with currents that are not too strong **Condition Status: Unfavourable. (Recovering).**
- River lamprey *Lampetra fluviatilis,* which are similar to sea lamprey, and is an anadromous species; it has similar freshwater requirements and threats. **Condition Status: Unfavourable. (Recovering).**
- Bullhead *Cottus gobio* is a qualifying feature for this SAC, it is a small bottom-living fish that inhabits a variety of rivers, streams and stony lakes. It appears to favour fast-flowing, clear shallow water with a hard substrate (gravel/cobble/pebble) and is frequently found in the headwaters of upland streams. However, it also occurs in lowland situations on softer substrates so long as the water is well-oxygenated and there is sufficient cover. It is not found in badly polluted rivers. **Condition Status: Unfavourable (Unclassified).**
- Otter *Lutra lutra* is a semi-aquatic mammal that can utilise both coastal marine/brackish and Inland riverine habitats. Inland populations utilise a range of running and standing freshwaters. These must have an abundant supply of food (normally associated with high water quality), together with suitable habitat, such as vegetated riverbanks, islands, reedbeds and woodland, which are used for foraging, breeding and resting. Poor water quality and persecution are key threats to otter in the UK. **Condition Status: Favourable (Maintained).**

3.2.4.2 Other qualifying features, but not primary features of the SAC are:

- Sea lamprey *Petromyzon marinus;* a primitive, jawless fish resembling an eel. It is the largest of the lampreys found in the UK. It occurs in estuaries and easily accessible rivers and is an anadromous species (i.e. spawning in freshwater but completing its life cycle in the sea). Like the other species of lamprey, sea lampreys need clean gravel for spawning, and marginal silt or sand for the burrowing juvenile ammocoetes. Sea lampreys have a preference for warm waters in which to spawn. Key threats are barriers such as weirs and dams, as well as polluted sections of river, which may impede migration to spawning grounds. **Condition Status: Unfavourable (Unclassified).**

[13] NRW (September 2022) Core Management Plan for Afonydd Cleddau SAC

- Another non-primary (habitat) qualifying feature for the SAC is the water course of plain to montane levels feature with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. This habitat type is characterised by the abundance of water-crowfoots and its hybrid. Floating mats of these white-flowered species related to buttercups are characteristic of river channels in early to mid-summer. They may modify water flow, promote fine sediment deposition, and provide shelter and food for fish and invertebrate animals. **Condition Status: Unfavourable (Unclassified).**
- Active forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) ***Priority feature.** This feature consists of woods that are dominated by alder *Alnus glutinosa* and willow *Salix spp.* on flood plains. This habitat largely occurs on moderately base-rich, eutrophic soils that experience periodic inundation. These are often dynamic habitats and part of a wider successional series of habitats. Clearance of riverine woodland has eliminated most true alluvial forests in the UK. Many surviving fragments, as elsewhere in Europe, are fragmentary and often of recent origin. Residual alder woods frequently occur in association with other woodland types or with other wetland habitats such as fens. **Condition Status: Unfavourable (Unclassified).**
- Active raised bogs ***Priority feature** This feature is peat-forming ecosystems that have developed during thousands of years of peat accumulation, to such an extent that the depth of peat isolates them from the influence of groundwater. Typically, lowland raised bogs form a raised dome of peat irrigated solely by rainfall. Raised bogs are widespread but unevenly distributed in the UK. **Condition Status: Unfavourable (Declining).**

It must be noted that much of the data on which these conditions have been assessed is very old, some greater than 20 years. Greater detail on the age of the data are discussed further in Section 4 and presented in Appendix B Table 7-2

Many of the issues / risks leading to these ratings are consistent or repeated across the qualifying features, and include pressures such as:

- Grazing / Overgrazing
- Invasive non-native species
- Water pollution (diffuse sources)
- Water quality issues

At a high-level, the conservation objectives for each of the qualifying features is to return to **Favourable** condition status. For a complete table of the qualifying features, their respective condition statuses and conservation objectives, refer to Appendix B.

3.2.5 Additional Information

Other aquatic plants which occur on the Western Cleddau, typical plants for this type of river include stream water-crowfoot *Ranunculus penicillatus ssp. penicillatus*, intermediate water-starwort *Callitriche hamulata*, the liverworts endive pellia *Pellia endiviifolia* and great scented liverwort *Conocephalum conicum*, brook-side feather-moss *Amblystegium fluviatile* and greater water-moss *Fontinalis antipyretica*, and species fringing the river channel include fool's-water-cress *Apium nodiflorum*, water-cress *Rorippa nasturtium-aquaticum*, hemlock water-dropwort *Oenanthe crocata*, purple-loosetrife *Lythrum salicaria*, bittersweet *Solanum dulcamara* and remote sedge *Carex remota*.

For the Eastern Cleddau, Water crowfoot habitat, typically including stream water-crowfoot *Ranunculus penicillatus ssp. penicillatus*, alternate water-milfoil *Myriophyllum alterniflorum*, water-mosses *Fontinalis spp.*, common water-starwort *Callitriche stagnalis*, intermediate water-starwort *C. hamulata*, accompanied by a diverse lower plant flora in the splash zone is found throughout the river system where the conditions are suitable.

There are levels of variable tree cover along the banks of the Afonydd Cleddau and the tributaries. There are low levels of tree cover in the Cleddau estuary towns, for instance Pembroke and Pembroke Dock have a canopy cover of 13-14% only[14]. However, there are plans to improve the canopy provision in these areas in the future.

Other notable species include the Allis shad, *Alosa alosa,* it is part of the herring family and very similar to the Twaite shad (*Alosa fallax*). The Allis shad is rare and declining throughout its range on the western coasts of Europe, from southern Norway to Spain, and in the Mediterranean eastwards to northern Italy. Sites in the UK have been selected where allis shad has been reliably recorded as present, where there is previous evidence of breeding, and where there still appear to be favourable conditions for breeding. There is only one recently confirmed spawning population in the UK. There are some small populations in the Afonydd Cleddau, but these are at risk of further decline. It is currently illegal to fish for Allis shad in Wales. There are efforts to restore this population to the Afonydd Cleddau through the 4 Rivers for LIFE project and other projects. It could be considered a potential flagship species within the NMP.

3.3 Current Pressures

To understand the current pressures of Phosphorus (P) in the Cleddau catchment, it is crucial to identify and analyse both the sources of P, which can be categorized into point and diffuse sources, and the pathways through which these sources enter the watercourse.

Point sources are specific, identifiable sources of P discharge directly into the watercourses, such as wastewater treatment plants, industrial effluents, and septic tanks. Diffuse sources, on the other hand, are more dispersed and challenging to control. These include agricultural runoff, urban stormwater, and soil erosion. Agricultural activities are a major contributor, with fertilizers and manure applications leading to phosphorus leaching into the water system.

The pathways through which phosphorus enters the watercourses are as critical as the sources themselves. Understanding these pathways helps in devising effective mitigation strategies. The primary pathways for phosphorus entry include surface runoff, subsurface flow, and direct discharge.

This section will consider the sources and pathways currently pressurising the Cleddau catchment.

3.3.1 Overview

As noted in Section 3.2.4, the qualifying features of the Afonydd Cleddau as classified by the Core Management Plan are mostly unfavourable condition. Several pressures have been highlighted, which have contributed to this status. Amongst those discussed are issues of water quality and water pollution.

Elevated phosphorus levels in rivers pose a significant environmental concern. Excessive phosphorus can stimulate the rapid growth of algae, deplete oxygen levels, and disrupt aquatic ecosystems, ultimately impacting the health of rivers and their associated flora and fauna. This also has indirect implications on drinking water abstraction and recreation.

In Wales, following the Joint Nature Conservation Committee (JNCC) common standards monitoring guidance for rivers that was published in September 2016[15], phosphorus pollution in riverine SACs rose to prominence in January 2021 when NRW set out new stringent water quality targets and issued a compliance report, this

[14] Town Tree Cover in Pembrokeshire

[15] Joint Nature Conservation Committee (September 2016) Common Standards Monitoring Guidance. ISSN 1743-8160 (online)

concluded several failures against the new targets within the Cleddau catchment (discussed further in Section 4.1).

To understand their contribution to the phosphorus load to the rivers, and to assess any improvements needed to their WwTWs discharges, DCWW updated and re-calibrated their water quality models using the regulator and industry standard tool known as SAGIS (Source Apportionment Geographical Information System), further discussed in Section **Error! Reference source not found.**~~3.3.4~~. According to the (SAGIS)[16] modelling results, under current conditions, approximately **8 kg** of phosphorus is discharged from the Eastern Cleddau and **20 kg** of phosphorus is discharged from the Western Cleddau on a daily basis.

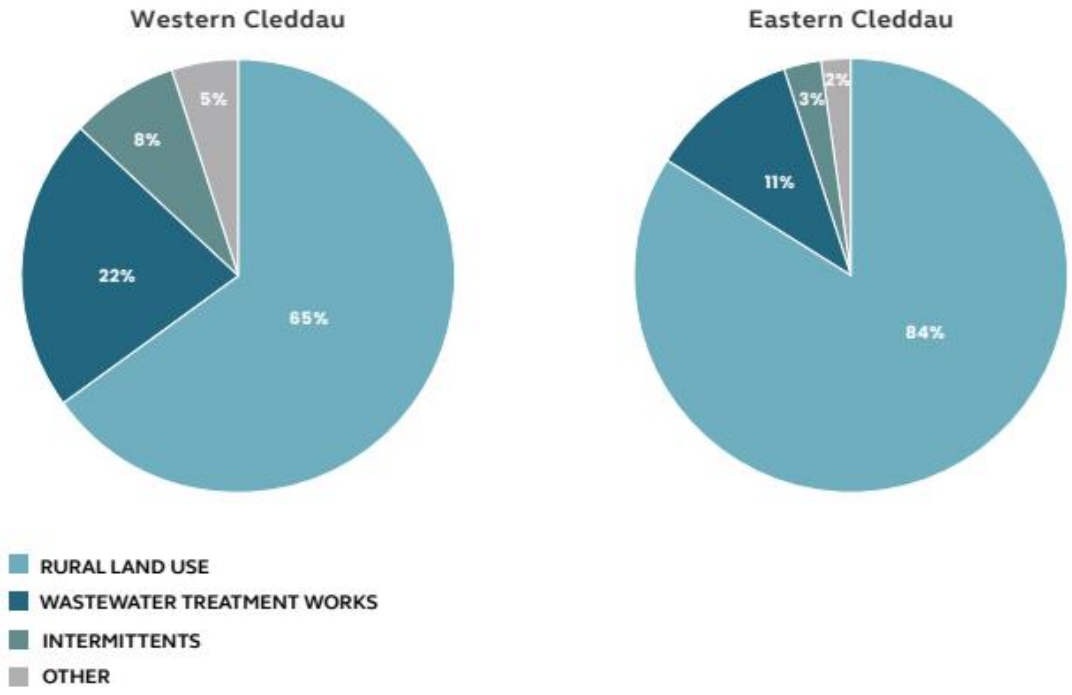

Figure 3-2 – Source Apportionment Outputs

Note: Figures show P apportionment by source at the furthest downstream point on the Western Cleddau and Eastern Cleddau. 'Intermittents' cover inputs from combined sewer overflows and storm tanks during heavy rainfall events. 'Other sources' is a broad category that includes inputs from urban areas, industrial activities, and septic tanks.

3.3.2 Rural Land Use

This represents the largest contribution of phosphorus into the Afonydd Cleddau, at 65% and 84% in the Western and Eastern Cleddau, respectively. A review of land use data for the catchment reveals that approximately 45k ha of land is associated to farming – this represents approximately 89% of the catchment, above the Welsh average 80%[17].

[16] DCWW (2023). Phosphorus Source Apportionment Summary: Afonydd Cleddau

[17] NRW (July 2023) Natural Resources Wales / Area Statements and farmers, foresters and land managers.

3.3.2.1 Agriculture

The catchment is home to approximately 660 farms, and is characterised by intensive agriculture, mainly dairy farming, although sheep rearing and early potato growing are locally important. Dairy farming in particular plays an important part in the local economy. Pembrokeshire produces 50% of Welsh potatoes and 25% of Welsh milk.

Table 3-2 presents a breakdown of the types of farming classifications within the Cleddau catchment, including a calculation of the relative % compared to the total. This highlights that a significant % of land is utilised for grazing livestock such as dairy cows.

The Cleddau catchment area is home to a diverse array of livestock. Among the most numerous are poultry, amounting to approximately 684,000. This is followed by cattle, with a substantial count of around 70,100, and sheep, numbering approximately 69,700. Other animals present include pigs and goats, both with populations of approximately 300, and horses, which number around 1,100.

The significant presence of these animals, particularly poultry and cattle, has important implications for phosphorus losses to watercourses. Livestock farming often involves the application of manure to fields, which can be a major source of phosphorus. When phosphorus from manure is not absorbed by plants, it can run off into nearby streams and rivers, leading to diffuse pollution.

Table 3-2 breakdown of farming classifications within the Cleddau

Type	Description	Land take (ha)	Land take as % of total
Perm pasture	Grassland that has not been resown in the last 5 years	27.2	61%
Rough graze	Sole rights rough grazing excluding any use of common land	1.7	4%
New grass	Grassland that has been resown in the last 5 years	5.5	12%
Cereals	Mainly wheat and barley and including other cereals for combining	2.8	6%
Stockfeed	Maize and other crops intended to be fed to animals	1.5	3%
Other crops	Potatoes, oil seed rape, other arable crops and horticultural crops	1.4	3%
Woods + Other	Woodland on farms plus land on farms not used directly for agriculture	4.4	10%
All land	Total land on farms excluding any use of common land	44.5	100%
All crops	Cereals, stockfeed and other crops	5.7	13%

3.3.2.2 Other land uses

There are three main migratory salmonid rivers in the area, the Nevern, Eastern and Western Cleddau. Almost all the streams and rivers are abundant in brown trout, with smaller coastal streams, such as the Solva and Gwaun, containing smaller stocks of both salmon and sea trout. There are also a number of thriving still water fisheries that have developed for trout and coarse fish. There are two net fisheries within the area, the last remaining compass net fishery in England and Wales on the Eastern and Western Cleddau and a single seine net is operational on the Nevern estuary. There is commercial fishing for sea fish and shellfish. Pacific oysters were cultured in the Haven up to around a decade or so ago in the Carew/Cresswell area and native oyster beds are widespread from Milford Haven town up to Picton Point. These are dredged commercially, the annual harvest being generally not more than 10 tonnes. Cockles and mussels, whilst present within the area, are not currently exploited commercially, although application to the Welsh Government has recently been made in respect of the latter at Angle Shelf. Application for classification has also been made in recent years in relation to Carpet Shell Clams and Razors.

3.3.2.3 Sources and Pathways

Table 3-3~~Table 3-3~~ presents the key sources of P pollution by rural land use type.

Table 3-3: key sources/pathways of P pollution

Agricultural Activity	Source of P Pollution	Pathways	Description	Importance in the Cleddau Catchment
Livestock Farming	Animal Manure / slurry spreading	Surface Runoff, Subsurface Drainage	Grain based feeds, high in P can elevate levels of P in manure. Phosphorus in animal manure can be carried by runoff from fields or directly deposited into waterbodies, particularly in areas with inadequate buffering. High animal populations can create challenges for farmers in terms of slurry storage and management, and can lead to practice of slurry spreading to manage manure on farms.	High. The Cleddau has a substantial number of cattle.
Arable / Horticultural Farming	Fertiliser Application	Surface Runoff, Leaching	Phosphorus from fertilisers can be carried by surface runoff or leach through the soil into waterways, especially during periods of heavy rainfall. Ploughing and compaction can exacerbate this issue.	High. Whilst crops represent a much smaller % of the total land use in the Cleddau, there is a still significant application of fertiliser applied to maize and grass in the catchment.

Agricultural Activity	Source of P Pollution	Pathways	Description	Importance in the Cleddau Catchment
All Farming Types	Soil Erosion	Surface Runoff	Eroded soil carrying phosphorus can be transported by surface runoff, and the sediment can act as a carrier for phosphorus into watercourses. Can be exacerbated by livestock farming due to scrub removal and soil exposure.	High. Soil erosion is a major pathway for phosphorus loss and significantly affects water quality.
All Farming Types	Drainage Management	Surface run-off / preferential pathways	Drainage management practices on farms will vary significantly based on local context and infrastructure. Where there is no separation of clean and dirty water, there is higher potential for P to be exported directly into the waterways.	High, considering the types of farming prevalent, management of drainage on farms will be critical.
Historic practices	Legacy P	Surface Runoff, Leaching	Legacy P, accumulated from years of excessive fertiliser and slurry applications, significantly contributes to ongoing P loss to the environment. This surplus poses a threat as it continuously leaches into water bodies.	High. Whilst limited data is available, it is highly likely that years of livestock farming in the Cleddau has contributed to high P levels within the catchment.

(This is not an exhaustive list, and rural land use extends beyond agriculture, with other possible pathways not listed here, e.g. forestry).

As shown in Table 3-3~~Table 3-3~~, the main pathways of phosphorus from agriculture include farmyard drainage systems, livestock near watercourses and spreading manure, artificial fertiliser and sewage sludge. High P export from agriculture is typically the result of non-compliance with regulations.

To address the issue, a combination of strategies targeting both current practices and legacy P reserves is necessary. Work undertaken for the RePhoKUs[18] project on the Wye highlights the following mitigation measures to help reduce P loss from agricultural lands:

- Reduce P Inputs: Reducing the amount of P applied to fields through fertilisers and manures is a critical first step. Farmers should be encouraged to use P more efficiently by matching applications to

[18] Paul J. A. Withers, Shane A. Rothwell, Kirsty J. Forber and Christopher Lyon (May 2022) RePhoKUs_Wye_Report_310522.pdf

crop needs and avoiding excessive use. This can be achieved through improved nutrient management planning and regular soil testing to monitor P levels.

- Manage Legacy P: Drawing down soil P levels to the agronomic optimum is essential for long-term sustainability. The RePhoKUs pot trial results suggest that legacy P reserves can support crop production for several years without additional P inputs. Encouraging farmers to rely on these reserves and avoid fresh P applications can help reduce the risk of P loss. Research should explore the feasibility of farming at lower P indices (e.g., P Index 1) to further mitigate P pollution.
- Implement Structural Controls: Structural measures such as buffer strips, constructed wetlands, and sediment traps can help intercept P before it reaches water bodies. These features can capture sediment-bound P and reduce runoff velocity, allowing more time for P to settle out of the water.
- Adopt Catchment-Wide Approaches: Effective P management requires a coordinated effort at the catchment level. Stakeholders, including farmers, water companies, environmental groups, and government agencies, should collaborate to develop and implement comprehensive nutrient management plans.

3.3.3 Wastewater Treatment Works (WwTWs)

This is a point source pressure, identified as the second largest contributor of P levels with the river Cleddau catchment. Within the Eastern Cleddau catchment, there are 5 WwTWs owned and operated by DCWW. Within the Western Cleddau catchment, there are 12 WwTWs owned and operated by DCWW. Major WwTWs, such as Clynderwen WwTW, Letterston West and Wolfscastle, serving the urban populations of Clynderwen, Letterston and Wolfscastle are notable within the catchment.

In February 2023, DCWW published an open letter to its stakeholders outlining progress made on the issue of phosphorus in Welsh SACs. Alongside this letter, details of the Review of Permits (RoP) were published. NRWs public register for environmental permits or licences hosts the ultimate decision documents supporting the RoP.

The RoP was completed in June 2024 including the revised phosphorus limits on WwTW Environmental Permits[19].

The SAGIS Tool is a GIS-based tool to quantify and apportion the loads and concentrations of chemicals to Water Framework Directive (WFD) waterbodies. SAGIS modelling has been used to identify where DCWW must remove additional phosphorus in order to meet their 'fair share' of the improvements needed. Under this regulatory programme, all WwTWs discharging over 20 m^3/day to a SAC or discharging to a non-designated waterbody draining to a SAC (i.e., where there is no total phosphorus (TP) limit currently in place), will meet a backstop (maximum) phosphorus permit limit of 5 mg/l by the end of the investment programme (2032).[20] However, there are circumstances where the actual permitted value will be lower than 5 mg/l due to the river needs, as identified by the SAGIS modelling outputs. These <5mg/l permits may be amendments to existing permits and/or new proposed limits, which may require WwTWs enhancements in order to achieve that lower limit.

According to the SAGIS model, which is based on the current (pre-RoP) performance, WwTWs account for 11% and 22% of the average phosphorus concentration (mg/l) in the East and West Cleddau, respectively. The concentration and load apportionment are different because inputs from different sources tend to occur under differing river flow conditions. For example, inputs from treatment works occur continuously (i.e. under high and low flow conditions).

[19] Natural Resources Wales / Phosphorus limits on environmental permits for waste water treatment work discharges
[20] DCWW (2023) Phosphorus Programme Cover Letter.

In June 2024 NRW completed a review of the phosphorus limits on all environmental permits of DCWW's owned WwTW, which discharge a dry weather flow exceeding 20 m^3/day. Thirteen of DCWW's WwTWs exceed this limit and so were part of the review. Only 3 met the required backstop permit of 5mg/l; the remaining 10 WwTWs have already implemented or will implement a tighter permit before the end of the investment programme (2032) as shown in Table 3-4.[21]

Table 3-4 NRW Review of Permits

WwTW	Issue date of reviewed permit	P Limit (1) mg/l	Effective date of P limit (1) mg/l	P Limit (2) mg/l	Effective date of P limit (2) mg/l
Ambleston	01/02/2024	5mg/l	08/02/2025	-	-
Camrose	06/12/2023	5mg/l	13/12/2023	4.5mg/l	31/03/2030
Clarbeston	29/04/2024	5mg/l	07/05/2024	1.5mg/l	31/03/2030
Clynderwen	10/07/2023	1mg/l	10/07/2023	0.25mg/l	31/03/2030
Keeston	19/01/2024	5mg/l	26/01/2024	1.5mg/l	31/03/2030
Letterston west	26/03/2024	5mg/l	04/04/2024	2.5mg/l	31/12/2025
Llanddewi velfrey	11/06/2024	5mg/l	18/06/2024	1mg/l	31/03/2032
Maenclochog	02/08/2023	2mg/l	02/08/2023	-	-
Mathry	27/06/2024	5mg/l	28/01/2028	1mg/l	31/03/2030
Puncheston	13/12/2023	5mg/l	20/12/2023	-	-
Spittal	03/06/2024	0.6mg/l	31/03/2025	-	-
Treffgarne	26/01/2024	5mg/l	02/02/2025	-	-
Wolfscastle	23/01/2024	5mg/l	30/01/2024	2.3mg/l	31/12/2025
Castlemorris*	-	-	-	-	-
Llysyfran Dam*	-	-	-	-	-
Panteg*	-	-	-	-	-
Walton*	-	-	-	-	-

[21] DCWW (2024). Phosphorus limits on environmental permits for wastewater treatment work discharges

**Several WwTW no longer require a variation or phosphorus limits because they discharge under 20m3/day of treated sewage effluent.*

The RoP and planned investment on DCWW's behalf represents a reduction of a current pressure from a significant point source contribution of phosphorus from WwTW effluent into the Afonydd Cleddau. It should be noted that many of the improvements will take place and be implemented at different times throughout future investment programmes up to 2032, in agreement with NRW.

Whilst the driver for the improvement works has been ensuring DCWW meets its fair share requirements to deliver SAC compliance, this may help to unlock housing developments planned for by the respective LPAs, as new development can be appropriately serviced by many of the newly permitted works without risking negative impacts within the Afonydd Cleddau. However, this would need to be considered case-by-case by the LPA, ensuring nutrient neutrality principals are applied where appropriate.

When considering the current pressures in the Cleddau catchment from WwTWs, it is important to consider the agreed permits (as per the RoP), and then whether the works have sufficient treatment capacity headroom to accept new development whilst remaining within their permit. Ongoing consultation between DCWW, LPAs and developers will still be needed to manage the risk of exceeding the available headroom capacity, using the most up-to-date information.

3.3.4 Septic Tanks/Private Waste Treatment Works

In rural areas, reliance on private waste management including private treatment works is more prevalent where it is not possible to connect to a DCWW operated WwTW. In these instances, developments are reliant on the use of either septic tanks or package treatment plants (PTP).

A legal septic tank should not discharge directly into a watercourse, this is because septic tanks will discharge to ground where the breakdown of effluent in a drainage field provides secondary treatment. It is noted that some older septic tanks do discharge to ground near a watercourse thus may be hydraulicly connected to a watercourse. PTP have the potential to discharge near or directly into a surface waterbody. Both septic tanks and PTP are subject to either an environmental discharge permit or an exemption of a permit by NRW.

According to the NRW Water Quality Exemptions data set[22] there is currently a total of 1721 exempt discharges of treated domestic sewage to either surface or groundwater, managing vegetation near/on inland water, substances to ground for scientific purposes and discharges from open loop heating and cooling systems. It is noted that the dataset does not distinguish between the different types of treatment except calling them different exemption types with the following categories for the Cleddau catchment: Sewage Discharge, small discharge or unknown. In the Cleddau catchment 1712 of the exemptions are classified as Sewage Discharge, 2 small discharges and 7 unknown discharges.

According to the NRW Permitted Discharges to Controlled Waters with Conditions data set[23] there is currently a total of 62 permitted discharges (38 PTP and 24 Septic Tanks). Both solutions likely offer far reduced performance in terms of P removal when compared to a traditional WwTW. Due to the nature of septic tanks, they are not a mitigation option for the removal of P through upgrades (except for older tanks permitted to discharge near a watercourse). PTPs have a wider scope for improvement and P removal within the Cleddau catchment

P from septic tanks is classified under the source apportionment modelling under 'Other' sources, representing only 3% and 8% of the total daily load in the Eastern and Western Cleddau, respectively.

[22] Natural Resources Wales Water Quality Exemptions | DataMapWales
[23] Permitted Discharges to Controlled Waters with Conditions | DataMapWales

However, there are notable uncertainties in the representation of 'Other' sources in the SAGIS modelling, particularly concerning the contribution of P from septic tanks and private treatment plants. The model's treatment of these sources can be challenging due to the variability in performance and discharge practices.

3.3.5 Storm Overflows (SOs)

Under the source apportionment modelling, SOs are classified as an “intermittent” source of phosphorus, in the Cleddau catchment, accounting for 2% and 5% of the total daily load in the Eastern Cleddau and Western Cleddau. SOs are named as such as they receive both foul and surface water drainage inputs. SOs have a finite capacity, and so during periods of heavy rainfall, capacity can be quickly used up, resulting in the need to discharge the excess untreated water to the nearest watercourse via a SO to prevent flooding of homes and business. These overflows are permitted by the regulator NRW and in Wales are subject to permit conditions which require them to operate only in circumstances of exceptional rainfall. It is worth noting that, based on discussions with DCWW, SAGIS determines the SO P contribution based on the quantity of SO in the waterbody, not the number of spills by each SO. This assumption, therefore, does not capture the actual operation of overflows, and could potentially underestimate their impact on P loading.

In September 2023, Welsh Government announced the publication of the Storm Overflow Evidence for Wales (SOEfW) report.[24] The report provides detail on national options to reduce or remove SOs, recognising the technical and financial barriers to each option, as well as the benefits afforded. The report recognises a methodology for estimating the environmental impact of spills, noting key caveats.

Ultimately, the link between a spill and the environmental impact of the spill is complex and can only ever be estimated. As a current pressure on the Afonydd Cleddau, current evidence (noting limitations) suggests that SOs are not a significant contribution to the daily average load (<5%). However, efforts to reduce them would have multiple benefits within the SAC and may ease other pressures and reduce more short-term impacts introduced by Sos. DCWW are identifying schemes within their next (2025-2030) business plan for overflows focussing on areas of greatest environmental impact across the catchment and more widely.

It is worth noting that NRW were the first regulator to require the wastewater companies operating in Wales to install monitors on storm overflows to record storm spills[25]. These are known as Event Duration Monitors (EDMs). In Wales, the majority of EDMs were installed by 2020, based on the latest 2023 report, coverage is now over 99% across the network. Data is collected and published annually on their performance[26]. In July 2022, Julie James, Minister for Climate Change launched the Wales Better River Quality Taskforce. The taskforce has collaboratively developed action plans to gather greater evidence on the impact of storm overflows on rivers, to reduce the impacts they cause, to improve regulation and to educate the public on sewer misuse.

3.3.6 Industry

Below their tidal limits, the Eastern and Western Cleddau join to form the Daugleddau, an extensive tidal reach of important ecological value. Downstream of the Cleddau Bridge, the Daugleddau broadens into the Haven, one of the largest natural harbours in the world, offering deep water access and moorings. This port is the most important in Wales and one of the largest in the UK.

Although parts of Milford Haven and Neyland were initially developed due to a large, thriving fishing industry, the main industry within this area now relates to oil and gas around the Haven, with sea fishing significantly

[24] Welsh Government (September 2023) Storm overflow evidence for Wales (SOEfW). Stantec

[25] NRW (October 2023) Storm Overflows.

[26] NRW (August 2023) Storm overflow spill data report 2022

diminished. The oil industry became established around the Haven in the 1960s. Today, the oil refinery operated by Valero (Pembroke) is the only one in operation, with the other two former refinery sites having been converted into liquid natural gas terminals, linking via a 197-mile high-pressure gas pipeline to the national gas network at Tirley in Gloucestershire. Some years after the demolition of the former oil-fired Pembroke power station, the new combined-cycle gas turbine station opened in September 2012.

Extractive industries have diminished over time. The area was formerly important for mining and quarrying, with around 100 in operation at one time. These largely small-scale operations were mostly seeking limestone or slate. The coal industry was important in Pembrokeshire in the last century although there are no environmental legacies of any significance arising from this.

3.3.7 Urban Pressures

Diffuse pollution from urban areas is considered under the source apportionment modelling under 'Other' sources, representing only 3% and 8% of the total daily load in the Eastern and Western Cleddau, respectively. Whilst rainfall runoff from impermeable areas in urban environments such as roads, drives and roofs etc. is not expected to be a significant source of P, they can create pressure on SO systems if they do not drain to a separate surface water sewer system, thus exacerbating the issues discussed in Section 3.3.5.

3.3.8 Water Abstraction

DCWW supply the area with potable water and also raw water to some industry.[27] Their major abstractions are at Canaston on the Eastern Cleddau, which provides water for most of South Pembrokeshire, and Crow Hill on the Western Cleddau. Llys y Fran reservoir on the Syfynwy (a tributary of the Eastern Cleddau) is used to regulate flows in the Eastern Cleddau to enable abstraction at Canaston at times of low river flows. Although a large proportion of the total licensed abstraction relates to industrial use, most of the usage is low consumption, with the water being returned back to rivers and estuaries. The majority of licensed abstractions (by number) in the area are for spray irrigation and most of these are for filling winter storage reservoirs and so do not have an impact on low river flows.

3.4 Future pressures

This section outlines the future pressures, including any uncertainties, likely to have impact on the issue of nutrient concentrations within the Afonydd Cleddau.

3.4.1 Development

The population in the Cleddau and Pembrokeshire Coastal Rivers region is set to decrease from 167,995 (in the year of publication) to 134,000 by 2050[28]. In theory, this should ease the pressure on existing WwTWs, and lead to an overall net decrease in P to the Cleddau catchment from them. However, there is still planned growth within the LPA's Local Development Plans (LDP).

Therefore, it is important to recognise that the location of major urban developments is critical to the apportionment of P impacts. For example, major developments in localised areas can create pressure points for any receiving WwTWs, leading to localised increases in phosphorus loading. Whilst a great deal of work has been done to recognise future pressures on WwTWs, and DCWW are investing in improvements to their works to enable development to take place, it should be noted that future concentrations of development (i.e.,

[27] DCWW. Cleddau and Pembrokeshire Coastal Rivers Management Catchment Summary

[28] DCWW. River Basin Catchment Summary

beyond the current LDP) do pose a pressure to the sustainable management of nutrients in the Cleddau catchments. Forward planning and collaboration between the LPAs and DCWW will be key to controlling this pressure.

It is worth noting that the RoP process, discussed in Section 3.3.3, only covers permit changes and required improvements up to 2032. Furthermore, not all WwTW have planned improvements within the Cleddau catchments. This may be due to the works falling under the minimum requirements for Dry Weather Flow (DWF) of 20m^3/day, the site currently meeting its new permit requirement(s) or the SAGIS modelling not resulting in a required permit change, aligning with fair share principles.

3.4.2 Wastewater Treatment Future Capacity

Amongst the options to improve P removal at WwTWs is the use of Nature-based solutions. In recognition of this, DCWW[29] have expressed their position on what intervention measures they will and will not support for phosphorus mitigation in conjunction with their WwTWs, over and above their permit requirements, providing an opportunity for third parties. Constructed Wetlands are one type of solution where DCWW would support collaborative delivery at some locations, to further remove phosphorus from their effluent, once their permit limit has been met.

DCWW have provided an overview of where collaboration opportunities for constructed treatment wetlands (CTW) could be available for any interested third parties. Such CTWs provide extra polishing to the treated wastewater effluent by passing it through a series of interconnected shallow holding areas planted with native wetland species such as reeds, rush, iris, sedges, marsh marigold and watercress, species composition dependant on the desired wetland function and location. CTWs are engineered to mimic the physical, chemical, and biological processes occurring in natural wetlands. Not only do the wetlands have a practical water quality benefit, but they provide a huge biodiversity asset and create a valuable habitat for local wildlife.

To aid identifying where collaboration maybe possible, each WwTW has been screened into a category (A, B, C or D) to highlight the different opportunities available. Category B, C and D WwTW offer opportunities for CTW solutions to provide additional P reduction. At these locations, headroom could be created by third parties to further reduce the loading of P to the Afonydd Cleddau, allowing future development in the long-term to be secured. Progress of solutions in collaboration with DCWW should be tracked to better understand the future pressures within the catchment.

Constructed wetlands must meet the requirements of the NRW position dated October 2023. For water quality improvements this outlines NRW's position on using constructed wetlands for treated sewage effluent (waste), untreated sewage effluent and treated waste effluent from a waste operation. Nutrient Management Boards wish to look at the further treatment of treated sewage effluent (waste) for nutrient neutrality and improvement. Such wetlands would be under third party ownership. There is no written statement from NRW regarding the specifics for the regulation of such systems. If the final effluent discharge (waste) is redirected away from entering a waterbody to a third party constructed wetland there are a number of risks the third-party owners need to be aware of:

- The third party would become a "waste operator" of any system providing further treatment of the WwTW final effluent (waste) before discharge to the water body.
- The waste operator would be legally responsible for the quality of the water discharged from the wetland site.
- The waste operator would also be responsible for the implications of any treatment (e.g. the WwTW) prior to their wetland as the only point of regulatory control would be at the discharge from the wetland

[29] DCWW (2023) Collaboration on Phosphorus Reduction Schemes Guidance

into the water body. That is, whomever adopted the constructed wetland would be responsible for all the wastewater treatment entering that wetland. As a waste operator the third party would be able to specify the criteria the waste entering their system must meet. Failure to meet the regard standard would require the waste operator to take action against the owner of the waste (the WwTWs operator).

- The previously regulated water discharge activity (final effluent) from the WwTW would not require a permit as there is no discharge to controlled waters (the waterbody). Duty of care requirements would apply to the two parties.

In effect, this means the liability on a third party adopting a constructed wetland is currently prohibitive, the NMB have raised this issue with stakeholder including the Welsh Government and will continue to work with all parties for a solution. There is currently no agreement in place with regulators of how this could be achieved.

3.4.3 Rural Land Use Change and Legacy P

Whilst it is difficult to predict rural land use change, such as agricultural behavioural change, it is recognised that shifts in the types of farming activities traditionally seen in the Cleddau catchment will impact the export of nutrients including phosphorus to the SAC. At present, the catchment is struggling to cope with the intensity of livestock farming. Furthermore, this is a compounding issue i.e., years of historic livestock farming have likely contributed to high P levels in the underlying soils of the Cleddau catchment.

Whilst balancing the need for food security and financial security for farms, there is an urgent need to address current practices.

3.4.4 Storm Overflows (SOs)

In the SOEfW, all of the waterbodies in the Afonydd Cleddau catchment are listed as being at a low risk of environmental harm if no interventions are actioned to reduce spills by 2050. Whilst this highlights the fact that SOs are not likely to be a significant concern for the NMB in reducing nutrient pollution to the Afonydd Cleddau SAC, it highlights the need to continue to track changes in this area of work within Wales and to consider the added or secondary benefits of mitigation measures that might reduce pressure on the SO network.

3.4.5 Rural Population Growth

New rural developments may not be able to connect to an existing public treatment works, due to no capacity or the absence of a public network and may rely on either Package Treatment Plants or Septic tanks to serve their properties. These solutions will typically perform less well than DCWW managed WwTWs. The LPA will need to consider the impacts of rural developments, and their reliance on private wastewater treatments.

3.4.6 Marine SACs and Nitrogen

Details of content and release date of Marine SAC guidance have not been specified by NRW. However, it is understood that modelling has been completed, and that Marine SAC guidance will be issued pending legal consultations. The principal nutrient known to affect marine aquatic environments is nitrogen, although this does not preclude the possibility of other nutrient constraints also. The effect on nutrient sensitive environments that are served by failing SAC in Wales can be foreseen using the current examples in England, the Netherlands and on a global scale.

At this stage, the anticipated effect is entirely speculative but would likely include the imposition of an environmental constraint to development as has been the case with P guidance and drive tightened permits on discharges to the Marine SAC. The areas that will be affected by any new guidelines will be coastal and estuarine river catchments.

3.4.7 Ammonia

Natural Resources Wales (NRW) published an evidence report[30] in January 2024 about water quality within Special Area of Conservation (SAC) rivers in Wales. The report complements NRW's 2021 phosphorus compliance report and looks at compliance against seven additional water quality targets including ammonia.

It focuses on 127 water bodies within the nine SAC river catchments, Cleddau, Eden, Gwyrfai, Teifi, Tywi, Glaslyn, Dee, Usk and Wye, using data collected between 1st January 2017-31st December 2019.

The Cleddau catchment has several water bodies failing to meet the Total Ammonia target, making it the only SAC with recurring Total Ammonia failures and the only one with a Unionised Ammonia failure. These exceedances were detected in both the Eastern Cleddau sub-catchment (Deepford Brook) and the Western Cleddau sub-catchment (Anghof, Cartlett Brook, and Rudbaxton Water). These results indicate a severe water quality issue.

The ammonia failures in the Cleddau catchment suggest consistent issues related to organic pollution and nutrient enrichment, necessitating targeted measures to address these water quality challenges.

3.4.8 Climate Change

UK Climate Impacts Programme predicts that, by the 2050s, temperatures across Wales could rise by 1.1 to 4.1°C. Annual average rainfall in Wales is predicted to remain roughly the same as present, but there is likely to be a large difference in the patterns of summer and winter rainfall. Increased winter rainfall is expected which may also lead to intense, but short-lived, rainfall events. Summer rainfall may decrease, and short duration droughts (12-18 months) are likely to become more frequent. [31]

The effects of climate change which include, drought, extreme precipitation events, increased temperature, elevated atmospheric carbon dioxide (eCO_2), and saltwater intrusion induced by sea level rise, all share a closely knitted relationship with phosphorus in waterbodies.

Table 3-5 Influence of climate change impacts on phosphorus levels in waterbodies

Climatic changes	Effects on phosphorus content in waterbodies
Rise in temperature/ heatwaves	Increased soil and air temperatures influence soil microbial communities and P-solubilising microbes, but their effects on phosphorus losses are uncertain. Likewise, eCO_2 may increase plant growth, phosphorus demand, and soil phosphorus cycling, but its impact on phosphorus losses is unclear. Saltwater intrusion caused by sea level rise can further mobilise phosphorus in high (legacy) phosphorus soils and enhance phosphorus loss from land to water.
Excess rain	Extreme precipitation events directly impact runoff, causing accelerated transportation of dissolved and particulate phosphorus from soils, exacerbated after the application of fertilisers and manures. The unpredictability of such extreme

[30] NRW Assessment of water quality in protected rivers in Wales

[31] Welsh Government (December 2018) Draft Climate Change Adaptation Plan for Wales. Consultation Document.

Climatic changes	Effects on phosphorus content in waterbodies
	precipitation leads to greater incidental phosphorus losses as appropriately timing of nutrient applications is more challenging.
Droughts	Droughts during summers can lead to significant lowering of water flows which can lead to increased concentration of nutrients, stagnation which causes phosphorus to concentrate and amplify eutrophication.

3.4.9 Land Availability

Another future pressure to consider is the availability of land for the purpose of nutrient mitigation. Assuming that new, future housing requires mitigation to demonstrate nutrient neutrality, then appropriate measures to offset the net increase in phosphorus would be required. As plans and developments come forward through the years, it will be important to ensure that mitigation coming through does not significantly remove opportunities for other types of intervention in line with the conservation objectives of the SAC e.g., avoiding the development of land for a constructed wetland, when it could have been better used for woodland planting. Furthermore, availability of suitable candidate sites for mitigation, may diminish as plans develop.

4 Evidence Base Review

The purpose of the evidence base review is to gather and analyse relevant information to support decision-making for nutrient management within the Afonydd Cleddau SAC. This review aims to achieve two key objectives:

- Firstly, it involves a comprehensive assessment of datasets that evaluate the current compliance of the SAC in relation to phosphorus levels. By examining these datasets, the review aims to identify areas where compliance is not being met and determine the extent of these failures. This analysis will provide insights into the existing challenges and shortcomings in managing phosphorus.
- Secondly, the evidence base review seeks to identify any notable gaps in the available data. These gaps may represent areas where additional information is needed to make more informed decisions regarding nutrient management. By understanding these data gaps, the review will enable the NMB to identify priorities for further research and monitoring efforts.

Ultimately, the focus of the evidence base review is to establish our current understanding of the SAC, evaluate the reliability of existing data, and identify areas where information is lacking. By doing so, this will ensure the NMB is able to make better informed decisions to enhance the condition of the SAC and ensure its long-term ecological health.

This section should be read in conjunction with the supporting figures (Appendix A) and ecology evidence base review tables (Appendix B).

The majority of the evidence base review was undertaken January to March 2024. Any new or emerging data or guidance will be captured in the next revision of the NMP.

4.1 Phosphorus Targets & Monitoring Data

4.1.1 Phosphorus Data Overview

This section will introduce the water quality data (phosphorus only), SAGIS modelling and compliance assessments to contextualise the available data for the Afonydd Cleddau operational catchment. Point phosphorus data used by NRW and the WFD will be reviewed, and commentary will be provided on how robust this data is for analysis and determining compliance. Any spatial, temporal or data quality concerns will be outlined, with a focus on the implications for compliance failures. With recommendations provided for potential future sampling and further analysis in order to improve any current conclusions.

Whilst the point phosphorus data will be used to address SAC waterbody compliance, the results and analysis of SAGIS modelling will outline the source apportionment of phosphorus to understand what is causing high phosphorus loads. The spatial implications of the point data will also be contextualised with the SAGIS data to provide a more detailed overview of the operational catchment. The SAGIS model data will steer the type of mitigation measures presented in Section 5, through identifying which sub catchments are influenced primarily by wastewater treatment works, rural land use, storm overflows and other sources.

Data from the NRW WFD water quality archive[32] and NRW SAC phosphorus assessment data[33] have both been obtained for the data analysis on the Afonydd Cleddau. This data was used to understand the current

[32] Natural Resources Wales, water quality archive, accessed February 2024 at: Data catalogue | DataMapWales (gov.wales)
[33] Natural Resources Wales, SAC phosphorus assessment data, accessed February 2024 at: Natural Resources Wales / Compliance Assessment of Welsh River SACs Against Phosphorus Targets

compliance data, potential trends in data since 2017 and what additional data for further compliance is available from the WFD monitoring work and studies.

4.1.2 NRW Compliance Assessment Data

NRW published a "compliance assessment of Welsh River SACs against phosphorus targets" in January 2021. [34] This assessment used phosphorus concentration data from the NRW water quality database for a three-year period between January 2017 to December 2019 for all sample points within nine SAC waterbodies. In total, 125 water bodies were in scope. Overall, 39% of assessed SAC water bodies passed their targets whilst 61% failed. Further to this assessment, an update entitled "Update to phosphorus targets for water bodies in SAC rivers in Wales" was published (2023), [35] this report reassesses six water bodies located within the Afon Dyfrdwy (River Dee), Afon Eden, River Usk and Afonydd Cleddau operational catchments. The phosphorus target for one waterbody (Deepford Brook - headwaters to conf with Syfynwy) within the Afonydd Cleddau was relaxed from 39 (µg l^{-1}) to 40 (µg l^{-1}). The changes are due to the water body having been assigned either an incorrect altitude, alkalinity or river size or incorrect phosphorus data used during the original target setting process. Regardless of this change, the waterbody is still failing its targets.

The compliance targets were set using the JNCC common standards monitoring guidance for rivers published in September 2016.[15] Average annual and growing-season means (March-Sept) were calculated by NRW for each sample point and the highest of the two values was selected to be compared against the targets. A minimum of 8 samples at each sample point was required to calculate the means.

The JNCC methodology employs a pass/ fail criteria, with no consideration for outliers. So, a single high reading is reported as a failure when the mean is above the target. NRW have conducted sensitivity testing to determine the impact of high readings. Following the process, any failing sites were allocated one of two categories: confirmed or unconfirmed failure. This method is isolated in that it only looks at a single assessment point and not additional sample locations within the wider catchment.

In the event of multiple sample locations within a catchment, a conservative approach is taken whereby the worst performing sample location is used for the compliance assessment. The determinant used by NRW was soluble reactive phosphorus (SRP) but decanted settled samples can be used as well.

Whilst the water quality data is considered to be of good quality, a number of limitations and assumptions has been made by NRW (Table 4-1~~Table 4-1~~).

Table 4-1: Summary of Data Quality Issues (SAC Compliance Assessment)

Issue	Definition	Impact or limitation
Limit of Detection (LoD)	LoD means the minimum concentration of phosphorus that the sampling method is able to register. Prior to 2016, the LoD for all monitoring samples was 20 micrograms per litre (ug/l), classified as 'Low'.	Data for the compliance assessment starts from 01/01/2017 to avoid issues using the 'Low' method. Where 'Low' samples only were available after (01/01/2017) these were disregarded for assessments where the compliance target concentration was equal to or less than LoD.

[34] Natural Resources Wales (2021), Available at: Natural Resources Wales / Compliance Assessment of Welsh River SACs Against Phosphorus Targets

[35] Natural Resources Wales (2023), Available at: Natural Resources Wales / Update to phosphorus targets for water bodies in Special Area of Conservation (SAC) rivers in Wales

Issue	Definition	Impact or limitation
	Since 2016, a new method for EA labs has been used with a LoD of 1 ug/l or 4 ug/l at NRW labs, classified as 'Very Low'.	Where 'Low' or 'Very Low' samples were available, but the compliance target is higher than the LoD (e.g., 50 ug/l), a value of half the LoD has been used in the assessment.
Sample holding time	In 2017, NRW did not have the technology available to run the 'Very Low' testing method and so relied upon the Environment Agency to carry out this testing, sending samples into England. This often resulted in holding times for samples (i.e., the time between the sample being taken and tested) exceeding 3 days, which NRW assessed as limiting confidence in results.	NRW state that exceeding holding time has the potential to reduce concentration of phosphorus, introducing a risk that including this data in the compliance assessment would underestimate the annual mean. As a result, many samples through 2017 are disregarded from the assessment. This is discussed further in Section 4.1.5 as analysis conducted by Arcadis showed that the removal of this data resulted in a lower annual/ growing season mean. NRW have not confirmed which of the data was removed, and so this requires confirmation in collaboration with NRW.
Sample frequency	Ignoring samples removed from the compliance assessment, typically 12 samples per year were available for all sampling points.	Whilst it is important to recognise the challenges posed by resource and budget restrictions in carrying out a national monitoring programme approx. monthly samples whilst valuable, are not comprehensive, and will invariably miss in-month fluctuations as weather conditions and land use activities change during the year.
Sample Spacing	A single sampling location is used for the purpose of the compliance assessment, based on the monitoring point that provides the worst-case scenario.	Whilst this is a conservative approach for the compliance assessment, it misses an opportunity for more in-depth analysis. A more comprehensive assessment would consider all data points, asset the worst performing sites and what might be driving the failures.

4.1.3 Water Framework Directive (WFD) Data

In addition to the NRW compliance assessment, the Water Framework Directive (WFD) also has targets for phosphorus. River Basin Management Plans (RBMP) set out the strategy, including a programme of measures, for each catchment to comply with the requirements of the WFD. These plans are developed by NRW, and were published in 2009, with updates published in 2015 and 2022, each update is classified as a new cycle. When assessing phosphorus targets the current cycles data is taken into account. Ecological determinants are classified as Bad, Poor, Moderate, Good, High, and Chemical determinants are classified as either Fail or Good to determine an overall status of Bad, Poor, Moderate, Good and High. Whilst the NRW assessment call the determinand used Phosphorus (SRP), the WFD calls it orthophosphate, reactive as P. Whilst chemically the SRP encompasses orthophosphate, reactive as P, checks have been undertaken before and during the report to ensure that these are the same data source.

It is important to note the differences between a WFD assessment of Phosphorus compliance and the SAC Assessment. Such that the WFD will use multiple sample locations within the catchment to determine the status of each determinand, in addition the WFD updates the current compliance of determinands when new

data becomes available. This is in contrast to the current NRW compliance assessment which has a rigid pass / fail criteria and when the updated targets report was published new data was not used for all locations.

The WFD has a total 197 sample locations within the Cleddau operational catchment area. Some of these sample locations are not currently active and will have been used for previous cycles. The Freshwater sample locations and WFD phosphorus classifications are shown in Figure 4-1~~Figure 4-1~~. Whilst the WFD compliance is shown on the map, it is important to restate the different and more stringent targets set under the SAC compliance assessment. As such, using the WFD classifications to assess priority / problem catchment at a more granular scale is unlikely to provide benefits to the NMB in delivering this NMP. Instead, a more comprehensive understanding of the base data, particularly in the context of the SAC compliance failures, would potentially help pin-point areas in the catchment of greatest need.

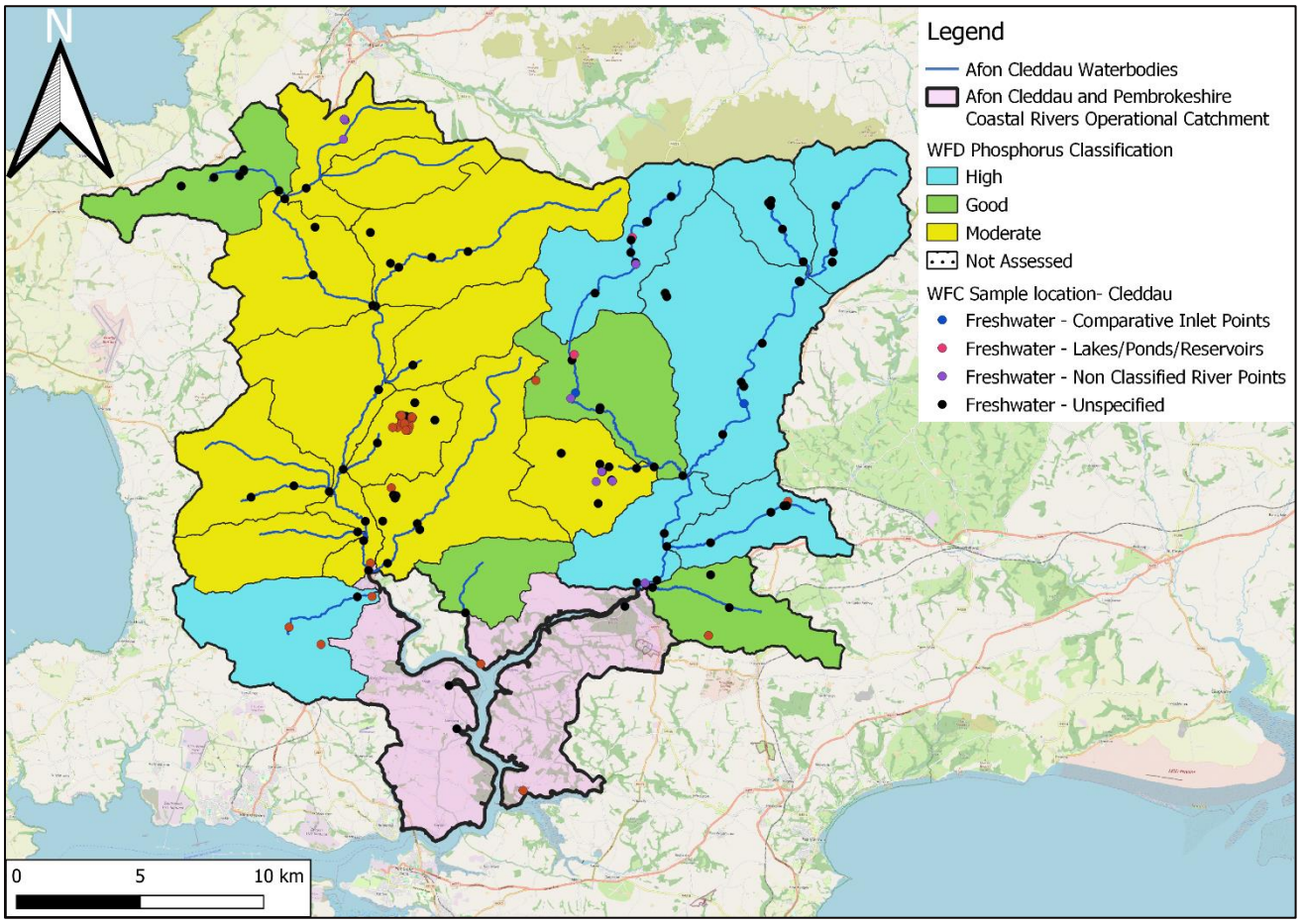

Figure 4-1: Afonydd Cleddau WFD sample locations and phosphorus classifications.

Background map contains OpenStreetMap data © OpenStreetMap contributors. Catchment and river data sourced from the NRW. WFD data sources from the WFD and NRW.

4.1.4 Current SAC compliance with phosphorus targets

The Afonydd Cleddau SAC is covered by 19 waterbodies, of these 19, 15 are assessed within the NRW compliance assessment. 16 assessment points (one catchment has two sample locations) are located within the Afonydd Cleddau, as shown in Table 4-2~~Table 4-2~~. The number of samples, the Phosphorus standard, the annual mean, the growing season mean and the Phosphorus target with pass/fail, are presented in Table 4-2~~Table 4-2~~. Of the 16 assessment points, 10 waterbody catchments are classified as failing under the NRW compliance assessment.

Table 4-2: Summary of Afonydd Cleddau Compliance Assessment Results

Waterbody Name	Site No.	No. Samples	Annual Mean (ug/l)	Growing Season Mean (ug/l)	Target (Exceedance Pass -ve / Fail +ve) (ug/l)
Western Cleddau					
W Cleddau - headwaters to conf with Cleddau North	83786	24	23	17	15 (+8)
Nant y Bugail - headwaters to conf with Cleddau N.	N/A	-	-	-	Not assessed
Cleddau North - H'waters to conf with W. Cled	N/A	-		-	Not assessed
Western Cleddau - Cleddau North to Anghof conf	85017	26	42	44	40 (+4)
Anghof - headwaters to conf with Western Cleddau	85003	28	36	38	37 (+1)
W Cleddau - Anghof conf to Cartlett Brook conf	32803	20	49	52	40 (+12)
W Cleddau - Anghof conf to Cartlett Brook conf	32804	22	43	46	40 (+6)
Spittal Brook - headwaters to conf with W. Cleddau	85004	21	32	38	30 (+8)
Camrose Brook - headwaters to conf with W. Cleddau	85006	28	48	55	30 (+25)

Waterbody Name	Site No.	No. Samples	Annual Mean (ug/l)	Growing Season Mean (ug/l)	Target (Exceedance Pass -ve / Fail +ve) (ug/l)
Rudbaxton Water - HW to conf with W. Cleddau	85035	21	79	105	30 (+75)
Cartlett Brook - HW to conf with W. Cleddau	85008	29	76	89	30 (+59)
Eastern Cleddau					
Eastern Cleddau - headwaters to conf with Wern	32498	17	3	4	10 (-6)
Wern - headwaters to conf with Eastern Cleddau	32496	26	3	3	10 (-7)
E. Cleddau - conf with Wern to conf with Syfynwy	32495	26	11	12	15 (-3)
Syfynwy - headwaters to Llys-y-fran	N/A	-	-	-	Not assessed
Syfynwy - Llys-y-fran to conf with E Cleddau	32406	13	24	-	39 (-15)
Eastern Cleddau - conf with Syfynwy to tidal limit	88181	26	14	13	20 (-6)
Longford Brook - HW to conf with E. Cleddau	N/A	-	-	-	Not assessed
Narbeth Brook - headwaters to conf with E. Cleddau	32407	19	35	40	34 (+5)

Waterbody Name	Site No.	No. Samples	Annual Mean (ug/l)	Growing Season Mean (ug/l)	Target (Exceedance Pass -ve / Fail +ve) (ug/l)
Deepford Brook - headwaters to conf with Syfynwy	86005	28	44	50	39 (+11)

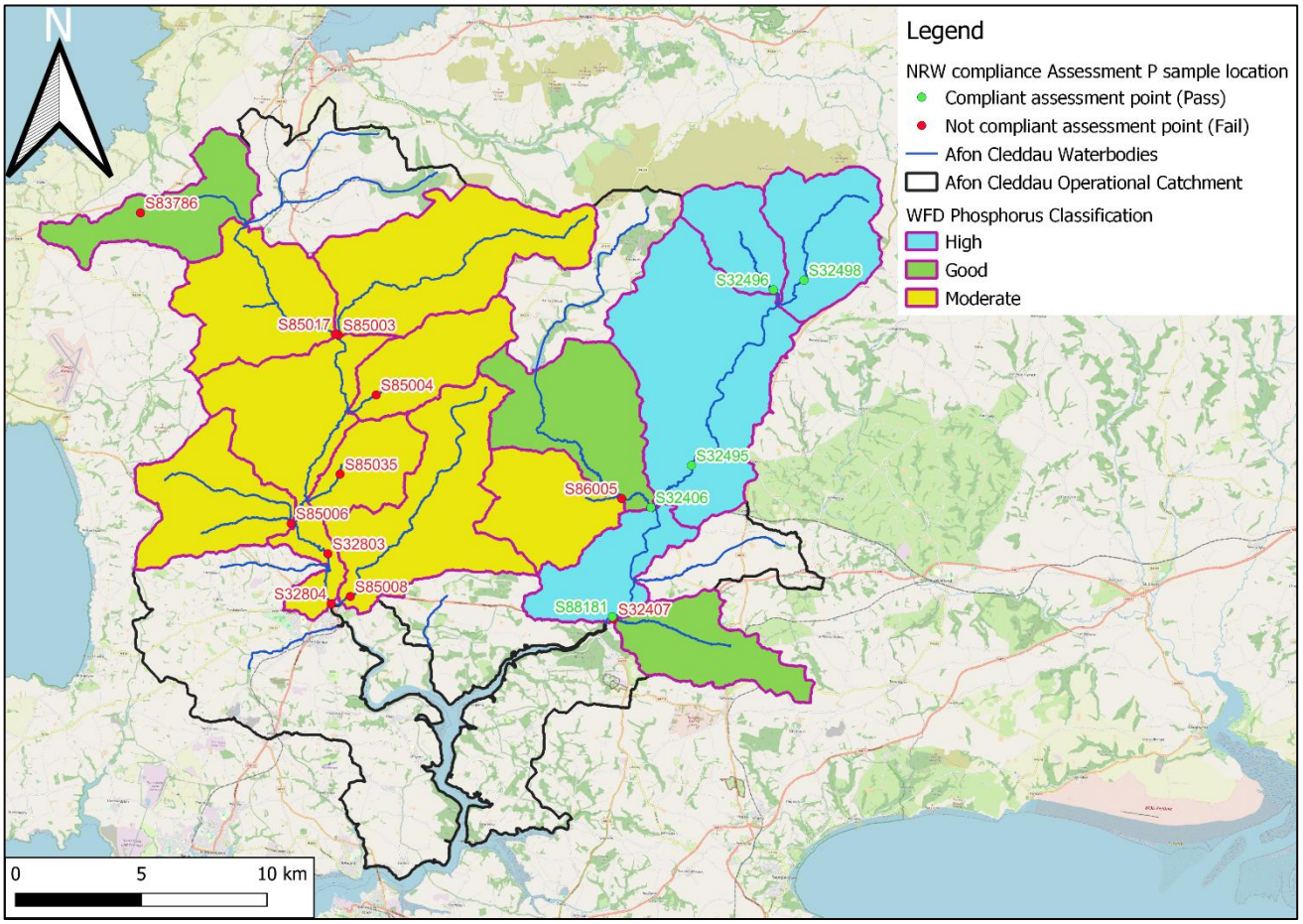

Figure 4-2: Afonydd Cleddau WFD classifications and NRW sample locations. (2021 NRW compliance data).

Background map contains OpenStreetMap data © OpenStreetMap contributors. Catchment and river data sourced from the NRW. WFD data sources from the WFD and NRW.

4.1.5 Summary of data quality issues impacting SAC Compliance Assessment

As discussed in Section 4 and summarised in Table 4-3, several data quality issues have impacted the availability of water quality data to inform the SAC compliance Assessment. A RAG assessment is presented in Table 4-3 on the data quality issues and the impact it has had on the SAC compliance assessment per individual waterbody.

Table 4-3: Summary of data quality impacts and limitations on SAC compliance assessment and understanding.

Waterbody Name (Site no.)	No. of Samples removed from assessment	Data Quality Issues	Commentary	Impact/ limitation (*Low, Medium, High)
Western Cleddau				
W Cleddau - headwaters to conf with Cleddau North (83786)	6	Holding time	Samples removed (due to Holding time) decreases the growing season annual mean by 2.7 ug/l.	**Low**
		Sample spacing	Single sampling location in the middle of the catchment available between 2017 and 2023, limiting comprehensive understanding of failure within the catchment.	**High**
Western Cleddau - Cleddau North to Anghof conf (85017)	8	Holding time	Samples removed (due to Holding time) decreases the growing season mean by 3 ug/l.	**Low**
		Sample spacing	Single sampling location at downstream end of the catchment available between 2017 and 2023, with multiple upstream tributary catchments, limiting comprehensive understanding of catchment failure.	**High**
Anghof - headwaters to conf with Western Cleddau (85003)	6	Holding time	Samples removed (due to Holding time) decreases the growing season mean by 6.6 ug/l.	**Low**
		Sample spacing	Single sampling location at downstream end of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**High**
W Cleddau - Anghof conf to Cartlett Brook conf (32803)	N/A	Data quality	Data not available in WFD data set.	N/A
W Cleddau - Anghof conf to Cartlett Brook conf (32804)	9	Holding time	Samples removed (due to Holding time) decrease the growing season mean by 3 ug/l.	**Low**

Waterbody Name (Site no.)	No. of Samples removed from assessment	Data Quality Issues	Commentary	Impact/ limitation (*Low, Medium, High)
Spittal Brook - headwaters to conf with W. Cleddau (85004)	7	Holding time	Samples removed (due to Holding time) increase the growing season mean by 1.3 ug/l but decreases the annual mean by 3 ug/l	**Low**
		Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**Moderate**
Camrose Brook - headwaters to conf with W. Cleddau (85006)	6	Holding time	Samples removed (due to holding time) increase the growing season mean by 1.4 ug/l	**Low**
		Sample spacing	Single sampling location at downstream end of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**High**
Rudbaxton Water - HW to conf with W. Cleddau (85035)	7	Holding time	Samples removed (due to holding time) increase the growing season mean by 12.7 ug/l.	**Low**
		Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**Moderate**
Cartlett Brook - HW to conf with W. Cleddau (85008)	7	Holding time	Samples removed (due to holding time) increases the growing season mean by 4.2 ug/l.	**Low**
		Sample spacing	Single sampling location at downstream end of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**High**
Eastern Cleddau				
Eastern Cleddau - headwaters to conf with Wern (32498)	18	Holding time & LoD	Samples removed (due to holding time & LoD) decrease both means by 15 ug/l making the site compliant.	**High**
		Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment.	**Moderate**

Waterbody Name (Site no.)	No. of Samples removed from assessment	Data Quality Issues	Commentary	Impact/ limitation (*Low, Medium, High)
Wern - headwaters to conf with Eastern Cleddau (32496)	9	Holding time & LoD	Samples removed (due to holding time) and halving decreases the annual mean by 0.9 ug/l.	**Moderate**
		Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment.	**Moderate**
E. Cleddau - conf with Wern to conf with Syfynwy (32495)	9	Holding time	Samples removed (due to holding time) decreases the annual mean by 0.6 ug/l.	**Low**
		Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment.	**Moderate**
Syfynwy - Llys-y-fran to conf with E Cleddau (32406)	0	Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, with upstream tributaries, limiting comprehensive understanding of catchment.	**High**
Eastern Cleddau - conf with Syfynwy to tidal limit (88181)	8	Holding time	Samples removed (due to holding time) decreases the annual mean by 1 ug/l.	**Low**
		Sample spacing	Single sampling location in middle of the catchment available between 2017 and 2023, with upstream tributaries, limiting comprehensive understanding of catchment.	**Moderate**
Narbeth Brook - headwaters to conf with E. Cleddau (32407)	17	Holding time	Samples removed (due to holding time) decreases the growing season mean by 7.5 ug/l.	**Low**
		Sample spacing	Single sampling location at downstream end of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**High**
Deepford Brook - headwaters to conf with Syfynwy (86005)	9	Holding time	Samples removed (due to holding time) decreases the growing season mean by 27.1 ug/l.	**Low**
		Sample spacing	Single sampling location at downstream end of the catchment available between 2017 and 2023, limiting comprehensive understanding of catchment failure.	**High**

*Low rating = no impact on result or understanding of catchment Pass/Fail, Moderate = no impact on result but limited understanding, High = Impacts result and understanding)

4.1.6 Trends in Phosphorus Data

Data from the NRW WFD water quality archive and NRW SAC phosphorus assessment data have both been obtained for the data analysis on the Afonydd Cleddau. Only WFD data for the NRW assessment points has been used due to the amount of WFD points and was not within scope for Arcadis to review. This data was used to understand the current compliance data, potential trends in data since 2017 and what additional data is available from the WFD. As detailed in Section 4.1.4, the Afonydd Cleddau currently has 16 unique assessment points, with one waterbody being assessed by two assessment points. Of the 16 unique assessment points which have sufficient data to assess compliance, all but one of them have data removed from the full WFD data set, which ranges from 7 to 18 samples removed.

All except two sample locations have sufficient data (greater than 10 samples) between 2020 and 2023 to assess further compliance. The two sample locations do not have any data available.

Table 4-4: Summary of samples collected for the Afonydd Cleddau between 2020 and 2023.

Waterbody Name	No. Samples (2020 –23)	Commentary	Trend* (Green = trend decreasing, Amber = trend and mean increases , Red = trend increases significantly or not enough data)
Western Cleddau			
W Cleddau - headwaters to conf with Cleddau North (83786)	19	3 samples collected in 2021, 4 samples collected in 2022 and 12 samples collected in 2023.	Trend and means increase
Western Cleddau - Cleddau North to Anghof conf (85017)	26	2 samples collected in 2020, 3 samples collected in 2021, 12 samples collected in 2022 and 9 samples collected in 2023.	Trend and means increase
Anghof - headwaters to conf with Western Cleddau (85003)	23	2 samples collected in 2020, zero samples collected in 2021, 12 samples collected in 2022 and 9 samples collected in 2023.	Trend and means increase
W Cleddau - Anghof conf to Cartlett Brook conf (32803)	35	8 samples collected in 2020, 3 samples collected in 2021, 11 samples collected in 2022 and 13 samples collected in 2023.	Trend and means decrease

Waterbody Name	No. Samples (2020 –23)	Commentary	Trend* (Green = trend decreasing, Amber = trend and mean increases , Red = trend increases significantly or not enough data)
W Cleddau - Anghof conf to Cartlett Brook conf (32804)	11	1 sample collected in 2020, 3 samples collected in 2021, 4 samples collected in 2022, and 3 samples collected in 2023.	Trend and means increase
Spittal Brook - headwaters to conf with W. Cleddau (85004)	26	1 sample collected in 2020, 3 samples collected in 2021, 12 samples collected in 2022 and 10 samples collected in 2023.	Trend and means increase
Camrose Brook - headwaters to conf with W. Cleddau (85006)	19	1 sample collected in 2020, 3 samples collected in 2021, 12 samples collected in 2022 and 3 samples collected in 2023.	Trend and means increase
Rudbaxton Water - HW to conf with W. Cleddau (85035)	11	1 sample collected in 2020, 3 samples collected in 2021, 4 samples collected in 2022 and 3 samples collected in 2023.	Trend and means increase
Cartlett Brook - HW to conf with W. Cleddau (85008)	13	3 samples collected in 2020, 2021 and 2023 and 4 samples collected in 2022.	Trend and means increase
Eastern Cleddau			
Eastern Cleddau - headwaters to conf with Wern (32498)	10	2 samples collected in 2020, zero samples collected in 2021 and 2022 and 8 samples collected in 2023.	Trend decreases however due to LoD issues this cannot be confirmed
Wern - headwaters to conf with Eastern Cleddau (32496)	23	2 samples collected in 2020, 3 samples collected in 2021, 12 samples collected in 2022 and 6 samples collected in 2023.	Samples collected at 4 ug/l LoD trend analysis cannot be performed

Waterbody Name	No. Samples (2020 –23)	Commentary	Trend* (Green = trend decreasing, Amber = trend and mean increases , Red = trend increases significantly or not enough data)
E. Cleddau - conf with Wern to conf with Syfynwy (32495)	10	2 samples collected in 2020, no samples collected in 2021 and 2022, and 8 samples collected in 2023.	**Trend and means decrease**
Syfynwy - headwaters to Llys-y-fran	N/A	Not Assessed	N/A
Syfynwy - Llys-y-fran to conf with E Cleddau (32406)	17	1 sample collected in 2020, 3 samples collected in 2021, 4 samples collected in 2022 and 9 samples collected in 2023.	**Trend increasing, annual mean decreasing, growing season mean not calculated in previous assessment but below target**
Eastern Cleddau - conf with Syfynwy to tidal limit (88181)	31	7 samples collected in 2020, 3 samples collected in 2021, 12 samples collected in 2022 and 9 samples collected in 2023.	**Trend and means increase**
Longford Brook - HW to conf with E. Cleddau	N/A	Not Assessed	N/A
Narbeth Brook - headwaters to conf with E. Cleddau (32407)	11	2 samples collected in 2020, no samples collected in 2021 and 2022, and 9 samples collected in 2023.	**Trend and means increase**
Deepford Brook - headwaters to conf with Syfynwy (86005)	10	1 sample collected in 2020, 2 samples collected in 2021, 4 samples collected in 2022 and 3 samples collected in 2023.	**Trend and means decrease**

4.1.7 Summary and Recommendations

4.1.7.1 Water quality data collection and analysis issues

What is clear from this is that a wealth of data is available to better understand water quality issues within the Cleddau. Whilst many of the data quality issues listed in Table 4-1~~Table 4-1~~ will remain true for the WFD data collected, the fact remains that more data is available than data used to inform the simple pass/fail compliance assessment. This extra WFD data can also help in identifying potential solutions to intercept phosphorus sources across the catchment, focussing on problematic areas. However, what is not clear is how best to use this information.

Since the NRW set more stringent compliance targets than the WFD, a method that allowed for a finer LoD was required (as discussed in Section 4.1.2). Hence, NRW used WFD sample locations to obtain samples but employed a different method to analyse for phosphorus. This data has subsequently been uploaded to the WFD water quality archive.

Therefore, assistance from the regulator to better understand this data is needed, explored further in Section 4.1.7.3.

4.1.7.2 Water Quality Data Conclusion

The data used within the compliance assessment is deemed to not be robust for the current compliance assessment for several reasons. Firstly, the number of samples (once accounted for removed samples) is deemed to be low, with total samples ranging between 13 and 29 which for a three-year assessment period is less than once per month. All of the assessment points had data removed for various reasons (see Section 4.1.5 for more details), the inclusion of the removed values would not change the overall compliance of each assessment point. Whilst the assessment points cover the majority of the Afonydd Cleddau SAC, as shown in Figure 4-2 above four waterbodies are not assessed. Of these four waterbodies two are classified as Moderate by the WFD and two are classified as High. Lastly, additional concerns are raised over future compliance assessments as WFD data becomes sparse in 2020-2023 and some locations are assessed with a higher LoD.

NRW had an action under the river pollution summit action plan to explore the acceptability of citizen science[36] data. This has now been completed, with NRW providing general recommendations on the potential contribution of citizen science data, as well as updating their position statement on citizen science and producing guidance to support citizen science groups.

4.1.7.3 Recommendations

- Request clarity from NRW on use of WFD data to better inform decision making; compliance data alone may focus attention on worst affected areas but may miss an opportunity to gain greater insight into phosphorus concentrations within the catchment.
- Request clarity from NRW on some of the data quality concerns raised in this report to ensure current compliance assessment results are correct and understand how the updated compliance assessment will make use of more recent information (particularly considering lack of data in 2020 and 2021 due to COVID-19).

[36] NRW (No date) An assessment of the use and acceptability of citizen science data to support better water quality for Wales

- Communicate with stakeholders with citizen science initiatives around the importance of collecting additional water quality sampling data in catchments with sparse sampling points and limited frequency of sampling. Additional sampling could ensure solutions are directed into the right places, but also ensure the improvements are measured sufficiently.
- NRW are in the process of updating the SAC water quality compliance data and reports, which are planned for publication in early 2025. Therefore, it is recommended that the next major revision of this NMP is planned around a similar time to account for this update.
- It is recommended that citizen science initiatives within the Cleddau are explored in collaboration with the wider stakeholder group (including NRW) to ensure a joined-up approach.
- Ensuring the raw data collected from the water quality archive matches the data eventually used to inform the WFD compliance assessments.
- Auditing which of the freshwater sampling points remain active and will continue to be active through the delivery period of this NMP.
- Understanding whether any additional monitoring in the catchment is planned to better inform either the WFD assessments, or future SAC compliance assessments.

4.2 Source Apportionment (SAGIS) Data

Source Apportionment Geographical Information System (SAGIS) is a water quality modelling approach, used extensively in the UK to underpin investments in measures to improve water quality. NRW and DCWW published updated SAGIS modelling results for the nine P sensitive, riverine SACs in Wales in 2023, including the Afonydd Cleddau (SAGIS Non-Technical Calibration Report for the Afonydd Cleddau[37]). This section will summarise and review the findings of the updated SAGIS modelling.

4.2.1 SAGIS Data Summary

The SAGIS model uses measurement and sector data to create a modelled representation of phosphorus loads and contributions from key sectors within a catchment. There are four contributions of phosphorus that are quantified within the SAGIS data:

- Sewage Treatment Works or Wastewater Treatment Works (STW /WwTW)
- Rural land use (Agriculture/Forestry)
- Intermittent sources (SOs/Storm Tanks)
- Other (Urban Runoff, Industry and Septic Tanks)

The SAGIS model has been developed utilising measurement data (e.g., monitoring activities including water quality and river flow information), sector data (considering annual load inputs to the waterbody from industry, septic tanks and rural land), agricultural sector data (considering P losses to the waterbody at a 1 km^2 grid scale Phosphorus and Sediment Yield Characterisation in Catchment Model (PSYCHIC; Davison et al., 2008; Stromqvist et al., 2008), and SO data to represent intermittent discharges.

For detailed discussion on the input data and assumptions informing the SAGIS modelling, refer to the technical reports published by DCWW, this report will focus on the findings and highlighting any limitations / data gaps of relevance to the NMP.

[37] DCWW, SAGIS Non-Technical Calibration Report for the Afonydd Cleddau 2023, SAC Rivers: Source Apportionment Reports | Dŵr Cymru Welsh Water (Dŵrcymru.com)

4.2.2 SAGIS Results

Figure 4-3 presents the catchment overview figure, as presented in the DCWW SAGIS model update report. This highlights a total load of 20 kg/day measured at the downstream end of the Western Cleddau (Anghof confluence to Cartlett Brook confluence) at downstream boundary GB110061031340. Approximately 8 kg/day is discharged from the Eastern Cleddau (confluence with Syfnynwy to tidal limit) measured at the WFD monitoring point 120010. In the Western Cleddau results state that 65% of the orthophosphate load is from rural land use, 22% from sewage treatment works, 5% from Intermittent sources and 8% from other sources. In the Eastern Cleddau, rural land use contributes 84%, 11% from sewage treatment works, 2% from storm overflows and a further 3% from other sources. The model uses data from a 4-year period for river flow data and STW discharge flow and quality data (2016-2019).

In addition to the updated model reports, DCWW has published sector source apportionment data for all SAC river basins in DCWWs operational area. This data is provided in excel format, allowing the user to breakdown the model by waterbody and look at the total load per day per catchment and the relative contribution of sectors on a more granular scale. In support of this NMP, analysis has been carried out on this more granular data, to build a picture of source apportionment at operational catchment level (as per the catchments presented in Figure 4-2). A summary of the SAGIS modelling data split by operational catchment is provided in Table 4-5.

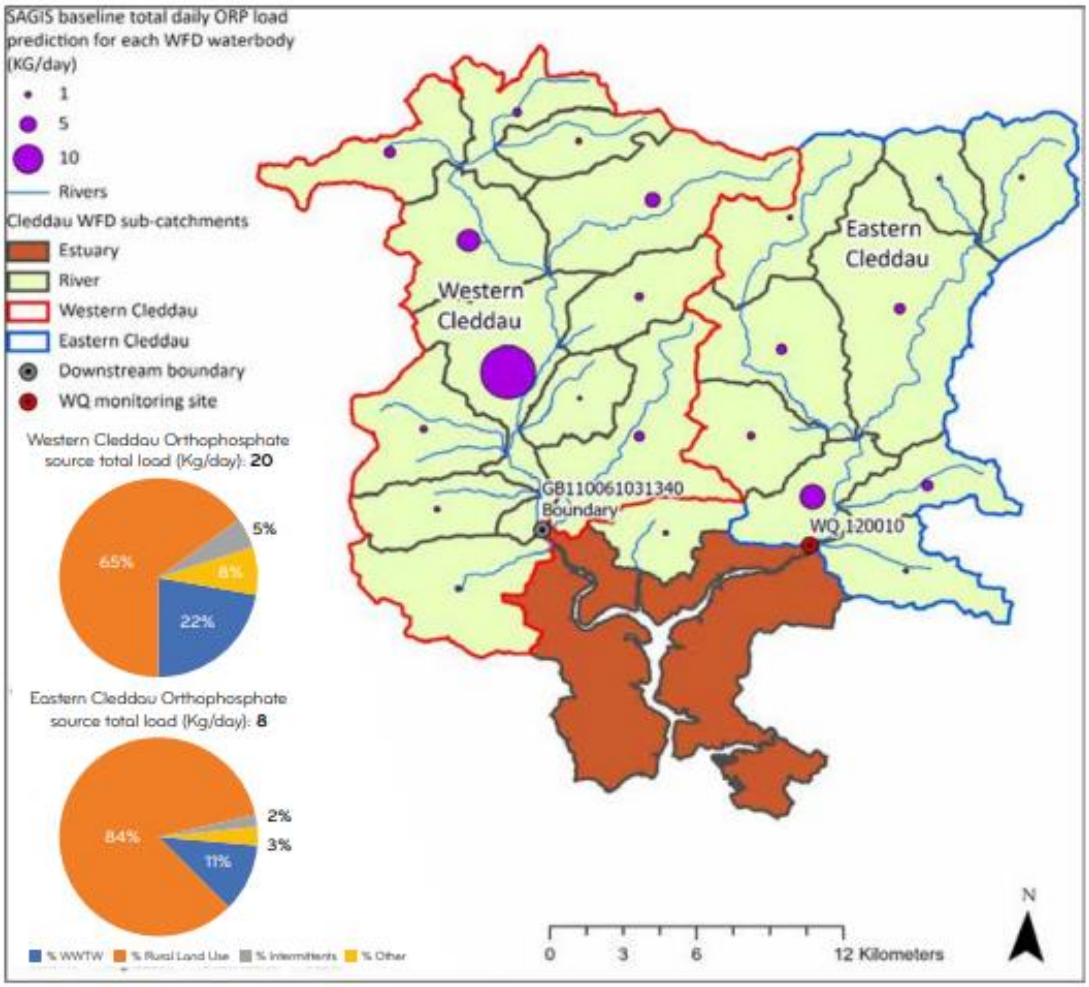

Figure 4-3: Catchment Overview – Phosphorus apportionment by source at the furthest downstream point on the Afonydd Cleddau[37][36].

4.2.3 SAGIS Data Quality & Limitations

Model performance for the Afonydd Cleddau SAC was assessed using 22 monitor locations. Two of the monitoring locations were situated outside of the Afonydd Cleddau SAC. There was a good level of agreement between measured and simulated values at 19 monitor locations, with 17 locations within the SAC boundary. Three locations were considered to have a poor level of agreement. The model is in line with agreed guidance and fit for the purpose of informing wastewater planning decisions.

Analysis of the sector source apportionment data (presented in Table 4-5) indicates a slight difference in the total load at the downstream end of the Western Cleddau (Anghof conf to Cartlett Brook conf) when compared against the reported value in Figure 4-3, 21.27 versus 20 kg/day. The discrepancy between these figures is the result of phosphorus load percentages being used in Figure 4-3 and concentration percentages being used in Table 4-5. Fair-share rules were applied for concentrations and the SAGIS outputs are more accurate for phosphorus concentrations. The DCWW SAGIS data does not include data for the downstream monitor location of the Eastern Cleddau (conf with Syfnynwy to tidal limit).

In addition, the following key limitations are highlighted:

- The impact and representations of SOs in the SAGIS model are not well understood.
- Agricultural sector source apportionment is based on a PSYCHIC modelling utilising 2010 agricultural census data despite more recent census data being available.
- SAGIS modelling considers decay effects to the downstream extent of the catchment, as such the source apportionment modelling may not reflect the total input loads and concentrations as they change through the catchment. This limits the ability to identify specific sources and interventions in catchment, leading to only broad-scale strategic interventions / investments (particularly difficult in larger waterbody catchments).

4.2.4 SAGIS Data Summary

Based on the information presented in the DCWW update reports, the SAGIS modelling is of good quality, performing well in calibration. This gives confidence that the model can provide sound estimates of source apportionment at the scale reported (i.e., waterbody level). However, as discussed above, there are several limitations for intermittent sources.

Although SAGIS modelling is being completed principally to develop plans for DCWW's wastewater investments and the Review of Permits, it also informs potential future catchment-wide holistic interventions. Therefore, in large catchments the use of just the downstream phosphorus concentration estimates within the SAC may not be the most effective means of identifying exact sources within the catchment and developing targeted and holistic solutions. Finding means of breaking down the results further, and exploring the more granular detail of input and concentration throughout a catchment could generate better understanding of problem areas and drive better decision-making.

Table 4-5: Summary of Sector Source Apportionment data by Operational Catchment.

Operational Catchment	No. of WFD Waterbodies	No. SAC catchments	Orthophosphate Total Load (kg/day)	Source Apportionment (%) *			
				WwTW	Intermittents	Rural Land Use	Other
Western Cleddau	13	10	21.27	23.7%	1.8%	69.1%	5.4%
Eastern Cleddau	9	9	8	11%	2%	84%	3%

**For the Western Cleddau, % values presented in the table are from the raw data provided by DCWW which provides a breakdown of source apportionment by concentration and not total load, as such, these % values are slightly different to the values presented in Figure 4-3. These values are not supplied in the raw data for the Eastern Cleddau, and so the values presented are simply replicated from Figure 4-3.*

4.3 Ecological Documents and Data

4.3.1 Key documents

A wide range of documents have been assessed for their relevance, limitations and gaps as part of the evidence base review that has been conducted. These have totalled 62 separate evidence sources of varying forms.

Of these documents, 27 were reviewed in detail from an ecological perspective with regards to their use to the NMP in their current form and the review highlighted any gaps or issues for evidencing the current status of the SAC and future success.

Selected key elements from the following documents have been presented within Section 4.4 and Appendix B, these are:

- **Prioritised Improvement Plans (PIPs): latest received 02 October 2024**, the underpinning information of surveys ranges from 2003 and 2013
- **Western Wales River Basin Management Plan (RBMP) 2021 – 2027 (NRW):** Baseline assessment 2021 to show changes since 2015 (but this will be updated in future for the next RBMP and repeated every 3 years). The risk assessments of various environmental pressures range from 2014 to 2022 (these assessments are valid until 2024, including those from the second cycle i.e. 2014 as these were assessed over a longer term so did not require updating)
- **Core Management Plan (CMP) (September 2022):** Including Conservation Objectives (NRW) for Afonydd Cleddau based on surveys of qualifying features (2004 to 2012)
- **SAC Standard data forms for the Afonydd Cleddau (November 2017) JNCC**
- Key stakeholders and activities in the catchment (various)
- Dedicated species surveys reports (various)

4.4 Ecology review data gaps and actions

4.4.1 Age of Data

Despite many of the documents having been produced after the tightening of phosphorus targets, many have data underpinning evidence around the SAC qualifying features that is many years old (over 20 years in some instances):

- **Prioritised Improvement Plans (PIPs):** although the latest received PIP was published October 2024, the underpinning information of surveys ranges from 2003 and 2013
- **Western Wales River Basin Management Plan (RBMP) 2021 – 2027 (NRW):** Risk assessment for water quality updated 2019-22 and risk assessment for other environmental pressures updated 2014.
- **Core Management Plan (CMPs):** the surveys of qualifying features are more than 10 years old (2004 to 2012)
- **SAC Standard data forms Afonydd Cleddau:** Data form last published in 2017.

The status of these plans require clarification. Further detail is provided within Table 7-2 in Appendix B.

4.4.2 Survey Data

Having access to recent survey data and assessment of qualifying features is useful for understanding the overall ecosystem health of the SAC and therefore taking a holistic view towards water quality.

The survey data for assessing the qualifying features (species and habitats) within the Afonydd Cleddau SAC for the Core Management Plan are in some cases up to 20 years old. For the PIP documents, the reports discuss survey data ranging from 2003 to 2013 and the accompanying Priority Matrix displays the same. There are possibilities that the real coverage of priority habitats and the populations of qualifying species may have changed since these surveys.

The Core Management Plan itself also states for several of the qualifying features that surveys should be carried out on them. It is also quite challenging to get up-to-date data for the qualifying features, should the NMP be able to pull together these disparate data sources this would be very valuable for those seeking to demonstrate success.

4.4.3 Rankings of Risk to Qualifying Features

The PIP documents contain a Risk RAG rating for issues affecting qualifying features and an accompanying Issue Prioritisation Summary Matrix. However, these present some seeming inconsistencies, potentially due to differing levels of granularity and complexity and are unclear. It is important that these rankings are clear and consistent as they ultimately inform what actions are required in the SAC to maintain populations of qualifying species/habitats, and therefore the funding that is needed. Up to date and consistent reasoning for this is necessary.

4.5 Overall Summary

There is a large and disparate amount of data which the NMP can collate, which will be invaluable to those wanting a rapid overview as to the latest status of the SAC and its qualifying features. This does not however replace the existing NRW documents which are supporting the regulatory duties of NRW, instead this can provide more information via multiple stakeholders and citizen science to provide more regular updates and more comprehensive details.

It is clear that a consolidated evidence base and monitoring plan with appropriate mapping aligned with collated and up to date survey data is essential to underpinning and monitoring the overall water quality and biodiversity in the Cleddau.

The following actions are recommended as part of updating the NMP and NMB to monitor or support in the future, as part of the Action plan:

- Present the key document and qualifying features data as per: Table 7-2 and Table 7-3 in Appendix B with clear survey, assessment and publication dates.
- A review of all monitoring points and survey standards for key indicator species for the NMP.
- While not SAC species, there is potential to include Atlantic Salmon as a long-term key indicator species for the NMP due to the water quality sensitivities or introduce as a flagship species for the NMB.
- Choose short-term floral and/or faunal key indicator species potentially salmon and otter, salmon because of their water quality sensitivity their detailed monitoring already being undertaken and otter due to their requirement for unpolluted water with a large and varied supply of food. Otter surveys can be undertaken all year round.
- Update of the P compliance assessment with the most recent available data.

- Breakdown the larger SAC catchments and apply new targets. This will identify problem locations and drive mitigation in specific areas.
- Investigate using the latest EDM data to improve the understanding of SO spills in each catchment and conclude whether this is sufficient.
- Update the SAGIS data with the latest water quality and agricultural data.
- The latest WwTW water quality sampling information will provide insight into the effectiveness of treatment and compliance against DCWWs phosphorus permits that have been implemented. River water quality sampling can indicate the effectiveness of the mitigation options across the catchment.
- Review of the Agricultural census data to provide confidence within the SAGIS model.
- Further analysis to support the current assessment points could be undertaken on the wider WFD data set, however a key limitation of the 'Low' LoD is acknowledged. Advice and support from NRW should be sought to ensure the correct data is being used, and to better understand the potential use of the WFD dataset, which is much larger and may have its own data quality considerations.
- The number of samples collected in 2020 and 2021 for all operational catchments is not sufficient to aid future analysis. It is recommended that a review of monitoring plans is undertaken to ensure a sufficient number of samples are collected. Guidance from NRW should be sought to understand what data (over what period) will be used to inform the next iteration of compliance assessments.
- Using the same assessment point for multiple catchments and only sampling / assessing once in a large waterbody is cause for concern and can result in missed spikes. It is recommended that a review of the monitoring plans is undertaken to ensure a robust spatial / temporal collection is undertaken.

4.6 Existing and Proposed mitigation

4.6.1 Existing Initiatives overview

There are a large number of regulations, policies, groups, and initiatives that are or have been active in the Afonydd Cleddau catchment, activities designed to protect and restore the Afonydd Cleddau SAC. Key partners are the Welsh Government, NRW, DCWW, Carmarthenshire, Ceredigion and Pembrokeshire LPAs and Afonydd Cymru working in partnership with farmers, anglers, researchers, local communities and other stakeholders. These initiatives and partners/stakeholders have been captured in Table 4-6.

Some initiatives aim to prevent the nutrient being released into the environment or reduce the nutrient runoff into watercourses, there are also initiatives on overall river restoration and improving ecosystem health, there are also those to support surveys for monitoring and engagement for awareness raising and facilitation of collaboration, for example:

- Awareness raising and advice provided by a range of stakeholders;
- Sustainable farming initiatives such as, reducing inputs from agriculture at the source by reducing fertilisation and changing land use;
- Preventing polluted water from agriculture from running off into the water course by surface water and foul water separation;
- Improving wastewater treatment works to remove nutrients before discharging effluent;
- Design and implementation of sustainable drainage systems (SuDS) such as swales, conveyance channels, filtration strips, and infiltration basins to prevent nutrients entering the watercourse;
- Design and implementation of retention ponds, detention basins, and constructed wetlands to remove nutrients before entering the waterbodies;
- Creation of integrated buffer zones through permanent grassland, scrub of woodland buffering the river and private sewerage drainage fields;
- Re-naturalising of river channels and removal of barriers to fish passage and migration;
- Blocking of drainage ditches to reduce surface water runoff;
- Using engineered log jams, granular treatment media, and willow beds to hold water on land;
- Research and citizen science led surveys of qualifying and indicator species; and
- Install lined attenuation storage tanks for an end of pipe solution.

4.6.2 Sustainable Farming

The drivers for sustainable practices within agriculture are clear. Such as, supporting the UK Net Zero by 2050 on greenhouse gas emissions, targets on halting biodiversity loss by 2030, reducing spend on fertilisers and pesticides and retaining fertile soil are essential for food security. There are multiple public and privately funded incentives for payments for ecosystem services for farmers such as the Sustainable Farming Scheme (SFS), that, aims to reward farmers fairly for their positive contribution to sustainable land management, and so in theory this pressure should ease.

The SFS in Wales is an initiative aimed at promoting sustainable agricultural practices and supporting farmers in improving environmental outcomes. The scheme is part of the wider agricultural policy reform in Wales, following the departure from the European Union's Common Agricultural Policy. At the time of writing, the SFS is still in the development phase, with the Welsh Government having completed consultation on 7th March 2024. The latest information can be accessed on the SFS webpage[38]. Final details outlining the SFS are due

[38] Sustainable Farming Scheme | GOV.WALES

to be published in summer 2025, with the scheme scheduled to start on the 1st January 2026, following which, a better understanding on how the above drivers impact sustainable agricultural practices will be possible.

The consultation process represents the final step in delivering the SFS, which will become a new long-term programme to support the agricultural industry in Wales. Within the consultation documents, the proposals were outlined, detailing a range of actions and support available to meet the Sustainable Land Management Objectives.

Overall, the SFS in Wales represents a shift towards a more sustainable and environmentally conscious approach to farming. Its success will depend on effective implementation, adequate funding, and strong collaboration between the Welsh Government, farmers, and other key stakeholders to achieve the desired outcomes of improved sustainability, environmental protection, and the long-term viability of the agricultural sector. However, the voluntary nature of the scheme is important to recognise, and strong up-take / engagement /funding will be necessary in order to realise impacts for the long-term health of the Afonydd Cleddau.

4.6.3 Asset Management Plans Updates

Across the Water Industry, capital investment in water and sewerage infrastructure is managed in 5-yearly Asset Management Plans (AMP). The current cycle, AMP7, runs from April 2020 to March 2025, and AMP8 will run from April 2025 to March 2030. The AMP, along with delivering essential investment in infrastructure from an operational and maintenance perspective, seeks to ensure appropriate large-scale investment is undertaken to provide capacity for new development and growth.

The AMP programme is funded via the revenue received through annual customer bills paying for water and / or sewerage services. A key consideration as part of this is to ensure that customers' bills are affordable to them, a matter which is approved by our economic regulator Ofwat. This creates a natural negotiation with the level of investment that can be supported in any particular AMP period from the value agreed with Ofwat. DCWW therefore have to prioritise the funding available to ensure it is used in the most appropriate way, but the not-for-profit status results in further infrastructure investment than if there were shareholders. This has been evidenced throughout the company's history as a not-for-profit business, most recently during AMP7, in the form of £60million in extra funding provided to begin phosphorus removal schemes earlier than scheduled.

The Business Plan for AMP8 has already been submitted to Ofwat. As can be appreciated, DCWW's operational area covers all 25 Welsh Local Planning Authorities (LPA), as well as the whole of the English County of Herefordshire, and parts of some other bordering English LPAs. As such, a cost/benefit analysis needs to be undertaken to determine what schemes are the most feasible and affordable to undertake given that a balance needs to be struck with day-to-day operational investment and the need to ensure that customer bills remain affordable.

4.6.4 National Environment Programme (NEP)

DCWW have new environmental obligations in AMP8, as identified through NRWs' Water Quality National Environment Programme (WQ NEP).

The NEP outlines the improvements needed for DCWW to comply with new or amended environmental legislation and identifies investigations needed to inform, in evidence led way, potential investment requirements in subsequent AMP periods.

The precise make-up of the NEP is determined by NRW in dialogue with DCWW, Welsh Government, and other stakeholders. It includes some short-term requirements (for 2030) and some long-term objectives. The next NEP will be dominated by schemes intended to limit harm from sewer overflows and improve river water quality

across the whole of Wales. Improvements required to reduce or limit phosphorus in certain final effluent discharges form part of the NEP.

These NEP improvements are based on the 2021 NRW compliance data (Natural Resources Wales / Update to phosphorus targets for water bodies in Special Area of Conservation (SAC) rivers in Wales). NRW have since released updated 2024 compliance data (Natural Resources Wales / Assessment of water quality in Wales 2024) .

4.6.5 Summary of existing Initiatives and Stakeholders

Table 4-6 consolidates a selection of these initiatives with hyperlinks to significant sources. There are so many excellent activities and engaged partners working in and around the Afonydd Cleddau on activities which can support the favourable condition of the river and deliver more wider benefits. The information is however very disparate and rarely mapped. It is clear that a consolidated partners, funding streams and actions list with appropriate mapping aligned with collated and up to date survey data information would be hugely beneficial to stakeholders who would like to support the improvement of water quality in the Afonydd Cleddau.

The Afonydd Cleddau sits within the South West Wales Area Statement[39] which includes a key theme of 'ensuring sustainable land management'. Furthermore, the Pembrokeshire Public Services Board[40] has a well-being plan with focus on three areas one being tackling climate change and nature emergency. Such plans or projects shall be subject to an appropriate assessment of its implications for the site in view of the site's conservation objectives.

Further recommendations on mapping and monitoring these existing activities are discussed in Section 6.

Table 4-6: Existing Initiative, Opportunities, Mitigation and Collaboration

Initiatives	Partners/Regulators	Actions and Aims	Timings
Well-being of Future Generations (Wales) Act 2015 (as amended)	Welsh Government/NRW/LPAs	In this Act "sustainable development" means the process of improving the economic, social, environmental and cultural well-being of Wales by taking action, in accordance with the sustainable development principle, aimed at achieving the well-being goals. The seven well-being goals ('the goals') are available in the associated weblink.	2015 - Ongoing
Environment (Wales) Act 2016	Welsh Government/NRW	Sustainable Management of Natural Resources (SMNR) at the core of regulations and policy implementation from agriculture, forestry and flood defence to development planning - undertaking catchment-wide initiatives that will deliver for fish stock improvements.	2016 - Ongoing
Special Area of Conservation under the Conservation of Habitats and Species Regulations, 2017 as amended	Welsh Government/NRW/LPAs	Places a duty to assess proposed works within or affecting the Afon Cleddau SAC. If there is likely to be a significant effect a Habitats Regulations Assessment (HRA) will be required. Sufficient avoidance and/or mitigation is required to prevent adverse effect on the integrity of the SAC (unless there are imperative reasons of overriding public interest, IROPI) for the plan or project to proceed.	2017 - Ongoing

[39] Natural Resources Wales / Introduction to South West Area Statement
[40] Well-being Plan - Pembrokeshire County Council

Initiatives	Partners/Regulators	Actions and Aims	Timings
The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021	Welsh Government/NRW/LPAs	Regulatory measures to address agricultural pollution in Wales. It focuses on farmers where the environmental risk from poor manure management is greatest. There is also a lot of excellent guidance to support these regulations such as Enhanced Nutrient Management approach - Guidance for Farmers and Land Managers.	2021-Ongoing
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017	Welsh Government/NRW/LPAs	This regulation imposes duties on the Secretary of State, Welsh Ministers, the EA and NRW to carry out certain functions so as to ensure compliance with the EU directives, in particular when deciding whether to grant, vary or revoke certain permits and licences which affect water quality.	2017-Ongoing
Agriculture (Wales) Act 2023	Welsh Government/NRW/LPAs/NFU	A support framework which can accommodate the development of agriculture and forestry within Wales for the next fifteen to twenty years. The Bill's policy framework is a response to the legislative framework established by the Well-being of Future Generations (Wales) Act 2015 and the Environment (Wales) Act 2016. It will create a new system of farm payments that "rewards farmers for their response to the climate and nature emergencies" and supports them to produce food sustainably (Sustainable Farming Scheme).	2023-Ongoing
The Building Resilience In Catchments (BRICs)	Ecosystem Enterprise Partnership (EEP)/ Welsh Government/Pembrokeshire Coastal Forum (PCF)	The Building Resilience In Catchments (BRICs) project trialled a nutrient trading scheme with on the ground actions with the trial catchments being Milford Haven and Cleddau. A number of projects have been undertaken with PCF including Ecobank in 2015 looking at the feasibility of nutrient trading in Pembrokeshire.	2017-2019
First Milk Regenerative Agriculture	First Milk/PCF	First Milk are a farmer led business who are working with PCF relating to Payments for Ecosystem Services (PES) in particular highlighting the advantages of a Nutrient Credit Exchange with delivery through private companies[41]. One such PES scheme is working with First Milk creamery in Haverfordwest working with farmers to offset Nitrates, phosphorus, and sediment from the creamery effluent treatment plant.	2012 - Ongoing

[41] Nutrient Trading Case Study: PCF - Pembrokeshire Coastal Forum (PCF)

Initiatives	Partners/Regulators	Actions and Aims	Timings
Strategic River Restoration Plan for the Cleddau Rivers	NRW	Strategic River Restoration Plan for the Afonydd Cleddau laid out a number of restoration options for the river. A method of prioritisation of these proposals was developed in order to aid future river restoration planning, also highlighting high-level restoration costs.	Unknown
The Cleddau Project, restoring the health of our waterway from source to sea	Various independent local individuals/Welsh Rivers Trust	An informal group of local people who want to act now to help save and protect the tributaries, estuary, plants and animals of the whole Cleddau catchment. Cleddau Catchment Assessment Project is a major Citizen Science water testing project throughout the Cleddau catchment in partnership with West Wales Rivers Trust's Adopt a Tributary initiative, initially funded by DCWW's Citizen Science Support Programme. My River - development of an education & community programme delivering workshops & activities to schools & the community, culminating in an exhibition of the children's river-related work at HaverHub in summer 2024 including a Cleddau curriculum. Developed a user-friendly web page to log water pollution reporting to National Resources Wales (and/or Dŵr Cymru as appropriate) as a means of assessing the speed and quality of their responses.	Ongoing
Dairy Project	Natural Resources Wales	NRW's "The Dairy Project", aimed to reduce agricultural pollution, where officers visited over 800 dairy farms in Wales. The officers have carried out pollution control visits offering advice and guidance to dairy farmers, helping ensure they are compliant with legislation and reduce the risk of pollution. Building on this work presents a potential collaboration opportunity for reducing nutrient pollution within SAC from agricultural sources in Pembrokeshire and Carmarthenshire.	2018-2021
The West Wales Rivers Trust	West Wales Rivers Trust	The West Wales Rivers Trust was formed in 2017 with the aim of restoring and safeguarding the rivers, lakes and wetlands of Pembrokeshire, Carmarthenshire and Ceredigion. The objectives of the Trust include promoting awareness of environmental issues and best practice, encouraging recreational enjoyment of rivers, lakes and wetlands, and undertaking research into restoring damaged habitats.	2017 - Ongoing
National Surface Water Management and SuDS Group Members	Natural Resources Wales/ Dŵr Cymru Welsh Water/ Welsh Government/ Welsh Local Government Association/ Home Builders Federation/ CIWEM/ Atkins Global/ Consumer Council for Water/ Institution of Civil Engineers.	The main objectives from this group are to provide a source of expertise in the field of surface water management and to encourage collaborative working, especially when identifying where benefits can be maximised. They also aim to provide support to LLFA for the implementation of SuDS and in the development of Flood Risk Management Plans. This is in addition to providing advice and signpost to stakeholders to facilitate the necessary skills and expertise for surface water and SuDS management.	2011 - Ongoing
Four Rivers for LIFE	NRW/Welsh Government/ DCWW/National Park Authority/Brecon Beacons National	The Four Rivers for LIFE, is a large river restoration project across four river SAC rivers (Teifi, Tywi, Cleddau and the Usk), which will run for 5 years. This is partly European Union funded,	2022 - 2027

Initiatives	Partners/Regulators	Actions and Aims	Timings
	Park Authority/ Agricultural Research Centre Coleg Sir Gar/ Woodland Trust.	with match funding from WG, DCWW, BBNP Authority, Woodland Trust, etc. Totalling a £9.1 million investment. The project aims to significantly improve the conservation status of multiple habitats and species on four SAC Rivers in mid and South Wales. As a holistic river restoration project, it will take a nature-based approach to address multiple pressures across the catchments of the four SAC. The methods used for this project, and the learning and knowledge, will be shared with other river restoration and fisheries communities across the UK and Europe. The project will also work with the International Union for Conservation of Nature (IUCN) National Committee for the UK (NCUK) River Restoration and Biodiversity group. The project will also support the development of a conservation strategy for all other SAC rivers in Wales based on the techniques, approaches and principles developed during the project and compliments the existing LIFE Dee River project. This presents a potential collaboration opportunity for addressing nutrient neutrality / restoring the SAC to favourable status. The 4 Rivers for LIFE project aims to improve the conservation status of 4 SAC rivers in Wales including the Afonydd Cleddau with one of the target features being the Atlantic Salmon. It raises the question as to whether these should be considered as flagship species for the NMP.	
Salmon and sea trout plan of action for Wales 2020:	NRW	Outlines the actions for NRW in order to secure the protection and restoration of populations of salmon and sea trout in Welsh rivers. Both are iconic species, requiring high quality freshwater habitats to thrive. They demonstrate to society the environmental quality of our catchments, whilst also providing important opportunities for healthy and valuable recreation.	2020 - Ongoing
NRW Water Quality Improvement Projects	NRW/Welsh Government	The Welsh Government allocated funds to NRW for 2020 to 2021 to carry out work with partners on 15 smaller scale projects to tackle areas affected by increased levels of pollutants, such as phosphorus and improve marine biodiversity.	2020-2021
Wales Land Management Forum agriculture sub group	NRW/National Farmers Union Cymru (NFU Cymru)/Farmers Union of Wales (FUW)/Country Land and Business Association (CLA)/The Wales Federation of Young Farmers Clubs (Wales YFC)/Tenant Farmers Association (TFA) /Confor	Tasked with undertaking root cause analysis to achieve a common understanding of the causes of agricultural pollution and the ways in which these are currently addressed through the investigation, agreement, reporting and delivery on potential solutions, taking an integrated approach, working across organisations. They have produced a report outlining their key findings and objectives. One of which was the updating of the Code of Good Agricultural Practice (which was last updated in April 2019) and having a “one stop shop” location for advice as it is currently disparate and not always aligned with latest policy and guidance.	2017-Ongoing

Initiatives	Partners/Regulators	Actions and Aims	Timings
Wales Water Management Forum	NRW/DCWW/WG/United Utilities/NFU Cymru/Consumer Council for Water/TFA Cymru/HD Cymru/Confor/Coal Authority/CLA/WEL/Canoe Wales/NWWT)/EA/Ofwat	Purpose is to provide an opportunity for membership organisations to share evidence and explore opportunities for working together collaboratively towards the sustainable management of water in Wales. Membership is wide ranging including but not only, forestry to recreation, agriculture, the Welsh government and the Environment Agency.	2018 - Ongoing
Wales Fisheries Forum	NRW/Afonydd Cymru/Angling Cymru/Angling Trust/Atlantic Salmon Trust/Campaign for the Protection of Welsh Fisheries/Countryside Alliance Wales/Institute of Fisheries Management – Welsh Branch/Salmon and Trout Conservation Cymru/Welsh Salmon and Trout Angling Association/Wild Trout Trust	Represents a range of stakeholders with an interest in the freshwater and diadromous fisheries resources of Wales and the work of NRW and others to maintain, improve and develop migratory and freshwater fisheries in Wales.	2017 - Ongoing
Wales Better River Quality Taskforce	WG, NRW, DCWW, Hafren Dyfrdwy and Ofwat. Independent advice from Afonydd Cymru and the Consumer Council for Water.	Collaboratively developed action plans to gather greater evidence on the impact of storm overflows on rivers, to reduce the impacts they cause, to improve regulation and to educate the public on sewer misuse. Taskforce is now also developing an action plan for road runoff in Wales.	2022 - Ongoing
Sustainable Farming Scheme	Welsh Government	Primary source of government support for farming aimed at promoting sustainable agricultural practices and supporting farmers in improving environmental outcomes. At the time of writing, the SFS is still in the development phase with final decisions to be made in 2025.	2024 - Ongoing

5 Options Appraisal

There has been a significant amount of work undertaken with respect to the solutions that can target and mitigate nutrient levels. This includes a high-level review of opportunities and mitigation options outlined in the WG Mitigation Menu[42] (national focus), the West Wales Nutrient Mitigation Options Technical Review [43] (regional focus) and it is understood that a catchment specific action plan focussing on LDP allocations within Pembrokeshire is under development to identify mitigation in the Cleddau (catchment focus).

Furthermore, the Building Resilience into Catchments (BRICs) project, conducted by PCF and PLANED[44], evaluated options for creating a nutrient trading platform in Pembrokeshire. Using the Farmscoper tool, the project quantified nutrient reductions for various mitigation measures and assessed their costs and benefits. The measures included reversion to woodland, riparian buffer strips, cover crops, reduced cultivation systems, fencing off rivers from livestock etc.

Finally, the RePhoKUs[18] report is worth discussing, mentioned earlier in Section 3.3.2.3, as this discusses further mitigation targeting specifically the balance of nutrients in/out of the Wye and impacts of legacy P in soils.

Between these documents and guidelines, a comprehensive understanding of potential mitigation measures can be gathered. The challenge lies in bringing these together into a conceptual framework for easier contextualising catchment pressures to help delivery of solutions, focussing on what mitigation is implementable and best placed in specific catchments to achieve the objectives of this NMP.

To achieve this, this section will:

1. Outline the conceptual framework for mitigation delivery, breaking the catchment down into sub-catchments;
2. How to categorise measures relative to the objectives of the NMP;
3. Consider the solutions that will work and where focus should be prioritised;
4. Consider the means to quantify potential impacts; and
5. Consider the implementation of solutions to enable action plan development at catchment and sub-catchment scales.

[42] Welsh Government (2023) Mitigation Measures Menu. River pollution summit action plan.

[43] Ricardo (August 2023) Nutrient Mitigation Options Technical Review. Guidance on phosphorus mitigation options for use in Carmarthenshire, Pembrokeshire and Ceredigion.

[44] ADAS (November 2022) Quantifying the Phosphorus reduction of the Building Resilience in Catchments(BRICs) Development Plan.

5.1 Afonydd Cleddau Sub-Catchment Mitigation Prioritisation

When considering potential mitigation efforts on the Afonydd Cleddau, looking at the entire WFD operational catchment is too broad a focus whereas considering all 22 WFD water body catchments potentially too narrow. As such, the operational catchment has been separated into eight sub-catchments (comprising the 22 WFD catchments and amounting to the total operational catchment) to allow focus areas to develop suitable actions.

The eight sub-catchments are presented in Figure 5-1. Data relating to SAGIS, SAC Compliance and WFD have been aggregated for each sub-catchment to allow an understanding of the sources of pollution, the scale of improvements required to achieve compliance and what mitigation measures should be focussed on to achieve the objectives of the NMP.

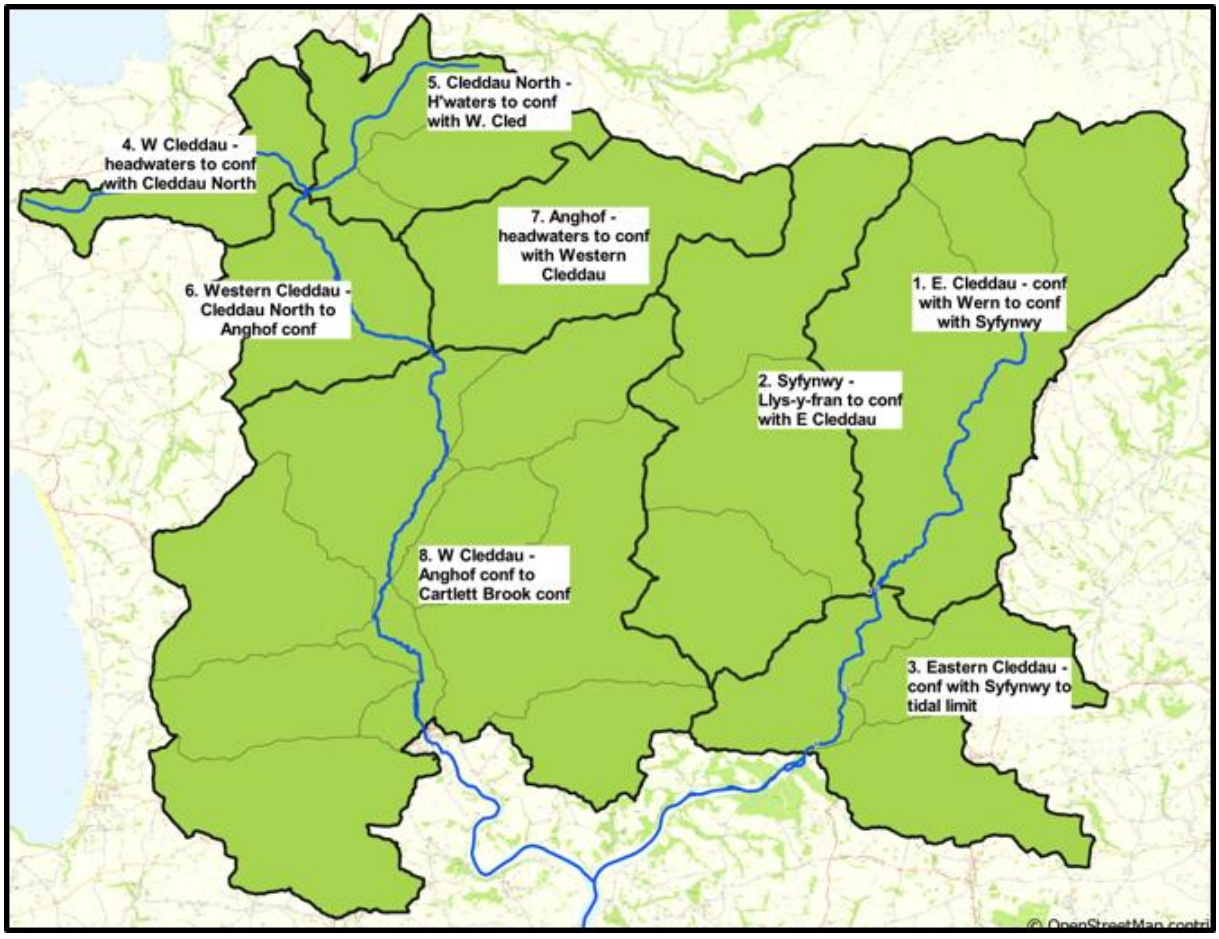

Figure 5-1: Afonydd Cleddau Sub Catchment Map

To understand the scale of the challenge, each sub-catchment has been explored in detail. We have considered the number of settlements, WwTWs, PTPs and septic tanks, source apportionment (inc. estimated contribution from agriculture), WFD data and SAC compliance data associated with each WFD catchment on the Cleddau, and aggregated these datasets by the eight sub-catchments in Figure 5-1. However, a similar breakdown of farmland and livestock data is not available for sub-catchment level at present from the NRW and WG, which is a notable limitation considering the agriculture dominance in the Cleddau catchment.

To estimate the mitigation requirements for each sub-catchment, we have focussed on the extent of SAC compliance failures (where data is available). Taking an example, WFD waterbody; Narbeth Brook - headwaters to conf with E. Cleddau (ID: GB110061030660) in Sub-catchment 3, is currently failing to meet its SAC compliance target. Its growing season mean has been reported at 40µg/l versus a target of 34 µg/l. In the absence of more detailed modelling, we have assumed that this failure can be expressed as a % reduction required i.e., if we reduce the phosphorus inputs in this catchment by 15%, we will also see an equivalent 15% reduction in the concentration, bringing this failing catchment into compliance. However, Sub-catchment 8 has multiple WFD waterbodies that are currently failing their SAC compliance targets and therefore the % reduction for each failing WFD waterbody was calculated to determine the total reduction required in the phosphorus inputs in this sub-catchment.

By repeating this calculation across all failing SAC catchments, we can estimate the required % reduction of P in order to bring the SAC into compliance, supporting a return to favourable condition.

Table 5-1~~Table 5-1~~ presents a summary of the prioritisation process for the Afonydd Cleddau. The table is split into eight sub-catchments, and presents several key pieces of information:

- **Annual P Concentration:** For illustrative purposes, we will only report here the worst case observed P Concentration at the waterbodies which are failing to meet their SAC P targets. For those sub-catchments which are passing their SAC P targets as well as there are multiple passing waterbodies (e.g. Sub-catchment 1), the table only shows the passing waterbody closest to reaching its target.
- **P Target:** For illustrative purposes, we will report here the P target at the SAC catchments that are failing.
- **Difference:** this is the deficit between the Annual P concentration and the P target (at the failing SAC catchment).
- **Reduction Required:** This is the estimated reduction in P load required to meet the target. It is based on the reductions required at all failing SAC catchments, versus the total load in the wider drainage sub-catchment upstream.
- **WFD, SAC and Failing SAC Waterbodies (Wbs):** the next three columns indicate the number of Waterbodies in this sub-catchment, how many of them are classified as SACs and the names of the failing SACs.
- **Current Total Phosphorus Load:** the total Orthophosphate load at the downstream end of the sub-catchment as per SAGIS.
- **Projected additional Total Phosphorus (TP) Budget:** The additional TP introduced by new development as per the LDPs of impacting Local Authorities.
- **SAGIS (%):** Summary information of source apportionment broken down by sub-catchment.
- **Priority:** A low – high priority rating based on the information presented in the table. Catchments with failing SACs, high TP loads and projected development are highest priority. Non-failing SACs with low TP loads and no projected development are lowest priority.

Table 5-1: Afonydd Cleddau draft method of sub-catchment priority ranking

ID	Sub-Catchment Name	Operational Catchment	Annual P Concentration (ug/l)	P Target (ug/l)	Difference (ug/l)	Reduction Required (%)	# WFD Wbs	# SAC Wbs	Name of Failing SAC Waterbodies	Current Total Phosphorus Load at downstream end (kg / day)	Projected Additional TP Budget for known LDP Development (kg / year)*	SAGIS Source Apportionment (%)				Priority**
												WwTW	SO	Rural	Other	
1	E. Cleddau - conf with Wern to conf with Syfynwy	Eastern Cleddau	12.50	15	-2.50	-	3	3	None failing	2.700	TBC	4	0	92	3	Low
2	Syfynwy - Llys-y-fran to conf with E Cleddau		50.20	40	10.20	20%	3	3	Deepford Brook - headwaters to conf with Syfynwy	2.515	TBC	6	0	92	2	High
3	Eastern Cleddau - conf with Syfynwy to tidal limit		40.00	34	6.00	15%	3	3	Narbeth Brook - headwaters to conf with E. Cleddau	3.670	TBC	16	1	80	3	Medium
4	W Cleddau - headwaters to conf with Cleddau North	Western Cleddau	23.33	15	8.33	36%	1	1	W Cleddau - headwaters to conf with Cleddau North	3.281	TBC	27	0	71	2	High
5	Cleddau North - H'waters to conf with W. Cled		No data	40	-	-	2	2	None failing	1.927	TBC	0	0	97	3	High***
6	Western Cleddau - Cleddau North to Anghof conf		43.54	40	3.54	8%	1	1	Western Cleddau - Cleddau North to Anghof conf	9.515	TBC	37	0	61	2	High
7	Anghof - headwaters to conf with Western Cleddau		38.24	37	1.24	3%	1	1	Anghof - headwaters to conf with Western Cleddau	4.115	TBC	14	6	78	1	Medium
8	W Cleddau - Anghof conf to Cartlett Brook conf		104.70****	30	74.70	71%****	8	5	"W Cleddau - Anghof conf to Cartlett Brook conf Camrose Brook - headwaters to conf with W. Cleddau Rudbaxton Water - HW to conf with W. Cleddau Cartlett Brook - HW to conf with W. Cleddau Spittal Brook - headwaters to conf with W. Cleddau	21.265	TBC	24	2	69	5	High

**The Pembrokeshire County Council (PCC) LDP (LDP2) is still being development which will confirm which any the additional TP budget to mitigate, if applicable.*

***Priorities could change once the additional TP budget from the LDP is confirmed.*

****SAC Compliance data not assessed and so priority of improvement in this catchment unknown. High priority assigned to highlight the need to gain deeper understanding.*

***** Based on the worst failing waterbody within sub-catchment 8 since there are five failing waterbodies. The annual observed P concentration ranges from 32.4 µg/l – 104.7 µg/l and P target also varies from 30 – 40 µg/l, resulting with a reduction required varying between 22% and 71% across them.*

By far the most pressing challenge in the Cleddau catchment is at Sub-catchment 8 as there are five failing waterbodies and it has the largest annual P load. Here, a 34% total reduction of the P load is required to meet compliance requirements (based on the calculations discussed later in Section 5.5), which equates to a removal of approximately 3.9 TP T/yr. Sub-catchment 4 also represents a challenge, requiring a 36% reduction. However, given its relative size, this only equated to a removal of approximately 0.35 TP T/yr. Further details on the exact reduction requirements are presented in the Section 5.6~~5.6~~.

The other important information presented in Table 5-1~~Table 5-1~~ relates to source apportionment. In every catchment in the Cleddau, rural land use is the dominant source of P. As discussed in 3.1.3, 89% of this is likely to be attributable to agriculture, which focusses mitigation efforts significantly.

5.2 Mitigation Measures

As discussed earlier in this section, this NMP must help to achieve two main objectives; first to ensure that new developments planned in the catchment are accounted for and can be mitigated to ensure no impact (nutrient neutrality) and second to explore measures that can help restore the catchment to favourable condition. Also, while management of phosphorus in the riverine SAC is the main objective, the NMP offers an important opportunity to consider overall river restoration, including healthy populations of flagship species and the delivery of wider environmental benefits where possible.

Measures can be classified as either Category 1 or Category 2. Appendix C of the Habitats Regulations Assessment Addendum[45] provides the concept of both Category 1 and Category 2 measures, including the planning and key environmental legislation context related to the importance of addressing the phosphorus compliance issue. Section 5.2.3 below also provides a summary of Category 1 and Category 2 measures from a regulatory compliance perspective.

Ensuring water companies, businesses, local authority and private waste discharges as well as the agricultural industry are compliant with the regulations is a key measure in reducing phosphorus pollution, along with implementing other physical interventions described in the HRA Addendum and this NMP.

A complete list of Category 1 and Category 2 measures, which could be deployed across the catchment can be found in Appendix C, in the format of following:

- Interventions matrix with the associated phosphorus removal, wider benefits and potential delivery partners -Table C-7-1: Cleddau NMP Phosphorus Removal Interventions Matrix~~Table C-7-1: Cleddau NMP Phosphorus Removal Interventions Matrix~~
- Supplementary guidance for implementing these interventions -Table C-7-2: Supplementary guidance on how to deliver potential interventions measures for reducing phosphorus levels in the Afonydd Cleddau Catchment~~Table C-7-2: Supplementary guidance on how to deliver potential interventions measures for reducing phosphorus levels in the Afonydd Cleddau Catchment~~

This information illustrates the range of additional benefits these measures could bring, including but not limited to, increased biodiversity, climate resilience, amenity value and air quality improvements.

[45] Carmarthenshire County Council (February 2024). Habitats Regulations Assessment 2nd Addendum Report. Revised 2018-2033 Local Development Plan.

5.2.1 Category 1 Measures

Category 1 measures would help mitigate the additional nutrient budget generated by the current planned residential growth from the respective LPAs to avoid any adverse effects to the SAC as a result of the treatment of extra wastewater alongside any surface runoff discharge impacts from the change of land use.

The responsibility for identifying and delivering Category 1 measures to ensure nutrient neutrality rests with the LPAs and developers, in collaboration with the NMB.

The checklist for Category 1 measures includes:

- Measures are effective for the lifetime of the development
- Measures are achievable and can be maintained
- The expected nutrient mitigation benefits of such measures are certain and can be quantified
- The measures are deliverable in line with an agreed timetable ahead of the development occupation
- Delivery of such measures will not compromise the ability to meet the SAC targets in the future (i.e. will not undermine delivery of other category 2 measures in the catchment)

The following are the potential key Category 1 measures that will satisfy the above checklist for the inclusion within the Afonydd Cleddau NMP:

- Enhanced wastewater treatment – includes ferric dosing, electrocoagulation, enhanced biological phosphorus removal and algae treatment
- Constructed wetlands, reedbeds and willow beds
- Sustainable Urban Drainage Systems (SuDS)

It is also worth noting that correctly designed additional Category 1 measures (e.g. riparian buffers, private sewerage with drainage fields and private sewerage upgrades) may be viable at suitable locations, if their adoption and maintenance over the lifetime of the plan or project can also be guaranteed with suitable legal agreements, along with technical assessments are undertaken to demonstrate their effectiveness.

As discussed in Section 3.3.3 **Error! Reference source not found.**, enhanced wastewater treatment options are currently being implemented by DCWW as part of the AMP investment within the Phosphorus Reduction Programme, which implement tightened discharge permits to reduce TP loading from the wastewater discharges at some locations alongside the introduction of 5 mg/l backstop permits. However, they are mainly part of Category 2 measures reported below to bring the failing SAC catchment to favourable conditions, in line with ‘fair share’ and “polluter pays” principles to reflect DCWW’s responsibility. Nevertheless, there may be opportunities for further improvements at DCWW and privately owned sewage systems as Category 1 measures, if additional developer funding can be secured for implementing them and long-term maintenance can be secured.

Similarly, SuDS are mandatory in Wales and must be considered by developers. However, the proportion of TP arising from surface runoff is relatively small compared to that of wastewater discharge. This means that the incorporation of SuDS will have minimal impact in reducing their overall TP discharge. Nevertheless, if suitable SuDS are designed and incorporated within drainage proposals in line with CIRIA Guidance[46] then some nutrient reduction benefits can be assigned to SuDS as Category 1 measures.

It is currently understood that the All Wales Calculator[47] will include a Stage 3S, which will allow the user to calculate the nutrient load removed from SuDS in the proposed development. The total load removed through

[46] CIRIA (December 2022) Using SuDS to reduce phosphorus in surface water runoff (C808F)

[47] Welsh Government (March 2023) Relieving pressures on Special Areas of Conservation (SAC) river catchments to support delivery of affordable housing: action plan

SuDS is then removed from the final nutrient budget calculation. Any additional nutrient budget would need to be mitigated via other Category 1 measures. The All Wales Calculator has not been published at the time of writing this NMP.

The Ecosystem Enterprise Partnership[48], led by the Pembrokeshire Coastal Forum and funded by the UK Government, has undertaken significant work to explore measures for supporting development in Pembrokeshire, including the Cleddau catchment. The project focused on developing mitigation plans that incorporate nature-based solutions to address phosphorus pollution from new housing developments. Three demonstrator locations, Narberth, Cilgerran, and Wolfscastle, were studied in detail. The project identified several nature-based options, such as field buffers, riparian buffer strips, floodplain woodlands, and constructed wetlands, which altogether aim to reduce P levels and support sustainable urban development in the region. Therefore, exploration of Category 1 measures (such as constructed wetlands) in the catchment could review the locations under the relevant sub-catchment action plans. However, this would need to balance the availability of category 2 measures in delivering SAC compliance. However, results from the scenario modelling set out in this report show that land availability for measures should not be a limiting factor.

5.2.2 Category 2 Measures

Category 2 measures are focused on restoring the conservation objectives for the SAC and the existing WFD requirements through delivering an overall reduction in phosphorus pressures on the SAC (i.e., over and above Category 1 measures).

Examples of Category 2 measures include reduction of agricultural phosphorus at source, farming source control, surface water separation, Soil and Crop management, wetlands, tree and woodland planting, integrated buffer zones, river channel re-naturalisation, drainage ditch blocking, engineered log jams and SuDS.

Whilst Category 2 measures can have medium to high phosphorus mitigation potential, their delivery and long-term maintenance are deemed generally more uncertain than Category 1 measures. As such, Category 2 measures are not fully compliant measures for securing mitigation in perpetuity and so would not generally satisfy an assessment against the Habitat Regulations. However, they may be still used as effective bridging solutions, as part of a package of wider nutrient neutrality measures (subject to detailed discussions with NRW and NMB), alongside its important role to restore the SAC back to favourable conditions.

The exception to this is Category 2 measures that are associated with reductions from WwTWs including Review of Permits and SO improvements that can provide this high-level certainty.

[48] Ecosystem Enterprise Partnership (November 2022) Mitigation-Plans_overview_Methodologies_Report_final.pdf

5.2.3 Mitigation Provision

For regulatory compliance clarity, avoidance and/or mitigation are presented as two categories, alongside Category 1 and Category 2 measures as follows:

- **Category 1:** To facilitate the delivery of development and avoid adverse effects to the SAC from planned growth as a result of wastewater inputs carrying phosphorus into the SACs under Article 6(3) of the Habitats Directive "*Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment …… the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned".* Category 1 measures are necessarily more quantifiable with a tangible delivery, that the LPA can control and manage over the lifetime of the plan or project. The Category 1 opportunities evolved are presented in Table C-7-1. Appendix C also explains the full range of available Category 1 measures, including the wider benefits and funding opportunities for these.
- **Category 2:**To achieve the conservation objectives of the SAC and Water Framework Directive requirements and restore favourable conservation status (referred to as 'Category 2 measures') "*under Article 6(2) of the Habitats Directive Member States shall take appropriate steps to avoid, in the Special Areas of Conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive*." Category 2 measures are more strategic long-term goals for which there are numerous regulatory stakeholders who hold this duty. The Category 2 opportunities evolved are presented in Table 4-6 in Section 4.6.4 details the existing Category 2 activities recently or currently being undertaken in the catchment. Appendix C also explains the full range of available Category 2 measures, including the wider benefits and funding opportunities for these.

Category 1 measures can be further separated into the following avoidance or mitigation categories:

Avoidance

- Those that avoid any input of excess phosphorus into the SAC by the tightening of wastewater treatment permits such that any excess phosphorus would be "stripped" from the wastewater before it is discharged.
- Effluent from any development is directed towards a constructed wetland to remove excess phosphorus where possible. Prior to this, the effluent from development will be treated by WwTWs (those without tightened permits) and it is then directed towards a constructed wetland to remove excess phosphorus before discharging.

Mitigation where it is not possible to avoid discharging wastewater effluent with excess phosphorus due to the location of the development/s:

- Surface run off with extra phosphorus due to the land use change would be directed towards a suitably located constructed wetland or another SuDS feature to in effect "remove" phosphorus from the river that would otherwise enter, therefore offsetting the effluent from planned development. Riparian buffers and upgrades to private sewage treatment systems in the wider catchment would also be considered where appropriate.
- Effluent from wastewater treatment plants at suitable locations in the catchment further upstream would be directed towards a constructed wetland to in effect "remove" phosphorus from the river that would otherwise enter, therefore offsetting the effluent from planned development in downstream locations.

It should be noted that the measures required to restore the SAC are likely to be a mixture of Category 1 and 2 measures. It is noted that measures which provide potential headroom to provide further development will not be counted as restoring the SAC and vice versa.

Opportunities

Our research and modelling as evidenced to date have shown that land availability for SAC restoration is not a limiting factor. Moreover, the opportunities being brought forward by the LDP would not likely happen without the development driving and funding the opportunities. The constructed wetland opportunities with phosphorus removal capabilities in these cases have been conservatively assessed at present, such that they are likely to exceed removal capacity than currently estimated and therefore provide additional removals from either wastewater effluent entering and or surface water runoff and therefore are likely to contribute towards the restoration of the SAC. Their implementation is still under discussion with NRW.

Blockers to implementing and measuring the success of other opportunities are:

- Numerous efforts are being undertaken ranging from advice to farmers on nutrient management to cover crop and buffer strip planting but their location, size and duration are often not captured nor is their phosphorus removal calculated, nor is their efficacy monitored once the initiative ends.
- Collaboration is required from numerous stakeholders to plan, implement and adopt measures (including monitoring their efficacy), while many stakeholders have broadly the same goals it can be challenging to align within the appropriate timeframe and locations.
- While there is a great deal of public and private finance available for biodiversity enhancements and general river restoration, the business cases, stakeholder collaboration and benefits demonstration and appropriate monitoring is often lacking.

NMB Role

The role of the NMB will be to gather the necessary information on existing actions, including lessons learned and additional funding for maintaining and/or monitoring efficacy. Also to facilitate new opportunities, align these stakeholders, support with funding applications and monitor implementation and efficacy with regards to phosphorus reduction

5.3 Mitigation Summary

Based on the sub-catchment of P, it is possible identify which mitigation measures should be focussed on in each of the sub-catchments. For simplicity, mitigation measures have been "bucketed" into 1 of 7 focus areas as shown in Table 5-2 below.

Table 5-2: Summary of Mitigation Focus Areas

Focus	Point Source	Diffuse Source	Cat 1	Cat 2	Mitigation Measures (Bold = Priority)	Commentary
CoAP		✓		✓	• 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** • Do not apply manure to high-risk areas • **Do not spread slurry or poultry manure at high-risk times** • **Do not spread farmyard manure to fields at high-risk times** • Store solid manure heaps on an impermeable base and collect effluent • Site solid manure heaps away from watercourses and field drains • Incorporate manure into the soil	Rural land use is the dominant source of P into the Afonydd Cleddau SAC and therefore measures focusing on rural land use practice are critical to improving conditions in the SAC. Particularly in this catchment, the importance of understanding the issues around legacy P and high livestock numbers means that options around cover crops, slurry spreading, sediment traps, fencing and buffer strips etc may become more important.
SFS & Farm Source Control		✓		✓	• Reversion to woodland (inc. wet woodlands) • **Establish Cover Crops** • **Arable reversion to low input grassland** • **Riparian buffer strips** • **Under sown spring cereals** • **Reduced stocking on grassland** • Leave over winter stubbles • Adopt reduced cultivation systems • **Fencing (livestock)** • **Improved slurry management (above compliance)** • Silt traps and blocked ditches using adsorption materials • Drainage ditch blocking and engineered logjams • Terrestrial sediment traps • Soil health planning including soil testing • **Habitat maintenance** • **Create temporary habitat on open lands including wildlife cover crop establishment** • **Tree planting** • **Farmyard infrastructure improvements – to sperate clean and dirty water**	

Focus	Point Source	Diffuse Source	Cat 1	Cat 2	Mitigation Measures (Bold = Priority)	Commentary
					• **Farmyard infrastructure improvements – concrete hardstanding** • **Farmyard infrastructure improvements – guttering and drainage on buildings**	
Private Sewerage Upgrades	✓		✓	✓	• Use of drainage fields • Improvements to aging PTPs and Septic Tanks • Consider registration of septic tanks linked to property surveys on sale, to prove annual inspection and maintenance. • Investigate the validity and completeness of current exemptions record. • All PTPs should be permitted.	Whilst evidence base and stakeholder feedback do not suggest septic tanks and PTPs are a significant source of P, there are question marks on how accurate this is because of those extra ones that are currently exempted or not registered/maintained. Work ongoing in catchment to explore development not linked to public WwTWs **and** without a valid environmental permit and monitoring regime could rise to unknown sources and increased levels of P. This could be investigated.
Enhanced WwTW	✓		✓	✓	• Planned improvement works under AMP8 and AMP9	DCWW has announced several upgrades at WwTW within the catchment. This is mainly a Cat 2 measure (subject to headroom availability) but any further improvements made through developer funding could be considered as a Cat 1 measure.
Wetlands	✓		✓	✓	• Constructed wetlands at Category B WwTW	Several WwTW in the Cleddau are listed as category B i.e., there is a potential for constructed wetlands. These could be used as Cat 1 measures to release housing, or Cat 2 measures. Regulatory policy challenges on permitting remain for their delivery and adoption.
SuDS (urban)	✓	✓	✓	✓	• Swales • Rain Gardens / Tree Pits • Permeable Paving • Filter Drains • Filter Basins and Detention Basins • Infiltration Basins • Ponds and Constructed Wetlands • Green Roofs	As discussed in Table 3-1~~Table 3-1~~, the SAB is statutory function delivered by the local authority to ensure that drainage proposals are designed and built in accordance with national standards for sustainable drainage[49] published by Welsh Ministers SABs must approve SuDS applications for all new developments, and measures with higher P removal potential should be generally encouraged by the LPAs. Retro-fit SuDS within larger urban areas could be looked at, but SAGIS suggests urban sources of P are relatively low and so this is not a high priority measure.
Riparian buffers & Other	✓	✓	✓	✓	• Targeted Riparian buffers • Woodland planting and agroforestry • Hedgerow buffers • Willow beds	It is important to note the cross-over of this mitigation measure with Farm Source Control and SFS. However, riparian buffers have been looked at

[49] Welsh Government Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems

Focus	Point Source	Diffuse Source	Cat 1	Cat 2	Mitigation Measures (Bold = Priority)	Commentary
Nature Based Solutions					• River channel re-naturalisation • Woody debris and natural flood management • Rural SuDS (e.g. wetland scrapes, ponds)	separately to reflect the scale of current opportunities identified for their implementation and their relative effectiveness (subject to buffer widths etc.).

Further discussion on these mitigation measures can be found in Table C-7-1~~Table C-7-1~~ in Appendix C including discussion on advantages / disadvantages, partners, and funding mechanisms. Table C-7-2~~Table C-7-2~~ in Appendix C also includes further discussion on implementation for mitigation measures identified herein.

5.4 Mitigation Efficacy

Quantifying the potential for mitigation measures proposed is essential at all stages of delivery. This section will focus on how the P removal of proposed measures can be quantified at an early stage to help inform option appraisal and action plan delivery and meet the objectives of the NMP.

The two major pieces of work undertaken on mitigation measures to tackle P are the Welsh Government Mitigation Menu (national focus) and the Carmarthenshire County Council Nutrient Mitigation Options Technical Review (West Wales focus). Under the Welsh Government Mitigation Menu, 20 measures were highlighted. Under the West Wales focussed assessment, 10 measures were identified.

Appendix C provides a table of over 20 mitigation measures, brought together for consideration of these studies, building on previous experience and existing material which ranks the benefits, feasibility, maintenance and effectiveness of different interventions for different areas.

For the quantification of targeted mitigation for the sub-catchments, constructed wetlands, SuDS and other nature-based solutions all have established P removal quantification methods and values, which can help informing the NMP actions.

5.4.1 CoAP

WG's Explanatory Memorandum to the Water Resource (Control of Agricultural Pollution) (Wales) Regulations 2021[50] includes a regulatory impact assessment (RIA) of a potential policy chance to implement measures to address agricultural pollution in Wales.

Four key policy options were considered within the RIA where Option 2 involves applying measures to the whole of Wales with a review clause to consider the introduction of earned autonomy. As shown in Table 5-3, the maximum reduction that can be achieved through all proposed measures under Option 2 is likely to be around 6%, based on average reduction figures for Wales. It also shows that not spreading slurry/poultry manure at high-risk times has the biggest impact, with a reduction of 3.6% on P losses. RIA shows that Option 2 can achieve up to 50 Tn/year and taking this across the total 24,807 farms (or 1.69m ha of farmland) reported in Wales, which indicates an approximate reduction of 2.0 kg/yr per farm (or 0.03 kg/yr per hectare) in broad terms.

Although Option 2 does not present a positive Net Present Value (NPV) it is the preferred option. It is designed to reduce pollution from agriculture across the whole of Wales, addresses failure of water quality

[50] Explanatory Memorandum to the Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021.

standards under the Nitrates Directive and Water Framework Directive, minimises the risk of infraction and provides a level playing field for farm businesses. This option is also compatible with domestic obligations in respect of biodiversity and contributes to tackling climate change compared to the alternative options.

Table 5-3 Percentage change in pollutant losses following full implementation of individual measures required by Option 2, expressed relative to losses for the whole of Wales under current practice (%).

Measure	P Removal (%)
Use a fertiliser recommendation system	0.1
Integrate fertiliser and manure nutrient supply	0.5
Do not apply manufactured fertiliser to high-risk areas	<0.1
Avoid spreading manufactured fertiliser to fields at high-risk times (to End of March)	1.1
Avoid spreading manufactured fertiliser to fields at high-risk times (to End of February)	0.5
Increase the capacity of farm slurry stores to improve timing of slurry applications	*
Do not apply manure to high-risk areas	<0.1
Do not spread slurry or poultry manure at high-risk times	3.6
Do not spread farmyard manure (FYM) to fields at high-risk times	1.0

** Increased slurry storage facilitates changing manure application timing, so the P impacts of this measure are included under 'Do not spread slurry or poultry manure at high-risk times'.*

Pembrokeshire Coastal Forum (PCF) and Ecosystem Enterprise Partnership (EEP) have also undertaken a recent pilot study, which is yet to be formally published. It aimed to work with farmers to identify opportunities to reduce nutrients and improve water quality of rivers and transform them into investment-ready prospects that are costed and accompanied by detailed implementation procedures, gaining approval from the land manager. The project worked with 5 farms across 3060 acres (approximately 1238 ha) of diverse farmland including intensive dairy, arable, and a mixed farming (arable, beef, and dairy). Four of the farms fell within the lower reaches of the Cleddau River or in smaller rivers catchments entering the Cleddau Estuary, with 1 farm being within the Western Cleddau SAC River boundary.

This study used the Farmscoper tool to model baseline losses and the impact of various mitigation measures on nitrate-N, phosphorus, sediment, and ammonia. It showed a total reduction of 145.06 kg/yr can be achieved through the application of CoAP measures, which represents 13% total reduction of P across the five farms or 0.78 kg/yr/ha, which are significantly higher than the figures mentioned above from the RIA. It is important to highlight that the farms used in the study were already meeting compliance standards for nutrient management. Furthermore, that using compliance as a baseline, the study provides confidence that the 6% reduction value taken from the RIA is a precautionary value to be applied within the Cleddau NMP. It should be noted that following are examples of the extra measures included in this PCF and EEP study when compared with the measures included in the RIA mentioned above:

- Store solid manure heaps on an impermeable base and collect effluent
- Site solid manure heaps away from watercourses/field drains

- Incorporate manure into the soil

5.4.2 Farm Source Control & Sustainable Farming Scheme

Under this option both SFS and further farm source control measures will be explored to reduce P loading to the SAC waterbodies. The BRICs Project[44] and the recent pilot study conducted by PCF and EEP mentioned above serve as helpful information sources to inform this option assessment because they provide additional voluntary actions that could be applied beyond the universal actions currently proposed by SFS.

The BRICs Project aimed to extend the quantification of nutrient reductions to include agricultural phosphorus pollution. Using the Farmscoper tool, the project identified a suite of mitigation measures and estimated their potential uptake rates, costs, and benefits. The project developed representative land management systems for Pembrokeshire's farming, including dairy, lowland cattle, upland cattle, and arable systems. It identified several mitigation measures and quantified their potential impacts on P loss. shows the measures, field areas, and P savings, assuming both targeted and non-targeted approaches.

Targeted approaches refer to the application of mitigation measures in specific areas with high pollution connectivity to maximise phosphorus reductions, assuming 80% efficiency resulting in a total P reduction of 8.7 T/yr. Non-targeted approaches apply mitigation measures more broadly across all relevant land with average connectivity values of 50% for free-draining land and 80% for drained land, resulting in less efficient phosphorus reductions with a total P reduction of 5.6 T/yr. Table 5-4~~Table 5-4~~ below has been produced by analysis of the information presented in the BRICS report to indicate the P reduction efficacy of the measures modelled. Due to the nature of these interventions and possible funding routes, it is important to ensure that potential interventions are not double counted in budgetary calculations e.g., measures to meet CoAP compliance should not also be counted against voluntary measures, and that the interventions themselves are not accumulative eg agricultural reversion cannot figures are not also also counted as under sowing

Key

High efficacy Medium efficacy Low efficacy

Table 5-4: From BRICs Assessment of P Mitigation Measures

Measure	TP Reduction (kg/yr/ha)		Rank	
	Non targeted	Targeted	Non-targeted	Targeted
Reversion to woodland	0.77	2.17	1	1
Establish cover crops in autumn	0.60	1.74	2	2
Arable reversion to low input grassland	0.43	1.51	3	3
Establish riparian buffer strips	0.42	0.44	4	6
Under sown spring cereals	0.25	0.74	5	4
Reduced stocking on grassland	0.21	0.26	6	8
Leave over winter stubbles	0.18	0.54	7	5
Adopt reduced cultivation systems	0.06	0.36	8	7
Fence off rivers and streams from livestock	0.07	0.07	9	10
Use slurry injection application techniques	0.03	0.26	10	9
Construct troughs with concrete base	0.02	0.02	11	12

Measure	TP Reduction (kg/yr/ha)		Rank	
	Non targeted	Targeted	Non-targeted	Targeted
Cultivate and drill across the slope	0.02	0.04	12	11
Move feeders at regular intervals	0.01	0.01	13	13
Uncropped cultivated margins	0.00	0.00	14	14
Precision farming	0.00	0.00	14	14

As mentioned before in Section 5.4.1, a 13% reduction can be achieved through CoAP measures alone according to the PCF and EEP pilot study. Furthermore, this study shows a total reduction of 112.86 kg / year a further reduction is possible through voluntary actions with farm source control measures across the five farms. This represents an extra 10% P reduction that equals an average TP reduction of approximately 0.09 kg / year / ha. This TP reduction per ha is however lower than the estimates from BRICs for many of the measures explored / estimated in Table 5-4~~Table 5-4~~ above. The full report for the PCF farm pilot is not yet available, but details of the voluntary actions considered could reveal a great deal about the potential for voluntary actions to assist in returning the SAC to favourable condition.

According to PCF, the measures such as establishing cover crops, under sowing spring cereals, cultivating compacted tillage soils, planting areas of farm with wild bird seed / nectar flower mixtures, establishing in-field grass buffer strips and using slurry injection application techniques had the most P reduction impact. This is a helpful starting point, suggesting that farm-by-farm voluntary actions could prove helpful. However, critically, these are voluntary, the study is yet to confirm what expectations there may be from farmers in terms of payment for these voluntary actions, they fall well short of the >60% reductions needed in some of the most intensely farmed regions of the catchment, and intensive dairy farming has little land to implement such measures. Additional focus is also required on effective drainage control measures to keep flows within farm boundaries, separate dirty and clean water from the yards and improve soil health through good farming practices.

In addition, the following are likely to be the main universal actions proposed by SFS[51] to reduce P loading:

- UA7: Habitat Maintenance
- UA8: Create Temporary Habitat on Improved Land
- UA12: Woodland Maintenance
- UA13 Tree Planting and Hedgerow Creation Opportunity Plan

SFS also has Optional and Collaborative Actions Layer, which will build on the foundation provided by the Universal Actions Layer and will be complemented by the schemes launched in 2025, as part of the Preparatory Phase. They will provide the farmers with further funding opportunities to progress with additional economic, environmental and social actions.

WG's Mitigation Menu also provides useful additional information to develop Farm Source Control measures, which include:

- Silt traps and blocked ditches using adsorption materials: 50% P removal
- Drainage ditch blocking and engineered logjams: < 33% P removal
- Terrestrial sediment traps: < 33% P removal

[51] Welsh Government (November 2024) Sustainable Farming Scheme: proposed scheme outline (2024).

- Land Use/Practice-Changes: Agroforestry (5-72% P removal), cover crops (0-0.13 kg/ha/year), Changing cropland to wetland (0.18-0.5 k/ha/year), cessation of fertiliser/organic material application (0.03-0.5 kg/ha/year)

Table C-7-2~~Table C-7-2~~ in Appendix C give further supplementary guidance on the following measures:

- Reduction of Agricultural P at source
- Farming Source Control
- Surface Water Separation on farmland

Based on the above range of vital information, it was therefore considered that 10% total P reduction through a combination of voluntary Farm Source Control and SFS is a reasonable estimate to inform Cleddau NMP production purpose, if additional funding can be secured to implement such measures. However, the NMB is expected to lead some of the voluntary actions that have the greatest impact on P reduction in close collaboration with the farmers and stakeholders, as the SFS alone is unlikely to deliver 10% P reduction otherwise.

5.4.3 Septic Tanks

With the septic tanks, the average household in the UK typically generates between 1.5 to 2.2 grams of phosphorus per person per day, leading to an annual contribution of around 0.55 to 0.8 kg of TP per person. In rural areas within the Afonydd Cleddau Catchment, where many homes depend on septic tanks, these loads can accumulate across the landscape. In simple terms, calculating the annual TP baseline load with septic tanks involves determining the average per capita phosphorus generation and multiplying it by the number of people using septic tanks.

The Permitted Discharges to Controlled Waters with Conditions dataset[52] was sourced from the NRW Public Register. This dataset provides permit holder information for permitted discharges in Wales as required by the Environmental Permit (England and Wales) Regulations 2016. Information is held for all permitted discharges and covers all substances that are controlled by the permits.

Using this dataset, the number of registered septic tanks for each LPA area for the respective operational catchments were counted and summarised. For the domestic properties, residential homes and short stay accommodation units (holiday lets, B&B, caravan parks), the number of dwellings per septic tank unit were estimated precautionarily from the permitted daily total flow values along with the site description from the permit dataset sourced above. Where a multiple entry is given for the domestic property type in the permit record, only a value of two properties were given in the calculation at present since an exact figure is currently unavailable. For short stay accommodation units, number of units were estimated assuming a maximum permitted daily flow of 5 m^3/day per unit, which is deemed conservative. It should be noted that, additional septic tanks are located within the SAC but are exempt from licensing by NRW, these exemptions are associated with discharge of treated domestic sewage to either surface or groundwater, managing vegetation near/on inland water, substances to ground for scientific purposes and discharges from open loop heating/ cooling systems. For the purposes of this assessment, exempted or unregistered septic tanks are not included in the calculations, however work is currently underway to calculate the impact of this source and will be published in future iterations of the NMP.

Further discussed in Section 5.5.1.6, which suggests that 0.84 to 1.35 kg/yr/ per septic tank may be achieved by upgrading the existing units (i.e. where hydraulic connectivity risk exists with the nearby watercourses due to lack of performance or maintenance issues).

[52] Permitted Discharges to Controlled Waters with Conditions | DataMapWales

5.4.4 PTPs

Like the septic tanks for PTPs, the average household in the UK typically generates between 1.5 to 2.2 grams of phosphorus per person per day, leading to an annual contribution of around 0.55 to 0.8 kg of TP per person. While PTPs do offer some reduction in phosphorus levels, the cumulative load from multiple treatment plants can still contribute substantially to nutrient levels in local streams, rivers, and lakes. In simple terms, calculating the annual TP baseline load with PTPs involves determining the average per capita phosphorus generation and multiplying it by the number of people using PTP.

The Permitted Discharges to Controlled Waters with Conditions dataset was sourced from the NRW public Register. This dataset provides permit holder information for permitted discharges in Wales as required by the Environmental Permit (England and Wales) Regulations 2016. Information is held for all permitted discharges and covers all substances that are controlled by the permits.

Using this dataset, the number of PTPs for the respective operational catchments were counted and summarised. For the domestic properties, residential homes and short stay accommodation units (holiday lets, B&B, caravan parks), the number of dwellings per PTP unit were estimated precautionarily from the permitted daily total flow values along with the site description from the permit dataset sourced above. Where a multiple entry is given for the domestic property type in the permit record, only a value of two properties were given in the calculation at present since an exact figure is currently unavailable. For short stay accommodation units, number of units were estimated assuming a maximum permitted daily flow of 5 m^3/day per unit, which is deemed conservative. It should be noted that, additional PTP are located within the SAC but are exempt from licensing by NRW, these exemptions are associated with discharge of treated domestic sewage to either surface or groundwater, managing vegetation near/on inland water, substances to ground for scientific purposes and discharges from open loop heating/ cooling systems. For the purposes of this assessment exempted or unregistered PTPs are not included in the calculations, however work is currently underway to calculate the impact of this source and will be published in future iterations of the NMP.

Further discussed in Section 5.5.1.7, which suggests that 0.81 to 1.49 kg/yr/ per PTP may be achieved by upgrading the existing units.

5.4.5 Constructed wetlands

Median removal rates have previously been relied upon when assessing the P removal of wetlands. This helped to inform early indications of wetland requirements to offset development in the Afonydd Cleddau SAC. However, more detailed analyses can provide much greater confidence in the required land take (ha) and potential efficacy of the mitigation. Modelling, using the K-C and P-K-C approaches can provide a more detailed assessment (often showing higher P removal efficacy and lower treatment area than those initial estimates made with the median removal rates), allowing for better cost benefit analysis of the proposed solutions. It is recommended that where wetlands are identified, following initial feasibility studies, modelling is undertaken to quantify the potential impacts and make viability decisions.

Table 5-5 provides a summary of P removal rates (kg/yr) with 1ha of treatment wetlands, based on different methodologies and site-specific studies undertaken by Arcadis across Wales.

Table 5-5 Wetland P removal rates (kg/yr) with 1ha of treatment wetlands

Method	Description	Removal with 1 ha wetland / yr
Median Removal Rate	Using the wetland median removal rate of 1.2 g/m^2/yr	**12 kg/yr**

Method	Description	Removal with 1 ha wetland / yr
PKC method analysis for several wetland options in West Wales (Cilgeran, Cenarth, Llandysul, Adpar, Tregaron)	WwTW discharging at 5 mg/l backstop	**245 kg/yr**
	WwTW discharging at observed average P values	**137.5 kg/yr**
PKC method analysis for several wetland options in Dee – these are for even smaller WWTW locations in Wrexham council area (Bangar-on-Dee, Froncysyllte and Bronington)	WwTW discharging at 5 mg/l backstop	**114.2 kg/yr**
	WwTW discharging at observed average P values	**97.4 kg/yr**

Based on the estimated P removal rates in Table 5-5, an assumed 100kg/ha/yr removal rate has been applied as a precautionary value in catchments where Category B WwTWs (Table 5-1~~Table 5-1~~) are present.

5.4.6 SuDS

SuDS can be quantified utilising the All-Wales Nutrient Budget Calculator Stage 3s – This applies to new developments, which should ensure to incorporate SuDS into designs as this a mandatory requirement within Wales but also has benefits in demonstrating Nutrient Neutrality (SuDS being a Category 1 measure for developments). Similarly, this calculator could also be utilised to appraise P reduction benefits of retrofitting of SuDS.

5.4.7 Riparian Buffers & Other Nature Based Solutions

The TP removal rates for riparian buffers were acquired from the Welsh Government's Mitigation Menu Guidance[42~~44~~], which provides a range of TP removal rates: a lower limit of 31%, a median rate of 65%, and a higher rate of 99%. These rates are based on empirical data, riparian buffer widths, site characteristics and best practices for nutrient management. Based on the discussions held with Afonydd Cymru and West Wales Rivers Trust, it was considered that it would be difficult to implement riparian buffer widths wider than 6m generally due to landowner concerns on loss of agricultural productivity and hindrance to site operations. Therefore, as a conservative basis the lower TP removal rate of 31% was adopted in the Scenario Modelling (in conjunction with a 6m minimum buffer width) unless a wider riparian buffer is deemed essential as an exception to meet the minimum Category 2a TP removal requirement in certain WFD waterbodies due to the lack of upstream eligible areas.

There are a number of SuDS and NbS which could be implemented across the Cleddau SAC catchment to make up the shortfall for achieving favourable P status. Riparian buffers have been explored as one of the main mitigation opportunities due to the availability of data relating to their performance for TP removal, as well as scale of spatial mapping available for locating buffer strips. Further detail on riparian buffer strips is provided in Section 5.5.

The All-Wales Nutrient Budget Calculator and interventions matrix (Appendix C) can assist in quantifying a variety of different mitigation measures within the catchment. These can be explored on a case-by-case basis to make up any shortfall in Category 2 measures to return the SAC to favourable status, further discussed in the sub-catchment action plans (Section 6.2).

For measures that seek to intercept run-off high in nutrients (e.g., buffer strips, rural SuDS and sediment traps etc.), the following steps can be applied to quantify the P reduction if needed:

1. Use GIS to find a Riparian buffer spot by analysing the catchment area.
2. Calculate the catchment size and identify different land covers like soil types and farm types.
3. Use the All-Wales Nutrient Budget Calculator to determine Total Phosphorus (TP) export coefficients for each land cover type.
4. Multiply export coefficients by area to calculate total TP load entering the buffer.
5. Apply a precautionary TP removal rate (assumed from the Welsh Government Mitigation Menu) to estimate the TP retained by the buffer.

For measures that look to change land use (e.g., Agriculture land use changes like cover crops or agroforestry), the following steps can be applied to quantify the P reduction if needed:

1. Use the All-Wales Nutrient Budget Calculator to determine the current TP export of the existing land use.
2. Apply the new land use type (cover crops or otherwise) and determine the proposed TP export of the new land use.
3. The difference between the two is the TP saved by the measure.

Following is some of the P removal rates that are given in the Welsh Government Mitigation Menu, which will help in these calculations:

- Riparian buffers: 31 – 99% P removal
- Field margin or forestry buffers: 11-95% P removal
- Constructed wetlands: 29-44% P removal
- Willow beds: 85-100% P removal
- Land Use/Practice-Changes: Agroforestry (5-72% P removal), cover crops (0-0.13 kg/ha/year), Changing cropland to wetland (0.18-0.5 k/ha/year), cessation of fertiliser/organic material application (0.03-0.5 kg/ha/year).

5.5 Scenario Modelling

Additional high-level scenario modelling has been undertaken since the interim NMP produced in summer 2024. This is to help develop a better understanding around the quantum of reduction and mitigation required in each operational catchment to achieve the phosphorus conservation target of the Afonydd Cleddau SAC (using Category 2 measures) as well as facilitate nutrient neutrality for proposed developments by the PCC LDP (using Category 1 measures).

5.5.1.1 Baseline Phosphorus Load

TP loads, measured in tonnes per year, was sourced from the SEPARATE[53] (Sector Pollutant Apportionment for the Aquatic Environment) database. SEPARATE is a multiple pollutant source apportionment screening framework developed for England and Wales, containing source apportionment data summarised by non-coastal WFD Cycle 2 waterbodies.

[53] SEPARATE

This database includes calculated emissions to the aquatic environment from both diffuse sources (such as agriculture, urban areas, river channel banks, atmospheric deposition, and groundwater) and point sources (including sewage treatment works, septic tanks, combined sewer overflows, and storm tanks).

5.5.1.2 Quantifying Minimum Improvement Requirements

Using NRW's currently published SAC phosphorus compliance data, the recorded worst-case concentration for each assessed waterbody was determined from the average and growing season mean annual measured Orthophosphate values. This worst-case concentration was then compared with the minimum compliance target for all failing waterbodies in the respective operational catchment, and from this a minimum reduction percentage value was first calculated to achieve favourable conditions for them. It was assumed that percentages reduction values required for Orthophosphate and TP would be the same.

Using this reduction percentage, the minimum TP removal amount (tonnes per year) to achieve favourable conditions for any failing WFD waterbody catchments within the corresponding operational catchments were estimated (see Table 5-6).

Table 5-6: TP Reduction Minimum Requirement (t/year)

ID	Sub-Catchment Name	Category 2 TP Reduction Minimum Requirement (t/year)
2	Syfynwy - Llys-y-fran to conf with E Cleddau	0.230
3	Eastern Cleddau - conf with Syfynwy to tidal limit	0.131
4	W Cleddau - headwaters to conf with Cleddau North	0.350
6	Western Cleddau - Cleddau North to Anghof conf	0.171
7	Anghof - headwaters to conf with Western Cleddau	0.083
8	W Cleddau - Anghof conf to Cartlett Brook conf	3.933
TOTAL		**4.896**

5.5.1.3 Quantifying Potential TP Removal

The scenario modelling was initially performed for the following mitigation options for reducing TP in the Afonydd Cleddau SAC, as described in the sections below:

- Improving DCWW WwTWs
- Implementing new riparian buffers
- Upgrading existing private septic tanks
- Upgrading existing private package treatment plants

This was then followed by further high-level estimates for the following mitigation options, using the assumed mitigation efficacy presented in Section 5.4 and the findings from these are also summarised in Section 5.5.1.8:

- CoAP – 6% P reduction

- Farm Source Control and SFS – 10% P reduction
- Constructed wetlands - 100kg/ha/yr P reduction

5.5.1.4 Improving DCWW WwTWs

The TP removal available within each operational catchment from the planned DCWW WwTW improvements following the RoP under the Phosphorus Reduction Programme was determined as summarised below in Table 5-7.

Table 5-7 TP Reductions from DCWW WwTW Improvements

ID	Sub-Catchment ID	Total Reduction (t/yr)	Improved WwTW	Comments
1	E. Cleddau - conf with Wern to conf with Syfynwy	0.000	n/a	Catchment currently not failing
2	Syfynwy - Llys-y-fran to conf with E Cleddau	0.000	n/a	n/a
3	Eastern Cleddau - conf with Syfynwy to tidal limit	0.230	Clynderwen and Llanddewi Velfrey	By 2030 and 2032
4	W Cleddau - headwaters to conf with Cleddau North	0.283	Mathry	By beginning of 2028
5	Cleddau North - H'waters to conf with W. Cled	0.000	n/a	Catchment currently not failing
6	Western Cleddau - Cleddau North to Anghof conf	0.611	Letterston West	By the end of 2025
7	Anghof - headwaters to conf with Western Cleddau	0.000	Wolfcastle	By the end of 2025
8	W Cleddau - Anghof conf to Cartlett Brook conf	0.511	Treffgarne Ambleston Spittal Camrose Clarbeston Keeston	By early 2025 By early 2025 By early 2025 By early 2030 By early 2030 By early 2030
	TOTAL	**1.636**		

5.5.1.5 Implementing new riparian buffers

TP reductions provided by DCWW due to WwTW improvements (from Table 5-7~~Table 5-7~~ above) were first deducted where necessary to estimate the remaining Category 2 reductions required by riparian buffers within the respective failing operational catchments as summarised in Table 5-8 below. However, further riparian buffer opportunities are available with the operational catchments, which can also provide additional Category 2 or Category 1 mitigation if needed, and these are illustrated in Table 5-11~~Table 5-11~~ under scenario modelling summary.

Table 5-8: Category 2 Riparian Buffer Minimum Requirements.

ID	Sub-Catchment Name	Category 2 TP Remaining Reduction Minimum Requirement (t/year)	Category 2 Riparian Buffer Minimum Requirement				
			Length (km)	Intercepted Area (ha)	Capital Cost** (£)	Maintenance Cost** (£)	Min Riparian Buffer width (m) / TP % removal rate
2	Syfynwy - Llys-y-fran to conf with E Cleddau	0.230	16.62	1230.32	166,000	1,000	6m, 31%
4	W Cleddau - headwaters to conf with Cleddau North	0.067	8.56	425.24	86,000	<1,000	6m, 31%
7	Anghof - headwaters to conf with Western Cleddau	0.083	6.69	405.84	67,000	<1,000	6m, 31%
8	W Cleddau - Anghof conf to Cartlett Brook conf	3.422	120.53	15442.57	1,205,000	6,000	6m, 31%
3	Eastern Cleddau - conf with Syfynwy to tidal limit	N/A*					
TOTAL		**3.801**	**152.41**	**17,503.97**	**1,524,000**	**8,000**	**-**

**0.230 t/year is available from DCWW improvements compared to the 0.131 t/year minimum requirement.*
***costs rounded to the nearest £'000*

Each WFD waterbody catchment within an operational catchment was also assigned with a hydraulic connectivity reference to schematise the operational catchment. This hydraulic connectivity reference was used to identify eligible offsetting areas for the failing WFD waterbodies, based on its position in the operational catchment and hydraulic connectivity to the failing WFD waterbodies so that only upstream WFD waterbodies are considered as eligible areas. Identifying these areas helps in planning effective mitigation strategies.

Care was taken to avoid double counting of upstream eligible areas for Category 2 mitigation so that only eligible WFD waterbodies within the same operational catchment are currently included to achieve 100% TP mitigation requirement to achieve SAC compliance target through riparian buffers. An eligible area is only included once in the mitigation calculation to be conservative although in some cases upstream eligible areas (both in the same operational catchment and other upstream operational catchments) can provide mitigation to downstream hydraulically connected multiple failing WFD waterbodies in practice.

Available new riparian buffer opportunities were identified using NRW's working with natural processes (WWNPs) riparian woodland mapping dataset[54]. Riparian buffers can be used as Category 2a Measures as they play a significant role in nutrient management by acting as buffers that reduce phosphorus runoff into waterbodies. The potential riparian woodland buffer opportunities in each WFD waterbody catchment were determined to give a total area available for implementing riparian buffers (see Appendix D).

WWNP data was interrogated to estimate the areas associated with the available riparian buffers within each operational catchment, but the lengths are not possible to calculate without individually digitising them. Assuming an average width of 50m for the buffer strip (generally they vary between 40-50m width in WWNP data, excluding some isolated locations), the total available equivalent theoretical length of buffer strips within each WFD water body was then calculated to give the same estimated total available area. For this theoretical purpose, a 50m width for the riparian buffer was considered sufficiently precautionary as use of a smaller width (e.g. 6m adopted for the P removal estimates purpose below) will result in excessively longer length than what is currently mapped in WWNP data.

The baseline TP load for the available riparian buffer length within each WFD waterbody was then estimated by using the TP estimates obtained from SEPARATE database above in conjunction with an assumed proportion of the WFD drainage catchment to be intercepted by the respective riparian buffers. For this purpose, it was generally considered 60% of each WFD waterbody catchment will contribute TP load to the new riparian buffers.

The TP removal rates for riparian buffers were acquired from the WG's Mitigation Measures Menu Guidance, which provides a range of TP removal rates: a lower limit of 31%, a median rate of 65%, and a higher rate of 99%. These rates are based on empirical data, riparian buffer widths, site characteristics and best practices for nutrient management. Based on the discussions held with stakeholders, it was considered that it would be generally difficult to implement riparian buffer widths wider than 6m due to landowner concerns on loss of agricultural productivity and hindrance to site operations. Therefore, as a conservative basis the lower TP removal rate of 31% was currently adopted in the Scenario Modelling (in conjunction with a 6m minimum buffer width). However, estimates were also given with a 20m wide buffer using a 65% removal rate where a 6m buffer may not provide sufficient TP reductions to meet favourable conditions.

Capital costs have been estimated using an average value of £10 per meter of fencing. However, this excludes the additional costs of gates and livestock water troughs, which will require costing on a site-specific basis.

Annual maintenance costs were calculated from the RHDHV Report titled "River Clun SAC Phosphate Mitigation Solutions for Residential Development" (Report Ref: PC3212-RHD-ZZ-XX-RP-Z-0001, April 2022), quoting a cost of £5 per 100 meters for maintaining a 20-meter-wide grass strip. However, this is a very conservative figure, with site-specific surveys required to determine actual costs.

[54] WWNP Riparian Woodland Potential - Wales | DataMapWales

5.5.1.6 Upgrading existing Septic Tanks

The West Wales nutrient budget calculator was then used to work out the baseline annual wastewater TP load per unit using the default TP load per septic tank as 11.6mg/l. For the domestic properties, a per capita consumption (pcc) of 120 l/p/d was used but for short stay accommodation types a slightly higher pcc value of 150 l/p/d used. Two mitigation scenarios were worked out. Option 1 is where TP load per septic tank was taken as 5mg/l to reflect a new septic tank replacement. Option 2 is where the existing septic tank will be replaced with a modern package treatment plant where TP load per Package Treatment Plants (PTP) was taken as 1mg/l. Using these values, the annual wastewater TP load from the septic tanks were calculated for the baseline and the two mitigated options, to estimate the potential TP reduction. This information can be then presented for each operational catchment (see Table 5-9).

However, the total TP reduction that can achieved with either Option 1 or Option 2 is very limited because only 24 records of septic tanks were found across the Afonydd Cleddau catchment from NRW's Permitted Discharges to Controlled Waters with Conditions dataset. It is also possible that the calculation currently underestimates the number of dwellings where multiple dwellings are noted in the absence of accurate values.

The TP reduction for Option 1 and Option 2 for the entire Afonydd Cleddau SAC catchment is 20.22 kg/year and 32.49 kg/year respectively, which may be taken forward as Category 1 or Category 2 measures if deemed necessary (subject to further assessment where hydraulic connectivity risk exists with the nearby watercourses due to lack of performance or maintenance issues, including practical implementation considerations).

Table 5-9 Potential TP reduction using Septic Tanks in each Operational catchment.

Sub catchment Name	No. of Septic Tanks	Reduction in Annual wastewater TP Load (kg/yr)	
		Option-1	Option-2
1. E. Cleddau - conf with Wern to conf with Syfynwy	1	0.64	1.03
2. Syfynwy - Llys-y-fran to conf with E Cleddau	4	0.64	1.03
3. Eastern Cleddau - conf with Syfynwy to tidal limit	5	8.19	13.15
4. W Cleddau - headwaters to conf with Cleddau North	1	1.29	2.07
5. Cleddau North - H'waters to conf with W. Cled	1	0.64	1.03
6. Western Cleddau - Cleddau North to Anghof conf	2	1.28	2.06
7. Anghof - headwaters to conf with Western Cleddau	1	0.64	1.03
8. W Cleddau - Anghof conf to Cartlett Brook conf	9	6.9	11.09
TOTAL	**24**	**20.22**	**32.49**

5.5.1.7 Upgrading existing PTPs

The West Wales nutrient budget calculator was then used to work out the baseline annual wastewater TP load per unit using the default TP load per PTP as 9.7mg/l. For the domestic properties, a pcc of 120 l/p/d was used but for short stay accommodation types a slightly higher pcc value of 150 l/p/d used. Two mitigation scenarios were worked out. Option 1 is where TP load per PTP was taken as 5mg/l to reflect a new PTP replacement and Option 2 where TP load per PTP was taken as 1mg/l to reflect a new PTP replacement. Using these values, the annual wastewater TP load from the PTPs were calculated for the baseline and the

two mitigated options, to estimate the potential TP reduction. This information can be then presented for each operational catchment (see Table 5-10~~Table 5-10~~).

However, the total TP reduction that can achieved with either Option 1 or Option 2 is very limited because only 38 records of PTPs were found across the entire Afonydd Cleddau catchment from NRW's The Permitted Discharges to Controlled Waters with Conditions dataset. It is also possible that the calculation currently underestimates the number of dwellings where multiple dwellings are noted in the absence of accurate values.

The total TP reduction for Option 1 and Option 2 for the entire Afonydd Cleddau SAC catchment is 30.61 kg/year and 56.78 kg/year respectively, which may be taken forward as Category 1 or Category 2 measures if deemed necessary (subject to further assessment and practical implementation considerations).

Table 5-10 Potential TP reduction using PTP in each Operational catchment

Sub catchment Name	No. of PTPs	Reduction in Annual wastewater TP Load (kg/yr)	
		Option-1	Option-2
1. E. Cleddau - conf with Wern to conf with Syfynwy	12	6.34	11.79
2. Syfynwy - Llys-y-fran to conf with E Cleddau	3	1.35	2.52
3. Eastern Cleddau - conf with Syfynwy to tidal limit	8	10.38	19.24
4. W Cleddau - headwaters to conf with Cleddau North	1	3.09	5.72
5. Cleddau North - H'waters to conf with W. Cled	2	1.37	2.53
7. Anghof - headwaters to conf with Western Cleddau	2	0.9	1.68
8. W Cleddau - Anghof conf to Cartlett Brook conf	10	7.18	13.3
TOTAL	**38**	**30.61**	**56.78**

5.5.1.8 Scenario Modelling Results Summary

Table 5-11 below summarises Category 2 minimum TP requirements for each operational catchment along with potential TP reductions available from all available Category 2 measures.

Further information on Category 1 and Category 2 measures are given in Section 5.3, Appendix C and Appendix D. They should be explored to develop the Action Plans presented in Section 5.6 for each operational catchment, by working closely with the NMB and the impacted landowners, as the NMP is further developed.

Many of mitigation measures (both Category 1 and Category 2) have been currently identified from a desk-based study approach. Whilst these are intended to provide a guide to the NMB around what opportunities are available in the catchment, it is also clear from discussions with the NRW, Afonydd Cymru and West Wales Rivers Trust, that landowner appetite and stakeholder engagement is key to ensuring the right mitigation is implemented, with shared benefits. Therefore, whilst the measures highlighted in this report are there to guide the NMB, landowner engagement will play a crucial role in developing solutions further.

Whilst Category 2 measures can have medium to high phosphorus mitigation potential, their delivery and long-term maintenance are deemed generally more uncertain than Category 1 measures. As such, Category 2 measures are not fully compliant measures for securing mitigation in perpetuity and so would not generally satisfy an assessment against the Habitat Regulations or providing nutrient credits to allow new

developments. However, they may be still used as effective bridging solutions, as part of a package of wider nutrient neutrality measures (subject to detailed discussions with NRW and NMB), alongside its important role to restore the SAC back to favourable conditions. The exception to this is Category 2 measures that are associated with reductions from WwTWs including RoPs and SO improvements that can provide this high-level certainty.

The summary presented in Table 5-11 for scenario modelling illustrates that there are theoretically enough Category 2 measures across the catchment to achieve favourable conditions, but timescale for this is currently uncertain. Also, considering the agricultural dominance in Cleddau catchment, reduction of agricultural phosphorus at source through CoAP, farming source control (incl. surface water separation) and SFS would be key. This will then reduce the scale and over reliance of riparian buffers Category 2 measures required to achieve favourable conditions. Therefore, further effort is needed to better understand the efficacy and practicality of implementing such measures.

The legacy P issue is another risk as the true scale is currently unclear. Rephokus report states that “water quality in the Wye catchment, and many other livestock-dominated catchments, will not greatly improve without reducing the agricultural P surplus and drawing-down P-rich soils to at least the agronomic optimum. This will take many years. It also states that a combination of reducing the number of livestock and processing of livestock manures to recover renewable fertilisers that can substitute for imported P products is needed to effectively reduce the P surplus.

The requirement of land for the purpose of nutrient avoidance and mitigation is strategic in its location and such suitable land may not always readily available. Therefore, the NMB will have to work closely with the landowners to identify the most suitable locations for mitigation and ensure their viability, including long-term maintenance. Appropriate tracking of mitigation and environmental improvement works across the Afonydd Cleddau catchment will be vital for the NMB to be effective in its delivery of the NMP. This could include exploring opportunities to better map existing work and quantify their impacts.

The role of the NMB and the NMPs in this instance is critical. Plans reviewed on a regular basis will be able to consider the changing baseline condition within the SAC with respect to phosphorus compliance (or Nitrate compliance should this develop as a requirement). Assuming the NMP is successful, and that some of the continuing efforts to improve wastewater and rural land use exports of phosphorus to the Afonydd Cleddau SAC are implemented sustainably, it may be that the issue of phosphorus compliance in the Afonydd Cleddau SAC eases, with sufficient environmental headroom provided to have confidence in securing the long-term health of the Afonydd Cleddau from a nutrient perspective. Equally, should it prove that conditions are worsening for one reason or another, the NMB will be able to react accordingly, taking into consideration the availability of mitigation within the catchment as plans progress.

Table 5-11 Summary per operational catchment of available Category 1 and 2 mitigation reductions and the overall surplus or shortfall.

ID	Sub-Catchment Name	Current TP Load	Cat 2a Min TP Target (t/yr)	Target TP Load (t/yr)	LDP Development	WwTW Improvements	PTP / SP Upgrades	CoAP	SFS / Additional Farm Source Control	Constructed Wetlands	Riparian Buffers	Minimum Potential TP Load	Total TP Reduction (t/yr)
1	E. Cleddau - conf with Wern to conf with Syfynwy	4.75	0	4.75	TBC	0	-0.013	-0.24	-0.398	0	-0.88	3.217	1.14
2	Syfynwy - Llys-y-fran to conf with E Cleddau	3.69	0.23	3.46	TBC	0	-0.004	-0.2	-0.331	0	-1.03	2.127	1.23
3	Eastern Cleddau - conf with Syfynwy to tidal limit	3.1	0.131	2.97	TBC	-0.23	-0.032	-0.11	-0.188	0	-0.58	1.96	0.95
4	W Cleddau - headwaters to conf with Cleddau North	0.98	0.35	0.63	TBC	-0.283	-0.008	-0.04	-0.066	-0.1	-0.18	0.301	0.61
5	Cleddau North - H'waters to conf with W. Cled	2.03	0	2.03	TBC	-0.029	-0.004	-0.08	-0.135	0	-0.38	1.404	0.49
6	Western Cleddau - Cleddau North to Anghof conf	2.1	0.171	1.929	TBC	-0.582	-0.002	-0.06	-0.105	0	-0.39	0.958	1.04
7	Anghof - headwaters to conf with Western Cleddau	2.56	0.083	2.477	TBC	0	-0.003	-0.12	-0.2	-0.2	-0.48	1.561	0.8
8	W Cleddau - Anghof conf to Cartlett Brook conf	11.55	3.933	7.617	TBC	-0.511	-0.024	-0.53	-0.882	-0.3	-3.22	6.081	4.59
		30.76	**4.896**	**25.864**		**-1.636**	**-0.089**	**-1.383**	**-2.305**	**-0.6**	**-7.139**	**17.608**	**10.847**

5.6 Options Prioritisation

Considering the priorities rankings in Table 5-1~~Table 5-1~~, each of the measures screened into the appraisal at catchment scale, have been highlighted as being either '**high**', '**moderate**', or '**low**' impact solutions. This is presented in Table 5-12~~Table 5-12~~ along with the Annual P Concentration, P target, differences and priority taken from Table 5-1~~Table 5-1~~ for each sub-catchment.

In addition to the impact of interventions, their feasibility for implementation should also be considered. Appendix D provides detailed mapping showing mitigation opportunities across the sub-catchments.

With respect to holistic catchment management mitigation, following core datasets are notable:

West Wales Rivers Trust have conducted a Sediment Pathways assessment, helping to identify areas where diffuse sources enter the watercourses and enabling identification of measures to mitigate and prioritise them.

The Nutrient Management Board have undertaken soil erosion and vulnerability modelling within West Wales to analyse and map the risk of nutrient runoff and loss. The modelling focuses on soil, slope and land use as the key factors for nutrient loss and qualified these risks into an overall nutrient loss risk, ranging from slight to very high. In addition to the overall risk, the dominant risk factors have been mapped which allows for more targeted potential solutions.

Soil composition and topographical features tend to be relatively consistent over time, while land use and land cover are more variable. Changes in land cover types can occur as a result of natural processes like erosion and ecological succession, as well as human activities such as farming and reforestation. An indicative analysis was carried out to identify areas of potential change in the level of risk of nutrient loss. These data sets, in combination with the data above, can be used as a starting point to identify risk areas and what mitigation measures would be best suited to treat nutrients at the relevant sources.

West Wales Nutrient Mitigation Options Technical Review has produced several useful datasets including the use of alternative source appointment data and on a WFD catchment basis, indicators for nature-based solution potential including tree planting.

These datasets can be combined in a GIS Platform to enable relatively quick selection of high potential areas whilst also assessing their high-level feasibility (i.e., considering constraints such as ancient woodlands, habitats and heritage). In Section 6.2 (Action Plan) each sub-catchment will identify potential Category 1 and 2 measures to explore in further detail (Section **Error! Reference source not found.**~~6.2.1~~-6.2.8). This high-level feasibility study identifies aspirational targets, with ground truthing and site-specific surveys required to determine accurate figures.

Table 5-12: Intervention Action Plan

ID	NMP sub-catchment	Annual P Concentration (ug/l)	P Target (ug/l)	Difference	LDP Impact (kg/ year)	Dominant Source (%)	Farm Source Control & SFS	CoAP	Private Sewerage Measures (Package Treatment Plants)	Wastewater Treatment Works Upgrades	New Constructed Wetlands	Urban SuDS – New and Retrofitting*	Riparian Buffers and Other Nature-based Solutions	Catchment Priority**
1	E. Cleddau - conf with Wern to conf with Syfynwy	12.5****	15****	-2.5	TBC	Rural (92%)	Good potential for P removal. Catchment is not failing; opportunities could be explored to aid downstream catchments.	Important to ensuring long-term compliance – benefits will take time to develop.	Limited no. of PTPs listed	No planned improvements.	Limited opportunities in this catchment, not a priority.	New SuDS supported by policy but only low scale impact	74km of potential riparian buffers have been identified. Catchment is not failing; opportunities could be explored to aid downstream catchments.	**Low**
2	Syfynwy - Llys-y-fran to conf with E Cleddau	50.2	40	10.2	TBC	Rural (92%)	High potential given dominant source of P. Proactively pursue to meet targets.	Important to ensuring long-term compliance – benefits will take time to develop.	Several PTPs and WQ permit exemptions – limited benefit compared to other mitigations.	No planned improvements.	Limited opportunities in this catchment, not a priority.	New SuDS supported by policy but only low scale impact	61km of riparian buffers have been identified - Proactively explore to meet targets.	**High**
3	Eastern Cleddau - conf with Syfynwy to tidal limit	40	34	6	TBC	Rural (80%)	Good potential for P removal. Opportunities could be explored to aid downstream catchments.	Important to ensuring long-term compliance – benefits will take time to develop.	Several PTPs and WQ permit exemptions	Improvements at Clynderwen and Llanddewi Velfrey STW enough to achieve target (assuming no further development)	Limited opportunities in this catchment, not a priority.	New SuDS supported by policy but only low scale impact	40km of riparian buffers have been identified	**Medium**
4	W Cleddau - headwaters to conf with Cleddau North	23.33	15	8.333	TBC	Rural (71%)	High potential given dominant source of P. Proactively pursue to meet targets.	Important to ensuring long-term compliance – benefits will take time to develop.	Limited benefit in comparison to alternative mitigations	Planned improvements at Mathry WwTW important to meeting targets.	Castlemorris is a Cat. B1 WwTW i.e., potential for further TP removal.	New SuDS supported by policy but only low scale impact	23km of riparian buffers have been identified – Lower priority given other mitigation opportunities	**High**
5	Cleddau North - H'waters to conf with W. Cled	No Data	40	No Data	TBC	Rural (97%)	Until compliance data is available, proactively pursue.	Important to ensuring long-term compliance – benefits will take time to develop.	Limited benefit in comparison to alternative mitigations	Improvements at Panteg STW planned, but limited benefits	Limited opportunities in this catchment, not a priority.	New SuDS supported by policy but only low scale impact	30km of riparian buffers have been identified. Lower priority until compliance data is confirmed.	**High*** **
6	Western Cleddau - Cleddau North to Anghof conf	43.54	40	3.540	TBC	Rural (61%)	Good potential for P removal. Opportunities could be explored to aid downstream catchments.	Important to ensuring long-term compliance – benefits will take time to develop.	Limited benefit in comparison to alternative mitigations	Improvements at Letterston West STW important to meeting targets.	Limited opportunities in this catchment, not a priority.	New SuDS supported by policy but only low scale impact	20km of riparian buffers have been identified	**High**
7	Anghof - headwaters to conf with Western Cleddau	38.24	37	1.238	TBC	Rural (78%)	Important measure given uncertainty around Wetlands. Proactively pursue.	Important to ensuring long-term compliance – benefits will take time to develop.	Limited no. of PTPs listed	No planned improvements.	Wolfscastle and Puncheston WwTWs classified as Cat. B1 i.e., potential for further TP removal.	New SuDS supported by policy but only low scale impact	38km of riparian buffers have been identified – lower priority considering other opportunities.	**Medium**
8	W Cleddau - Anghof conf to Cartlett Brook conf	104.7*****	30*****	74.7	TBC	Rural (69%)	Critical Measure considering scale of failures and catchment area – Proactively pursue.	Important factor in addressing long-term compliance in the catchment.	Significant PTPs and WQ permit exemptions – lower priority considering other opportunities.	Improvements at 6 WwTW important to meeting targets.	3 WwTWs are classified as Cat.B1 i.e., potential for further TP removal.	New SuDS supported by policy but only low scale impact	128km of riparian buffers have been identified – proactively explore to meet targets.	**High**

**Priorities could change once the additional TP budget from the LDP is confirmed.*

***Impacts of urban appraisal could change once urban areas with new developments are confirmed in the LDP.*

****SAC Compliance data not assessed and so priority of improvement in this catchment unknown. High priority assigned to highlight the need to gain deeper understanding.*

***** only shows the passing waterbody closest to reaching its target sine there are multiple passing waterbodies in Sub-catchment 1.*

******Based on the worst failing waterbody within Sub-catchment 8 since there are five failing waterbodies. The annual observed P concentration ranges from 32.4 µg/l – 104.7 µg/l and P target also varies from 30 – 40 µg/l.*

5.6.1 Further Considerations

The requirement of land for the purpose of nutrient avoidance and mitigation is strategic in its location and such suitable land may not always readily available.

Appropriate tracking of mitigation and environmental improvement works across the Afonydd Cleddau catchment will be vital for the NMB to be effective in its delivery of the NMP. This could include exploring opportunities to better map existing work and quantify their impacts.

The role of the NMB and the NMPs in this instance is critical. Plans reviewed on a regular basis will be able to consider the changing baseline condition within the SAC with respect to P compliance (or Nitrate compliance should this develop as a requirement). Assuming the NMP is successful, and that some of the continuing efforts to improve wastewater and rural land use exports of P to the Afonydd Cleddau SAC are implemented sustainably, it may be that the issue of phosphorus compliance in the Afonydd Cleddau SAC eases, with sufficient environmental headroom provided by a range of mitigation to have confidence in securing the long-term health of the Afonydd Cleddau from a nutrient perspective. Equally, should it prove that conditions are worsening for one reason or another, the NMB will be able to react accordingly, taking into consideration the availability of mitigation within the catchment as plans progress.

It is important to note site specific factors, such as landowner support/willingness to collaborate which would need to be considered, as well as potential sensitivities of the sites, such as historic, cultural and biodiversity values.

In order to further define and prioritise areas for proposed mitigation, more in-depth stakeholder consultation and site visits would need to take place. In addition, site-specific monitoring and management plans would need to be established to monitor and evaluate local phosphorus removal efficiencies and ensure phosphorus mitigation requirements are being met, now and in the future.

These themes are explored further in the sub-catchment action plan Section 6.

6 Action Plan

Sub-catchment priorities have been presented Sections **Error! Reference source not found.**~~6.2.1~~ through to 6.2.8. Dedicated mitigation will be progressed at a sub-catchment level. The following section provides a series of actions to be delivered by a range of stakeholders within the Cleddau catchment in line with the objectives of the NMP. Section 6.1 highlights holistic actions that are catchment scale and aim to track / monitor key pressures or address data gaps. Section 6.2 onwards highlights sub-catchment actions, i.e., targeted mitigation that specifically addresses nutrient management.

Funding and resources will be a key consideration for delivering actions and the sub-catchment action plans will help identify priority actions and cost estimates to streamline funding allocation.

6.1 Holistic Actions

Table 6-1 below provides some recommended holistic actions which should be considered alongside the sub-catchment actions. While the table has suggested and action owner it is key that all NMB stakeholders are collaborating in each area.

Table 6-1 Holistic Actions

Action	Commentary	Lead	Impact	Stakeholder Actions	Priority
Collaborations	Providing a forum for multiple stakeholders to discuss, present and progress interventions, activities and initiatives for phosphorus reduction. This could include policy and legislation drivers, sharing best practice and technical advice.	NMB	To drive the implementation of interventions activities and initiatives for phosphorus reduction.	• Facilitate collaboration through stakeholder engagement and meetings • Annual updates to the NMP • To provide a framework and facilitate collation of catchment activities. • Assist with monitoring activities with regard to P.	High
Promotion of policy and legislative compliance	There are a suite of existing policies and legislation that if fully implemented would support the overall aims of the NMB. Support for additional policy or policy amendments could also be beneficial.	NMB / TAG/NRW/WG	Accelerate the implementation of existing policy and legislation and demonstrate if and when new policy and legislation are required.	• NMB to continue to liaise with NRW, DCWW and WG around regulatory and policy implementation and or changes that would affect phosphorus reduction • NMB to provide the evidence base for the need and effectiveness for existing and/or new policy and legislative drivers • NRW to provide details of compliance failures to aid selection of relevant intervention measures • WG to consider support for funding to increase NRW farm visit rates to ensure CoAP compliance. • Review with NRW the policy for 3rd party ownership of treatment wetlands	High
Set up Agricultural Land Management Taskforce	Agriculture represents the main sources of P in the Cleddau catchment and requires urgent attention to reduce levels and achieve compliance. Stakeholder groups like the WLMF and others have made good progress in many areas, working constructively with farmers to deliver positive action. This needs to be given further resource and consideration by WG.	NMB/WG	Provide clear direction on the efforts needed to tackle the issue of nutrient pollution in the Cleddau and the steps required to address agricultural sources.	• Investigate the nutrient balance of the Cleddau catchment and outline steps to address import vs. export. • Investigate quality of soil in key areas, considering issues of compaction and legacy P to identify clear mitigation opportunities. • Identify policy levers that could be utilised or introduced to address agricultural impacts on SAC compliance. • WG to consider additional measures to protect the SAC from agricultural source P in waterbodies that are heavily reliant on voluntary measures and fail to meet compliance targets	High
Improving Data Gaps	It is clear that with respect to agricultural inputs within the Cleddau catchment, there are data gaps that limit potential for the NMB to take action. These data gaps need to be addressed in order to improve the certainty of this plan.	NMB / TAG/WG	Will provide clarity on where to target measures within the catchment. Will better define the full-scale of the challenge.	• DCWW to provide detailed data relating to the existing SAGIS model, including P loads as inputs to the catchment by source. • WG to provide details of livestock data by river catchment. • NMB to review Land Spreading permits to determine focus areas / hot spots for intervention.	High
Fund Raising	Support a business case with high level benefit cost ratios and stakeholder benefit mapping to map the right opportunities to the right funders.	NMB	Provide access to funds for stakeholders and facilitate the creation of a business case to secure funding for water quality improvements.	• Create a framework for writing business cases • Align benefits calculations with other WG strategies and targets, e.g. SFS, Net Benefit for Biodiversity and the Net Zero Strategic Plan.	High
WwTW Improvements	DCWW have outlined a significant P improvement programme which will see upgrades to a number of WwTW within the Cleddau catchment, with other sites receiving backstop permits. It is important to also note the issue of capacity for additional connections in terms of flow and treatment capacity.	NMB / DCWW	Improvements delivered at WwTW will reduce P levels within final effluent and result in lower concentrations of total phosphorus in the SAC catchments.	• NMB to continue to liaise with DCWW on a regular basis and gather regular updates on the improvement programme and other initiatives led by DCWW with respect to P.	High
Water Quality Data	A review of the water quality data informing SAC P Compliance has found several aspects on which NRW support is required to better understand the data and implications of data quality concerns. Furthermore, additional data is available via the Water Quality Archive, such as the data informing WFD assessments. In raw	NMB / NRW	Understanding water quality data is crucial to targeting solutions in the right places. Making use of the best available data will boost the chances of success. Establishing future monitoring programme plans will help the NMB to track progress,	• Request Technical Discussion re: water quality data for SAC compliance and WFD assessments. • Outline concerns around spatial / temporal sampling regime to NRW for comment. • Identify areas where additional sampling may be beneficial in support of the evidence base.	High

Action	Commentary	Lead	Impact	Stakeholder Actions	Priority
	format, it is unclear whether this could provide additional detail and insight to inform decision making.		demonstrating that interventions are ultimately lowering P levels in the Cleddau. Monitoring will be required for opportunities as well as wider monitoring to demonstrate success and to locate specific issues.	• Explore citizen science and farmer opportunities	
Source Apportionment Data	A review of the outputs from SAGIS modelling has confirmed usefulness at a high-level in identifying mitigation measures. However, limitations exist including the granularity of the data i.e., sub-catchment scale only and the link between downstream concentrations and upstream inputs. Furthermore, representation of 'Other' sources (such as Septic Tanks) and CSOs carries limitations.	NMB / NRW / DCWW	Understanding of source inputs on a more detailed scale would allow for much enhanced success rates with respect to nutrient export reduction.	• Explore with NRW and DCWW what data exists within the models that could be shared to better inform decision making. • Review the limitations associated with CSO / Other sources and assess whether improvements could be made to assumptions / representations. • Investigate whether additional modelling could benefit the assessment of mitigation measures, potentially even supporting modelling of proposed interventions to estimate impacts.	High
Farmer Engagement / SFS / Farm Source Control	Engage with farmers to understand how the Sustainable Farming Scheme/ Farm Source Control and other land use management changes can support phosphorus removal. NMB / Agriculture sector collaboration can support applications for funding and delivering measures related to nutrient management.	NMB / WG / Agri-sector / TAG	Support of rural land use management change and source control has the potential to have a significant impact on Phosphorus reduction via the reduction of nutrient export to the Afonydd Cleddau.	• Monitor progress of SFS and Farm source control with regards to phosphorus • Exchange information such as soil nutrient data • Understand how SFS could support the farming community directly to deliver mitigation measures. • Support the farming community with implementation and funding of SFS aligned with phosphorus reduction opportunities. • WG to consider additional funding to increase NRW farm visit rates to ensure compliance of CoAP • Conduct an analysis of the mass balance surplus of phosphate in the Cleddau to determine if the excess either accumulates in the soil (Legacy P) and/or runs-off / leaches into the river, causing hyper-nutrification. This will provide understanding of the magnitude of soil legacy and inform farm source reduction and mitigation opportunities.	High
P Monitoring	Mitigation tracked in collaboration with stakeholders and assessed on an annual basis will determine the likely P removal due to interventions in line with the annual P compliance reports and the planned local development.	NMB	Impact of improved monitoring will be a greater understanding of the impact of P and the effectiveness of interventions.	• Develop an interventions actions and initiatives tracker which will collate activities to measure phosphorus reduction. • Update tracker annually	High
Climate Change	Climate change has been identified as a future pressure which has potential exacerbate the issue of nutrient impacts within the SAC.	NMB / TAG	Tracking of weather events such as storms (frequency / severity) or periods of drought (rivers at low flows) when combined with monitoring could help the NMB better understand the impacts of climate change.	• TAG to consider link between river level, flow and rainfall data and water quality monitoring to better track potential impacts of climate change in the long term. • Laise on potential for SAGIS modelling to incorporate future rainfall and flow patterns	Medium
Septic Tanks / PTPs	Action required to consider inputs from these sources (see Source Apportionment Data action). Further action needed to explore exempt discharges, unregistered discharges, better manage existing permits, provide guidance to existing asset owners and new ones.	NMB	Until further information is known, this will ensure compliance with existing permits and promote best practice for asset owners reducing export of P to catchment.	• NRW and NMB to collaborate on means to manage permits and unregistered discharges from these assets in the catchment. • Issue guidance on best practice for these assets. • NMB and Pembrokeshire County Council to collaborate on mapping unregistered discharges into catchment	Medium
Storm Overflows	Monitor progress of the environmental regulation of overflows action plan as well as other efforts across Wales and the Cleddau to better understand the issue of SOs and critically their impact on nutrient pollution.	NMB / NRW / DCWW / WG / TAG	The impact of SOs on nutrient pollution is not well understood. NMB should seek clarity on research / initiatives in this space to improve evidence base as well as track progress of solutions.	• Engage with WG, NRW and DCWW to audit existing initiatives and planned programmes. • Engage with DCWW to understand key causes of failing SO's to support interventions and prevention.	Low

Action	Commentary	Lead	Impact	Stakeholder Actions	Priority
Additional Tracking metrics	While P will be monitored other indicators can be relevant such as, the number of farms under nutrient management schemes, flagship species population status, soil compaction, soil health diary numbers, number of people involved in P removal projects etc.	NMB/ TAG	Additional tracking metrics will assist with the overall aim of the NMB to improve overall river restoration including healthy populations of flagship species and overall water quality.	• Collation of interventions, mitigation and monitoring initiatives. • Choosing additional tracking metrics.	Low
Ecology General	Ultimately the water quality requirements are to facilitate a healthy ecosystem which includes key taxa. Otter, salmon and freshwater pearl mussel are keystone species important as indicators as to the overall long-term health of the Cleddau and could be selected as NMP Action Plan flagship species.	NMB / TAG	Cleddau NMP flagship species could focus funding as well as collaboration, survey standardisation and additional metrics of long-term success.	• Choose Flagship species • Liaise with multiple stakeholders to draw up some standard operating procedures for surveys and reporting. • Explore citizen science and farmer opportunities • Facilitate opportunities for multiple benefits e.g. where biodiversity projects could be aligned with phosphorus reduction targets and vice versa	Low

6.2 Sub-catchment Action Plans

Sections **Error! Reference source not found.**~~6.2.1~~ through to 6.2.8 present sub-catchment action plans, including waterfall charts documenting the total availability of mitigation if the various focus areas for mitigation are explored to their fullest. It should be noted that , the practicalities of reaching full potential for these focus areas is another challenge, both in terms of stakeholder support, funding, and land availability. Furthermore, some focus areas contain overlapping activities e.g., riparian buffers could form activities in farm source control and the riparian buffer category. As such, this figure should be seen as a theoretically possible scenario, which demonstrates that land availability is unlikely to be an issue but coordinated implementation is a challenge. The success of the NMP will be in investigating opportunities within each of the focus areas and sub-catchments to meet the required reductions. The data presented below is based on the results of the Scenario Modelling (Section 5.5) using the SEPARATE data and mitigation efficiencies outlined in Section 5.4.

It is important to highlight the differences in the output of the SEPARATE and the SAGIS models, the different metrics used, and the limitations in comparing the outputs of the two models.

What Sections **Error! Reference source not found.**~~6.2.1~~ through to 6.2.8 demonstrate is that to achieve the target for compliance, the currently established mitigation will only go so far. The need for reliance on riparian buffers and other NbS highlights that CoAP and voluntary farm control measures alone are not sufficient to meet compliance. Furthermore, particularly in this catchment, the legacy P issue is likely to be a factor in continued high levels of P leaching into the Cleddau.

It is likely not practical for the significant volume of NbS to be delivered, focusing purely on interception of surface runoff. This requires therefore a catchment scale approach, and a focus on the long-term sustainability of agricultural practices in the catchment delivering reductions at source. The holistic actions focusing on legacy P and soil health will be one such key step required to help secure the future compliance of this catchment. An analysis of soil (Legacy P) is being undertaken. This will provide understanding of the magnitude of soil legacy and inform farm source reduction and mitigation opportunities. Findings of the legacy P analysis in the Cleddau catchment will be incorporated into future iterations of the Plan. Furthermore, exploration of upstream interventions in the other sub-catchments will help reduce the export from upstream and help matters in certain failing sub-catchments in the downstream sections.

Assumptions and Limitations

It's important to note that the waterfall charts presented in this section represent estimated removal potential based on broad assumptions on removal rates. A blend of mitigation measures, delivered under each of the focus areas highlighted, will be required, and the exact split is of less consequence or importance than their ultimate delivery to achieve P reductions. The figure is therefore intended to demonstrate what is theoretically possible versus the target required. It helps in identifying where the challenges are likely to lie and is helpful to demonstrate where the delivery of Category 1 measures to release development will not result in a barrier to restoring the SAC to favourable condition through the implementation of Category 2 measures, if planned correctly through an integrated strategy employing a range of measures.

Estimates for the removal potential resulting from CoAP / Farm Source Control measures have been currently calculated by taking the % removal estimates, as documented in Section 5.4, and applying to the total agricultural load for the sub-catchment as a whole. However, it is important to recognise that implementation of mitigation measures under these focus areas would need to be prioritised spatially, ensuring that the removal is targeted in areas upstream of SAC compliance monitoring points where P reduction benefits are highest. In other words, if 10% removal of the total catchment load is required, this may need to be concentrated in certain sub-catchments to ensure SAC P compliance is met, which means greater than >10% reduction may be required (especially where the failing waterbodies are located at headwaters within a sub-

catchment). This is a risk that should be managed through further refinements to the current scenario modelling outputs at a more granular levels as the NMP progresses. Hydraulic connectivity here is key, and the figures in Appendix D should be referred to when selecting appropriate catchments for mitigation.

Equally in some cases, upstream improvements from other sub-catchments may provide additional downstream benefits not currently incorporated into the scenario modelling calculations. These should be factored into future modelling and actions as measures are brought forward.

6.2.1 Sub-Catchment 1

Sub-catchment 1, on the Eastern Cleddau, contains 3 WFD waterbodies (E. Cleddau - conf with Wern to conf with Syfynwy, Wern - headwaters to conf with Eastern Cleddau and Eastern Cleddau - headwaters to conf with Wern), including the tributaries of the Wern and headwaters of the Eastern Cleddau. The Afon Wern's upper reaches abut the Mynydd Preseli Site of Special Scientific Interest (SSSI), flowing through narrow wooded valleys, before joining the Eastern Cleddau. There are few settlements in this largely rural catchment, served by a single WwTW (Maenclochog Clynderwen).

All the WFD catchments were assessed for SAC compliance in this sub-catchment and were found to pass. The overall WFD status for each waterbody is good with the exception of the Wern, classified as Poor.

However, downstream Sub-catchments could benefit from interventions implemented in this area, and therefore mitigation opportunities should not be ignored. *Figure 6-1*~~Figure 6-1~~ presents an overview of the total opportunity available in the Sub-catchment broken down by focus area. This shows that through CoAP and Farm Source Control measures, there is an opportunity to remove more than 0.6 TP Tn / yr. Furthermore, opportunities for riparian buffers and other nature-based solutions could be explored across the catchment, this could include wet woodlands along the Afon Wern, helping to slow the flow and improve water quality more generally.

Generic actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. This will need to consider the number of non-compliant farms per catchment (currently unknown). However, in general, the higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture could prove important in securing future compliance of the catchment whilst also improving the situation for downstream catchments.
- Promote natural flood management: Peak flow events exacerbate the potential for nutrient pollution with increased surface water runoff, mobilising P-rich sediment, and the frequency of these events is predicted to increase with climate change . Efforts to slow the flow could not only reduce P export to the catchment but reduce the risk of flooding downstream through better regulated flows. Liaise with NRW and Local Council to understand whether measures are already being explored to this end.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export.

Table 6-2 Sub-catchment 1 action tracker presents an action plan tracker which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

In summary, based on current information, Sub-catchment 1 does not require immediate or urgent action to address P compliance. However, measures could still prove valuable in securing the long-term health of the Cleddau, and efforts in this upstream sub-catchment may offer benefits to downstream sub-catchments.

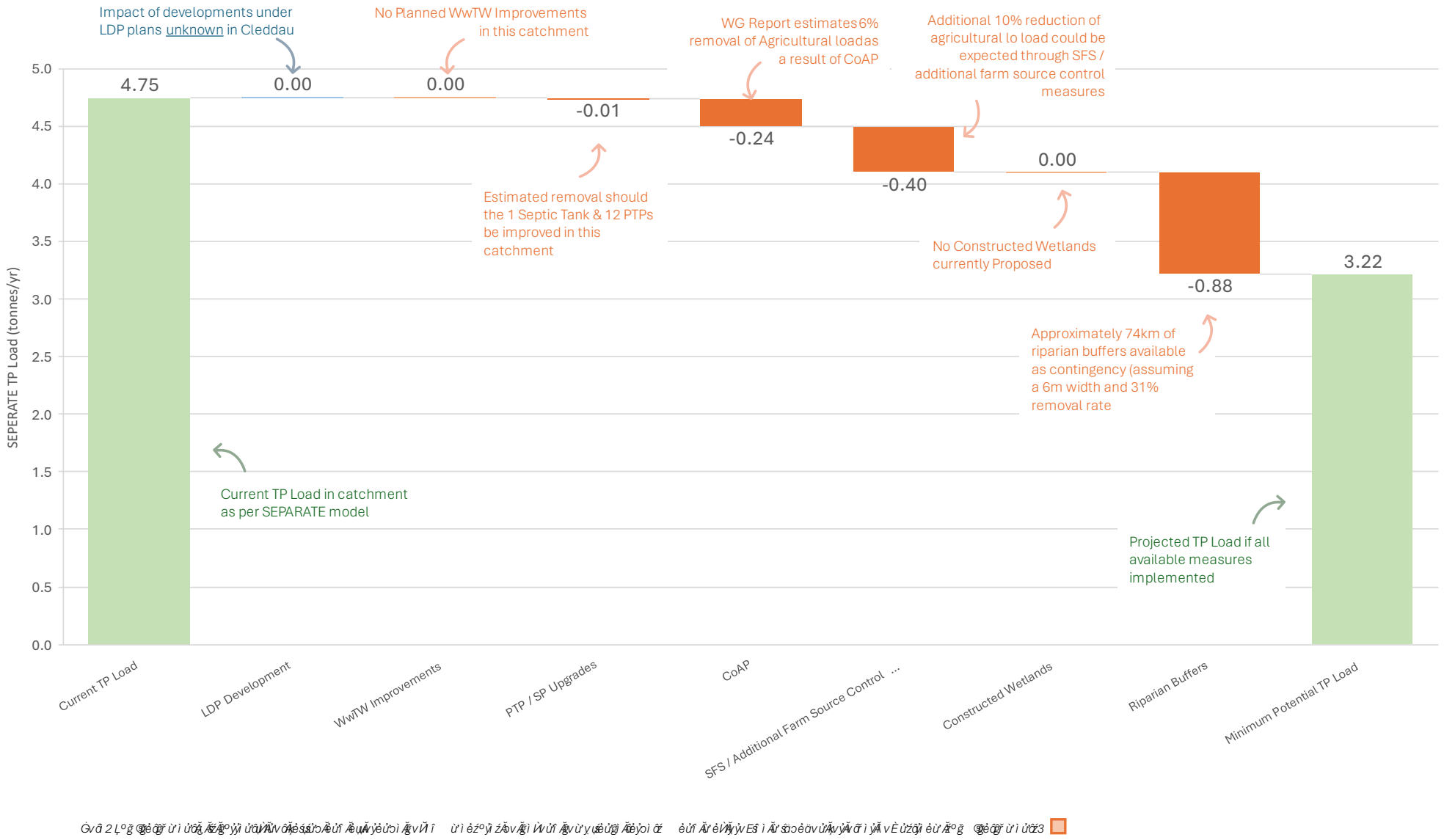

Figure 6-1 Sub-catchment 1 waterfall chart.

Table 6-2 Sub-catchment 1 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Work with key stakeholders to ensure that CoAP is successfully implemented in this catchment.	Agriculture a primary source of P in the catchment. Compliance with regulations offers a chance to enhance current situation in the catchment whilst offering benefits for downstream.	Up to 0.24	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – legislator with responsibilities to ensure legal requirements are set. NRW – Enforcement of regulations WLMF – stakeholder group with remit to work collaboratively and constructively towards aims of CoAP.	1	Senedd CoAP~~5050~~ report produced, estimating the benefits of CoAP and costs / benefits associated with delivery.	NRW - provide details of CoAP activities in this catchment, including timescales for delivering benefits.
Farm Source Control and SFS	Investigate farms willing to consider voluntary measures to reduce P export in the catchment	Agriculture the dominant source of P in catchment. Whilst the catchment is passing, improvements could support downstream catchments.	Up to 0.40	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities in catchment. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	Whilst not a priority for SAC compliance, there is an opportunity for nature-based solutions to improve the resilience of the catchment and improve water quality more generally.	Up to 0.88	TBC	CAPEX up to £740,000 assuming full mitigation opportunity implemented Annual OPEX up to £4,000 per year assuming full mitigation opportunity realised. This has assumed riparian buffers are adopted, exact split of other nature-based solutions too uncertain to quantify at this stage. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.2 Sub-Catchment 2

Sub-catchment 2, on the Eastern Cleddau, contains 3 WFD waterbody catchments (Deepford Brook - headwaters to conf with Syfynwy, Syfynwy - headwaters to Llys-y-Fran and Syfynwy - Llys-y-Fran to conf with E Cleddau), including the tributaries of the Deepford Brook and Syfynwy. The catchment is largely rural, with only small settlements, and there are two WwTW in the catchment, Llysfran Dam and Walton East (both in the compliant Syfynwy catchment downstream).

Of the 3 WFD waterbodies, only 2 were assessed for SAC compliance in this catchment. The headwaters of the Syfynwy were not assessed. The Deepford brook was found to fail, 20% above its target. The Syfynwy downstream of the Deepford brook though was found to pass. The overall WFD status for all waterbodies is moderate to good. As a result, and as shown in *Figure 6-2*~~Figure 6-2~~, this sub-catchment is currently classified as High priority with respect to P mitigation.

Given that the failures are in the upper catchment, Deepford brook, it is important to note that mitigation measures should be prioritised here to achieve SAC compliance. *Table 6-3 Sub-catchment 2 overview*~~Table 6-3~~ below highlights the picture within this sub-catchment for all waterbodies assessed by the SAC P compliance assessment.

Table 6-3 Sub-catchment 2 overview

ID	WFD catchment	Key Source	Current TP Load (Tn / Yr)	SAC Status	Target TP Load (Tn / Yr)	Target Reduction (%)	Comment
2.3	GB110061030690 - Deepford Brook - headwaters to conf with Syfynwy	Agriculture (92%)	1.13	Fail	0.90	20%	Required reduction in catchment to achieve target.
2.2	GB110061030700 - Syfynwy - Llys-y-fran to conf with E Cleddau	Agriculture (81%)	1.5	Comply	-	-	No reduction required – Mitigation may have benefits downstream
2.1	GB110061038300 - Syfynwy - headwaters to Llys-y-fran	Agriculture (84%)	1.06	Not Assessed	-	-	Uncertain – requires monitoring.

Given the predominant source of P in this catchment, measures need to focus on limiting P export from farming practices. As shown in *Figure 6-2*~~Figure 6-2~~, there is an opportunity to remove 0.53 TP Tn / yr through CoAP and Farm source control, however this focuses on the total catchment. Applied to the Deepford brook, this only equates to a reduction of 0.17 TP Tn / yr i.e., 0.06 TP Tn / yr short of the compliance target. However, with nearly 62km of riparian buffer strip opportunities in the catchment, equating to a removal potential of more than 1 Tn / yr, there is opportunity to address this. To equate the scale of the challenge, the shortfall could be addressed with approximately 4km of buffer strips (at 6m width) in the failing Deepford brook catchment, targeted at areas of highest risk. This requirement (in terms of length) could be further reduced with wider buffers subject to the existing nutrient pathways in the falling SAC catchment. Furthermore, other

nature-based solutions such as wetlands on farms, tree-planting and other measures documented in Appendix C offer opportunities to reduce P export to the catchment and need to be explored.

Despite this, implementation remains a challenge, and achieving compliance in this catchment relies heavily on voluntary actions through farm source control and SFS, achieving compliance under CoAP and delivery of Nature Based Solutions in the catchment. This needs to be addressed through closer farm engagement, identification of key opportunities in the catchment, and improved analysis of options through more detailed quantification methods, e.g., Farmscoper modelling similar to the work undertaken by PCF in exploring on-farm measures.

For the remaining catchments in this area, mitigation opportunities should not be ignored. Opportunities for riparian buffers and other nature-based solutions could be explored across the catchment, including natural flood management to slow the flow and improve water quality more generally.

Generic actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate and securing compliance in the Deepford Brook.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture will be vital to addressing compliance in the Deepford brook. This should be proactively explored, including an assessment of the catchments agricultural profile, no. of farms, type of farming, collaboration opportunities.
- Promote natural flood management: Peak flow events exacerbate the potential for nutrient pollution with increased surface water runoff, mobilising P-rich sediment, and the frequency of these events is predicted to increase with climate change. Efforts to slow the flow could not only reduce P export to the catchment but reduce the risk of flooding downstream through better regulated flows. Liaise with NRW and Local Council to understand whether measures are already being explored to this end.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, considering some of the catchments were not assessed in the previous SAC compliance round. This could include focussed citizen science efforts in the failing catchment.

Table 6-4~~Table 6-4~~ presents an action plan tracker which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

In summary, based on current information, Sub-catchment 2 requires action to address P compliance. These measures should focus on the Deepford Brook based on current information. With limited commitment / certainty around the measures relating to CoAP and Farm Source Control, there is a risk that without change, conditions will continue to worsen, and SAC compliance will not be achieved.

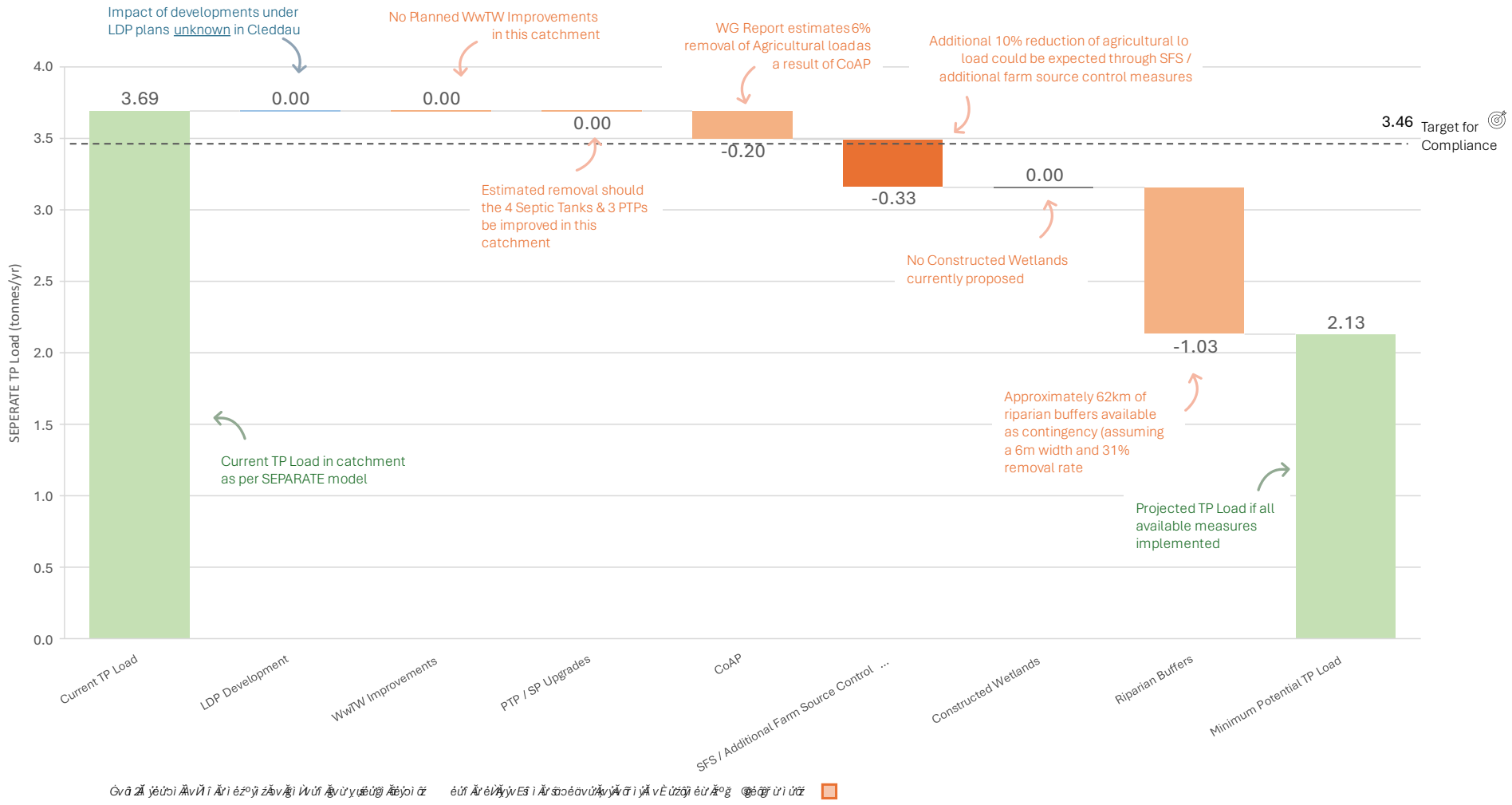

Figure 6-2 Sub-catchment 2 waterfall chart.

Table 6-4 Sub-catchment 2 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Work with key stakeholders to ensure that CoAP is successfully implemented in this catchment.	Important to maintaining SAC compliance and improving situation downstream. Focus on Deepford Brook required.	Up to 0.20	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – legislator with responsibilities to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF – stakeholder group with remit to work collaboratively and constructively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	Lead stakeholders - provide details of CoAP activities in this catchment, including details of farm compliance in key catchments, documentation of failures, and timescales for delivering benefits.
Farm Source Control and SFS	Proactively explore opportunities to implement measures to reduce P export in the catchment from farms. Establishment of 'Zero flow' farms should be explored through in line with the holistic actions around farm source control.	Vital action in this catchment, particularly the Deepford Brook. Current projection of 10% should be seen as minimum target, further reductions would be needed to secure SAC compliance on the Deepford Brook.	Up to 0.33	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities in catchment. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	This measure needs to be explored given that CoAP and Farm Source Control measures are unlikely to meet the requirements for compliance. Details on sediment transport risk are highlighted in Appendix D and can guide where to focus efforts. Nature Based Solution such as woodland planting should be explored. Existing measures, if they are progressing, should be highlighted, quantified and tracked.	Up to 1.03	TBC	CAPEX up to £620,000 assuming full mitigation opportunity implemented Annual OPEX of £3,000 per year assuming full mitigation opportunity realised. This has assumed riparian buffers are adopted, exact split of other nature-based solutions too uncertain to quantify at this stage. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.3 Sub-Catchment 3

Sub-catchment 3, on the Eastern Cleddau, contains 3 WFD waterbody catchments (Longford Brook - HW to conf with E. Cleddau, Narbeth Brook - headwaters to conf with E. Cleddau and Eastern Cleddau - conf with Syfynwy to tidal limit), including the tributaries of the Longford Brook and Narbeth Brook. Further downstream on the Eastern Cleddau, the catchment has a larger number of settlements including the town of Narberth. Two WwTW of note are situated within this catchment, namely, Clynderwen and Llanddewi Velfrey.

The Longford Brook was not assessed for SAC compliance. The Eastern Cleddau to the tidal limit was found to comply, within its target comfortably. The Narbeth Brook was found to fail, approximately 15% above its compliance target. The overall WFD waterbody status for each of these waterbodies is Moderate.

Table 6-5 below highlights the picture within this sub-catchment for all waterbodies assessed by the SAC P compliance assessment.

Table 6-5 Sub-catchment 3 overview

ID	WFD catchment	Key Source	Current TP Load (Tn / Yr)	SAC Status	Target TP Load (Tn / Yr)	Target Reduction (%)	Comment
3.1	GB110061030680 - Longford Brook - HW to conf with E. Cleddau	WwTW (52%)	1.59	Not Assessed	-	-	Uncertain – required monitoring.
3.2	GB110061030660 - Narbeth Brook - headwaters to conf with E. Cleddau	Agriculture (83%)	0.87	Fail	0.74	15%	Requires targeted mitigation to improve and meet compliance targets.
3.3	GB110061030670 - Eastern Cleddau - conf with Syfynwy to tidal limit	Agriculture (81%)	0.64	Comply	-	-	No Reduction Required.

Whilst Longford brook was not assessed, improvements planned at the WwTW in this catchment will improve export of P to the catchment. Whilst this should be monitored, this may provide some confidence that measures are in place to ensure this catchment is compliant. Furthermore, this will have impacts on the downstream reaches of the Eastern Cleddau, which is currently compliant. As such, measures do not need to be proactively explored in these catchments to meet SAC compliance, albeit measures delivered under CoAP, or other schemes may offer benefits for water quality more generally.

The Narbeth Brook represents the most challenging aspect of the catchment, where the failure necessitates action to address the dominant source of P, which is agriculture. Figure 6-3 shows a potential reduction of 0.3 T/yr, however applied to the Narbeth Brook specifically, this only equates to an estimated 0.11 T/yr i.e., a 0.02 T/yr shortfall.

However, with nearly 12km of riparian buffer strip opportunities in the Sub-catchment, equating to a removal potential of more than 0.16 Tn / yr, there is opportunity to address this. To equate the scale of the challenge, the shortfall could be addressed with approximately 1km of buffer strips (at 6m width) in the failing Narbeth Brook catchment, targeted at areas of highest risk. This requirement (in terms of length) could be further reduced with wider buffers subject to the existing nutrient pathways in the falling SAC catchment. Furthermore, other nature-based solutions such as wetlands on farms, tree-planting and other measures documented in Appendix C offer opportunities to reduce P export to the catchment could be explored.

Further to this, an assessment of existing PTPs and SPs (as mapped in Appendix D), reveals that the majority of the catchments private sewage treatment lies in the Narbeth Brook catchment, i.e., the majority of the potential 0.03 T/yr removal potential could be secured in this catchment if targeted improvements were made.

Generic Actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture will be vital to addressing compliance in the Narbeth brook. This should be proactively explored, including an assessment of the catchments agricultural profile, no. of farms, type of farming, collaboration opportunities.
- Private Sewerage: Mapping suggests a significant no. of private sewerage assets in the Narbeth catchment, which if improved could improve conditions. It should be noted that there are limitations to the current modelling of these assets in source apportionment models and so the impact of this measure should be further investigated. This also does not include exempt discharges to the catchment. This should be investigated in the Narbeth catchment.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export. This could include focussed citizen science efforts in the failing catchment.

Table 6-6~~Table 6-6~~ presents an action plan table which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

Form

In summary, based on current information, Sub-catchment 3 requires action to address P compliance. These measures should focus on the Narbeth Brook based on current information. Additional work focussing on the prevalence of private sewerage assets in this catchment offers a tangible avenue for improvements which could prove important. However, agriculture remains a significant source of P in the catchment and with limited commitment / certainty around the measures relating to CoAP and Farm Source Control, there is a risk that without change, conditions will continue to worsen, and SAC compliance will not be achieved.

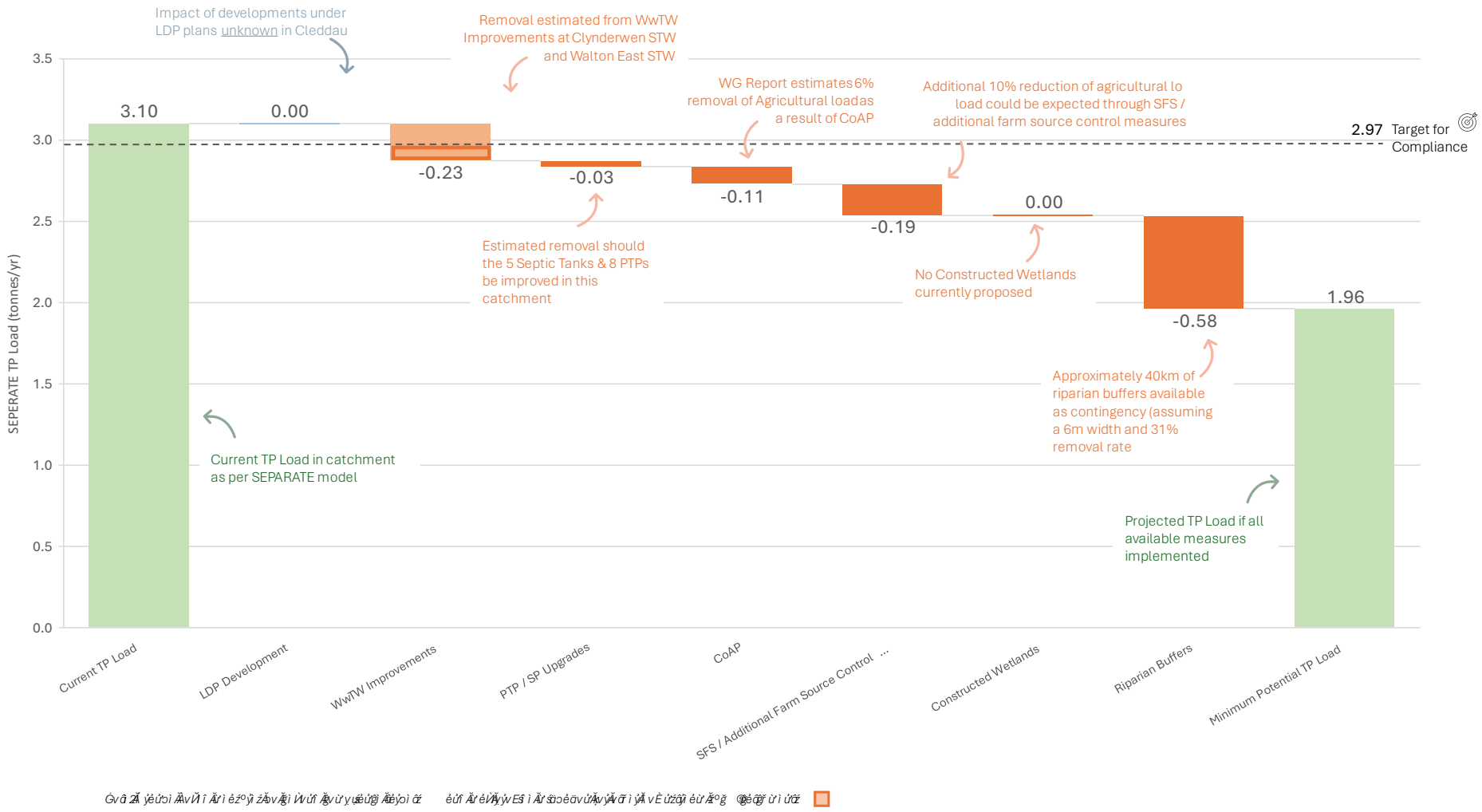

Figure 6-3 Sub-catchment 3 waterfall chart.

Table 6-6 Sub-catchment 3 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Work with key stakeholders to ensure that CoAP is successfully implemented in this catchment.	Important to achieve SAC Compliance and secure long-term health across wider catchment. Focus on Narbeth Brook required.	Up to 0.11	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF –remit to work collaboratively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	Lead stakeholders - provide details of CoAP activities in this catchment, including details of farm compliance in key catchments, documentation of failures, and timescales for delivering benefits.
Farm Source Control and SFS	Proactively explore opportunities to implement measures to reduce P export in the catchment from farms. Establishment of 'Zero flow' farms could be explored in line with the holistic actions around farm source control.	Vital action in this catchment, particularly the Narbeth Brook.	Up to 0.19	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
PTPs / SPs	Assess / address performance of private sewerage assets in the catchment	Private sewerage a relatively high contribution in the Narbeth Brook compared to other catchments (noting limitations around source apportionment modelling). Improvements to these assets could prove important in the Narbeth catchment.	Up to 0.03	TBC	TBC – Uncertain what level of improvements could be required e.g., complete upgrades of assets vs. enforcement of compliance / best practice management of assets	NMB and NRW to collaborate considering links to local planning authority and permitting.	1	Locations of assets flagged in the catchment (Appendix D) Estimation of reduction potential calculated for each asset	Confirm challenge considering exemptions within the catchment. Liaise with NRW to assess current understanding of management practices / compliance against permits for these assets. Approach asset owners to identify opportunities for improvement.
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	This measure needs to be explored given that CoAP and Farm Source Control measures are unlikely to meet the requirements for compliance. Details on sediment transport risk are highlighted in Appendix D and can guide where to focus efforts. Nature Based Solution such as woodland planting should be explored. Existing measures, if they are progressing, should be highlighted, quantified and tracked.	Up to 0.58	TBC	CAPEX up to £400,000 assuming full mitigation opportunity realised. Annual OPEX up to £2,000/yr assuming full mitigation opportunity realised. This assumes riparian buffers only, exact split of other nature-based solutions too uncertain to quantify. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.4 Sub-Catchment 4

Sub-catchment 4, on the Western Cleddau, contains a single WFD waterbody (W Cleddau - headwaters to conf with Cleddau North). The catchment is predominantly rural, with only a small number of settlements. Two WwTW are present in the catchment (Castle Morris and Mathry).

The catchment is found to have failed its SAC compliance targets being approximately 36% above its target. The overall WFD status of the waterbody is Moderate. Table 6-7 below highlights the picture within this sub-catchment for all waterbodies assessed by the SAC P compliance assessment.

Table 6-7 Sub-catchment 4 overview

ID	WFD catchment	Key Source	Current TP Load (Tn / Yr)	SAC Status	Target TP Load (Tn / Yr)	Target Reduction (%)	Comment
4.1	GB110061038670 - W Cleddau - headwaters to conf with Cleddau North	Agriculture (67%)	0.98	Fail	0.63	36%	Mitigation required to address compliance failure.

As Figure 6-4 shows, improvements to WwTW in the catchment already go a significant way towards achieving the compliance target, providing an estimated 0.28 Tn / yr reduction. Furthermore, the improved permit at Castlemoris will be 4mg/l meaning it is listed as a Category B1 WwTW under DCWW's collaboration categories, i.e., is eligible for further collaboration opportunities such as constructed wetlands to further improve P removal. As such, an opportunity to remove 0.38 tn / yr is available if these measures are delivered / explored. This would be sufficient to achieve compliance.

However, given uncertainty with the feasibility of delivering wetlands, discussed earlier in this plan, it is important to also focus on agricultural inputs, particularly given these remain the most significant contribution in the catchment. CoAP, Farm Source Control and SFS measures offer an opportunity to realise a further 0.17 t/yr reduction in TP export to the catchment. In addition, there is opportunity to explore riparian buffers and other nature-based solutions that could deliver reductions up to 0.18 T/yr.

Generic Actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture will be vital to addressing compliance in the Narbeth brook. This should be proactively explored, including an assessment of the catchments agricultural profile, no. of farms, type of farming, collaboration opportunities.
- Wetlands: A collaboration opportunity exists in this catchment and should be explored in further detail. Work to resolve current uncertainty around wetland adoption is required as per the holistic actions to ensure this measure can be delivered.
- Private Sewerage: Mapping suggests a significant no. of private sewerage assets in the Narbeth catchment, which if improved could improve conditions. It should be noted that there are limitations to the

current modelling of these assets in source apportionment models and so the impact of this measure should be further investigated. This also does not include exempt discharges to the catchment. This should be investigated in the Narbeth catchment.

- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export. This could include focussed citizen science efforts in the failing catchment.

In summary, based on current information, Sub-catchment 4 requires action to address phosphorus compliance. Planned enhancement works at the WwTWs in the catchment go a long way towards meeting the compliance target for the catchment. Were a constructed wetland also delivered at the Category B1 WwTW, this would likely be sufficient to meet compliance. However, exploration of measures to address agricultural exports should also be explored, particularly given uncertainty around wetlands. Furthermore, any additional measures in this upstream catchment, beyond compliance, could assist in improving the situation downstream, for example, this catchment feeds into sub-catchment 6.

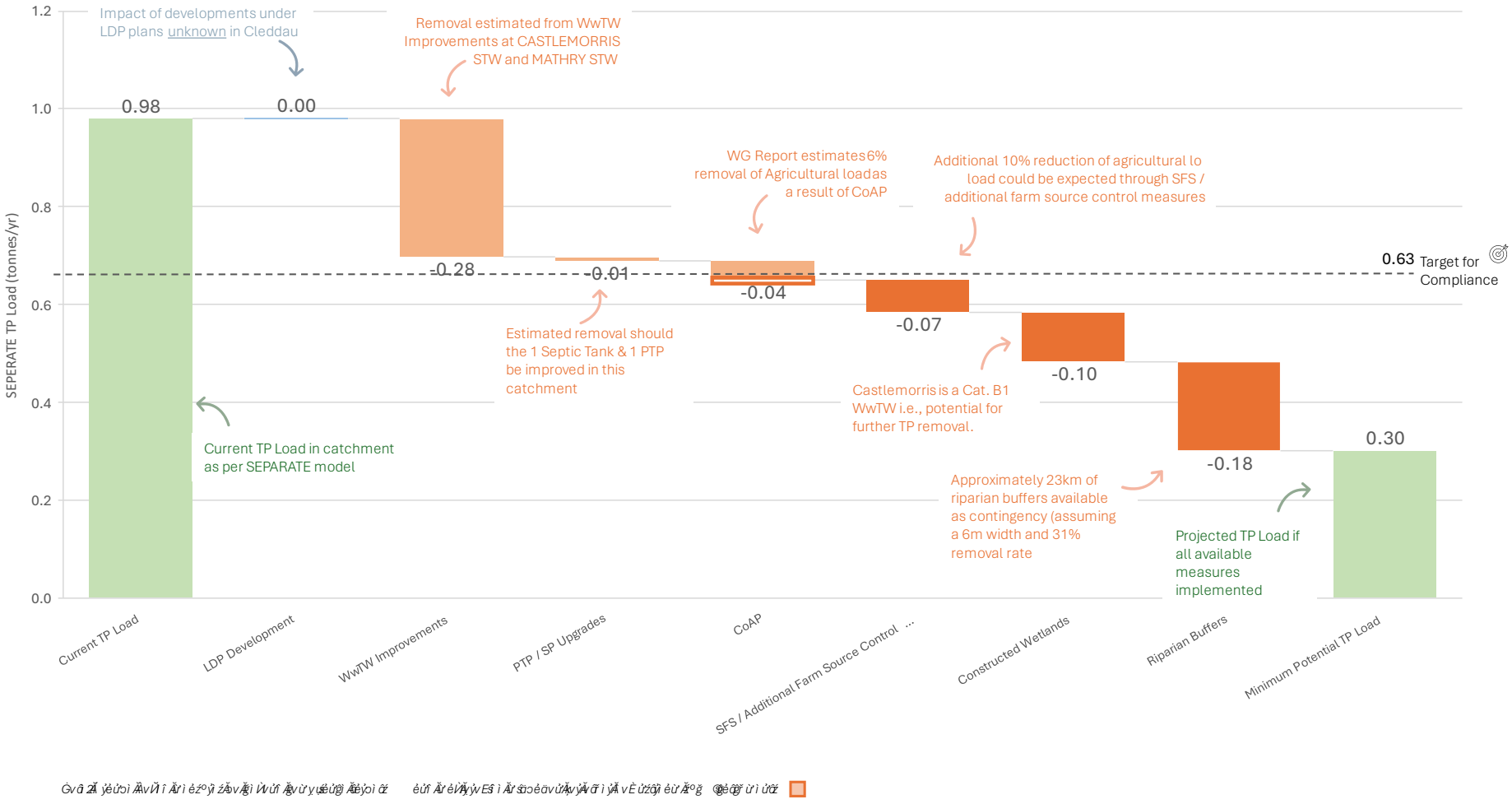

Figure 6-4 Sub-catchment 4 waterfall chart.

Table 6-8 Sub-catchment 4 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Work with key stakeholders to ensure that CoAP is successfully implemented in this catchment.	Important to achieve SAC Compliance and secure long-term health across wider catchment.	Up to 0.11	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF –remit to work collaboratively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	Lead stakeholders - provide details of CoAP activities in this catchment, including details of farm compliance in key catchments, documentation of failures, and timescales for delivering benefits.
Farm Source Control and SFS	Proactively explore opportunities to implement measures to reduce P export in the catchment from farms. Establishment of 'Zero flow' farms could be explored in line with the holistic actions around farm source control.	Important action given uncertainty around Wetlands and potential for improvements in this catchment to support downstream efforts.	Up to 0.07	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Enhanced WwTW	Improvements at Mathry WwTWs.	As part of the RoP and DCWW's Improvement plans, this asset will be upgraded to deliver enhanced P removal	0.28	2025-2030	-	DCWW will oversee the planned improvement works and can provide updates to the NMB	4 – 5	DCWW to provide an update	DCWW to provide regular updates to the NMB
Wetlands	Opportunity for constructed wetlands at Castlemoris	A constructed wetland at Castlemoris is available considering DCWW's collaboration categorisation (Cat. B1). This could remove additional P from the catchment, above the upgrades already planned at this WWTW.	Estimated 0.1	TBC	CAPEX up to £300,000 assuming a 1ha wetland at £30/m^3 Annual OPEX up to £1,000/yr Based on EA Report– SC080039/R9 £0.1 / m^2 of wetland surface area for estimating ongoing annual maintenance costs	NMB, NRW and DCWW to work collaboratively on taking this opportunity forwards.	1	Locations flagged in the catchment (Appendix D) Estimation of reduction potential calculated.	Clarify / resolve adoption policy for wetlands. Progress to Technical Feasibility i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	This measure could prove important for downstream catchments, assuming other measures listed above are delivered. Details on sediment transport risk are highlighted in Appendix D and can guide where to focus efforts. Nature Based Solution such as woodland planting should be explored. Existing measures, if they are progressing, should be highlighted, quantified and tracked.	Up to 0.18	TBC	CAPEX up to £230,000 assuming full mitigation opportunity realised. Annual OPEX up to £1,200/yr assuming full mitigation opportunity realised. This assumes riparian buffers only, exact split of other nature-based solutions too uncertain to quantify. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.5 Sub-Catchment 5

Sub-catchment 5, on the Western Cleddau, contains a 2 WFD waterbody catchments (Nant y Bugail - headwaters to conf with Cleddau N.and Cleddau North - H'waters to conf with W. Cled), including the tributary Nant y Bugail. The catchment is predominantly rural, with only a small number of settlements. Panteg is the notable WwTW in the catchment.

Neither catchment was assessed for SAC compliance in the most recently available report. The overall WFD status for each waterbody is moderate. This creates uncertainty as to the current status of the catchments. However, considering that catchments downstream experience widespread failures (particularly in sub-catchment 8), it remains important to explore mitigation opportunities in this catchment.

Figure 6-5 presents an overview of the total opportunity available in the catchment broken down by focus area. This shows that through CoAP, Farm Source Control and SFS measures, there is an opportunity to remove more than 0.2 Tn / yr. Furthermore, opportunities for riparian buffers and other nature-based solutions could be explored across the catchment. Finally, planned improvements at Panteg STW will remove 0.03 tn / yr when complete. These actions combined, can assist in securing long-term compliance of these catchments whilst providing benefits for downstream.

Generic Actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture could prove important in securing future compliance of the catchment whilst also improving the situation for downstream catchments.
- Promote natural flood management: Peak flow events exacerbate the potential for nutrient pollution with increased surface water runoff, mobilising P-rich sediment, and the frequency of these events is predicted to increase with climate change. Efforts to slow the flow could not only reduce P export to the catchment but reduce the risk of flooding downstream through better regulated flows. Liaise with NRW and Local Council to understand whether measures are already being explored to this end.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export. This could include focussed monitoring efforts in this catchment by citizen science groups.

Table 6-9~~Table 6-9~~ presents an action plan table which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

In summary, based on current information, Sub-catchment 5 does not require immediate or urgent action to address P compliance. However, given the uncertainty attached to the current assessment period, measures should still be explored. Efforts in this catchment may offer benefits to downstream catchments.

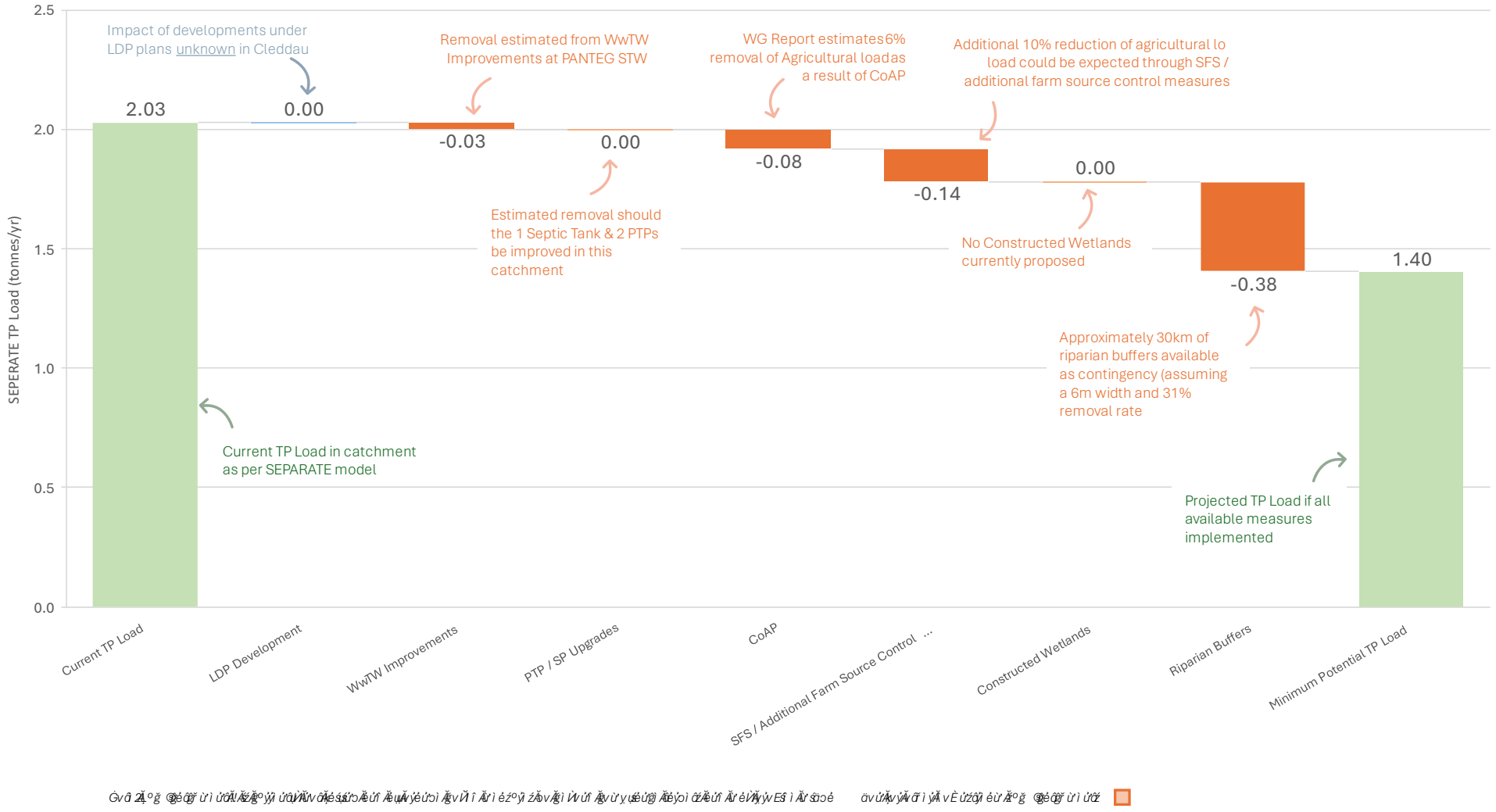

Figure 6-5 Sub-catchment 5 waterfall chart.

Table 6-9 Sub-catchment 5 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Agriculture a primary source of P in the catchment. Compliance with regulations offers a chance.	Important to maintaining SAC compliance and improving situation downstream	Up to 0.08	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF –remit to work collaboratively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	NRW - provide details of CoAP activities in this catchment, including timescales for delivering benefits.
Farm Source Control and SFS	Investigate farms willing to consider voluntary measures to reduce P export in the catchment	Agriculture the dominant source of P in catchment. Whilst the catchment is passing, improvements could support downstream catchments.	Up to 0.14	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities in catchment. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Enhanced WwTW	Improvements at Panteg WwTWs	As part of the RoP and DCWW's Improvement plans, this asset will be upgraded to deliver enhanced P removal	0.03	2025-2030	-	DCWW will oversee the planned improvement works and can provide updates to the NMB	4 – 5	DCWW to provide an update	DCWW to provide regular updates to the NMB
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	Whilst not a priority for SAC compliance, there is an opportunity for nature-based solutions to improve the resilience of the catchment and improve water quality more generally.	Up to 0.38	TBC	CAPEX up to £300,000 assuming full mitigation opportunity implemented Annual OPEX up to £1,500 per year assuming full mitigation opportunity realised. This has assumed riparian buffers are adopted, exact split of other nature-based solutions too uncertain to quantify at this stage. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.6 Sub-Catchment 6

Sub-catchment 6, on the Western Cleddau, contains a single WFD waterbody (W Cleddau - Cleddau North to Anghof conf). The catchment is predominantly rural, with only a small number of settlements. Letterston West is the notable WwTW in the catchment.

The catchment is currently failing its SAC compliance targets being approximately 8% above its target. The overall WFD status of the waterbody is Moderate. Table 6-10 below highlights the picture within this sub-catchment for all waterbodies assessed by the SAC P compliance assessment.

Table 6-10 Sub-catchment 6 overview

ID	WFD catchment	Key Source	Current TP Load (Tn / Yr)	SAC Status	Target TP Load (Tn / Yr)	Target Reduction (%)	Comment
6.1	GB110061038651 - Western Cleddau - Cleddau North to Anghof conf	Agriculture (50%)	2.1	Fail	1.93	8%	Mitigation required to address compliance failure.

Figure 6-6 presents an overview of the total opportunity available in the catchment broken down by focus area. This shows that the removal estimated at Letterston West STW offers a significant reduction in P within the catchment at 0.58 Tn / yr. This is enough to bring the catchment back into compliance.

However, agriculture is also a key source of P (in fact the largest source) and so measures relating to CoAP, Farm Source Control and SFS should not be discounted. These offer a combined opportunity to remove 0.17 Tn / yr. In addition, opportunities for riparian buffers and other nature-based solutions offer a potential removal of 0.39 Tn / yr. By exploring these actions, pressure on downstream catchments can be relieved.

Generic Actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture could prove important in securing future compliance of the catchment whilst also improving the situation for downstream catchments.
- Promote natural flood management: Peak flow events exacerbate the potential for nutrient pollution with increased surface water runoff, mobilising P-rich sediment, and the frequency of these events is predicted to increase with climate change. Efforts to slow the flow could not only reduce P export to the catchment but reduce the risk of flooding downstream through better regulated flows. Liaise with NRW and Local Council to understand whether measures are already being explored to this end.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export. This could include focussed monitoring efforts in this catchment by citizen science groups.

Table 6-11~~Table 6-11~~ presents an action plan table which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

In summary, based on current information, Sub-catchment 6 requires action to address P compliance. Currently, planned measures at Letterston WwTW are projected to sufficiently reduce P export and achieve compliance. However, catchments further downstream have more difficult challenges, and so efforts to explore mitigation to further reduce P should be explored, focussing on agricultural sources.

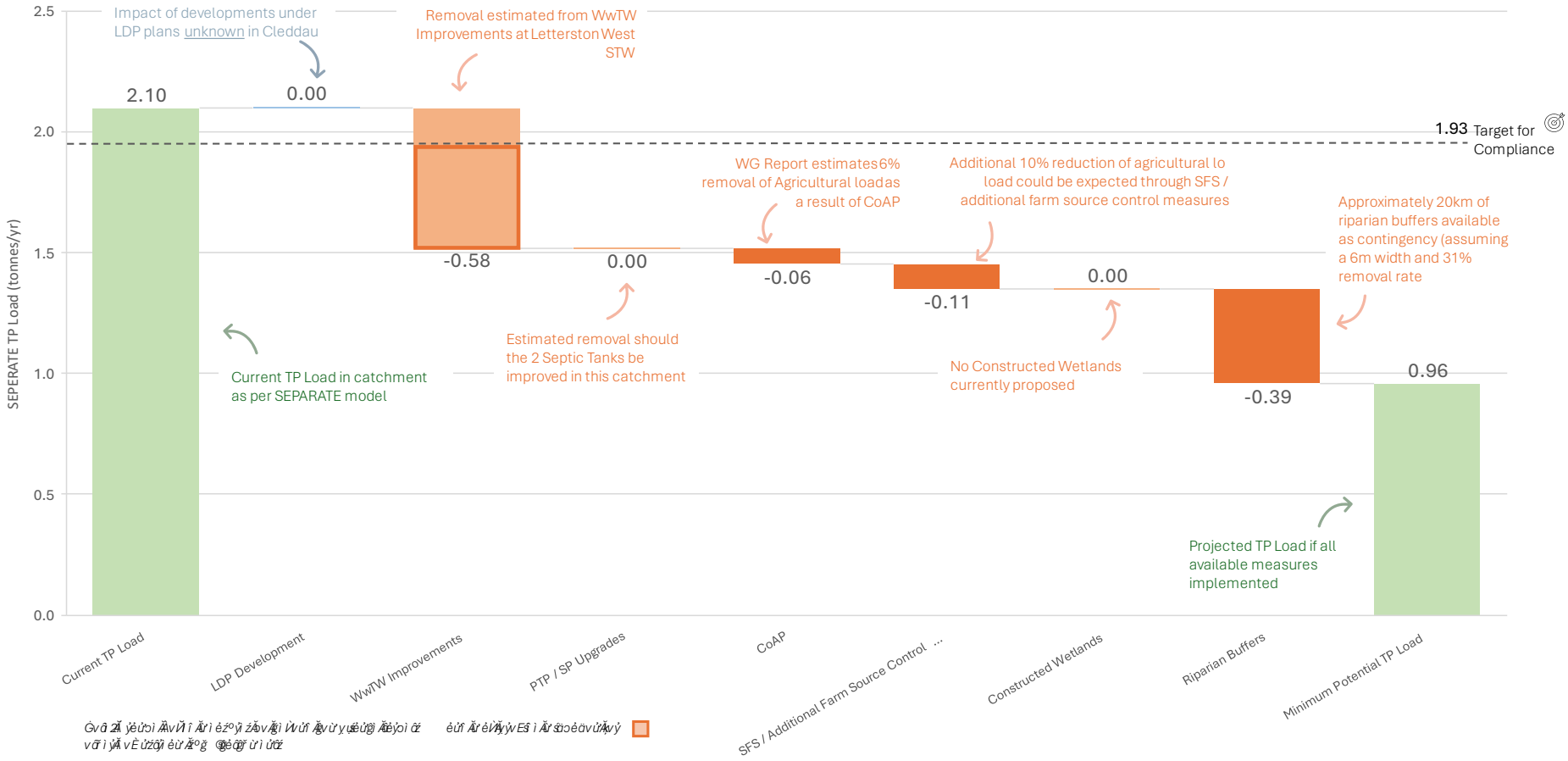

Figure 6-6 Sub-catchment 6 waterfall chart.

Table 6-11 Sub-catchment 6 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Agriculture a primary source of P in the catchment. Compliance with regulations offers a chance.	Important to maintaining SAC compliance and improving situation downstream	Up to 0.06	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF –remit to work collaboratively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	NRW - provide details of CoAP activities in this catchment, including timescales for delivering benefits.
Farm Source Control and SFS	Investigate farms willing to consider voluntary measures to reduce P export in the catchment	Agriculture the dominant source of P in catchment. Whilst the catchment is passing, improvements could support downstream catchments.	Up to 0.11	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities in catchment. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Enhanced WwTW	Improvements at Letterston West STW	As part of the RoP and DCWW's Improvement plans, this asset will be upgraded to deliver enhanced P removal	0.58	2025-2030	-	DCWW will oversee the planned improvement works and can provide updates to the NMB	4 – 5	DCWW to provide an update	DCWW to provide regular updates to the NMB
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	Whilst not a priority for SAC compliance, there is an opportunity for nature-based solutions to improve the resilience of the catchment and improve water quality more generally.	Up to 0.39	TBC	CAPEX up to £200,000 assuming full mitigation opportunity implemented Annual OPEX up to £1,500 per year assuming full mitigation opportunity realised. This has assumed riparian buffers are adopted, exact split of other nature-based solutions too uncertain to quantify at this stage. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.7 Sub-Catchment 7

Sub-catchment 7, on the Western Cleddau, contains a single WFD waterbody (Anghof - headwaters to conf with Western Cleddau). The catchment is predominantly rural, with only a small number of settlements. Two WwTW are notable in the catchment, Puncheston and Wolfscastle.

The catchment is currently failing its SAC compliance targets being approximately 3% above its target. The overall WFD status of the waterbody is Moderate. Table 6-12 below highlights the picture within this sub-catchment for all waterbodies assessed by the SAC P compliance assessment.

Table 6-12 Sub-catchment 7 overview

ID	WFD catchment	Key Source	Current TP Load (Tn / Yr)	SAC Status	Target TP Load (Tn / Yr)	Target Reduction (%)	Comment
6.1	GB110061038690 - Anghof - headwaters to conf with Western Cleddau	Agriculture (78%)	2.56	Fail	2.48	3%	Mitigation required to address compliance failure.

Figure 6-7 presents an overview of the total opportunity available in the catchment broken down by focus area. This shows that through CoAP,Farm Source Control and SFS measures, there is an opportunity to remove more than 0.32 Tn / yr, well above the required reduction to achieve compliance in this catchment. Furthermore, opportunities for constructed wetlands may exist at the two WwTW in the catchment, as they are both Category B1. Finally, there remains opportunity to explore riparian buffers or other nature-based solutions, offering a further reduction opportunity of 0.48 tn / yr.

Generic Actions for this catchment are:

- Promotion of policy and legislative compliance (CoAP): Important in realising the 6% reduction in TP estimated from CoAP. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture could prove important in securing compliance of the catchment whilst also improving the situation for downstream catchments.
- Promote natural flood management: Peak flow events exacerbate the potential for nutrient pollution with increased surface water runoff, mobilising P-rich sediment, and the frequency of these events is predicted to increase with climate change. Efforts to slow the flow could not only reduce P export to the catchment but reduce the risk of flooding downstream through better regulated flows. Liaise with NRW and Local Council to understand whether measures are already being explored to this end.
- Wetlands: A collaboration opportunity exists in this catchment and should be explored in further detail. Work to resolve current uncertainty around wetland adoption is required as per the holistic actions to ensure this measure can be delivered.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.

- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export. This could include focussed monitoring efforts in this catchment by citizen science groups.

Table 6-13~~Table 6-13~~ presents an action plan table which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

In summary, based on current information, Sub-catchment 7 requires action to address P compliance. Given the relatively small % reduction needed in this catchment, actions proposed under CoAP and Farm Source Control are likely to be sufficient. However, further opportunities including constructed wetlands at the category B WwTW offering opportunities to go beyond compliance and provide benefits for the struggling catchments downstream.

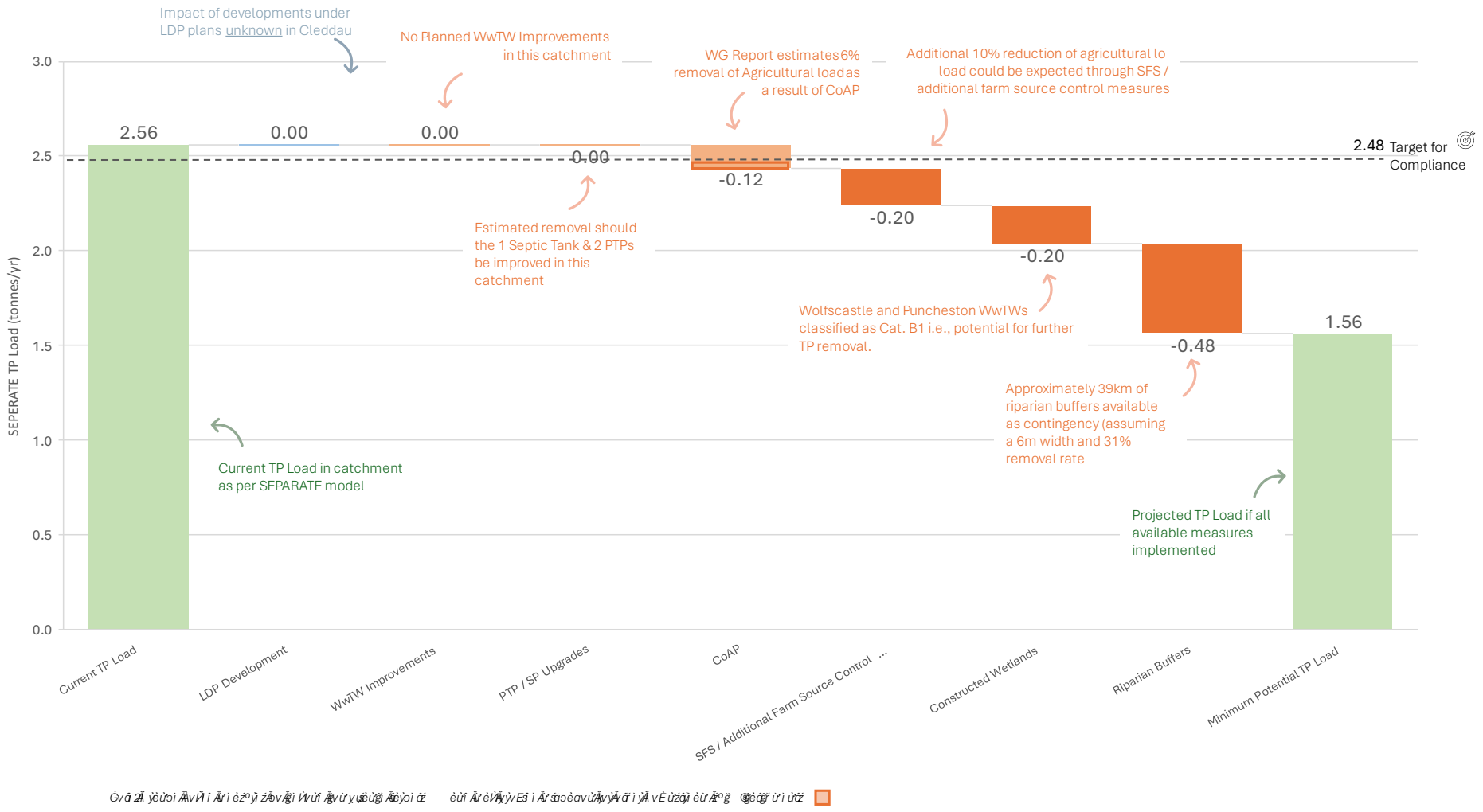

Figure 6-7 Sub-catchment 7 waterfall chart.

Table 6-13 Sub-catchment 7 action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Work with key stakeholders to ensure that CoAP is successfully implemented in this catchment.	Important to achieve SAC Compliance and secure long-term health across wider catchment.	Up to 0.12	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF –remit to work collaboratively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	Lead stakeholders - provide details of CoAP activities in this catchment, including details of farm compliance in key catchments, documentation of failures, and timescales for delivering benefits.
Farm Source Control and SFS	Proactively explore opportunities to implement measures to reduce P export in the catchment from farms. Establishment of 'Zero flow' farms could be explored in line with the holistic actions around farm source control.	Important action given uncertainty around Wetlands and potential for improvements in this catchment to support downstream efforts.	Up to 0.20	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment.	Engage farming community to discuss mitigation opportunities. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Wetlands	Opportunity for Constructed Wetlands at Puncheston and Wolfscastle	Constructed Wetlands possible considering DCWW's collaboration categorisation (Cat. B1). This could remove additional P from the catchment.	Estimated 0.2	TBC	CAPEX up to £300,000 assuming a 1ha wetland at £30/m^3 Annual OPEX up to £1,000/yr Based on EA Report– SC080039/R9 £0.1 / m^2 of wetland surface area for estimating ongoing annual maintenance costs	NMB, NRW and DCWW to work collaboratively on taking this opportunity forwards.	1	Locations flagged in the catchment (Appendix D) Estimation of reduction potential calculated.	Clarify / resolve adoption policy for wetlands. Progress to Technical Feasibility i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	This measure could prove important for downstream catchments, assuming other measures listed above are delivered. Details on sediment transport risk are highlighted in Appendix D and can guide where to focus efforts. Nature Based Solution such as woodland planting should be explored. Existing measures, if they are progressing, should be highlighted, quantified and tracked.	Up to 0.48	TBC	CAPEX up to £390,000 assuming full mitigation opportunity realised. Annual OPEX up to £1,200/yr assuming full mitigation opportunity realised. This assumes riparian buffers only, exact split of other nature-based solutions too uncertain to quantify. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

6.2.8 Sub-Catchment 8

Sub-Catchment 8 is the largest in this study and most challenging. Of the 8 WFD waterbodies in the catchment, 5 are included in the riverine SAC. All 5 are failing to meet compliance targets for P. The predominant source of P in the catchment is agriculture. In this catchment, a significant percentage of the farms relate to livestock, mostly cattle.

The overall WFD status of the waterbody is Moderate to High, with the exception of the Millin Brook - headwaters to tidal limit, which is classified as Poor. Table 6-14 below highlights the picture within this sub-catchment for all waterbodies assessed by the SAC P compliance assessment.

Table 6-14 Sub-Catchment 8 overview

ID	WFD catchment	Key Source	Current TP Load (Tn / Yr)	SAC Status	Target TP Load (Tn / Yr)	Target Reduction (%)	Comment
8.1	GB110061031340 - W Cleddau - Anghof conf to Cartlett Brook conf	Agriculture (68%)	1.8	Fail	1.39	23%	Required reduction in catchment to achieve target.
8.4	GB110061031180 - Camrose Brook - headwaters to conf with W. Cleddau	Agriculture (66%)	1.63	Fail	0.89	45%	Required reduction in catchment to achieve target.
8.3	GB110061031190 - Rudbaxton Water - HW to conf with W. Cleddau	Agriculture (79%)	1.15	Fail	0.33	71%	Required reduction in catchment to achieve target. Note: if 50% reduction is achieved in 8.5, target reduction could reduce.
8.6	GB110061031330 - Cartlett Brook - HW to conf with W. Cleddau	Agriculture (72%)	2.67	Fail	0.90	66%	Required reduction in catchment to achieve target.
8.2	GB110061031350 - Spittal Brook - headwaters to conf with W. Cleddau	Agriculture (85%)	0.88	Fail	0.69	22%	Required reduction in catchment to achieve target.

Across the five catchments, a total reduction of 3.93 Tn / yr is required, representing an overall 34% reduction in P loading within the catchment. However, in some of the catchments presented in Table 6-14, the challenge is far more pronounced with reductions of up to 71% required. Figure 6-8, therefore, is useful in demonstrating that theoretically there is sufficient opportunity for mitigation in the catchment i.e., delivery of category 1

measures to support development should not impede the ability to deliver category 2 measures. However, this does not mean that meeting compliance will be straightforward.

Firstly, the spatial element cannot be ignored, including connectivity of upstream catchments. According to their IDs (as per Table 6-14), 8.2, 8.3, 8.4 and 8.5 discharge to catchment 8.1 (where a 23% reduction is required). Catchment 8.1 will already receive inputs from further upstream including remaining sub-catchment 4, 5 and 6 in the Western Cleddau where two of them are currently failing their SAC P targets. As discussed in these previous sections, if additional measures to reduce P in these upstream catchments are pursued, then could go some way towards achieving compliance in 8.1.

However, most challenging will be the reductions in the remaining smaller failing SAC tributaries in Sub-catchment 8 where agricultural inputs are high and the reduction needs far more significant in terms of % and TP than other catchments considered. These failing SAC catchments will not benefit from upstream interventions, and so the reduction needs to be driven by measures introduced locally. The 6% and 10% reductions available through CoAP, Farm Source Control and SFS measures will not go far enough to address the issues. Furthermore, whilst Category B WwTWs are present, these occur in catchment 8.1, 8.2 and 8.4 and so won't address the two most significant challenges; Rudbaxten water (8.3) and Cartlett Brook (8.6).

Whilst 128km of riparian buffer and other nature-based solution opportunity have been identified, the sheer scale at which this would need to be delivered in each failing catchment is unlikely to be achieved. As such, other measures need to be explored urgently, addressing the root causes of high P levels in the lower reaches of the Cleddau. Issues of soil quality, farm practices management, and legacy P will be most pressing in these areas of the catchment.

Generic Actions for this catchment are:

- Data Gaps: The issue of data quality is perhaps most pressing in this catchment. Identifying the size, scale, livestock numbers associated to each farm, the P sources and levels in the soils (both legacy and new) and drainage characteristics of each farm is the only way to make progress in this challenging catchment. The holistic actions around data gaps should be progressed urgently in order to tackle the issues faced in the lower reaches of the Western Cleddau.
- Agricultural Land Management Taskforce: The holistic action to form a task force exploring impact of agriculture on the Cleddau and measures to address currently high exports should focus efforts on sub-catchment 8. This needs to focus on soil health / quality, nutrient management plans that readdress the balance of nutrient in vs. out of the catchment and other key challenges.
- Additional modelling: Further, more granular modelling of the failing SAC catchments may aid addressing P compliance. At the least, this could be exploring measures at individual failing waterbody level. However, opportunities could be explored for more detailed modelling inc. use of the DCWW's SAGIS model with additional enhancements to test proposed NMP interventions as per the holistic actions presented earlier in this section.
- Catchment based approach: As mitigation measures (across the Western Cleddau) are brought forward and realised, it will be important to consider the downstream benefits and understand how measures upstream are improving conditions downstream.
- Promotion of policy and legislative compliance (CoAP): Important in maximising reduction in TP estimated from CoAP so that the benefits will be higher than the 6% average estimate currently applied. The higher the compliance with regulations, the greater the chance of meeting or even exceeding this estimate.
- Farmer Engagement: Voluntary measures in this catchment to control diffuse sources of P from agriculture could prove important in securing compliance of the catchment whilst also improving the situation for downstream catchments.

- Promote natural flood management: Peak flow events exacerbate the potential for nutrient pollution with increased surface water runoff, mobilising P-rich sediment, and the frequency of these events is predicted to increase with climate change. Efforts to slow the flow could not only reduce P export to the catchment but reduce the risk of flooding downstream through better regulated flows. Liaise with NRW and Local Council to understand whether measures are already being explored to this end.
- Wetlands: Collaboration opportunities exist in this catchment and should be explored in further detail. Work to resolve current uncertainty around wetland adoption is required as per the holistic actions to ensure this measure can be delivered.
- Local Development Plans (LDP): The impact of the LDP is currently unknown, this should be confirmed with the council, i.e., are there developments planned in this catchment, what impact could they have and what Category 1 measures would be required to offset.
- Continue to monitor water quality within the catchment, particularly if measures are introduced to mitigate P export. This could include focussed monitoring efforts in this catchment by citizen science groups.

Table 6-15 presents an action plan table which should be kept up to date by the lead stakeholders. Next steps should be actioned and updated as per the approach set out in Section 7. The table only includes mitigation measures identified as medium or high priority under the options appraisal (section 5).

In summary, sub-catchment 8 is in urgent need of mitigation. The measures currently identified, at a high-level, demonstrate a clear challenge around implementation. Without intervention, that goes beyond voluntary measures on farms or current compliance regulations, the situation in the lower reaches of the Western Cleddau will not improve. Whilst the NMB and its stakeholders should continue to pursue opportunities, a robust plan to meet compliance in this catchment is not currently achievable. Addressing data gaps with regards to agricultural sources will go some way to better understanding what needs to be done. However, this needs to be carried out in tandem with a targeted look at options within the catchment to address the current balance of nutrients in / out of the catchment.

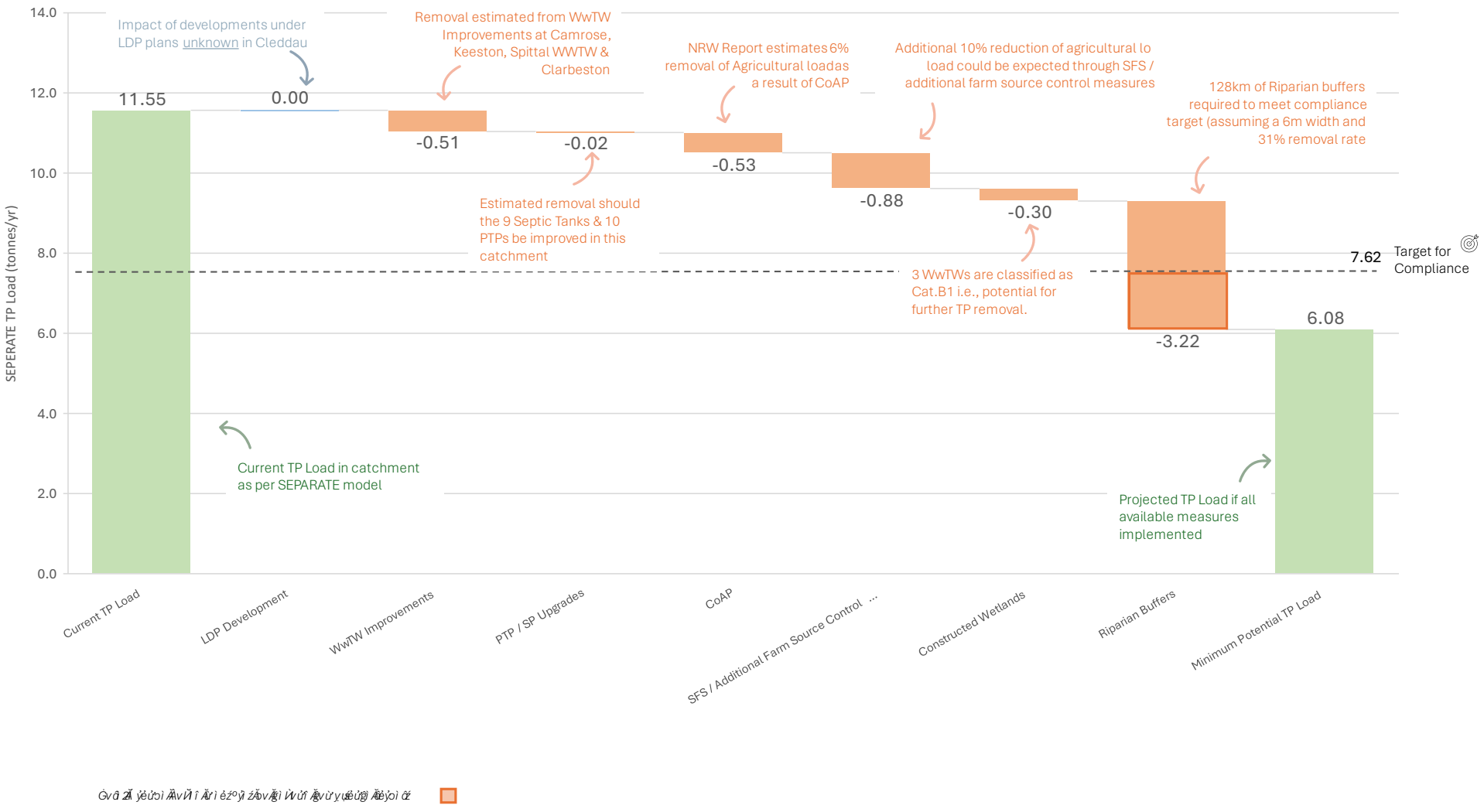

Figure 6-8: Sub-catchment 8 waterfall chart.

Table 6-15 Sub-Catchment 8 Action tracker

Focus Area	Action	Detail	Total P removal estimate (t/yr)	Timescales	Cost estimate (£)	Lead Stakeholder(s) & Responsibilities	Gateway	Progress so far	Next Steps
CoAP	Work with key stakeholders to ensure that CoAP is successfully implemented in this catchment.	Important to achieve SAC Compliance and secure long-term health across wider catchment.	Up to 0.53	TBC	NRW have calculated nationally – excluded from calculations as funding not required from NMB.	WG – to ensure legal requirements are set. NRW – Enforcement of regulations. WLMF –remit to work collaboratively towards aims of CoAP.	1	Senedd CoAP report produced estimating the benefits of CoAP and costs / benefits associated with delivery.	Lead stakeholders - provide details of CoAP activities in this catchment, including details of farm compliance in key catchments, documentation of failures, and timescales for delivering benefits.
Farm Source Control and SFS	Proactively explore opportunities to implement measures to reduce P export in the catchment from farms.	Agriculture the dominant source of P in catchment. Establishment of 'Zero flow' farms could be explored in line with the holistic actions around farm source control. Emphasis needed on how to achieve or surpass the 10% estimate.	Up to 0.88	TBC	TBC – work ongoing with farmers to consider payments required to incentivise voluntary measures. More work needed.	NMB and wider stakeholder groups – engage with landowners / farmers to identify those willing to collaborate on voluntary schemes or already participating.	1	Good examples and case studies within the Cleddau catchment – First Milk particularly relevant in this catchment.	Engage farming community to discuss mitigation opportunities. Identify potential locations for interventions, focussing on areas of high sediment transport risk first (see Appendix D) At high-level. quantify potential impacts of measures.
Enhanced WwTW	Improvements at Camrose, Keeston, Clarbeston and Spittal WwTWs.	As part of the RoP and DCWW's Improvement plans, these assets will be upgraded to deliver enhanced P removal	0.51	2025-2030	-	DCWW will oversee the planned improvement works and can provide updates to the NMB	4 – 5	DCWW to provide an update	DCWW to provide regular updates to the NMB
Wetlands	Opportunities at three Category B WwTW.	An opportunity for CONSTRUCTED WETLANDS at Castlemoris is available considering DCWW's collaboration categorisation (Cat. B1). This could remove additional P from the catchment, above the upgrades already planned at this WWTW.	Estimated 0.3	TBC	CAPEX up to £900,000 assuming a 1ha wetland at £30/m^3 Annual OPEX up to £3,000/yr Based on EA Report– SC080039/R9 £0.1 / m^2 of wetland surface area for estimating ongoing annual maintenance costs	NMB, NRW and DCWW to work collaboratively on taking this opportunity forwards.	1	Locations flagged in the catchment (Appendix D) Estimation of reduction potential calculated.	Clarify / resolve adoption policy for wetlands. Progress to Technical Feasibility i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.
Riparian buffers & other Nature Based Solutions	Investigate opportunities to deliver riparian buffers or other nature-based solutions (see Appendix C-1 for complete list)	This measure could prove important for downstream catchments, assuming other measures listed above are delivered. Details on sediment transport risk are highlighted in Appendix D and can guide where to focus efforts. Nature Based Solution such as woodland planting should be explored. Existing measures, if they are progressing, should be highlighted, quantified and tracked.	Up to 3.22	TBC	CAPEX up to £1,280,000 assuming full mitigation opportunity realised. Annual OPEX up to £6,500/yr assuming full mitigation opportunity realised. This assumes riparian buffers only, exact split of other nature-based solutions too uncertain to quantify. Further work needed as measures are brought forward.	NMB & wider stakeholder group	2	Riparian buffer locations have been identified through a desktop assessment, and sediment risk ratings mapped to identify areas of greatest impact (See Appendix D).	Progress to Technical Feasibility, where landowner buy-in is forthcoming i.e., identifying preferred potential options in the catchment and working through requirements of Gateway 2.

* Based on £10/m for 20m wide field margin for up to 130km of riparian buffer lengths and does not include annual maintenance costs.

** Based on £30/m^3 for 1ha + 25% buffer and does not include annual maintenance costs

6.3 Implementation Method

6.3.1 Overview

Implementation of mitigation measures will require design, funding and compliance. This section will outline the practicalities of delivering mitigation.

6.3.1.1 Design support

Appendix C presents a suite of solutions for phosphorus removal alongside their wider environmental benefits, potential delivery partners and elements to consider for feasibility. A library of case studies will be compiled to support the design and evidence base for mitigation measures. A number of sources have been cited within this document but engagement with and compilation of “live” projects will greatly facilitate delivery. A link to similar assessments and case studies should also be provided such as those presented in Appendix C but with greater detail, potentially to a prescribed template with some geographical data and costs to be integrated into an overall delivery platform.

6.3.1.2 Compliance facilitation

For priority options it is necessary to identify early-stage needs for stakeholder engagement or development of planning documentation including Habitats Regulations Assessment (HRA) screening, Environmental Impact Assessment (EIA) etc.

Currently it is likely that some form of HRA would need to be undertaken at a plan level for strategically planned interventions. Individual HRA’s may be required for individual opportunities. Any plan based HRA could also provide templates and guidance for could be provided project level HRAs (by opportunity) to streamline the requirements and reduce the time spent by stakeholders when bringing forward various opportunities.

6.3.1.3 Business case facilitation

Implementation of mitigation measures will be facilitated by taking a gateway approach to the potential interventions. The priority which has been defined by area and measure requires funding and delivery. Gateways and/or project stages must be linked closely to business case development e.g., maturity of design at Outline Business Case vs. Full Business Case. Where possible interventions should be aligned towards maximum multifunctional benefits and benefit stacking should be explored where possible. Funders for such projects would be a mixture of public, regulated and private companies such as:

Regulatory Water Related

- Ofwat Innovation Fund
- DCWW Community Fund

National Lottery

- Community Fund
- Local Places for Nature Fund
- Nature Networks Fund
- The Woodland Investment Grant

National Government

- The Levelling Up Fund

Welsh Government

- Rural Schemes
- NRW grants
- Sustainable Farming Scheme
- Multi-Annual Support Plan Agriculture

Private Investor

- Woodland Carbon Code
- Nutrient Trading Scheme
- Net Benefit for Biodiversity
- Carbon Credit trading

6.3.2 Intervention Gateways

When bringing interventions forward, it is important to present the priority and gateway stages that these interventions are at. Gateways 1 to 6 below outline this process. These interventions could be practical mitigation or collaboration and awareness raising items.

- **Gateway 0 – Identify and quantify the need:** High-level quantification of the mitigation requirement and broad location of intervention**.**
- **Gateway 1 – Identification of opportunity:** Produce a project concept note.
- **Gateway 2 – Technical feasibility and outline planning:** Identify a preferred option; undertake a high-level cost benefit analysis, environmental constraints, technical assessment (e.g. EIA/HRA/WFD compliance scoping etc.)
- **Gateway 3 – Funding and selection of option:** Appraise the option for viability; confirm governance agreement on progression.
- **Gateway 4 – Detailed design and planning:** Detailed Cost Benefit Analysis undertaken on the detailed design; detailed assessments (e.g. EIA/HRA/WFD compliance etc.); planning application approved; targets set.
- **Gateway 5 – Implementation:** Contractors and contractor documents appointed and created; construction.
- **Gateway 6 – Monitoring and Management:** Monitoring of success feeding back into management of the opportunity.

6.3.3 Tracking Measures

Each sub-catchment plan currently has an action tracking table. It is recommended that these tables are updated by stakeholder with specific measures being explored in the catchment. The current high-level actions should in time be replaced or built upon with more specific interventions e.g., as wetlands, buffer strips or farm level efforts are brought forward, they should be quantified, costed and built into the action plans. As the NMP is updated, these action tables should allow stakeholders and the NMB to track how measures are progressing.

7 Monitoring and Management

Monitoring and management of the Nutrient Management Plan represents a unique challenge for the NMB. Actions identified within this plan range from holistic actions such as addressing evidence gaps to specific interventions targeted at off-setting known development. Furthermore, actions have been split into Category 1 and 2 measures, and further controlled by gateways to help aid the implementation of measures and tracking of progress.

The ultimate aim is to mitigate the known impacts of additional development within the Afonydd Cleddau catchment (as per the LDPs from each local authority) through implementation of Category 1 measures whilst also delivering Category 2 measures to provide wider reductions in nutrient export to the Afonydd Cleddau and contribute to restoring the SAC to favourable condition.

The action plans highlighted in Section 6 has focussed on interventions where the NMB has a key role to play. However, there is clearly a much wider stakeholder group within this catchment contributing positively to the issue of nutrient management. For the NMB to be successful in its aims and efficient in its implementation, several means of monitoring pressures and tracking progress must be developed whilst encouraging more collaborative engagement at all levels.

7.1 Monitoring Stakeholder Progress

As discussed in the introduction to this section, several stakeholders of importance to the Afonydd Cleddau SAC have a duty to avoid deterioration and/or restore favourable conservation status of the SAC. As such they are implementing solutions and/or collecting key datasets that will be important to the NMB when considering progress.

Much of the data on which the current ecological conditions of the SAC have been assessed is very old, some greater than 20 years, disparately reported and may not have been undertaken to standard survey methods. Having better SAC qualifying feature data could impact on the approach the NMB and stakeholders may take to water quality improvement.

There are a variety of projects (both existing and planned) within the Afonydd Cleddau SAC which will all have a direct impact on restoring the riverine SAC back to favourable conditions. Further mapping of planned and on-going restoration works within the catchment could be brought into a database / web viewer to provide a single source of understanding on nature-based solutions (NbS) within the Afonydd Cleddau.

This, combined with a more robust monitoring programme from NRW, would allow for greater insight into the achievements and effectiveness of these projects within the waterbody and overall SAC health. At present, it is unclear what impact a number of schemes are having on the Afonydd Cleddau SAC.

It is recommended that key stakeholders are approached to confirm existing reporting mechanisms and agree a way forward which minimises additional work for all parties whilst ensuring clear tracking of projects and initiatives within the Afonydd Cleddau SAC. The NMB will be heavily reliant on several stakeholders to understand the effectiveness of this NMP and so agreement on reporting mechanisms and close collaboration is essential.

A clear monitoring and other data environment should be agreed upon with agreed data collection protocols and timelines so that information from multiple stakeholders can be collated and used in demonstrating success. This will be vital for funding applications as well as regulatory compliance.

Table 7-1: NMB Key Stakeholders

Stakeholder	Dŵr Cymru Welsh Water (DCWW)	Natural Resources Wales (NRW)	Local Planning Authorities (LPAs): Carmarthenshire County Council, Pembrokeshire County Council, Ceredigion County Council
Role	DCWW are a competent authority for their activities under the Regulations which implement the Habitats Directive and 'public bodies' under the Water Framework Directive. As such they also have a statutory duty to 'have regard' to the requirements of the Birds and Habitats Directives and to the River Basin Management Plan. DCWW's performance is tightly monitored and regulated, including Ofwat, Welsh Government and NRW. They are obligated for avoidance of deterioration of the SAC and assessment of any of their projects and/or plans that may affect the integrity of SAC and subsequently any required mitigation.	NRW is the Appropriate Nature Conservation Body (ANCB) for Wales and their functions include the management of Wales's forests and woodlands, pollution control, waste regulation, the management of water resources, flood and coastal risk management, fisheries, navigation and safeguarding of protected sites and species NRW are the "competent authority" responsible for the implementation of the Water Framework Directive and the Habitats Directive as transposed into Welsh law. They are obligated for avoidance of deterioration of the SAC and assessment of any of their projects and/or plans that may affect the integrity of SAC and subsequently any required mitigation.	LPAs are 'competent authorities' under the implementation of the Habitats Directives and must 'have regard' to the requirements of the Birds and Habitats Directives in exercising any of their functions. LPAs are responsible for ensuring that their decision making is compliant with the requirements of the Directive as implemented by the Habitat Regulations. They are obligated for avoidance of deterioration of the SAC and assessment of any of their projects and/or plans that may affect the integrity of SAC and subsequently any required mitigation.
Key activities / projects / Initiatives	Phosphorus Improvement Programme (present – 2032) Storm Overflow Strategy (present – 2025)	River monitoring programme Four Rivers for LIFE Project Tackling Pollution from Agriculture	LDPs Planning Applications
Existing Reporting Mechanisms to the NMB	TBC	TBC	Local authority planning portals / documentation
Importance to NMP	WwTW are a key source of TP within the Afonydd Cleddau SAC. The improvement programme will see several works in the Afonydd Cleddau catchment reduce TP export. Reporting on progress of this programme is essential to the release of development and monitoring any impact on river recovery.	NRW's river monitoring programme is currently the only means of tracking the impact of mitigation with respect to the status of the SAC. As such, the current temporal / spatial frequency of sampling needs to be reviewed in light of proposed interventions. Additional projects / initiatives in the catchment with potential to improve nutrient management are noted, however, monitoring is not known to have been implemented and so benefits will be difficult to quantify.	Development brought forward under LDPs or developers (approved by the LPA) have potential to introduce additional phosphorus to the SAC. The timing of development will be important and needs to be tied closely to delivery of strategic category 1 mitigation. Developments approved under the planning system may require nutrient neutrality to be demonstrated. The LPA will need to capture mitigation measures delivered by developers and feed this back into the NMP.
Monitoring Plan	Recommend a biannual update from DCWW on plans to improve water quality and, in particular, planned improvements to meet new phosphorus permits.	Recommend a biannual review of NRW actions. However, important updates to key initiatives are needed more urgently. For example, the current review of river monitoring and outcomes of this should be communicated as soon as available to address gaps raised in evidence base review.	The LPAs perform an important function within the NMB and so awareness / monitoring should not be a significant challenge. A mechanism to track mitigation brought forward relative to LDP housing trajectory is recommended in addition to a mechanism of tracking developer led mitigation to demonstrate neutrality. It will be the responsibility of whoever adopts the mitigation measure to ensure a suitable monitoring programme is in place. The LPA will ensure this is part of the contract for whoever implements and then manages the mitigation measure.

Table 6.2: NMB Additional Stakeholders

Stakeholder	Key activities	Link
Agriculture	The NMB has welcomed collaboration for various agricultural organisations including Farming Union Wales (FUW), National Farming Union Cymru (NFU Cymru) Nature Friendly Farming Group, Countryside and Land Alliance (CLA), Gelli Aur Agricultural College. Nutrient Management Plans for the West Wales Boards have been shared with the Wales Land Management Forum (WLMF) Agricultural Group. However, the NMB recognises that Unions and organisations do not speak for all land managers and farmers in the catchments and have encouraged individual representation and attendance to various on-line meetings and in-person events. It should be noted that there is no single voice for agriculture that can sit on the Board and so the NMB relies on input at the TAG and Stakeholder group to shape the plans and attain consensus on the interventions that are needed in this sector.	
Afonydd Cymru	Represent the six regional Welsh river trusts on a national level. The West Wales Rivers Trust cover rivers, lakes and wetlands in Pembrokeshire, Carmarthenshire and Ceredigion. In rural catchments they deliver land management advice and on-farm measures including riparian fencing and farm infrastructure improvements to minimise pollutant loss from farms while maximising efficiency & enhancing ecological health. They also deliver and river restoration activities and have been restoring sections of the Cleddau.	Our Projects - Afonydd Cymru
Pembrokeshire Coastal Forum	Forum leads on many nature restorative initiatives through their Ecosystem Enterprise Partnership working with land managers, industry, conservation managers and communities to allow the growth of Pembrokeshire's economy while improving the environment of the Milford Haven and Cleddau catchment. Their efforts through Building Resilience In Catchments (BRICs) is a combination of on the ground actions to improve water quality with the creation of a development plan for nutrient trading scheme within the Milford Haven catchment of the Cleddau River. The Building Natural Solutions work focuses on the challenges of phosphorus to future housing development through modelling of nutrient loss risk and proposing phosphorus mitigation plans for future housing development.	Projects - Pembrokeshire Coastal Forum (PCF)
The Cleddau Project	The Cleddau Project are comprised of local people who want to act now to help save and protect the tributaries, estuary, plants and animals of the whole Cleddau catchment. One of their initiatives is the Cleddau Catchment Assessment Project, a major Citizen Science water testing project throughout the Cleddau catchment in partnership with West Wales Rivers Trust's Adopt a Tributary initiative. Funding is now being sought to launch C-CAP (Cleddau Catchment Assessment Project) – a major Citizen Science water testing project in conjunction with the Adopt a Tributary initiative. Another is the My River project, development of an education & community programme delivering workshops & activities to schools & the community, culminating in an exhibition of the children's river-related work at HaverHub in summer 2024 including a Cleddau curriculum. They have also developed a user-friendly web page to Report Pollution to NRW and/or DCWW, as appropriate as a means of assessing the speed and quality of their responses	Projects - The Cleddau Project

7.2 Monitoring progress of the NMB Action Plan

Alongside the roles and responsibilities of the key stakeholders, the NMB has set out within this NMP a series of actions to address gaps in the evidence base as well as mitigation measures. These measures will address known / planned development (Category 1 measures) or provide wider improvements within the catchment designed to provide additional environmental headroom and assist in restoring the SAC to favourable condition (Category 2 measures).

As previously discussed, the NMB is a voluntary agreement between groups to facilitate the restoration of the SAC regarding nutrients in particular. The board is supported by a Technical Advisory Group (TAG) and a Stakeholder Group (SG).

To ensure the success of these actions, the following recommendations are made to support regular progress updates and management of the Action Plan:

1. Quarterly updates of the Action Plan tables presented in Section 6. This should be tracked in excel tables with access for all members of the NMB, SG and TAG.
2. In addition to the above, LPAs to provide a concise quarterly review of developments versus mitigation status to ensure that as development is brought forward, planning is in place to deliver mitigation.
3. Annual update of the NMP with an activity round up and formal update to the Action Plan tables, gateway and opportunity tracker.
4. Biannual updates from DCWW / NRW on key projects / initiatives to be captured and tracked by the NMB.
5. Agree regular reporting timelines for water quality monitoring to ensure measures and impact can be tracked (current cycle of reporting over several years will not successfully identify improvements)
6. Continued TAG and SG meetings at a regular interval to discuss case studies, project progress / deep dives to ensure knowledge sharing and innovation.

7.3 Quantifying outputs, monitoring effectiveness / benefits

Effective mitigation and compliance with the Habitat Regulations can be ensured in the following ways:

- Relevant experts and officers ensuring that there is implementation of sufficient mitigation to deliver the reductions required for the LDP;
- Ongoing monitoring of measures to best assess the actual reductions achieved upon implementation; and
- Monitoring of the SACs to ensure that in-combination effects from other LDPs and/or diffuse pollution sources are not exceeding targets.

Current monitoring programmes without review and change will not adequately capture these aspects and so additional monitoring will be required. It will be important to agree who will hold ultimate responsibility for this and amongst all stakeholders agree on an approach that aligns with the combined objective of helping to restore the SAC to favourable condition.

8.0 Conclusion

In recognition of the importance of SAC river catchments and through a strong desire to reverse their decline, the Welsh Government provided funding to establish the NMBs and to produce evidence-based Plans. This Nutrient Management Plan for the Afonydd Cleddau SAC represents a significant step forward in addressing phosphorus pollution within the catchment. Developed through robust evidence gathering and strong collaboration, it provides, for the first time, a single, detailed framework to guide targeted action, to support responsible development, and meet the SAC's phosphorus conservation targets.

The Plan acknowledges the limitations of current regulatory measures to meet compliance targets and highlights the need for nature-based solutions, legacy phosphorus management, and sustainable agricultural practices. Agricultural land use is a major source of excess nutrient in this catchment, and strong engagement of the agricultural community to bring about community-led approach that values both environmental stewardship and food security is critical. It is a living document, designed to evolve with new data, stakeholder input, and ongoing analysis to ensure long-term compliance and resilience for the catchment.

The Cleddau NMB, operating within the existing regulatory framework, plays a central role in coordinating the delivery identified. The Plan sets out clear roles, responsibilities, and actions, and feasible timelines now need to be agreed with action owners. These actions are underpinned by Welsh legislation and supported by the Welsh Government's commitment to use its regulatory levers where necessary.

A bilingual Non-Technical Summary is available at www.wwnmb.wales.

Appendix A

Supporting Figures

30209413-AUK-XX-XX-DR-CW-0001-P1

30209413-AUK-XX-XX-DR-CW-0002-P1

30209413-AUK-XX-XX-DR-CW-0003-P1

30209413-AUK-XX-XX-DR-CW-0004-P1

Appendix B

Ecology Evidence Base Review Tables

Table 7-2 – High-level review of key ecological documents

Document	Dates	Overall Findings	Existing Partners	Recommendations for Use	Limitations	Next Steps
Priority Improvement Plan (PIP)	Published 15/01/2024 Estimated costs date: 2020 Survey dates: Annex 1 Habitats Active raised bog: 23/10/12 Alder woodland on floodplains: 01/10/03 Rivers with floating vegetation often dominated by water-crowfoot: 01/09/05 Annex 2 Species Bullhead: 01/11/06 River lamprey: 01/03/13 Brook lamprey: 01/03/13 Otter: 06/12/12	A priority improvement plan (PIP) for SAC sites in Wales is a strategic document that identifies and prioritizes actions needed to enhance and conserve the natural environment within these designated areas. It outlines specific measures and initiatives aimed at improving the condition of habitats and species of European importance found within the site. The PIP serves as a roadmap for stakeholders, including landowners, conservation organizations, and policymakers, to work together in implementing targeted actions to address conservation challenges and achieve the desired outcomes for SAC sites. Two documents were provided per SAC by NRW: One is the PIP in report format, the second is a Priority Matrix report of priority issues and risks for the SAC. The Priority Matrix identifies the priority of the issues and risks which have (or are likely to have) an adverse impact on the habitat and species features on a National Site Network site. The assessment has included input from stakeholders. The report summarizes suggested actions from 2020 and beyond for managing high and medium priority issues and risks to the qualifying features of the SAC. • Details actions required for these challenges • Also details costs of some of the next actions required which could be useful • PIPs are considered live documents so will be reviewed and updated	• NRW (direct management and associated costs) • Welsh Government (Glastir Advanced and associated costs)	• Catchment Profile (Geography & Hydrology; SAC details; Current pressures; Future pressures) • SAC Action Review • Options Appraisal (Based on current and future pressures - Screening and prioritisation of what the catchment requires and possible actions; Options Appraisal Method; Implementation Method) • Actions Plan (Based on current and future pressures)	Dates of data: A significant limitation of the PIP matrix which informs the report summary is the date of the data used. The data relates to the status of the SAC qualifying features, with the data dates ranging from 2003 to 2013. All features were classified as being in an unfavourable condition, apart from Otter which was classed as favourable. The rankings of priority, issue and risk posed by each issue to the qualifying features will need to be updated if this is the data that they are based on (over a decade old) and before the Phosphorus targets were revised. It may be prudent for the risk of water quality to be increased in ranking as a result of the tightened phosphorus targets by NRW in 2021. The Priority Matrix differs from the main PIP report in terms of urgency and priority rankings. The inconsistency between rankings stated in the Priority Matrix and the report should have the reason for this clarified. Costs for actions underway or intended to go ahead in order to address the Issues and Risks may need updating.	Updates of all surveys for qualifying features where possible or updating using additional data. Change Nature 2000 mention to NSN. Include citations of any surveys or sources.
Western Wales River Basin Management Plan 2021 – 2027	• Published in 2022 • Risk assessment for water quality updated 2019-22 • Risk assessment for other environmental pressures updated 2014	RBMP summaries include: • SEA • HRA • Evidence data about the water environment • Protected areas • How the plans for Wales were developed The RBMP is a strategic set of documents that meet the statutory requirements of the Water Framework Directive (WFD) regulations 2017. The Afonydd Cleddau falls under Western Wales River Basin Management Plan 2021 – 2027. At present, the most updated iteration is for the third cycle, published in 2022. The RBMP is supported by a Habitat Regulation Assessment (HRA) conducted during the	NRW (Collected the data) DCWW (Mitigation project delivery) Welsh Government (WFD legislation) Wales Water Management Forum (stakeholder, worked with NRW) Wales Land Management Forum (WLMF) (Collaborator,	• General information / introduction • Catchment overview • Current status (includes ecological / geographical / hydrological information- useful to discuss the aims of the WFD here) • Current Pressures • Options Appraisal: For the inclusion of relevant case studies (funding sources, etc) and potentially link back to the aims of the WFD here • Action Plan: The document includes targets and next steps for the 2021 - 2027 period and aims for beyond this.	A risk assessment of each pressure type affecting waterbodies was carried out as part of this plan. P, chemicals and metals, dissolved inorganic nitrogen, dissolved oxygen and ammonia and physical modification were all updated in 2019 -2022, thus addresses the updated phosphorus target set in 2021 but not including the re-assessment undertaken in 2022 by NRW Other environmental pressures e.g. acidification, flow, invasive non-native species and sediment have not been updated since 2014 Raw data not included nor signposted	Risk assessments should be updated, especially those where the latest review was 2014. Key programmes and activities for managing pollution from sewage and wastewater should be updated where additional activities have occurred. A map of the project areas could be useful. Update links to sources. Potentially create a map within the document of data of any project actions to improve water quality and collating the activities within the river basin even on a high level. Or make clear for where this data should be

Document	Dates	Overall Findings	Existing Partners	Recommendations for Use	Limitations	Next Steps
		development of the RBMP to ensure compliance with environmental regulations. The HRA assesses potential impacts on habitats and species, guiding plan revisions to mitigate adverse effects.	stakeholder role and some data collection) Wales Fisheries Forum (WFF) (Collaborator, stakeholder role) Wales Marine Advisory and Action Group (WMAAG) (Collaborator, stakeholder role)		Next steps for after 2027 may need to be considered for the next iteration of the River Basin Management Plans Updates to schemes funded by DCWW in order to meet the objectives of the WFD are listed but these should be updated to include more recent programmes. May be useful for these documents to reference the recent NRW mitigation menu	visualised that these maps are available at Water Watch Wales. To include the new legislation regarding nitrate spreading and nutrient management plans To state the specific dates for when surveys that informed the classification. Clear links to the most recent raw data
NRW Core Management Plan – Afonydd Cleddau	• Published September 2022 Condition assessment data: • Sea Lamprey: Unfavourable: Unclassified (2012) • Brook lamprey: Recovering (2012) • River lamprey Recovering (2012) • Bullhead: Unfavourable: Unclassified (2012) • Otter: Favourable: Maintained 2004 • Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation: Unfavourable: Unclassified (2012) • Active raised bogs: Unfavourable: declining • Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae): Unfavourable: Unclassified (204	The Natural Resource Wales (NRW) core management plans are strategic documents for special areas of Conservation (SAC) and Special Protection Areas (SPA) in Wales. They outline the objectives and necessary actions to protect and enhance the natural environment within these designated areas. It provides guidance on achieving these objectives and implementing changes required by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, alongside the existing Conservation of Habitats and Species Regulations 2017. The plan is crucial in safeguarding the unique habitats and species found within SAC sites, ensuring their long-term conservation and sustainable use for future generations. Outline of past and current management, Vision for the Site; Site description and Site features, Conservation Objectives, Assessment of status and management requirements for each feature and an Action Plan. The vision for the Afonydd Cleddau SAC is to maintain and restore high ecological status, special fish species will be present in numbers that reflect a healthy and sustainable population, otter will continue to be found along the entire length of the river.	• NRW (Management) • DCWW (Management)	• General information / introduction • Catchment Profile (Geography & Hydrology; SAC; Current Pressures; Future Pressures) • Action Plan	The Afonydd Cleddau Core Management plan was last updated in September 2022.. In terms of the SAC features, they are in varying conditions however the majority of these classifications have been undertaken >10 years ago and so would benefit from updating. In the future there may be legislation regarding nitrogen water pollution as well as future legislation on marine protected areas. Thus, marine SAC Management Plans may need to be included going forward if they are hydrologically connected. .	Updated classification and favourable status to be based on new data. Include citations of any surveys or sources.
SAC Standard Data Forms	• Original Data Form Published 2000 • Updated Data Form Published: 2017 Annex 1 habitats: Water courses of plain to montane levels with the ‘Ranunculion fluitantis and Callitricho-Batrachion vegetation; Active Raised Bogs	The document summarises the date and designation of the Afonydd Cleddau as a SAC, with its designation confirmed in December 2004 under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea).. Abundance of all the qualifying features were ranked as present. The quality of the monitoring data used to inform the review of	• NRW (Named as responsible for the site management in Wales)	• Catchment Profile (Geography & Hydrology; SAC details; Current pressures; Future pressures) • Action Plan	Future updates could include revisiting the measured populations/abundance of qualifying features, their present coverage in the SAC, and the respective ranked challenges being faced to the SAC qualifying features through future surveys.	Include citations of any surveys or sources. Update any surveys of qualifying features where possible.

Document	Dates	Overall Findings	Existing Partners	Recommendations for Use	Limitations	Next Steps
	Degraded raised bogs still capable of natural regeneration Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) Annex II species: Alis shad (Alosa alosa) Bullhead (Cottus gobio) River lamprey (Lampetra fluviatilis) Brook lamprey (Lampetra planeri) Otter (Lutra lutra) Sea lamprey (Petromyzon marinus) Atlantic salmon (Salmo sala)	population size were described as deficient for all the qualifying feature species in the SAC.				

Table 7-3 -Evidence review per Qualifying features

Qualifying feature	Feature group	Condition Status	Dates	Form of data	Documents mentioned within	Gaps/Opportunities for bolstering	Different Data that is available
Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation	Annex 1 Habitats	Unfavourable (PIP) 01/09/05 Unfavourable unclassified (Core Management Plan) 2012	• 01/09/05 (PIP) • Feature Condition Assessment 2012, Macrophyte surveys 2003 • Core Management Plan • N/A (SAC Standard data form and River Basin Management Plan)	The first reporting cycle for the Core management plan appears to use the following survey: Grieve N, Clarke, Caswell SB, Newman JR. 2003. Macrophyte Surveys of the Cleddau and Selected Tributaries. CCW Contract Science Report In second reporting cycle of the Core Management Plan the macrophyte population was not assessed. The PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this habitat.	• PIP • Core Management Plan • SAC Standard data form	The water quality attributes used in the Core Management Plan have a low level of confidence as over half the units in the sites do not have any monitoring survey sites. Update status and water quality with more recent data or new surveys.	Little in comprehensive literature available. Further surveys needed to confirm current status.
Active Raised Bogs	Annex 1 Habitats	Unfavourable (PIP) 23/11/12 Unfavourable: declining (Core Management Plan) No Date	• 23/10/12 (PIP)	The Core Management Plan, PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this species.	• PIP • Core Management Plan • SAC Standard data form	Update status with more recent data or new surveys. Include references and dates for surveys	Little in comprehensive literature available. Further surveys needed to confirm current status
Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Annex 1 Habitats	Unfavourable (PIP) 01/10/03 Unfavourable: Unclassified (Core Management Plan) 2004	• 01/10/03 (PIP) • 2005 (Core Management Plan)	Lovering T. 2005. Afonydd Cleddau SAC Monitoring Report: Alluvial Woodland 2004. Internal unpublished report (Core Management Plan)	• PIP • Core Management Plan • SAC Standard data form	It was noted in the Core Management Plan that the aim of the 2004 survey was not to provide a condition assessment of the feature, rather to provide an overview of alluvial woodland presence within the SAC. Update status with more recent data or new surveys.	Little in comprehensive literature available. Further surveys needed to confirm current status
Bullhead	Annex 2 Species	Unfavourable (PIP) 01/11/06 Unfavourable: Unclassified (2012)	• 01/11/06 (PIP) • No source, 2012 (Core Management Plan) • N/A (SAC Standard data form and River Basin Management Plan)	The Core Management Plan, PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this species.	• PIP • Core Management Plan • SAC Standard data form	The water quality attributes used in the Core Management Plan have a low level of confidence as over half the units in the sites do not have any monitoring survey sites. Core management plan links to sources are not imbedded and not clear what the data source is. Update population status with more recent data or new surveys.	Little in comprehensive literature available. Further surveys needed to confirm current status
River lamprey	Annex 2 Species	Unfavourable (PIP) 01/03/13 Unfavourable: Recovering 2012 (Core Management Plan)	• 01/03/13 (PIP) • APEM (2005) (Core Management Plan) • N/A (SAC Standard data form and River Basin Management Plan)	APEM Aquatic Scientists 2005. Lamprey Survey on the Rivers Tywi, Teifi & Cleddau. Review of consents report No 7. (Core Management Plan) The PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this species.	• PIP • Core Management Plan • SAC Standard data form	The water quality attributes used in the Core Management Plan have a low level of confidence as over half the units in the sites do not have any monitoring survey sites. Core management plan links to sources are not imbedded and not clear what the data source is. Update population status with more recent data or new surveys.	Lamprey Survey data is available through the NBN atlas, collated for the Afonydd Cleddau based on a field survey conducted in 2012 using electrofishing. Note that this data is still >10 years out of date but similar methods could be used for updating the data.
Brook lamprey	Annex 2 Species	Unfavourable (PIP) 01/03/13 Unfavourable: Recovering 2012	• 01/03/13 (PIP) • APEM (2005) (Core Management Plan) • N/A (SAC Standard data form and River	APEM Aquatic Scientists 2005. Lamprey Survey on the Rivers Tywi, Teifi & Cleddau. Review of consents report No 7. (Core Management Plan)	• PIP • Core Management Plan	The water quality attributes used in the Core Management Plan have a low level of confidence as over half the units in the	Lamprey Survey data is available through the NBN atlas, collated for the Afonydd Cleddau based on a field survey conducted in 2012 using electrofishing. Note that this

Qualifying feature	Feature group	Condition Status	Dates	Form of data	Documents mentioned within	Gaps/Opportunities for bolstering	Different Data that is available
		(Core Management Plan)	Basin Management Plan)	The PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this species.	• SAC Standard data form	sites do not have any monitoring survey sites. Core management plan links to sources are not imbedded and not clear what the data source is. Update population status with more recent data or new surveys.	data is still >10 years out of date but similar methods could be used for updating the data.
Otter	Annex 2 Species	Favourable (PIP) 06/12/12 Favourable: Maintained (Core Management Plan) no date	• 06-12-12 (PIP) • Jones. 2004, Current and potential distribution condition and breeding success of the otter (Lutra lutra) in the Afonydd Cleddau catchments. (Core management plan) • N/A (SAC Standard data form and River Basin Management Plan)	Jones. 2004, Current and potential distribution condition and breeding success of the otter (Lutra lutra) in the Afonydd Cleddau catchments and condition mapping of Alluvial forests in the Afonydd Cleddau SAC. Report produced by The Wildlife Trust of South and West Wales' Water for Wildlife Team. CCW Report no.CCW/WA/31. This survey data is not easily found online. Otter Survey of Wales 2002. Environment Agency Wales, Cardiff. The PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this species.	• PIP • Core Management Plan • SAC Standard data form	Update population status with more recent data or new surveys.	Kean EF, and Chadwick EA 2021. Otter Survey of Wales 2015-2018. NRW Report No: 519, NRW. Sixth Otter Survey Wales
Sea lamprey	Annex 2 Species	Unfavourable (PIP) 01/03/10 Unfavourable Un-classified (Core Management Plan) 2012	• 31-10-2012 (PIP) • Not clear the source used for the 2012 assessment. • N/A (SAC Standard data form)	APEM Aquatic Scientists 2005. Lamprey Survey on the Rivers Tywi, Teifi & Cleddau. Review of consents report No 7. The PIP and SAC Standard data form documents do not provide any citations or links to the survey data mentioned for this species.	• PIP • Core Management Plan • SAC Standard data form	The water quality attributes used in the Core Management Plan have a low level of confidence as over half the units in the sites do not have any monitoring survey sites. Core management plan links to sources are not imbedded and not clear what the data source is. Update population status with more recent data or new surveys.	Lamprey Survey data is available through the NBN atlas, collated for the Afonydd Cleddau based on a field survey conducted in 2012 using electrofishing. Note that this data is still >10 years out of date but similar methods could be used for updating the data.
Atlantic salmon	Annex 2 Species	N/A	• Classified as non-significant population (SAC standard data form)	No source data is specified for Atlantic Salmon surveys in the SAC Standard Data form.	• SAC Standard data form	NRWs recent efforts to save this critically endangered species could be highlighted.	4 Rivers for LIFE project to improve the conservation status of 4 SAC rivers in Wales including the Afonydd Cleddau with one of the target features being the Atlantic Salmon. Any monitoring of the progress of projects aiming to improve Atlantic Salmon populations may inform future monitoring of the Atlantic Salmon population and possibly determine whether Atlantic Salmon should be a flagship species,

Table 7-4 -Afonydd Cleddau SAC condition status, associated risks and conservation objectives

Qualifying feature	Feature group	Feature Code	Condition Status	Issue/risks with priority rating as described in PIP	Conservation objectives
Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation	Annex 1 Habitats	3260	Unfavourable (PIP) Unfavourable unclassified (Core Management Plan)	Modified water courses – Medium Water pollution diffuse sources – High Water pollution - discharge(s)/point source (inc. thermal, radioactive and oil) - Medium Risk Freshwater non-native invasive species - Medium	Favourable condition status The conservation objective for the watercourse is met. The natural range of the plant communities represented within this feature should be stable or increasing in the SAC. The natural range is taken to mean those reaches where predominantly suitable habitat exists over the long term. The area covered by the feature within its natural range in the SAC should be stable or increasing. The conservation status of the feature's typical species should be favourable condition. The typical species are defined with reference to the species composition of the appropriate JNCC river vegetation type for the particular river reach, unless differing from this type due to natural variability when other typical species may be defined as appropriate.
Active raised bogs *Priority feature	Annex 1 Habitats	7110	Unfavourable (PIP) Unfavourable declining (Core Management Plan)	Air pollution – High Risk Freshwater non-native invasive species - Medium	Favourable condition status • On the mire expanse there are at least 3 of *Calluna vulgaris, Erica tetralix, Eriophorum angustifolium, E.vaginatum* & *Trichophorum cespitosum* constant, with a combined cover not exceeding 80% • No single species > 50% cover • At least one of *Andromeda polifolia, Drosera rotundifolia, Empetrum nigrum, Narthecium ossifragum* and *Vaccinium oxycoccos* occurs at least frequently • On the mire expanse only there are at least 2 of the following spp. constant, with a combined cover > 20%: *Sphagnum capillifolium, S. magellanicum, S. papillosum, S. tenellum* • No reduction in extent of microtopographic features (e.g. bog pools).
Bullhead (*Cottus gobio)*	Annex 2 Species	1163	Unfavourable (PIP) Unfavourable Un-classified (Core Management Plan)	Water pollution diffuse sources – High Water pollution - discharge(s)/point source (inc. thermal, radioactive and oil) - Medium Modified water courses – Medium	Favourable condition status • The conservation objective for the watercourse is met. • The population of the feature in the SAC must be stable or increasing over the long term. • The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. • Passage of the feature through the SAC is not to be hindered by artificial barriers such as weirs. • The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the habitat requirements of the features. The close proximity of different habitats facilitates movement of fish to new preferred habitats with age.
River lamprey *(Lampetra fluviatilis)*	Annex 2 Species	1099	Unfavourable (PIP) Unfavourable: recovering (Core Management Plan)	Grazing overgrazing – Medium Modified water courses – Medium Water pollution diffuse sources – High Water pollution - discharge(s)/point source (inc. thermal, radioactive and oil) - Medium Water abstraction - High Weirs and other in-channel structures – Medium	Favourable condition status • The conservation objective for the watercourse is met. • The population of the feature in the SAC must be stable or increasing over the long term. • The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. • Passage of the feature through the SAC is not to be hindered by artificial barriers such as weirs. • The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the habitat requirements of the features. The close proximity of different habitats facilitates movement of fish to new preferred habitats with age.
Brook lamprey (*Lampetra planeri)*	Annex 2 Species	1096	Unfavourable (PIP) Unfavourable: recovering (Core Management Plan)	Grazing overgrazing – Medium Modified water courses – Medium Water pollution diffuse sources – High	Same as river lamprey

Qualifying feature	Feature group	Feature Code	Condition Status	Issue/risks with priority rating as described in PIP	Conservation objectives
				Water pollution - discharge(s)/point source (inc. thermal, radioactive and oil) - Medium	
Sea lamprey (*Petromyzon marinus*)	Annex 2 Species	1095	Unfavourable (PIP) Unfavourable Unclassified (Core Management Plan)	Grazing overgrazing – Medium Modified water courses – Medium Water pollution diffuse sources – High Water pollution - discharge(s)/point source (inc. thermal, radioactive and oil) - Medium Water abstraction - High	Same as river lamprey
Otter (*Lutra lutra*)	Annex 2 Species	1355	Favourable (PIP) Favourable Maintained (Core Management Plan)	Water pollution diffuse sources – High Water pollution - discharge(s)/point source (inc. thermal, radioactive and oil) - Medium Modified water courses – Medium	Favourable condition status • The population of otters in the SAC is stable or increasing over the long term and reflects the natural carrying capacity of the habitat within the SAC • The SAC will have sufficient habitat, including riparian trees and vegetation and wetlands, to support the otter population in the long term • The natural range of otters in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. • The otter must be able to breed and recruit successfully in the SAC. The size of breeding territories may vary depending on prey abundance. • Otter food sources must be sufficient for maintenance of the population. • The safe movement and dispersal of individuals around the SAC is facilitated by the provision, where necessary, of suitable riparian habitat, and underpasses, ledges, fencing etc at road bridges and other artificial barriers. • No otter breeding site should be subject to a level of disturbance that could have an adverse effect on breeding success. Where necessary, potentially harmful levels of disturbance must be managed.
Atlantic salmon (*Salmo salar)**	Annex 2 Species	1106	Classified as non-significant population (SAC standard data form)	Largely water quality as well as symbiotic requirements with freshwater pearl mussel and trout.	The 4 Rivers for LIFE project aims to initiate conservation management for Atlantic salmon including re-introductions and this will continue until the population is reestablished. The NMP should potentially consider this species as a flagship species of the NMP for the Cleddau.

Appendix C

Cleddau NMP Phosphorus Removal Interventions Matrix and Supplementary Guidance

Table C-7-1: Cleddau NMP Phosphorus Removal Interventions Matrix

No	Intervention	Mitigation Category	Intervention Description	Benefits		Feasibility	Maintenance	Effectiveness
1	**Reduction of Agricultural Phosphorus at source**	Category 2	This solution focusses on changing farming practices. **Advantages:** Removes P at source, thus reducing pressure for alternative interventions downstream. Increases sustainability of soil. Associated pre-treated sludge biosolid provided by DCWW as a single accredited stakeholder. **Disadvantages:** Multiple stakeholders required to change long standing practices. Difficult to manage / monitor. Legacy P requires consideration i.e., 20years of continued P export needs to be considered in the land use change. **Delivery Partners:** Landowners, WG, The Council, NRW, NFU Cymru, DCWW, Env. NGOs		Increased biodiversity from a reduction in nutrient enrichment and in soil Aesthetic value Carbon sequestration	**Low**	**Medium**	**High**
2	**Farming Source Control**	Category 2	Farm improvement works to prevent Phosphorus from entering watercourses, which can include fencing. **Advantages:** A simple scheme that increases farm value and there is already an existing grant scheme, which can last a long time (50+ years) **Disadvantages:** Multiple stakeholders which may create long term management difficulties and requires seasonal vegetation management. **Delivery Partners:** NRW, NFU Cymru, Landowners/land managers, The Council, WG: WG Spending Commitments, Basic Payment Scheme, SFS, Glastir Advanced, Commons and Organic contracts scheme, National Forest for Wales, Food accreditation scheme, Farm Business Grant Scheme post 2024		Increased biodiversity in watercourse habitats from a reduction in nutrient enrichment and in soil Aesthetic value	**High**	**Medium**	**High**
3	**Surface Water Separation**	Category 1 & Category 2	This solution focuses on separating surface water from existing combined wastewater infrastructure - flows from new and existing developments to capture stormwater. **Advantages:** Already normal practice for new developments, which can prevent further pressure on SO discharges into the watercourse. Similar compensatory surface water removal approach already in place for Carmarthen Bay and Estuaries European Marine site. Surface Water rebate available from DCWW but impact is variable. **Disadvantages:** Costly to retrofit in urban areas, limited reduction in Phosphorus unless effective SuDS are incorporated **Delivery Partners:** Developers, The Council, DCWW, Wales Green Infrastructure Forum		Increased Capacity and efficiencies at WwTW	**High**	**Low**	**Low**
4	**Enhanced Wastewater Treatment Works**	Category 1	Increasing the ability of WwTWs to remove Phosphorus. **Advantages:** Presence of new total phosphorus permit may release headroom for new development to connect in certain areas, providing clear delivery mechanisms within DCWW. Opportunity to explore developer contributions. **Disadvantages**: Requires long term investment and potentially lengthy construction projects in certain areas. May transfer issues to biosolid spreading which would require extra controls although DCWW take a precautionary approach for application **Delivery Partners:** DCWW: Existing and new WWTW funding, Spending commitments. Developers, NRW, Ofwat, NFU Cymru, WG Spending Commitments.		Improved water quality	Medium	**High**	**High**

No	Intervention	Mitigation Category	Intervention Description	Benefits		Feasibility	Maintenance	Effectiveness
5	**Permeable paving**	Category 1	**Advantages:** Reduces peak flows and provides some treatment for surface water before drainage to river. Dual use of the landscape, prevents ponding, can be used in high density developments. **Disadvantages:** Not compatible with large sediment loads, only suitable for low traffic volume areas, maintenance to minimise silt clogging. **Delivery Partners:** Developers, The Council.		Natural Flood mitigations Temperature Regulation	**Medium**	**Low**	**High**
6	**Green roofs**	Category 1	**Advantages:** Reduced peak surface water flows and provides some water quality treatment, along with possible small reduction of storm water overloading DCWW networks and SO discharges, Mimics predevelopment state of water flows, can be retrofitted (site dependant), no additional land, can provide a return on investment from energy savings. **Disadvantages:** High cost compared to conventional roof, not appropriate for all sites and limited retrofitting abilities, requires high maintenance as any damage to roof membrane is more critical as water is encouraged to remain on the roof, limited impact of P removal. **Delivery Partners:** Developers, The Council, Business Improvements Districts for retrofits.		Increased Biodiversity Aesthetic value Thermal attenuation Climate resilience Water efficiency Noise Attenuation Air Quality improvements Health and wellbeing if accessible Increased longevity of roofs	**Medium**	**Medium**	**Medium**
7	**Swales**	Category 1	Shallow broad and vegetated channels designs to store and convey runoff to remove pollutants before the runoff enters the drainage system or waterbody. **Advantages:** Easy to incorporate into landscaping, good removal of urban pollutants, reduces runoff rates and volumes and low capital cost. Maintenance can be incorporated into general landscape management, pollution and blockages are visible and easily dealt with. **Disadvantages:** Not suitable for steep areas with roadside parking, limits the opportunities to use trees for landscaping, risks of blockages in existing pipework. **Delivery Partners:** Developers, The Council, Local Highways Agencies, WG, National Surface Water Management and SuDS Group, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge, NRW, Four Rivers for Life, Sustainable Drainage Feasibility Grant, DCWW: Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, Wales Green Infrastructure Forum, Living Streets Cymru, Active Travel and Safe Routes in Communities (SRiC) schemes, Heritage Lottery Fund, Esmee Fairburn Foundation		Biodiversity Amenity Aesthetic value Passive cooling	**Medium**	**Low**	**Medium**

No	Intervention	Mitigation Category	Intervention Description	Benefits	Feasibility	Maintenance	Effectiveness
8	**Conveyance Chanels**	Category 1	Channels and rills are open surface water channels with hard edges that can be planted with vegetation. **Advantages:** Effective water and pollution treatment can act as pre-treatment to remove silt before water is conveyed into further SuDS features, easy to construct. **Disadvantages:** Incorrect planting can cause silt build up, Need to give careful consideration to crossings, routine maintenance to remove litter/debris, large maintenance required every 5 years. **Delivery Partners**: Same as Swales	Biodiversity Increase Amenity Aesthetic value Passive cooling	Medium	Medium	Medium
9	**Filter Strips**	Category 1	Filter strips are vegetated areas designed to filter and treat stormwater runoff as it passes through the vegetation and underlying soil comprised of gently sloping grass and street trees. **Advantages**: Well suited to implementation in areas with heavy traffic, encourages evaporation, infiltration and interception. Easy to construct and low construction cost, effective pre-treatment option **Disadvantages:** Not suitable for all locations. No significant attenuation or reduction of extreme flows. **Delivery Partners**: Same as Swales	Biodiversity Amenity Aesthetic value Health and wellbeing Can encourage active transport	Medium	Medium	Medium
10	**Filter drains**	Category 1	Filter drains are stone filled trenches with underdrains alongside roads, paths or rail lines. **Advantages:** They can capture specific pollutants if there is a layer of treatment media included (the amount removed will depend on the treatment media used). Large ability for treatment since they are often created to be in parallel to the length of roads and paths. **Disadvantages:** It does not capture pollutants directly if treatment media is not added, No vegetation, Depending on the soil conditions and/or pollutant loads, there is risk of filter drains enabling P pollution migration into the underlying ground water, Flow exceedance could lead to temporary flooding. **Delivery Partners**: Same as Swales	Biodiversity (microorganisms, insects and amphibians) Amenity Can filter out fine sediments, metals and hydrocarbons (depending on filter media used) Encourage adsorption and biodegradation process	Medium	Low	Medium
11	**Filter Basin**	Category 1	Shallow landscaped areas with engineered soils, enhanced vegetation and filtration, which can also include trees. **Advantages:** Very effective in removing urban pollutants, including phosphorus, which can also reduce volume and runoff rates. Flexible layout to fit into landscape. Well-suited for installation in highly impervious areas, good retrofit capability and when lined, can be used to manage surface water runoff from areas with high groundwater pollution risks. **Disadvantages:** Requires landscaping and management. Susceptible to clogging if surrounding landscape is not managed. Not suitable for areas with steep slope. Should be used in conjunction with other SuDS components **Delivery Partners**: Same as Swales	Biodiversity Amenity Aesthetic value	Medium	Low	High
12	**Infiltration Basins (Bioretention. Ring Garden)**	Category 1	A solution based around, rain gardens, infiltration trenches and basins, soakaways, tree pits. **Advantages:** Rain gardens – Small and easy to retrofit, minimal land take, easy to maintain, flexible layout to fit into landscape and can be installed in impervious areas if designed correctly. Soakaways – Particulate P removal through sedimentation of solids upstream of soakaway and infiltration in the soakaway. Can reduce rate of run off and some volume reduction Tree pits – Can enhance the performance of other green infrastructure technologies. **Disadvantages:** Rain gardens – As they are often small, their impact can be limited, requires landscaping and management, susceptible to clogging if surrounding landscape is not managed. Not suitable for areas with steep slopes or impermeable soils.	Biodiversity Amenity Aesthetic value Natural flood mitigation Can reduce the risk of waterborne diseases	Medium	Medium	Medium

No	Intervention	Mitigation Category	Intervention Description	Benefits		Feasibility	Maintenance	Effectiveness
			Soakaways – Phosphorus removal highly dependent on infiltration rate and if there is an overflow. Tree pits – Nutrients can be cascaded downstream in extreme events. **Delivery Partners**: Same as Swales					
13	**Retention Ponds (Detention Ponds)**	Category 1	Building of ponds to retain water (retention ponds) designed to collect and temporarily store excess runoff during rainfall events. **Advantages:** Can cater for all storms and has good removal capability of urban pollutants. Can be used where groundwater is vulnerable, if lined. **Disadvantages:** No reduction in runoff volume. Anaerobic conditions can occur without regular inflow. Land take may limit use in high density sites. May not be suitable for steep sites, due to requirement for high embankments. Colonisation by invasive species could increase maintenance. Perceived health & safety risks may result in fencing and isolation of the pond. **Delivery Partners**: Same as Swales		Biodiversity Thermal attenuation Climate resilience Amenity Aesthetic value Recreation Natural flood mitigation	**Medium**	**Medium**	**High**
14	**Detention Basins**	Category 1	Detention basins are shallow landscaped depressions that are normally dry except during and immediately following storm events.. **Advantages:** Can cater for a wide range of rainfall events and can be used where groundwater is vulnerable, if lined. Simple to design and construct with a potential for dual land use. Easy to maintain. Safe and visible capture of accidental spillages. **Disadvantages:** Little reduction in runoff volume. Detention depths may be constrained by system inlet and outlet levels **Delivery Partners**: Same as Swales		Biodiversity Amenity Aesthetic value Health and wellbeing can double up as play and recreation areas Natural flood mitigation	**High**	**Low**	**Medium**
15	**Ponds**	Category 1	Larger bodies of standing water. Water is moved in out of the pond through runoff and flow. Can be surrounded by vegetation, grass, hard landscapes, and other surroundings **Advantages:** Uptake of P by plants and aquatic flora. P can also sediment out onto the base of the pond **Disadvantages:** Good practice for construction must be followed as badly designed ponds can act as exporters of dissolved P. Minimal direct infiltration potential. Cannot manage large inputs of water or exceedance flows **Development Partners:** Developers, The Council, Local Highways Agencies, WG, WG Spending Commitments, Basic Payment Scheme, SFS, National Surface Water Management and SuDS Group, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, Wales Green Infrastructure Forum		Biodiversity Amenity Aesthetic value Recreation Thermal attenuation	**Medium**	**Medium**	**Medium**
16	**Constructed Wetlands**	Category 1	Human-made systems designed to replicate the natural processes of wetlands, designed and maintained specifically for maximising P reduction from final effluent discharges. Plant roots can absorb nutrients and incorporate them into the plant structure. Can provide for tertiary treatment after effective primary and secondary foul treatment processes. **Advantages:** Good removal capability for pollutants and can trap large volumes of sediments. If lined, can be used where groundwater is vulnerable. Large wider environmental benefits and high longevity for functioning effectively (50+ years), Reed bed systems can be incorporated into wetlands which can further enhance biodiversity.		Biodiversity Amenity Aesthetic value Recreation Thermal attenuation/temperature regulation	**Medium**	**Medium**	**High**

No	Intervention	Mitigation Category	Intervention Description	Benefits	Feasibility	Maintenance	Effectiveness
			Disadvantages: Land take is high. Requires maintaining sufficient baseflows in dry periods, or intermittent flow, and there is limited depth range for flow attenuation. May release nutrients during non-growing season, which must be mitigated by good design and maintenance. Little reduction in runoff volume and less effective for steep sites and will require significant earthworks. Colonisation by invasive species could increase maintenance. Performance vulnerable to high sediment inflows. P will be bound in sludge which may require disposal and will require extra pre-treatment with solar drying and well managed biosolid spreading to satisfy crop need. Desludging could be every 10 years but depends on the wetland design. May need to replace bed material if it is saturated with nutrients if artificial bed material is used. Seasonal vegetation removal and management. Potential mosquito habitat. **Development Partners:** Developers, The Council, Welsh Rivers Trust, DCWW Spending Commitments, Rivers in Wales Environmental Investment, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, NFU Cymru, Local Nature Partnership for North East Wales, United Utilities, DCWW, WG, WG Spending Commitments, Basic Payment Scheme, SFS, Heritage Lottery Fund, Esmee Fairburn Foundation Ofwat Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge.	Climate resilience Carbon sequestration Natural flood mitigation Potential for water reuse			
17	**Integrated Buffer Zones**	Category 2	Also known as riparian buffer zones, are areas of vegetation and soil along the banks of water bodies such as rivers, streams, lakes, and wetlands. A solution involving increasing grassland, floodplain grassland, beetle banks, woodland and hedgerows. **Advantages:** Good capability for capture of pollutants and wider environmental benefits. **Disadvantages:** Reduced productive area under agriculture may release nutrients during non-growing season. Risk of increasing emissions of nitrous oxide and methane (greenhouse gases) **Development Partners:** Developers, The Council, Welsh Rivers Trust, , Rivers in Wales Environmental Investment, DCWW Community Fund, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, NFU Cymru, Cities for Trees, Local Nature Partnership Carmarthenshire , United Utilities, Salmon and Trout Conservation', WG, WG Spending Commitments, Basic Payment Scheme, SFS, Glastir Small Grant Scheme, Heritage Lottery Fund, Woodlands for Wales	Biodiversity Climate resilience Air quality Health and Wellbeing Educational Pest control Noise attenuation Amenity Aesthetic value	**Medium**	**Medium**	**High**
18	**Private Sewerage Drainage Fields**	Category 2	Also known as septic drain fields or leach fields, are an essential component of onsite sewage disposal systems for individual homes or small communities that are not connected to a centralized sewer system. Network of discharge pipes from septic tank or PTP laid in trenches under the ground surface so that effluent can be discharged to the ground. Effluent percolates through soil. Sediment bound P is immobilised and soluble P is bound to soils and sediments. **Advantages:** Likely to be less costly than a wetland system with less maintenance for same P removal performance. Can be delivered up to medium spatial scale (<100 units / <2.0 ha) **Disadvantages:** Longevity of scheme anticipated to be low (10-20 years). Increased usage of the drainage field with time can result in the soils or filter materials sorption capacity being reached. Fields where ground water flood risk is high or water table is within 2.0 m of ground surface are unsuitable. Provides no additional environmental benefits. **Development Partners:** Developers, NFU Cymru, The Council.	Efficiency and increased capacity at WwTW	**Medium**	**Low**	**High**
19	**River Channel Re-naturalisation**	Category 2	Works to return rivers to a more 'natural state' including: re-meandering, creating berms, pool-riffle systems, riparian planting and reconnecting channel to floodplain. Aims to improve the ecological health, biodiversity, and overall resilience of the river system.	Natural flood mitigation Biodiversity Amenity	**High**	**Low**	**Medium**

No	Intervention	Mitigation Category	Intervention Description	Benefits	Feasibility	Maintenance	Effectiveness
			Advantages: Good capability for capture of pollutants and wider environmental benefits. Can have high longevity for functioning effectively (50+ years). Minimal maintenance required during the establishment phase of the river channel. **Disadvantages:** Currently no industry standard regarding the design of larger scale river and floodplain re-naturalisation schemes to support the achievement of nutrient removal. Baseline and longer-term monitoring will be required prior to and following the implementation of a scheme in order to determine how much P the scheme is removing. P absorption to sediments is primary process of nutrient removal, however, the process is reversible with desorption occurring if P concentration of water drops below a threshold. Threshold is dynamic as the sorption capacity of sediments changes over time. Management regime may depend on the local context and degree of re-naturalisation. Potentially will be over a year until additional benefits are realised. **Development Partners:** The Council, Welsh Rivers Trust , Salmon and Trout Conservation', Land owners / land managers, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, WG, WG Spending Commitments, Basic Payment Scheme, SFS, Heritage Lottery Fund, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge	Aesthetic value Carbon sequestration Additional pollutant removal Health and well being Air quality Climate resilience			
20	**Drainage Ditch Blocking**	Category 2	Also known as ditch damming or ditch plugging Placing of barriers across ditches to slow the flow, increase residence times and prevent downstream transport of sediments. **Advantages:** Easy to construct, low construction cost and low maintenance (mainly visual inspections needed). **Disadvantages:** Low predictability / certainty of success, and low removal performance. Lack of UK based evidence for effectiveness; baseline and long-term monitoring is recommended pre-and post-implementation and may result in localised flooding during heavy rainfall events. Dam failure would have implications for P removal efficiency. Limited research currently available on the effectiveness of this method for nutrient removal. **Development Partners:** Land owners / land managers, The Council, NFU Cymru, Environmental NGOs, NRW, Sustainable Drainage Feasibility Grant, WG.	Natural flood mitigation Biodiversity Additional pollutant removal Carbon sequestration	Medium	Low	Low
21	**Engineered Log Jams**	Category 2	Leaky dams made of woody debris constructed to mimic beaver dams and slow flows and re-naturalise river reaches. **Advantages:** P removal achieved through sedimentation, chemicals sorption and biomass assimilation. Well-designed schemes will require little maintenance and could serve up to 100 units. **Disadvantages:** Risk being washed away in flood events – best suited to small watercourses < 2m wide. Lack of research for engineered log jams / beaver dams to confirm potential nutrient removal estimates; monitoring will be required pre/post scheme introduction to determine effectiveness. Potential for increased localised flooding. Adaptive management needed in case repairs are needed. Possibility that P removal may be short-term and that nutrients could be remobilised during floods. **Development Partners:** The Council, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, Welsh Rivers Trust , Salmon and Trout Conservation', Landowners / land managers, WG, WG Spending Commitments, Basic Payment Scheme, SFS, Heritage Lottery Fund, Esmee Fairburn Foundation, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge	Natural flood mitigation Biodiversity Carbon sequestration Additional pollutant removal	Medium	Low	Low
22	**Granular Treatment Media**	Category 1 and Category 2	Granular treatment media that has been designed to treat various pollutants. There are phosphorus specific granular treatment media. **Advantages:** Phosphorus technically achievable limit of 0.25mg/l (if infiltration possible and depending on the manufacturer) **Disadvantaged:** P removal highly dependent on manufacturer and how well assets are maintained. Filter media will need to be changed periodically.	Potential for grey water recycling May reduce unpleasant odours	Medium	Medium	Medium

No	Intervention	Mitigation Category	Intervention Description	Benefits		Feasibility	Maintenance	Effectiveness
			Development Partners: Landowners / land managers, The Council, NRW, Sustainable Drainage Feasibility Grant, Developers, Local Highways Agencies, National Surface Water Management and SuDS Group, Living Streets Cymru.					
23	**Willow Beds**	Category 1 and Category 2	Willow beds can be designed to treat stormwater from low/medium risk surfaces of small catchments. They allow capturing, attenuation, and evapotranspiration of captured flows. **Advantages:** Capture, attenuation and evapotranspiration of all flows so no discharge occurs. Uptake of P by the willow. Harvesting willow can be a valuable resource. If built as part of a closed systems, it is effective immediately. **Disadvantages:** Not commonly used in the UK, and where they are, they tend to be for private sewage treatment installations. To have optimal TP removal performance harvesting of willow will be required. Harvesting of willow is a valuable resource but the process is of harvesting it is onerous. Some sediment removal is required at the inlet and any suspended sediment may have to be removed periodically. Little information available currently regarding regulations on their implementation of water treatment. Effective only during the willow growing season. **Development Partners:** Landowners / land managers, The Council , NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, DCWW, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, Developers: Could help to deliver Net Benefit for Biodiversity, DCWW, WG, WG Spending Commitments, Basic Payment Scheme, SFS, Heritage Lottery Fund, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge.		Biodiversity Natural flood mitigation Aesthetic value Amenity value Carbon sequestration Can harvest the willow which could then be sold (offsets some of the maintenance costs)	**Medium**	**Low**	**High**
24	**Attenuation storage tanks (lined)**	Category 2	Lined cellular/crated or other storage below ground (no infiltration). **Advantages:** Particulate P removal through sedimentation of solids upstream of attenuation tank. **Disadvantages:** Attenuation tank is not designed to provide any P removal on its own. P removal highly dependent on upstream features and how well assets are maintained. Filters need changing every few years. **Development Partners:** Landowners / land managers, The Council, NRW, Developers: Could help to deliver Net Benefit for Biodiversity, DCWW, WG, WG Spending Commitments, Basic Payment Scheme		Natural flood mitigation	**Medium**	**High**	**Low**

Table C-7-2: Supplementary guidance on how to deliver potential interventions measures for reducing phosphorus levels in the Afonydd Cleddau Catchment

No	Intervention	Routes to deliver the intervention
1	**Reduction of Agricultural Phosphorus at source**	• Nutrient Management Planning: can help optimize the use of fertilizers and minimize phosphorus runoff. • Precision Agriculture Techniques (not sure up to what extend in our catchment): to apply fertilizers more precisely, based on site-specific soil nutrient levels and crop needs reducing the risk of over-application and phosphorus runoff. • Cover Crops and Crop Rotation (not sure up to what extend in our catchment): during fallow periods or between cash crops can help capture and retain excess phosphorus in the soil. • Conservation Tillage: to minimize soil erosion and nutrient runoff. By leaving crop residues on the soil surface, conservation tillage helps retain phosphorus and other nutrients in the field. • Reducing soil compaction to improve soil infiltration and root penetration • Buffer Strips and Riparian Zones: can help filter and trap phosphorus runoff from agricultural fields. These strips act as natural buffers, reducing the transport of nutrients into nearby waterways. • Manure Management: this ensures that manure is applied at appropriate rates and times to minimize phosphorus runoff. • Phosphorus-Specific Fertilizers: to release phosphorus slowly, reducing the risk of runoff. These fertilizers can be tailored to match crop nutrient requirements and minimize nutrient losses. • Soil Testing and Nutrient Monitoring: this enables targeted fertilization, reducing excess phosphorus and minimizing environmental risks. • Education and Outreach: Training and knowledge-sharing platforms can help farmers understand the benefits of sustainable phosphorus management. • Government Policies and Incentives: this can include incentivizing the adoption of sustainable practices, promoting research & development, and providing financial assistance for infrastructure improvements.
2	**Farming Source Control**	• Physical interventions to prevent nutrient entering the water courses, farm improvement works such as, such as slurry separation, confinement of farm machinery to certain areas of a field (controlled trafficking) fencing, improved guttering, sewage storage management
3	**Surface Water Separation on farmland**.	• Buffer Zones: can help intercept and filter runoff water, reducing the transport of phosphorus to nearby water bodies. • Diversion Structures: can help prevent direct phosphorus runoff. These structures slow down water flow, allowing sediment and phosphorus to settle out before being discharged into water bodies. • Contour Farming (not sure up to what extend applicable to our catchment): this helps to reduce water runoff and erosion, thus minimizing the transport of phosphorus from fields to surface waters. • Water Management: can help regulate water levels in fields. This can reduce the frequency and volume of surface runoff, limiting phosphorus transport into water bodies. • Precision Application Techniques: to apply fertilizers and phosphorus amendments only where and when needed. This helps reduce over-application and minimizes the potential for excess phosphorus runoff. • Soil Health Management: can retain phosphorus more effectively, reducing the likelihood of nutrient runoff.
4	**Enhanced Wastewater Treatment Works**	• Advanced Primary Treatment: to remove a higher percentage of suspended solids, oil, and grease from the influent wastewater. This can be achieved using advanced sedimentation systems, dissolved air flotation, or physical-chemical treatment • Biological Nutrient Removal (BNR): BNR processes are commonly employed in enhanced treatment works to remove nutrients, particularly nitrogen and phosphorus, from the wastewater. This involves incorporating additional treatment stages, such as anoxic and aerobic zones, to promote the biological processes that facilitate nutrient removal by bacteria. Granular biomass • Tertiary Treatments and/or Membrane Filtration: such as granular medium or cloth filtration, microfiltration, ultrafiltration, or reverse osmosis, to achieve superior removal of solids, bacteria, viruses, and other contaminants from the wastewater. Membrane filtration can provide a high level of effluent quality, making it suitable for reuse applications or meeting stringent discharge standards. • Advanced Oxidation Processes (AOP): AOPs, such as UV disinfection, ozonation, or advanced chemical oxidation, may be incorporated into enhanced treatment works to further reduce the concentration of persistent organic pollutants, micropollutants, or pathogens in the wastewater. AOPs can enhance the overall treatment efficiency and provide additional disinfection capabilities. • Sludge Treatment and Management: such as advanced anaerobic digestion, thermal treatment, or nutrient recovery from sludge. • Energy Efficiency and Resource Recovery: such as energy recovery from biogas or wastewater heat, to reduce operational energy consumption. Additionally, resource recovery techniques, such as nutrient recovery from wastewater or biogas utilization, can enhance sustainability and resource efficiency. • Monitoring and Control Systems: to optimize process performance, respond to changing influent conditions, and meet effluent quality targets. This can involve real-time monitoring, advanced sensors, and automation for efficient operation and maintenance.
5	**Permeable Paving**	• Permeable Surfaces: Such as permeable pavements, allows rainwater to infiltrate into the ground, reducing runoff volume and promoting groundwater recharge. Permeable surfaces can also remove pollutants through filtration and natural biological processes.
6	**Green roofs**	• Green Roofs: involve covering rooftops with vegetation, which absorbs and evaporates rainwater, reducing stormwater runoff. Green roofs can help regulate temperature, improve air quality, and provide additional habitat for wildlife.

7	**Swales**	• Water Management: Swales are designed to slow down the flow of stormwater runoff, allowing it to infiltrate into the ground or be absorbed by vegetation. This helps to reduce the volume and peak flow rate of runoff, minimizing the risk of flooding and erosion. • Pollutant Removal: Swales act as natural filters, removing pollutants from stormwater runoff. The vegetation and engineered soil in the swale help to trap and filter sediment, nutrients, heavy metals, and other contaminants, improving the quality of the water before it reaches water bodies. • Erosion Control: By slowing down the flow of water, swales help to prevent erosion of soil and prevent the loss of sediment. The vegetation in the swale stabilizes the soil and its root systems help to bind the soil together, reducing erosion. • Aesthetics and Landscaping: Swales can be landscaped with a variety of vegetation, such as grasses, shrubs, or native plants, providing an attractive and visually appealing feature in the landscape. They can enhance the aesthetic value of an area and contribute to biodiversity by providing habitat for wildlife. • Groundwater Recharge: Swales promote infiltration of stormwater into the ground, helping to recharge groundwater resources. This can help to replenish water tables and maintain a sustainable water balance in the local ecosystem. • Cost-Effectiveness: Swales are generally cost-effective compared to traditional stormwater management systems. They require less maintenance and are often less expensive to construct and maintain than engineered structures like underground pipes or detention basins. • Flexibility and Adaptability: Swales can be designed to fit the specific needs and constraints of a site. They can be incorporated into various types of landscapes, including residential, commercial, and industrial areas. Swales can be adapted to different slopes and soil conditions and can be designed to accommodate different flow rates and volumes of stormwater.
8	**Conveyance Chanels**	• Site Assessment and Planning: to determine the requirements and constraints of the drainage system. Consider factors such as topography, soil conditions, existing infrastructure, and water flow patterns. Develop a comprehensive drainage plan that includes the layout and alignment of conveyance channels. • Design and Engineering: to design the conveyance channels based on the site assessment and project objectives. Consider factors such as the anticipated flow rates, channel capacity, channel slope, and erosion control measures. Design the channels to accommodate the expected water volumes and velocities while minimizing erosion and sedimentation. • Construction and Excavation: according to the approved design. Ensure proper grading and shaping of the channel to facilitate water flow and prevent stagnant areas. Use appropriate construction techniques and equipment to ensure stability and proper compaction of the channel bed and sides. • Erosion Control and Stabilization: to prevent erosion and maintain the stability of the conveyance channels. This may include lining the channel with erosion-resistant materials, installing check dams or riprap, or incorporating vegetation to reinforce the channel banks and prevent erosion. • Outlet Structures and Junctions: at the downstream end of the conveyance channels to control the discharge of water into the receiving water body or drainage system. Junctions with other drainage features, such as culverts or other channels, should be properly designed to ensure smooth flow transitions and minimize the risk of blockages or backups. • Maintenance and Monitoring: including regular inspections, debris removal, vegetation management, and sediment control measures. Regularly monitor the conveyance channels to identify any signs of erosion, sediment buildup, or blockages. Promptly address any maintenance issues to ensure the proper functioning of the channels. • Safety Considerations: Ensure that the conveyance channels are designed and constructed with safety in mind. Install appropriate safety features, such as guardrails or warning signs, to prevent accidents and unauthorized access. Consider factors such as public safety, wildlife habitat, and floodplain management during the design and construction process. • Documentation and Record-Keeping: this documentation serves as a valuable resource for future reference, maintenance, and potential system upgrades.
9 to 11	**Filtration Strips, Drains, Basin**	• Site Assessment and Planning: to identify suitable locations for filtration strips. Consider factors such as slope, proximity to pollution sources, drainage patterns, and soil conditions. Determine the width and length of the strips based on the anticipated runoff volume and pollutant loading. • Design and Vegetation Selection: to design the filtration strips based on site conditions and project objectives. Select appropriate vegetation species that can effectively filter and treat stormwater runoff. Native plants or grasses are often preferred for their adaptability and pollutant removal capabilities. • Strip Width and Layout: based on the required treatment capacity and available space. Generally, wider strips provide greater treatment efficiency. Consider incorporating multiple strips or a combination of filtration strips and swales to enhance treatment effectiveness. • Soil Preparation: by removing existing vegetation, tilling, or aerating the soil, and incorporating organic matter or compost to improve its water-holding capacity and infiltration rates. Ensure proper grading and contouring to facilitate water flow through the strip. • Vegetation Establishment: following recommended planting techniques and densities. Monitor and provide appropriate irrigation and maintenance during the establishment phase to ensure successful vegetation growth. • Maintenance and Monitoring: including regular inspection, weed control, and vegetation management. Monitor the filtration strips for sediment buildup, erosion, and the health of the vegetation. Remove any accumulated sediment or debris as needed. • Public Education and Outreach: to raise awareness among the public about the purpose and benefits of filtration strips. Encourage residents and stakeholders to understand the importance of maintaining the strips and avoiding pollution inputs. • Monitoring and Evaluation: to ensure they are effectively treating stormwater runoff and removing pollutants. Assess the need for any modifications or adjustments based on monitoring results and changing site conditions.
12	**Infiltration Basins (Bioretention/Rain Garden)**	• Assessment and Planning: to identify suitable locations for infiltration basins. Consider factors such as soil type, depth to groundwater, slope, and proximity to buildings or utilities. Assess the anticipated runoff volume and soil infiltration capacity to determine the appropriate size and design of the basin.

		• Design and Engineering: to design the infiltration basin. Consider factors such as the basin shape, size, depth, and hydraulic capacity. Ensure that the design allows for proper infiltration rates and accommodates the anticipated runoff volume while preventing overflow or flooding. • Soil Testing and Preparation: to assess its infiltration capacity and suitability for the basin. Prepare the basin by excavating the designated area and shaping it according to the approved design. Ensure that the soil in the basin is properly graded and compacted to facilitate infiltration. • Rain Gardens and Bioretention: are landscaped depressions or shallow basins filled with vegetation and engineered soils that capture and treat runoff. They allow runoff to infiltrate into the ground and filter pollutants through biological and physical processes. • Outlet Structures and Overflow Management: such as a flow restrictor or orifice, to regulate the release of stormwater from the basin. Consider incorporating overflow structures, such as emergency spillways or swales, to manage excess runoff during heavy rainfall events and prevent erosion or damage to the basin. • Vegetation Establishment: such as native grasses, wildflowers, or wetland plants, in the basin to enhance infiltration, stabilize the soil, and provide habitat. Select plants that are adapted to the local climate, soil conditions, and water tolerance. Monitor and provide appropriate irrigation and maintenance during the establishment phase to ensure successful vegetation growth. • Maintenance and Monitoring: including regular inspection, sediment removal, vegetation management, and monitoring of infiltration rates. Remove accumulated sediment, debris, and invasive plants as needed. Monitor the basin's performance, including infiltration rates and water quality, to assess its effectiveness and identify any necessary maintenance or modifications. • Safety Considerations: such as fencing or warning signs, to prevent accidents and unauthorized access. Consider factors such as public safety, wildlife habitat, and floodplain management during the design and construction process. • Public Education and Outreach: to raise awareness among the public about the purpose and benefits of infiltration basins. Encourage residents and stakeholders to understand the importance of maintaining the basins and avoiding pollution inputs.
13	**Retention Ponds**	• Site Assessment and Planning: to identify suitable locations for retention ponds. Consider factors such as topography, soil type, drainage patterns, and proximity to development or impervious surfaces. Assess the anticipated runoff volume and design criteria to determine the appropriate size and configuration of the pond. • Design and Engineering: to design the retention pond. Consider factors such as the pond size, depth, outlet structures, and hydraulic capacity. The design should allow for the temporary storage of runoff and gradual release to prevent downstream flooding. Ensure compliance with local regulations and design criteria. • Excavation and Construction: according to the approved design. Shape the pond to facilitate sufficient storage capacity and proper water flow. Construct the necessary inlet and outlet structures, including pipes, weirs, or control structures, to manage the inflow and outflow of stormwater. • Erosion Control and Stabilization: such as erosion blankets, geotextiles, or vegetated slopes, to stabilize the pond's banks and prevent erosion. Consider adding riprap or other suitable materials to protect against wave action and erosion. • Vegetation Establishment: including native grasses, wetland plants, or riparian species. Vegetation helps stabilize the pond's banks, enhance water quality by filtering pollutants, provide habitat, and improve the overall aesthetics of the site. Monitor and provide appropriate irrigation and maintenance during the establishment phase to ensure successful vegetation growth. • Maintenance and Monitoring: including regular inspection, sediment removal, vegetation management, and monitoring of water levels and water quality. Remove accumulated sediment, debris, and invasive plants as needed. Monitor the pond's performance to assess its effectiveness in flood control and pollutant removal. • Safety Considerations: such as fencing, signage, or warning devices, to prevent accidents and unauthorized access. Consider factors such as public safety, wildlife habitat, and floodplain management during the design and construction process. • Public Education and Outreach: to raise awareness among the public about the purpose and benefits of retention ponds. Encourage residents and stakeholders to understand the importance of maintaining the pond's functionality and avoiding pollution inputs.
14	**Detention Basins**	• May or may not be vegetated, maintenance and design will depend on water regime
15	**Ponds**	• Site Selection and Assessment: based on factors such as topography, hydrology, soil conditions, and intended use (e.g., stormwater management, recreation, aesthetics). Consider environmental regulations and any necessary permits. • Design Phase: including its size, shape, depth, and surrounding landscaping. Consider factors such as water source, circulation, aquatic habitat, and potential inflows and outflows. • Regulatory Approvals: from local, state, or federal regulatory agencies before construction begins. This may involve environmental impact assessments and compliance with water management regulations. • Construction: which may involve excavation, shaping the pond basin, installation of liners or clay, construction of water inlets and outlets, and planting of aquatic vegetation. Adhere to construction best practices and consider erosion control measures. • Water Quality and Aeration: Depending on the intended use of the pond, consider water quality management strategies such as aeration systems, sediment removal, and nutrient control to maintain a healthy aquatic ecosystem. • Landscaping and Surroundings: to enhance its aesthetic appeal and integrate it into the surrounding environment. This may include native plantings, walking paths, seating areas, and wildlife habitat enhancements. • Maintenance and Monitoring: including regular inspections, sediment removal, vegetation management, and monitoring of water quality parameters. Consider long-term management needs and potential impacts on local ecosystems.
16	**Constructed Wetlands**	• Feasibility Assessment: to determine the suitability of the site for a constructed wetland. Consider factors such as land availability, soil conditions, and proximity to water sources.

		• Design Phase: including considerations such as the type of wetland (surface flow, subsurface flow, or hybrid), hydraulic retention time, plant species selection, and construction materials. • Regulatory and Permitting Considerations: from regulatory agencies at the local, state, or federal level. This may involve environmental impact assessments, water quality permits, and compliance with wetland protection regulations. • Construction: which may involve excavation, shaping the wetland cells, installation of liners if required, planting of wetland vegetation, and construction of water control structures. Adhere to construction best practices and consider erosion control measures. • Start-up and Establishment: which may involve introducing wetland plants, inoculating with appropriate microorganisms, and monitoring the initial development of the wetland ecosystem. • Monitoring and Maintenance: including regular inspections, vegetation management, water level control, and monitoring of water quality parameters. Consider long-term management needs and potential impacts on local ecosystems. • Community and Stakeholder Engagement: including local communities, environmental organizations, and regulatory agencies, to ensure transparency and address any concerns related to the construction and operation of the wetland.
17	**Integrated Buffer Zones**	• Feasibility Site Assessment: to identify suitable locations for integrated buffer zones. Consider factors such as topography, hydrology, soil conditions, and existing land use. • Design and Planning: for the creation or enhancement of integrated buffer zones, considering the specific characteristics of the site, the desired width of the buffer, and the types of vegetation to be planted. Considerations may also include the incorporation of native plant species, the establishment of wildlife corridors, and the potential for recreational and educational amenities. • Stakeholder Engagement: including landowners, local communities, and regulatory agencies, to garner support and input for the establishment of integrated buffer zones. Consider the perspectives of those directly impacted by the project and address any concerns or considerations. • Vegetation Establishment: considering factors such as hydrology, soil moisture, and plant community diversity. This may involve the use of seedlings, cuttings, or direct seeding methods. • Monitoring and Maintenance: for the integrated buffer zones, including regular inspections, vegetation management, and monitoring of water quality and wildlife habitat. Consider long-term management needs and potential impacts on local ecosystems. • Regulatory Compliance: with relevant environmental regulations and obtain any necessary permits or approvals from regulatory agencies at the local, state, or federal level. • Education and Outreach: to raise awareness about the importance of integrated buffer zones and engage the community in their stewardship. This may involve workshops, signage, and volunteer opportunities.
18	**Private Sewerage Drainage Fields**	• Site Assessment and Permitting: to determine the suitability of the property for a private sewerage drainage field, considering factors such as soil permeability, groundwater depth, and setbacks from wells, property lines, and water bodies. Obtain any necessary permits or approvals from local health or environmental authorities. • Design Phase: including the layout of trenches or beds, distribution piping, and the overall sizing of the field based on anticipated wastewater flows and soil characteristics. Considerations may also include slope, separation distances, and potential impacts on groundwater. • Construction: which may involve excavation, installation of distribution pipes, and backfilling with suitable fill material. Adhere to construction best practices, including proper compaction of soil and appropriate installation of piping and components. • Vegetative Cover and Landscaping: such as grass or shallow-rooted plants, to help enhance evapotranspiration and minimize soil erosion on the drainage field. • Maintenance and Monitoring: including regular inspections, vegetation management, and monitoring of system performance. This may involve periodic pumping of the septic tank and assessments of soil absorption rates. • Educational Outreach: regarding the proper use and maintenance of private sewerage drainage fields to ensure their long-term functionality and compliance with health and environmental standards. • Regulatory Compliance: with local regulations and standards for private sewerage systems, including periodic inspections and assessments to verify system functionality and acceptable environmental impact.
19	**River Channel Re-naturalisation**	• Evaluation and Planning: a comprehensive assessment of the river channel and its surrounding landscape to understand the historical conditions, current challenges, and opportunities for re-naturalization. This may involve ecological surveys, hydrological assessments, and analysis of historical maps and documents. • Stakeholder Engagement: including local communities, environmental organizations, landowners, and regulatory agencies, to gather input and support for the re-naturalization project. Consider the perspectives of those directly impacted by the project and address any concerns or considerations. • Design Phase (re-naturalisation plans): which may include modifications to the channel shape, bank stabilization, removal of artificial structures, and the reintroduction of natural features such as meanders, riffles, and pools. Considerations may also include the incorporation of native vegetation, creation of floodplain connectivity, and enhancement of wildlife habitat. • Regulatory Compliance: with relevant environmental regulations and obtain any necessary permits or approvals from regulatory agencies at the local, state, or federal level. This may involve environmental impact assessments and adherence to water management regulations. • Construction and Restoration (implement re-naturalisation plans): which may involve channel reshaping, vegetation planting, and placement of natural materials to restore aquatic and riparian habitats. Adhere to construction best practices and consider erosion control measures. • Monitoring and Adaptive Management: plan to assess the effectiveness of the re-naturalization efforts over time. This may involve tracking changes in water quality, habitat conditions, and ecological indicators to inform future management decisions.

		• Education and Outreach: to raise awareness about the importance of river channel re-naturalization and engage the community in the stewardship of restored river systems. This may involve workshops, signage, and volunteer opportunities.
20	**Drainage Ditch Blocking** Also known as, involves the deliberate obstruction or modification of a drainage ditch to manage water flow and improve water retention in a landscape. This technique is used to restore wetlands, control erosion, and create more favourable hydrological conditions.	• Assessment and Planning: to understand the existing hydrological conditions, erosion issues, and the potential benefits of blocking the ditch. Consider factors such as water flow rates, land use, and potential impacts on downstream areas. • Engage with Stakeholders: including landowners, local communities, and regulatory agencies, to gather input, address concerns, and ensure support for the ditch blocking project. • Design Phase: which may involve constructing barriers or installing structures to impede water flow. Considerations may include the materials used, the height and length of the barriers, and the potential impact on adjacent properties and ecosystems. • Permitting and Regulatory Compliance: from local, state, or federal regulatory agencies. Ensure compliance with environmental regulations and consider potential impacts on water quality, habitat, and downstream properties. Construction and Implementation: which may involve placing barriers, installing check dams, or modifying the shape of the ditch to slow down water flow and encourage water retention. Adhere to construction best practices and consider erosion control measures. • Monitoring and Assessment: to assess the effectiveness of the ditch blocking in achieving the desired hydrological outcomes. This may involve measuring water levels, monitoring changes in vegetation and habitat, and evaluating downstream impacts. • Maintenance and Adaptation: to ensure the ongoing functionality and effectiveness of the ditch blocking structures. Regular inspections, vegetation management, and sediment removal may be necessary. Adapt the approach as needed based on monitoring results and changing hydrological conditions.
21	**Engineered Log Jams**	• Assessment and Planning: of the river reach, including geomorphology, hydrology, and ecological conditions. Determine the locations where engineered log jams can provide the most benefit, such as areas prone to erosion, lacking in fish habitat, or requiring channel stabilization. • Design Phase: engineering plans for the engineered log jams, considering factors such as log size and type, placement patterns, and the desired hydraulic and ecological outcomes. Considerations may also include stream flow conditions, sediment transport, and potential impacts on flood risk. • Stakeholder Engagement: including landowners, local communities, environmental organizations, and regulatory agencies, to gather input, address concerns, and ensure support for the engineered log jam project. Consider the perspectives of those directly impacted by the project. • Log Procurement and Construction: Source suitable logs or woody debris and construct the engineered log jams according to the design plans. This may involve anchoring logs to the riverbed, securing them in place, and creating natural-looking structures that integrate with the surrounding environment. • Monitoring and Evaluation: to assess the effectiveness of the engineered log jams in achieving the desired outcomes. This may include monitoring changes in river morphology, sediment transport, water quality, and fish habitat. Adapt the approach as needed based on monitoring results. • Maintenance and Adaptation: to ensure the ongoing functionality and effectiveness of the engineered log jams. Regular inspections, log replacement, and sediment management may be necessary. Adapt the approach as needed based on changing river dynamics and ecological conditions. • Education and Outreach: to raise awareness about the benefits of engineered log jams and engage the community in the stewardship of river ecosystems. This may involve workshops, signage, and volunteer opportunities.
22	**Granular Treatment Media**	• Can be used onsite and targeted towards particular pollution treatment • It removes impurities using beds of sand, anthracite, or activated carbon. • The process is versatile, cost-effective, and relatively simple. • However, it requires regular maintenance and may have limitations in removing dissolved contaminants.
23	**Willow Beds**	• Constructed wetlands optimised for pollution removal due to the bioremediation potential of both plant, root, bacteria interface resulting in high pollutant removal efficiency
24	**Attenuation storage tanks (lined)**	• Below ground water storage, could also be a geo cellular system, can also be combined with trees in an urban street scape environment (e.g. Silvacell)

Appendix D

Mitigation Opportunity Mapping

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