



United Utilities Water

Water Resources Management Plan 2024

Biodiversity Net Gain and Natural Capital Assessment

Report for

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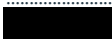
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UU final WRMP24 BNG-NCA

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1. Introduction

1.1 Background and purpose of this report

Water companies in England and Wales have a statutory requirement to prepare a Water Resources Management Plan (WRMP) every five years. The latest Water Resource Planning Guideline (WRPG) produced by the regulatory bodies¹ (Ofwat, The Environment Agency and Natural Resources Wales) states that water companies are required to ensure their WRMP delivers net biodiversity gain where appropriate, and uses a proportionate natural capital approach. This report is driven by this requirement and demonstrates how United Utilities Water (Uuw) will meet these requirements in the assessment of their WRMP24 feasible options and preferred plan.

United Utilities Water Resource Management Plan

The Water Act 2003 requires that all water companies in England Wales prepare and maintain Water Resources Management Plans (WRMPs). These plans set out how public water supply (PWS) will be maintained over a minimum of 25 years in a way that is economically, socially and environmentally sustainable. The WRMPs must be revised every five years.

United Utilities Water (Uuw) has finalised its Water Resources Management Plan 2024 (WRMP24). The WRMP24 sets out a long-term, best value and sustainable plan for water supplies in the North West. The WRMP24 plans for an adequate supply to meet demand from 2025 to 2050 and beyond, and a supply system that is resilient to drought. WRMPs are reviewed on a rolling five-year basis, with Uuw's most recent plan being published in 2019.

As part of the preparation of WRMP24, Uuw published its Draft Water Resources Management Plan 2024 (Draft WRMP24) for consultation between the 7th December 2022 and 15th March 2023, following submission to Defra. The Draft WRMP24 set out Uuw's proposals to ensure continued delivery of a secure and reliable supply of water from 2025 to 2050, looking beyond out to the year 2100.

Taking into account the responses received to the consultation on the Draft WRMP24 from regulators, stakeholders and the public, further engagement and environmental assessment, Uuw selected its preferred plan for WRMP24. A Revised Draft Water Resources Management Plan 2024 (Revised Draft WRMP24 or rdWRMP24) was prepared and submitted to the Secretary of State for review and approval (21 June 2023).

The Secretary of State subsequently requested further information on the Revised Draft WRMP (December 2023)², which was provided by Uuw alongside updated environmental reports (February 2024); however, modelling of some options demonstrated issues with Water Framework

¹ Ofwat, NRW & EA (2023), Water Resources Planning Guideline. Available at: <https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline>

² Letter from Defra Deputy Director – Water Sector Delivery to Uuw (no reference) dated December 2023

Directive (WFD) compliance, and so Defra’s ‘Direction to Publish’ letter³ indicated that amendments to the preferred options were required.

UUW’s WRMP24 has been developed within a regional water resources planning framework covering all or part of the operational areas of Dŵr Cymru Welsh Water (DCWW), Hafren Dyfrdwy (HD), Severn Trent Water (STW), South Staffordshire Water (SSW) and United Utilities Water (UUW)⁴ that is managed by Water Resources West (WRW). WRW is currently preparing a Regional Plan⁵ for the period 2025 to 2085 that will address long-term regional and inter-regional, multi-sectoral water resources management pressures and will draw on water resource options from the member water companies’ WRMP24s, as well as the Strategic Resource Options (SROs) being taken forward by the companies.

The Final WRMP24

Following consultation on the Draft WRMP24, UUW reviewed its best value plan for WRMP24 and as a result, the preferred plan was modified. In particular, the number of supply options which now make up the preferred plan for the Final WRMP24 has significantly reduced compared to the Draft, owing to, in particular, decreased water transfer needs (following the final regional planning reconciliation round).

The Draft WRMP24 included a total of 168 MI/d of exports to STW and Water Resources South East (WRSE) from UUW’s SRZ, starting with a 75 MI/d transfer in 2031. Seven supply options were included in preferred plan to support these transfers. Transfers to WRSE are not selected in the Final WRMP24 (linked to WRSE companies lowering their demand projections following consultation feedback) and STW’s need reduced to 25 MI/d, hence fewer supply options are required in WRMP24. When combined with updates to the demand management measures, this also means that improving UUW’s level of service for temporary use bans (TUBs) is no longer reliant on the dual-purposing of water transfer support options.

The final WRMP24 therefore proposes:

- one supply option, to provide 25MI/d of additional resource.
- 33 customer, distribution and production options to provide some 282MI/d.

The preferred portfolio supply-side option (including intended yield and approximate year by which the option would be required) is summarised in **Table 1.1**.

Table 1.1 Preferred Supply Options included in the Final WRMP24

Option ID	Option name	Yield (MI/d)	Description	Year selected
WR076	Bollin	25	Option WR076 involves the following construction elements: - A new river abstraction point on the River Bollin near Heatley and associated transfer pumping station;	2033

³ Letter from Defra Deputy Director (Floods and Water) to UU (no reference) dated 06 September 2024.

⁴ Hafren Dyfrdwy operates in mid-Wales and borders the WRW Regional Plan area; no Hafren Dyfrdwy water resources zones are included in the regional plan and so Hafren Dyfrdwy is an associate rather than core member of WRW.

⁵ EA (2020) *Water Resources National Framework: Appendix 2: Regional planning*.

Option ID	Option name	Yield (MI/d)	Description	Year selected
			<ul style="list-style-type: none"> - A new water quality monitoring point upstream of the proposed abstraction point; - A new 25MI/d water treatment works (WTW) on the outskirts of Altrincham; - A new 25MI/d treated water storage reservoir at the same location; - A new raw water transfer main (~5km) from abstraction point to the new WTW; - A new potable water supply main (~2.5km) from the WTW to an existing supply main; - Supply network reinforcements (~2.5km) to a connection point on the existing 302T1 supply main. <p>The option has a maximum capacity of 25 MI/d. With an average abstraction scenario, the rate of abstraction would peak in July at 22 MI/d, with a minimum of 3 MI/d in winter. With the '1 in 500 year drought' abstraction scenario, use of the option would be sustained at the maximum rate of 25 MI/d for a sustained period through spring, summer and early autumn.</p>	

The supply option in the preferred plan forms part of the North West Transfer (NWT) Strategic Resource Option (SRO). The NWT SRO is currently being assessed as part of RAPID’s gated process for SROs, which includes assessment of environmental compliance. The NWT environmental compliance assessments, and the supporting investigations, are ongoing, and completed outcomes will not be available until the RAPID Gate 3 submission in 2026. In consequence, the findings have not been available in time for the Final WRMP24 (and its assessment).

As a result, the preferred option, and other NWT options, all have residual uncertainties until investigations associated with NWT SRO Gate 3 conclude. Recognising this uncertainty, and consistent with the WRPG requirements⁶ and taking into account feedback from several environmental stakeholders including the Environment Agency (EA), Natural England (NE), Natural Resources Wales (NRW) and Mersey Rivers Trust, UUW has identified four alternative ‘WFD compliant’ WRMP options. With a combined output of 21.3 MI/d, they provide sufficient capacity to completely replace the supply option in the preferred plan, or alternative NWT options, in the event that they are required (the supply capacity requirement is 20.4 MI/d).

The options that comprise the reasonable alternative plan are listed in **Table 1.2**.

Table 1.2 3 Options included in the WRMP Reasonable Alternative

Option ID	Option name	Yield (MI/d)	Description
WR026c	SWN_ RIVER RIBBLE	4	

⁶ Section 9.4.3 of the of the WRPG sets out that where due to uncertainty, “Alternatives are included in the plan at company and/or regional level where the avoidance of an adverse effect on integrity of European sites is certain, and these are available, feasible and deliverable”

Option ID	Option name	Yield (MI/d)	Description
			[REDACTED]
WR065b	RES_WHITEHOLME	2	[REDACTED]
WR185	SSO_STOCKPORT PH II	12	[REDACTED]
WR191	PRO_NORTH LANCASHIRE	4	[REDACTED]

1.2 Biodiversity Net Gain, Natural Capital and Ecosystem Resilience

Biodiversity Net Gain (BNG) is an approach to the development of land and marine management that aims to leave biodiversity in a measurably better condition than prior to development. BNG seeks to provide a means of quantifying losses or gains in biodiversity value brought about by changes in land use, when designed and delivered well, BNG can secure benefits for nature, people and places, and for the economy⁷.

Natural Capital (NC) studies key components of nature which are essential for the long-term provision of benefits on which society relies. These components can have a direct or indirect value to people. A natural capital approach, which has been followed in this assessment, understands that nature underpins human wealth, health, wellbeing and culture and seeks to demonstrate the value of the natural environment for people and the economy⁸.

Natural assets provide ecosystem services such as regulating floods and improving air quality, and those ecosystem services provide benefits such as reducing the chance a house will flood or improved health. This benefit can then be valued through use of natural capital metrics, and can be used to help in the support of delivery of targets, such as putting a value on the potential delivery of BNG.

For options that affect Wales, a Sustainable Management of Natural Resources (SMNR) approach (NRW⁹) has been taken. The SMNR Principles aim to utilise natural resources in a way, and at a rate that, maintains and enhances the resilience of ecosystems and the benefits they provide. In doing so, the needs of present generations are met without compromising the ability of future generations to meet their needs. Following the SMNR Principles will also help to achieve the

⁷ Natural England (2021), Biodiversity Net Gain – more than just a number. Accessible via: <https://naturalengland.blog.gov.uk/2021/09/21/biodiversity-net-gain-more-than-just-a-number/>

⁸ UK Government (2021), Enabling a Natural Capital Approach (ENCA) – Updated 20 August 2021

⁹ <https://naturalresources.wales/media/678063/introducing-smnr-booklet-english-final.pdf>

Wellbeing Goals, which have been put in place to improve the social, economic, environmental and cultural wellbeing of Wales¹⁰. These goals fall under the Well-being of Future Generation (Wales) Act 2015. The application of the SMNR Principles and Wellbeing approach can help to identify solutions which provide multiple benefits under appropriate management. **Appendix A** sets out the SMNR principles and Wellbeing Goals, in relation to the scope of this assessment.

While the Environment (Wales) Act (2016) and the Environment Act (2021) in England are not completely synergistic, in this report the terms NCA and BNG have been used for ease of reference, noting that this method will also take account of ecosystem resilience and enhancement opportunities, as required for Wales.

1.3 Biodiversity Net Gain, Natural Capital and Ecosystem Resilience requirements for WRMPs

The purpose of a WRMP is to set out how a water company will achieve a secure supply of water for its customers whilst protecting the environment, and demonstrate that it is resilient to a range of future challenges including more extreme droughts, climate change, population growth.

As part of the WRMP, water companies must demonstrate that they have considered a range of environmental legislation and guidance, including the Environment Act (2021) and Environment (Wales) Act (2016). Additionally, the EA and NRW have published separate supplementary guidance on Environment and Society in decision-making^{11,12}, which provides more detail about the expectation for NCA or ecosystem resilience in England and Wales respectively, and how a Natural Capital Assessment (NCA) and ecosystem resilience can support decision-making. The purpose of this is to allow water companies and Regional Groups to “make decisions that do not devalue, and look to enhance the value of the natural world for society benefit” (WRPG Supplementary Guidance⁸) together with supporting water companies within WRW to promote plans that have the potential to deliver wider environmental and social benefits.

The requirements for a BNG and NCA of a water company WRMP are outlined in the 2023 WRPG, as shown in Box 1.

¹⁰ <https://gov.wales/well-being-future-generations-act-essentials-html#section-60668>

¹¹ EA (2021) WRPG 2024 supplementary guidance – Environment and society in decision-making. Published 24/03/2021

¹² NRW (2021) WRPG 2024 supplementary guidance – Environment and Society in decision-making (Wales). Published 07/04/2021

Box 1: WRPG 2023**Section 4.1.1 High-level considerations****England and Wales**

Ensure your plan contributes to the conservation and enhancement of biodiversity, delivers net biodiversity gain where appropriate, delivers environmental gain and uses a proportionate natural capital approach.

Consider your duty to conserve biodiversity under section 40 of the Natural Environment and Rural Communities Act (2006) and the list of species and habitats of principal importance set out in section 41 of the Act (England).

Takes a catchment based approach.

Wales

If your plan affects Wales, ensure your plan delivers biodiversity and environmental requirements and uses a proportionate natural capital approach.

Consider the biodiversity and resilience of ecosystems duty, the section 7 biodiversity lists and duty under the Environment (Wales) Act and Nature recovery action plan for Wales if you supply customers in Wales or your plan affects sites in Wales.

2. Approach to the Biodiversity Net Gain and Natural Capital assessments

2.1 Overview of approach

Biodiversity Net Gain Approach

The BNG assessment is based on use of the Defra Biodiversity Metric 3.0, to assess losses of biodiversity as a result of the options¹³. A GIS-based system has been used, using national datasets, to provide comprehensive coverage of habitat data.

To ensure U UW's Preferred Plan contributes to the conservation and enhancement of biodiversity and delivers biodiversity net gain, Defra's Biodiversity metric 3.0 has been used to demonstrate how net gain could be achieved on and off-site. Any options within the plan that need planning permission are legally required to provide BNG of 10% in England due to the Environment Act (2021). This is not a legal requirement of the WRMP itself, but it is logical to meet this requirement within the plan to demonstrate U UW's commitment to protecting and enhancing biodiversity, and demonstrate that 10% BNG can be achieved when required.

For options within the Preferred Plan, Potential Biodiversity Opportunity (PBO) areas have been identified. These sites are all within 5km from the option locations and are based on a scoring system largely reflecting the Lawton principles¹⁴, as explained further in **Section 2.3**. These sites should then be used in conjunction with the results from the Biodiversity metric, with the metric calculating how much mitigation would be required, and the PBO identification showing potentially beneficial locations for off-site mitigation.

Natural Capital Assessment Approach

WRPG Supplementary Guidance states that NCAs in England should include as a minimum the following five ecosystem services:

- Biodiversity and habitat;
- Climate regulation;
- Natural hazard regulation;
- Water purification;
- Water regulation.

And that in Wales, an additional ecosystem service should be included:

¹³ While a newer version of the metric, v3.1, has now been released, v3.0 has been used for these assessments to provide consistency across multiple WRMPs and through the stages of assessment

¹⁴ Prof. J. Lawton (2010), Making Space for Nature. Report for the UK Government

- Recreation and tourism.

At the project outset, a review was undertaken of other ecosystem services, through which it was agreed that the following additional services would be taken into account:

- ‘Health & Well-being’ services, which will support compliance with the ‘Well-being of Future Generations Act’ of Wales. This is currently considered to be inherent in the services listed above and is not assessed in its own right.
- Agriculture.

For consistency across the companies in Water Resources West, all of the ecosystem services listed above are included in the assessments for all companies, including this report for U UW.

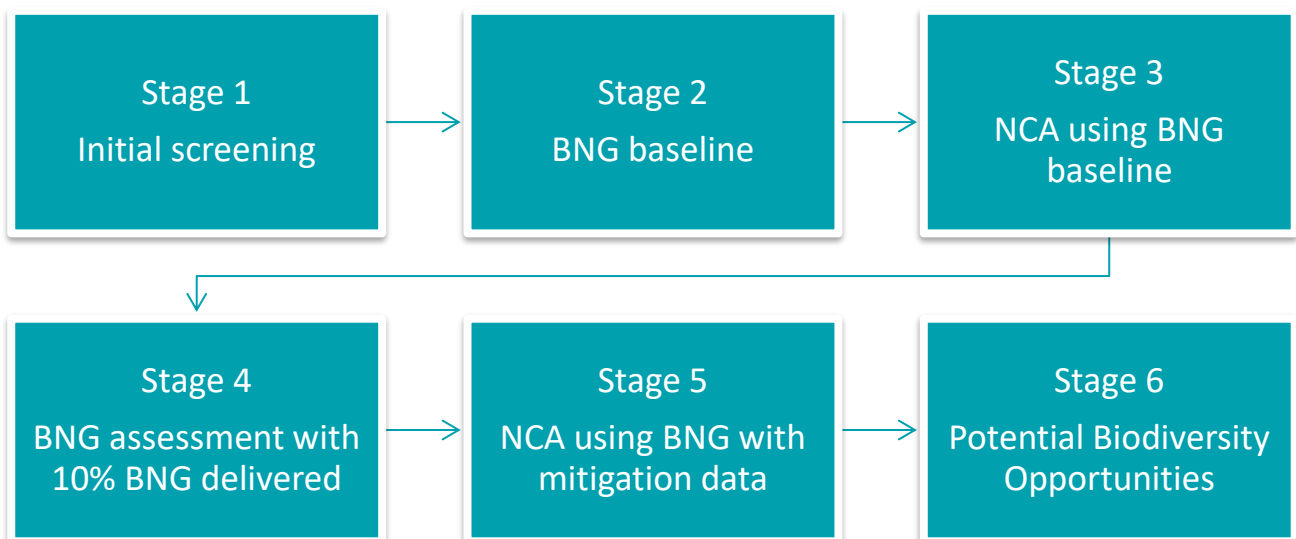
2.2 Sequential process

Throughout the WRMP process BNG and NCA have been considered in increasing levels of detail, proportionate to the wider WRMP programme. **Figure 2.1** shows the sequential process followed for the assessments. The approach taken for feasible options and consequent programmes of options is as follows:

- Feasible options – Stages 1 to 3 of **Figure 2.1**
- Preferred programme, and any reasonable alternative plans– Stages 1 to 6 of **Figure 2.1**.

In addition, for any options affecting Wales, an SMNR assessment is included between Stages 5 and 6.

Figure 2.1 The sequential process followed for the NC and BNG assessments



2.3 Methodology

Stage 1- Initial screening

This high-level qualitative scoring was necessary to assist with the development of the SEA and support detailed screening of options (and associated ecosystems) for the identification the preferred plan. The scoring also fed into Multi Criteria Decision Analysis (MCDA) (ValueStream1) and helped to support early decision making using the feasible options. Scores from 0 to +3 to 0 to -3 were awarded for each ecosystem service metric as a reflection of the potential level of benefit and disbenefit associated with the metric (allowing for benefits and disbenefits to be recognised separately where appropriate). Overall scores were calculated based on magnitude, scale, and duration of expected impacts, with each of magnitude and duration also being scored between -3 to +3, following the same rules as for the ecosystem services. A brief commentary was also included to describe the benefits or disbenefits.

The results of the Stage 1 assessments are not presented in this report, as they were used only to inform preliminary stages of assessment and were superseded by subsequent stages of assessment.

Stage 2- Biodiversity Net Gain baseline calculation

Baseline habitat area and condition

Areas of habitats were calculated in QGIS. The CORINE land cover dataset¹⁵ forms the basis of the habitat data, providing continuous coverage across the whole of the UK. This has been supplemented by other datasets where available, to provide improved resolution:

- The Priority Habitats Inventory¹⁶, covering all nationally mapped areas of priority habitat;
- National Forest Inventory 2018, to provide improved information about areas of forestry;
- OS Zoomstack, providing data about areas of open water and urban extents.

The footprint of impact was calculated for each option using GIS data provided by U UW:

- Where shapefile polygons were available for on-site infrastructure such as water treatment works or pumping stations, they were used directly;
- Where polygons were not available, a best estimate of area was made using grid references and illustrations provided by U UW;
- For pipelines, a 30m buffer (15m on each side) was assumed around polyline shapefiles.

¹⁵ <https://www.data.gov.uk/dataset/cd2c59e7-afd9-471d-a056-c5845619dcd7/corine-land-cover-2018-for-the-uk-isle-of-man-jersey-and-guernsey>

¹⁶ <https://www.data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england>

All areas were defined as having either a temporary or permanent loss of habitat. Pipelines were assumed to have a temporary impact, unless passing through woodland. The latter was classed as permanent to recognise the longer time period to reinstatement. All other types of infrastructure were classed as permanent. The areas of permanent and temporary loss were mapped over the habitat data, and run through a model that identified habitats which would be impacted by the construction and operation of the option. This model prioritises the habitat layers that have high resolution, importance and validity. This ensured that the most accurate and important data was not missed due to overlapping data of lower resolution.

All habitats were assumed to be in moderate condition (except those where only 'poor' or 'n/a' applies). The resulting habitat and condition data were then input to the Defra Biodiversity metric 3.0 spreadsheet in order to calculate the net loss.

Stage 3- Natural Capital Assessment

Data sources, gaps, and assessment

The NCA has been completed using the data sources described below, as recommended by the All Company Working Group (ACWG) environmental assessment guidance for SROs¹⁷ and the EA Water Resources Planning Guideline (WRPG) WRMP24 Supplementary Guidance on Environment and Society in Decision-Making¹⁸.

Natural Capital stocks

The assessment for the NC approach is based on the same available open-source data as used for the Stage 2 BNG assessment. The habitat types used for BNG were converted to broad habitat types to give the total area of each broad habitat impacted by each option. This provides a summary of the stock (i.e. the 'amount') of Natural Capital, which is used as the basis for the Ecosystem Service calculations. The conversion from the detailed habitat layers to broad habitat is outlined in **Appendix B**.

Broad habitat groupings were determined following the broad groups identified for calculation of carbon sequestration by land use from the EA's Supplementary Guidance (see **Table 2.1** below). Modified grassland has been classified as arable land and not grassland, as per advice from the Office for National Statistics (ONS) in developing a semi-natural grassland ecosystems account¹⁹. The UK NEA differentiates semi-natural grassland from improved and amenity grassland, as semi natural grassland has a much higher species-richness²⁰. Where a land cover class could belong in multiple broad habitat groups it was placed within the one that had a lower carbon sequestration rate, to give a more conservative estimate of benefits.

¹⁷ All Company Working Group (2020). WRMP environment assessment guidance and applicability with SROs

¹⁸ Environment Agency (2022) Water resources planning guideline supplementary guidance – Environment and society in decision-making - England. Published 3rd February 2022.

¹⁹ Office for National statistics (2018) Developing semi-natural grassland ecosystem accounts

²⁰ UK Habitat Classification Working Group (2018). UK Habitat Classification - Habitat Definitions V1.0 at <http://ecountability.co.uk/ukhabworkinggroup-ukhab>

Climate Regulation (carbon sequestration)

The carbon sequestration rates for NC stocks have been taken from the EA WRPG Supplementary Guidance, as shown in **Table 2.1**. Carbon sequestration rates of the relevant Natural Capital assets have been converted into monetary values using the Department for Business, Energy, and Industrial Strategy (BEIS) Carbon Values. As the prices published by BEIS are in £2020, GDP deflators were used to adjust them to the £2019 base year of modelling.

It is not possible to quantify the non-spatial changes in biodiversity and habitat ecosystem services arising from habitat condition improvement. To avoid overestimating the beneficial impact of the change in non-traded carbon sequestration value following BNG habitat creation / reinstatement, this value has been calculated by summing the change in non-traded carbon sequestration value during construction (the temporary loss), the permanent loss and creation.

The monetisation is based on the size of the area, temporary or permanent loss, and biodiversity value of the habitats affected. Higher biodiversity value habitats (e.g., woodland, lowland meadows, heathland) have higher carbon sequestration monetised value. The higher biodiversity habitats are typically more difficult to recreate following completion of the construction phase so loss and reinstatement of these habitats will result in a greater impact relative to lower value habitats (e.g., arable fields or modified grassland).

Table 2.1 Carbon sequestration of land use from EA WRPG Supplementary Guidance

Land use type	C seq rate (t/CO2e/ha/yr)
Woodland (deciduous)	4.97
Woodland (coniferous)	12.66
Arable land	0.10
Pastoral land	0.39
Grassland	0.39
Heathland & shrub	0.7
Urban	0

Natural Hazard Regulation

For the purposes of this assessment, natural hazard regulation has been taken to refer to regulation of flooding. Monetary values were sourced per broad habitat type from existing studies conducted in the UK. Values for woodland and wetlands/ floodplains broad habitat types were identified using the ENCA Services Databook²¹, where the associated studies were evaluated to ensure their suitability for benefit transfer.

An annual monetary value was only derived for the flood regulating services of woodland and wetland/ floodplain assets (see **Table 2.2**). Robust monetary values for other broad habitat types,

²¹ <https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca#enca-services-databook>

and which could be considered comparable to the values in **Table 2.2**, are not currently available. As a result, it has not been possible to provide a monetised estimate of other services.

Table 2.2 Benefit Transfer Values: Natural Hazard Regulation²²

Broad habitat type	Annual value	Reference
Woodland	115 (£2018/ha)	Forest Research (2018) & ENCA Services Databook
Freshwater (Open waters/ wetlands/ floodplains)	407 (£2011/ha)	Morris & Camino (2011) & ENCA Services Databook

Water Purification

The WRPG does not require the monetisation of Water Purification services, as these services are highly dependent on local factors (e.g. proximity to a water body) and there are limited tools available to provide accurate monetised assessment. Thus only a qualitative assessment has been undertaken. For Feasible options, an assessment was undertaken at Stage 1, based on habitat data and WFD status information from the EA's Catchment Explorer. As noted at the start of Section 3.1, that assessment has not been included here because it was superseded by later stages of assessment. For options included in the Preferred Plan and Reasonable Alternative Plan, a revised assessment was undertaken using similar information but also incorporating proximity to watercourses, with a score of between -1 (least impact) and -5 (greatest impact) being assigned to each option.

Water Regulation

The WRPG does not require the monetisation of Water Regulation services. It is considered that, with the available information, this service is best represented by the Water Framework Directive (WFD) Compliance Assessment. To avoid double counting, therefore, the WFD Compliance Assessment report should be referred to directly for the assessment of this service.

Recreation and Tourism

The Outdoor Recreation Valuation Tool (ORVal)²³ was used to estimate recreation demand from greenspaces, as a proxy for recreation value. Both open greenspaces and public footpaths were considered.

²² References:

- Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts.
- Morris & Camino (2011) UK National Ecosystem Assessment Economic Analysis Report, School of Applied Sciences, Cranfield University.

²³ <https://www.leep.exeter.ac.uk/orval/>

A conditional percentage was applied to the footpath values depending on the number of footpath intersections (and therefore alternative routes) present.

- If there are no intersections, and therefore no alternative routes, then we take 100% of the footpath value;
- If there are 1-2 intersections present, then 50% of the value is taken;
- If there are 3-4 intersections present, then 25% of the value is taken;
- And if there are 5+ intersections present, 10% of the value is taken.

The use of the ORVal tool has uncertainties surrounding the ‘true’ impact that the construction may have on recreation and tourism, with ORVal potentially giving an overstated account of the impact. This uncertainty has been reduced by using a developed conditional multipliers approach as outlined above. Additionally, the uncertainty has been reduced by assuming that the impact to recreation and tourism will be, in almost all cases, a temporary impact, although at this stage of assessment and when using the ORVal tool the actual duration of impact (e.g. a footpath closure) is not known. However, at this level of assessment, ORVal remains the recommended and most informative data set to use. The ORVal values are priced to £2016, and the values have been adjusted to £2019 for this assessment.

Agriculture

This assessment adopts the same principles for ecosystem services associated with agriculture as outlined in the UK Natural Capital Accounts, i.e. the distinction between what is considered ‘natural capital’ and what is ‘produced capital’ is defined as the “point at which vegetable biomass is extracted”²⁴. For the purposes of this assessment, to estimate the annual value per ha of ecosystem services relevant to agricultural production, an adaptation of the whole-farm income method outlined by the UK Office of National Statistics (ONS) Natural Capital Accounts was used²⁵. This approach was used as opposed to the industry residual value method adopted for the 2020 ONS Natural Capital Accounts as it allows for differentiation between the provisioning services associated with different farm types (in this case arable and pasture), and was therefore considered more appropriate for this assessment. The marginal values estimated per hectare derived from this method (presented in **Table 2.3** below) remain comparable to the estimated industry residual value per hectare reported by the ONS for their 2020 accounts (£241.80/ ha in 2018).

Table 2.3 Benefit transfer values: provisioning services supporting agriculture

	All farm types (average value/ha, 2019)	Arable (cropping) (average value £/ha, 2019)	Pasture (grazing livestock) (average value £/ha, 2019)
Northwest (United Utilities)	236.83	279.86	207.34
Wales (Welsh Dwr Cymru)	155.65	NA	158.57

²⁴ ONS (2017) Principles of Natural Capital Accounting. [Last accessed 29/04/2021] Accessible via: <https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting>

²⁵ Office for National Statistics (ONS), 2019. UK natural capital accounts methodology guide: October 2019, s.l.: ONS

	All farm types (average value/ha, 2019)	Arable (cropping) (average value £/ha, 2019)	Pasture (grazing livestock) (average value £/ha, 2019)
West Midlands (Severn Trent)	325.26	408.86	206.56
East of England (South Staffs Water)	365.68	354.99	286.29

These values represent the average farm output level estimate of the industry residual value for farms in the Northwest of England. Data was obtained from the Farm Business Survey (England)²⁶ and was subject to the following high-level calculation:

$$\frac{\text{Average output from agriculture} - \text{Average costs for agriculture}}{\text{Average total farm area (ha)}}$$

The original method outlined by the ONS (2019) was adapted after calculations with Southeast specific data resulted in a negative residual value per hectare for both arable and pasture. This would imply that the provisioning services of these natural assets have no inherent value and that they do not contribute to agricultural production. It is concluded in the literature that a probable explanation of negative resource rents is that they reflect market distortions such as subsidies²⁷. The original method outlined by the ONS excludes subsidies and agri-environment payments and activities from their calculation, however the adapted method adopted for this assessment includes these factors. An overview of what is included is outlined in **Table 2.4**.

The total annual benefit values calculated for this assessment make use of the Southeast estimated averages calculated for each of the variables and component for each of the high-level farm types associated with this assessment (arable and pasture).

Table 2.4 Components included within the adapted farm income method

Variable	Components included
Output from agriculture	<ul style="list-style-type: none"> • Output from agriculture (excl. subsidies and agri-environment payments) • Subsidies and payments to agriculture (excl. agri-environment payments) • Agri-environment and related payments (incl. HFA) • Basic Farm payment • Output from diversification
Costs for agriculture	<ul style="list-style-type: none"> • Costs for agriculture (excluding agri-environment activities) • Costs for agri-environment work • Costs of diversification out of agriculture • Costs associated with Basic Payment Scheme

²⁶ <https://farmbusinesssurvey.co.uk/>

²⁷ Obst, C., Hein, L., & Edens, B., (2016). National Accounting and the Valuation of Ecosystem Assets and their Services, Environ Resource Econ 64, pp 1-23.

Stage 4 – Biodiversity Net Gain Assessment with mitigation

This stage is only undertaken for the Preferred Programme and any Reasonable Alternatives.

The calculation of net loss/gain within the Biodiversity Metric 3.0 considers both direct impacts resulting in habitat loss (whether permanent or temporary) and changes in habitat condition. The areas required to achieve 10% net gain for each option have been identified based on the baseline habitats present within the option footprint, and following the requirements of the Biodiversity Metric 3.0. This included requirements such as requiring the same habitat (for High distinctiveness habitats) or replacement with the same habitat type or one of higher distinctiveness (for low distinctiveness habitats).

For the purposes of this assessment, it was assumed that the impact footprint as defined above comprises the entire site area. That is, from a planning perspective, it is assumed that the net gain requirement can be calculated directly as 10% of the biodiversity losses that were identified at Stage 2.

All habitats within the construction buffer are assumed to be lost and re-instated with the existing baseline habitat type and restored to the same condition, except those that will be replaced by permanent above-ground infrastructure.

The off-site mitigation required used in the assessments is intended to provide an indicative area off site habitat required to achieve 10% net gain for the schemes. Habitats, where possible, were used in the same proportions as the baseline habitats, excluding habitats which do not provide BNG Units and are not possible to enhance within the metric (e.g., Urban-sealed surface). Moderate to Very high distinctiveness habitats were mitigated through off site enhancement e.g., poor to moderate or moderate to good. It is not possible to enhance cropland in the Biodiversity Metric, so consequently modified grassland was used for off-site mitigation to offset impacts to crop land using a change in habitat type from poor condition Modified grassland to moderate condition Neutral grassland. Examples are shown in **Table 2.5** below.

Table 2.5 Off-site habitat enhancement rules used to calculate habitat area required to achieve 10% net gain

On-site baseline habitat lost	Off-site habitat pre-mitigation		Off-site habitat post-mitigation	
	Habitat	Condition	Habitat	Condition
Cropland	Modified grassland	Poor	Other neutral grassland	Moderate
Modified grassland	Modified grassland	Moderate	Other neutral grassland	Moderate
Other neutral grassland	Neutral grassland	Moderate	Other neutral grassland	Good
Woodland (broad leaved)	Modified grassland	Moderate	Woodland (broad leaved)	Moderate
Woodland (mixed)	Modified grassland	Moderate	Woodland (mixed)	Moderate
Traditional orchards	Modified grassland	Moderate	Traditional orchards	Moderate

On-site baseline habitat lost	Off-site habitat pre-mitigation		Off-site habitat post-mitigation	
	Habitat	Condition	Habitat	Condition
Floodplain wetland mosaic (CFGM)	Modified grassland	Moderate	Floodplain wetland mosaic (CFGM)	Moderate
Lowland calcareous grassland	Lowland calcareous grassland	Moderate	Lowland calcareous grassland	Good

Stage 5 – Natural Capital Assessment using the Biodiversity Net Gain Assessment with mitigation

This stage is only undertaken for the Preferred Programme and any Reasonable Alternatives.

The NCA undertaken in Stage 5 presents the temporary and permanent loss as at Stage 3, and also takes account of the areas planned for habitat creation and habitat improvement, including consideration of required mitigation for BNG (as calculated at Stage 4).

Between Stages 3 and 5, updated option information was received for some options, which in some cases has resulted in the temporary and permanent impacts differing slightly between the stages of assessment. Besides this, the same data sources were used in both Stage 3 and 5.

At this stage, with the data currently available, only the impacts of habitat succession can be quantified and not a change in habitat condition. For example, the impact on natural capital of land changing from arable land to semi-natural grassland can be quantified, but that of an area of semi-natural grassland changing condition from moderate to poor cannot be quantified. Quantification of land use change has taken place for natural hazard regulation and climate sequestration by calculating the monetary value of the baseline and post mitigation environment and subtracting the baseline from the post mitigation value.

Stage 6 – Identifying Potential Biodiversity Opportunity Areas

For options within the Preferred Plan, Potential Biodiversity Opportunity (PBO) areas have been identified. These sites are all within 5km of the option locations, and have been identified based on a scoring system (as shown in **Table 2.6**). A bespoke model has been developed, which pools together more than 20 datasets (those listed outlined in **Table 2.6**) to identify the PBOs, assign scores to them so they could be prioritised, and identify the most suitable PBOs for habitat restoration or creation. The scoring system is largely based on the Lawton principles²⁸, whereby effort should be made for new/enhanced habitats to be actively incorporated into a healthy ecological network (including landscape corridors, buffer zones, sustainable use areas, etc.), rather than being isolated. In addition to the datasets listed in **Table 2.6**, the system also considers variables from the Biodiversity Metric, the outputs from which should be used in conjunction with the PBOs, to identify sites with relevant habitat types.

²⁸ Prof. J. Lawton (2010), Making Space for Nature. Report for the UK Government

Table 2.6 Scoring criteria for Potential Biodiversity Opportunity areas

Scoring criteria	Dataset/source	Score			
		3	2	1	0
Distance to pipeline	Pipeline options	<1 km	1-3 km	3-5 km	>5 km
Within same LPA as scheme/option – county boundaries	Pipeline options Ordnance Survey GB Counties	Yes	-	-	No
Non-statutory designation	Local wildlife sites, proposed country parks, ecosites	Yes	-	-	No
Proximity to statutory sites	National Nature Reserves, Ramsar sites, Special Areas of Conservation, Special Protection Areas, SSSI sites, Local Nature Reserves	Within 2 km	Within 5 km	-	No
Strategic significance designation	Canal conservation and restoration, green networks, local greenspace, special landscape, sites for green infrastructure	Yes	-	-	No
Proximity to ancient woodland	Ancient Woodland England and Wales	0.3 km	1 km	-	No
Owned/operated or managed by the relevant water company/companies	Information provided by relevant water company	Yes	-	-	No
Identified as common land	Common Land England	-	-	No	Yes
Size	Calculated using QGIS	>5 ha	1-5 ha	<1 ha	-

3. Assessment outcomes for the feasible options

3.1 Feasible options included in the assessment

Through an extensive optioneering process, considering a wide range of potential options to balance future supply and demand, UUW's has selected the most suitable options to make up the feasible and constrained options list. This list includes both demand side and supply side options, of which only the latter are assumed to require assessment in this report (i.e. assuming that the demand-side options will not involve any land-take). The supply side options are presented in **Appendix C**: this includes all constrained options, as well as some feasible options that were considered at the time of the draft plan but have since been removed for various reasons.

The assessments in this chapter were undertaken based on the list of feasible options and option information available at the time of the draft plan. Since then, a number of variants of options have been introduced, including:

- WR015a1 and WR015a2: differing rates of abstraction at the same location;
- WR049d and WR049e: differing rates of abstraction at the same location;
- WR102b and WR102f: WR102b includes two sources whereas WR102f includes only one of those sources.

It may be assumed, for the purpose of these assessments, that the new variants will have the same BNG and natural capital values as the original variants, with any variability being immaterial. In other words, the assessment for WR015 in Appendix C applies to both WR015a1 and WR015a2, and so on.

3.2 Stage 2 (Biodiversity Net Gain) outcomes

The results of the Stage 2 Biodiversity Net Gain calculations are presented for all options in **Appendix C**.

Temporary losses of habitat (associated with pipeline construction) vary between 0 and -2578 Area Based Habitat Units (ABHU) per option. The greatest losses are associated with options that have the longer lengths of new pipeline that will need to be installed. The types of habitats that would be disturbed by pipeline construction vary, with extensive areas of modified grassland but also some high value habitat (most notably blanket bog).

Permanent losses of habitat include those associated with new permanent above-ground infrastructure, and loss of woodland during pipeline laying (this latter was assumed to be 'permanent' rather than temporary due to the length of time taken to replace the disturbed habitat). Permanent losses vary between 0 and -465 ABHU per option. The greatest losses are generally associated with pipelines crossing areas of woodland. In general, permanent infrastructure such as new water treatment works or pumping stations would be located on areas of relatively low-value habitat, although there are a small number proposed to be located on areas that are currently woodland.

3.3 Stage 3 (Natural Capital) outcomes

The results of the Stage 3 Natural Capital calculations are presented for all options in **Appendix D**.

Climate regulation

Temporary losses of the climate regulation service have been valued at between £0 and -£9,270 per year per option. The greatest losses relate to long pipelines that cross areas of blanket bog.

Permanent losses of the climate regulation service have been valued at between £0 and -£45,627 per year per option. The greatest losses are again associated with the long pipelines, some of which would require permanent access tracks to pumping stations and/or break point tanks, within areas of peat bog. Options involving permanent losses of woodland also result in relatively high losses of the climate regulation service.

Natural hazard regulation

Temporary losses of the natural hazard regulation service (with a focus on flooding) have been valued at between £0 and -£3,091 per year per option. As with climate regulation, the greatest losses relate to long pipelines that cross areas of blanket bog.

Permanent losses of the natural hazard regulation service have been valued at between £0 and -£10,101 per year per option. The greatest losses are again associated with the long pipelines involving permanent access tracks and other permanent infrastructure within areas of peat bog. Options involving permanent losses of woodland also result in relatively high losses of the natural hazard regulation service.

Recreation and tourism

Temporary losses of recreational benefits, as calculated using the Orval tool (described in **Section 2**), have been valued at between £0 and -£810,288 per year per option. The losses are associated with disruption to public footpaths, assuming that footpaths crossed by the pipeline route could not be used during construction. In general, options with longer pipelines and those in more highly populated/visited areas experience the greatest losses of value (the former because a longer pipeline has the potential to cross more footpaths. The latter because footpaths in highly populated/visited areas tend to have a higher value).

There are only a small number of options that have been assessed as having any permanent loss of recreational benefit, since most do not intersect with areas of open greenspace or public footpaths as shown in Orval. Eight options have been assessed as having a permanent loss of recreational benefits, with a maximum of -£241,440 per year per option. However, all eight options are reservoirs with footpaths around their perimeter, where the level of the reservoir would be raised. It is highly probable that a new footpath would be created above the height of the new top water level, and therefore there would not, in fact, be a long-term loss of recreational opportunity associated with these options.

The values obtained from Orval provide a useful comparison between options. However, they should not be compared to the other monetised services that are discussed here, because the Orval values are considered to be incomparably high.

Agriculture

Temporary losses of the agriculture service have been valued at between £0 and -£78,861 per year per option. The greatest losses relate to long pipelines that cross extensive areas of farmland.

Permanent losses of the agriculture service have been valued at between £0 and -£3,809 per year per option. While these are relatively modest (per year) compared to the temporary losses, due to the smaller areas involved, they would result in a permanent loss of farmland, whereas the farmland disturbed temporarily for laying of pipelines would subsequently be reinstated.

4. Assessment outcomes for the Preferred Programme and Reasonable Alternative Plan

4.1 Introduction

This section presents the Stages 4-6 assessments for UUW's WRMP24. These stages of assessment have been carried out for the options that are included in the:

- Preferred Plan, i.e. WR076;
- Reasonable Alternative Plan, including WR026c, WR065b, WR185 and WR191.

The Stages 4 (BNG) and 5 (Natural Capital) assessments are presented first, for the Preferred Programme (**Section 4.2**) and Reasonable Alternative Plan (**Section 4.3**). Subsequently, in **Section 4.4**, the Opportunity Mapping (Stage 6) is presented.

4.2 Preferred Plan

Stage 4 (Biodiversity Net Gain) outcomes

The results of the BNG assessment for the Preferred Plan are presented in **Table 4.1**. This shows the losses that would occur from both temporary and permanent land take. The gains have been calculated to achieve 10% net gain in response to both temporary and permanent losses. While not all of the works may require planning permission (in which case there would not be a statutory requirement for BNG), it was agreed with UUW that 10% net gain should be assumed for all activities involving land take, and should include temporary activities. This latter was agreed on the basis that the activities could last for two years or longer, which is the threshold at which BNG is required.

The total habitat units lost as a result of the preferred programme are calculated to be -61 ABHU, with the majority of habitats being modified grassland, crops and developed land. 10% net gain could be achieved through reinstating 43 ABHU on-site, and creating or enhancing habitat equating to 25 ABHU off-site.

Stage 5 (Natural Capital) outcomes

The results of the Natural Capital Assessment for the Preferred Plan are presented in **Table 4.2**.

Climate regulation

For the Preferred Plan, reflecting the limited habitat loss described above, losses of the climate regulation service would be limited, at -£148 per year. Assuming the BNG presented above, a small net gain of the climate regulation service could ultimately be achieved.

Natural hazard regulation

For the Preferred Plan, losses of the natural hazard regulation service would be very limited, at -£19 per year. Assuming the BNG presented above, a small net gain of the natural hazard regulation service could ultimately be achieved.

Water purification

As explained in **Section 2**, the water purification service has not been quantified or monetised, but a qualitative assessment is presented in **Appendix E**. Similar to natural hazard regulation, impacts on water purification would be very modest, with the option scoring the minimum qualitative score of -1.

Recreation and tourism

Temporary losses of recreational benefits, as calculated using the Orval tool (described in Section 2), have been valued at -£114,907²⁹ per year. This is associated with disruption to public footpaths, assuming that footpaths crossed by the pipeline route could not be used during construction. It is assumed that all footpaths would be fully restored following the construction works.

There are not anticipated to be any permanent effects on recreation and tourism associated with the options in the Preferred Plan.

Agriculture

Temporary losses of the agriculture service have been valued at -£3,681 per year, associated with the pipeline crossing areas mapped as arable land and modified grassland. It is assumed that this service would be restored following construction.

Permanent losses of the agriculture service have been valued at -£1,769 per year, as a result of the land take for the new water treatment works and abstraction location.

4.3 Reasonable Alternative Plan

Stage 4 (Biodiversity Net Gain) outcomes

The results of the BNG assessment for the Reasonable Alternative Plan are presented in the lower half of **Table 4.1**.

The total habitat units lost as a result of the Reasonable Alternative Plan are calculated to be -104 ABHU. This assumes losses associated with only two options (WR026c and WR185), with the other

²⁹ This value was calculated for an earlier iteration of WR076, during the draft plan. The ORVAL Tool was not available at the time of writing the Final Plan, to update the calculation, but the route has been reviewed to ensure that the costs are still appropriate.

two options not resulting in any biodiversity losses³⁰. 10% net gain could be achieved through reinstating 87 ABHU on-site, and creating or enhancing habitat equating to 29 ABHU off-site.

Stage 5 (Natural Capital) outcomes

The results of the Natural Capital Assessment for the Reasonable Alternative Plan are presented in the lower half of **Table 4.2**. Since biodiversity losses would occur only associated with two options, losses and gains of natural capital are considered for the same two options.

Climate regulation

Reflecting the limited habitat loss described above, losses of the climate regulation service would be limited, at between £0 and -£315 per year per option (accounting for both permanent and temporary losses). Assuming the BNG presented above, a very small net gain of the climate regulation service could ultimately be achieved.

Natural hazard regulation

Losses of the natural hazard regulation service would also be limited, at between £0 and -£166 per year per option (accounting for both permanent and temporary losses). Assuming the BNG presented above, a very small net gain of the natural hazard regulation service could ultimately be achieved.

Water purification

As explained in **Section 2**, the water purification service has not been quantified or monetised, but a qualitative assessment is presented in **Appendix E**. Overall, impacts on water purification would be modest, with the four options scoring 0 (the two options with no impact), -1 (WR185) and -3 (WR026c).

Recreation and tourism

Temporary losses of recreational benefits, as calculated using the Orval tool (described in Section 2), have been valued at between £0 and -£72,458 per year per option, with the greatest impact being associated with option WR026c. The losses are associated with disruption to public footpaths, assuming that footpaths crossed by the pipeline route could not be used during construction. It is assumed that all footpaths would be fully restored following the construction works.

There are not anticipated to be any permanent effects on recreation and tourism associated with the options in the Reasonable Alternative option.

³⁰ For option WR065b (Whiteholme Reservoir), it is assumed that restoring reservoir levels to their previous state will not constitute a change to habitat for the reservoir itself, and that works to raise the dam will be within the current footprint. If this is not the case, then BNG may need to be considered at a later design stage.

Agriculture

Temporary losses of the agriculture service have been valued at between £0 and -£4,468 per year per option. The greatest impact is associated with option WR026c, where the pipeline crosses areas mapped as modified grassland. It is assumed that this service would be restored following construction.

Permanent losses of the agriculture service would be limited, and have been valued at between £0 and -£144 per year per option.

Table 4.1 Calculated biodiversity losses and gains associated with the Preferred Programme and Reasonable Alternative Plan

	On-site baseline		On-site future		Off-site baseline		Off-site future		Total change	
	Sum of On-site area	Sum of On-site baseline units	Sum of On-site post-intervention units	Sum of On-site net change	Sum of Off-site area	Sum of Off-site baseline units	Sum of Off-site post-intervention units	Sum of Off-site net change	Total net change	% change compared to baseline
PREFERRED PROGRAMME										
█	26.12	60.93	42.58	-18.35	5.68	14.81	39.51	+24.70	+6.35	+10%
TOTAL	26.12	60.93	42.58	-18.35	5.68	14.81	39.51	+24.70	+6.35	+10%
REASONABLE ALTERNATIVE PLAN										
█	22.99	104.11	86.5	-17.61	9.1	40.04	68.48	28.44	10.83	10%
█	0	0	0	0	0	0	0	0	0	0
█	0.05	0.31	0	-0.31	0.117	0.51	0.85	0.34	0.03	10%
█	0	0	0	0	0	0	0	0	0	0
TOTAL	23.04	104.42	86.5	-17.92	9.217	40.55	69.33	28.78	10.86	10%

Table 4.2 Calculated Natural Capital losses and gains associated with the Preferred Programme and Reasonable Alternative Programme

Option ID	Climate regulation			Natural hazard regulation			Recreation		Agriculture		
	temporary loss (£/year)	permanent loss (£/year)	Gains resulting from mitigation (£/year)	temporary loss (£/year)	permanent loss (£/year)	Gains resulting from mitigation (£/year)	Temporary loss (£/year)	Gains resulting from mitigation	Temporary loss (£/year)	Permanent loss (£/year)	Gains resulting from mitigation
PREFERRED PROGRAMME											
█	-£ 104	-£ 44	£ 218	-£ 19	£ 0	£ 37	-£ 114,907	Assume 100% restored	-£ 3,681	-£ 1,769	Assume 100% of temporary loss restored, but 0% of permanent loss
REASONABLE ALTERNATIVE PLAN											
█	-£ 151	-£ 164	£ 412	-£ 112	-£ 54	£203	-£ 72,458	Assume 100% restored	-£ 4,468	-£ 144	Assume 100% of temporary loss restored, but 0% of permanent loss
█	£ 0	£ 0	£ 0	£ 0	£ 0	£ 0	£ 0		£ 0	£ 0	
█	£ 0	-£ 7	£ 14	£ 0	-£ 2	£5	£ 0		£ 0	-£ 6	
█	£ 0	£ 0	£ 0	£ 0	£ 0	£ 0	£ 0		£ 0	£ 0	

4.4 Mapping of Potential Biodiversity Opportunity Areas

Potential Biodiversity Opportunity Areas have been identified according to the methodology set out in **Section 2**. A heat-map demonstrating the distribution of areas potentially suitable for biodiversity opportunities is presented in **Figure 4.1**, in relation to the options in the Preferred Plan, and **Figure 4.2** in relation to the options in the Reasonable Alternative Plan. Higher scores indicate areas of potentially greater opportunity.

These maps and the data from which they are created can be used to identify high-scoring sites that present good opportunities for habitat creation within a wider network. These are most extensive in the areas in lighter greens and yellows in **Figures 4.1** and **4.2**, although localised opportunities may still be found elsewhere. It is important to consider opportunities within the vicinity of individual options, so that the habitat gain is provided close to the losses, and in order to provide the benefit to local communities.

Where there are multiple options within a plan, gaining an overview of the optimal options associated with the combined suite of options may also allow more integrated and effective opportunities to be identified. However it is recognised that in this case, there is only a single option in the Preferred Plan, and the options in the Reasonable Alternative Plan are widely spaced, so such opportunities may be limited.

Figure 4.1 Potential Biodiversity Opportunities associated with United Utilities' Preferred Programme

REDACTED

Figure 4.2 Potential Biodiversity Opportunities associated with United Utilities' Reasonable Alternative Plan

REDACTED

5. Summary

This report has presented the Biodiversity Net Gain and Natural Capital Assessments that have been undertaken for UUW's Final Water Resources Management Plan 2024. The approaches taken are in line with relevant guidance, notably the WRPG 2024 Supplementary Guidance on Environment and Society in Decision-making.

For the feasible options in the WRMP, this report has presented losses of biodiversity associated with all options that involve any temporary or permanent land-take. The losses have been assessed using the Defra biodiversity metric v3.0, based on spatial land use and habitat datasets with national coverage. Associated natural capital losses have been calculated for an agreed selection of ecosystem services. The assessment shows that the greatest impacts on biodiversity and associated regulating ecosystem services tend to be associated with options with long pipelines, particularly where they cross areas of woodland or blanket bog. For permanent above-ground infrastructure such as water treatment works, the greatest losses tend to be associated with options located on areas that are currently woodland.

The biodiversity losses were re-calculated for the options in the Preferred Plan and Reasonable Alternative Plans, finding:

- The total habitat units lost as a result of the preferred programme are calculated to be -61 ABHU. 10% net gain could be achieved through reinstating 43 ABHU on-site, and creating or enhancing habitat equating to 25 ABHU off-site.
- The total habitat units lost as a result of the Reasonable Alternative Plan are calculated to be -104 ABHU. 10% net gain could be achieved through reinstating 87 ABHU on-site, and creating or enhancing habitat equating to 29 ABHU off-site.

An opportunity mapping exercise has been carried out to identify potentially beneficial areas to locate the net gain associated with the Preferred Plan. The mapping has taken into account a range of factors including the LPA, local designations, proximity to statutory sites, proximity to ancient woodland and others. Taking these types of factors into account when identifying off-site opportunities for net gain allows a strategic approach to be taken to providing benefits to local communities, and incorporating habitats into wider ecological networks. Further work is anticipated within UUW towards selecting optimal sites, moving towards detailed design and implementation of the options. This work will build on the mapping exercise that has been undertaken so far, and be undertaken in consultation with local planning authorities. It will account for the wider strategy that is currently being developed within UUW to deliver BNG across its capital programme, and which includes the identification of opportunities for BNG across UUW's wider landholdings.

Appendix A

SMNR principles

A summary of the SMNR Principles and Wellbeing Goals for Wales, which have been considered in the assessment

SMNR Principles	Adaptive management	Manage adaptively by planning, monitoring, reviewing and where appropriate, changing actions
	Scale	Consider the appropriate spatial scale for action
	Collaboration and engagement	Promote and engage in collaboration and cooperation
	Public Participation	Make appropriate arrangements for public participation in decision-making
	Evidence	Take account of all relevant evidence, and gather evidence in respect of uncertainties
	Multiple benefits	Take account of the benefits and intrinsic value of natural resources and ecosystems
	Long term	Take account of the short-, medium- and long-term consequences of actions.
	Preventative action	Take action to prevent significant damage to ecosystems
	Building resilience	(i) diversity between and within ecosystems; (ii) the connections between and within ecosystems; (iii) the scale of ecosystems; (iv) the condition of ecosystems (including their structure and functioning); (v) the adaptability of ecosystems
Welsh Wellbeing Goals	A globally responsible Wales	A nation which, when doing anything to improve the economic, social, environmental and cultural well-being of Wales, takes account of whether doing such a thing may make a positive contribution to global well-being.
	A prosperous Wales	An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including action on climate change); and which develops a skilled and well-educated population in an economy which generates wealth and provides employment opportunities, allowing people to take advantage of the wealth generated through securing decent work.
	A Wales of vibrant culture and thriving Welsh language	A society that promotes and protects culture, heritage and the Welsh language, and which encourages people to participate in the arts, and sports and recreation.
	A Wales of cohesive communities	Attractive, viable, safe and well-connected communities.

A more equal Wales

A society that enables people to fulfil their potential no matter what their background or circumstances (including their socio-economic background and circumstances).

A healthier Wales

A society in which people's physical and mental well-being is maximised and in which choices and behaviours that benefit future health are understood.

Appendix B

Conversion from UKHab to Broad Habitats

Land Cover Classification	Broad habitat type
Cropland – Cereal crops	Arable
Modified grassland	Semi natural grassland
Heathland and shrub	Heathland and shrub
Lowland mixed deciduous woodland	Deciduous woodland
Neutral grassland	Semi natural grassland
Lakes – pond	Freshwater
Other coniferous woodland	Coniferous woodland
No habitat	Urban
Broadleaved woodland	Deciduous woodland
Poor semi-improved grassland	Semi natural grassland
Other rivers and streams	Freshwater
Eutrophic standing waters	Freshwater
Other coniferous woodland	Coniferous woodland
River and streams	Freshwater
Sparsely vegetated land	Sparsely vegetated land
Lowland heathland	Heathland and shrub
Other woodland mixed	Deciduous woodland
Traditional orchards	Semi natural grassland
Lowland meadows	Semi natural grassland
Floodplain wetland mosaic	Semi natural grassland
Traditional orchards	Semi natural grassland
Bramble	Heathland and shrub

Appendix C

Results of Stage 2 (feasible options) BNG calculations

Option ID	Total Area (ha)	Temporary impacts		Permanent impacts	
		Temporary area (ha)	Total units lost (ABHU)	Permanent area	Total units lost (ABHU)
██████	56.8012	54.9	-131	1.8882	-16.15
██████	20.731	19.905	-91.23	0.826	-6.74
██████	5.648	3.664	-19.58	1.984	-8.83
██████	10.709	10.559	-58.02	0.15	-0.66
██████	15.8331	14.5431	-68.32	1.29	-7.28
██████	46.683	44.507	-116.78	2.176	-14.41
██████	24.1	24	-79.2	0.1	-0.26
██████	105.62	100.5	-310.2	5.12	-41.78
██████	105.62	100.5	-310.2	5.12	-41.78
██████	105.62	100.5	-310.2	5.12	-41.78
██████	36.2312	35.035	-96.63	1.1962	-9.75
██████	68.86	60.7177	-252.12	7.2058	-54.53
██████	23.8161	15.8977	-61.41	7.9184	-69.02
██████	5.5484	4.5045	-20.68	1.0439	-9.17
██████	64.9393	60.556	-367.82	4.3833	-37.11
██████	22.9924	21.75	-97.06	1.1924	-16.92
██████	22.9924	21.75	-97.06	1.1924	-16.92
██████	15.91228	0	0	15.91228	-123.535
██████	31.82455	0	0	31.82455	-247.07

Option ID	Total Area (ha)	Temporary impacts		Permanent impacts	
		Temporary area (ha)	Total units lost (ABHU)	Permanent area	Total units lost (ABHU)
██████	24.9861	19.594	-79.69	5.3921	-35.55
██████	29.4618	26.69	-105.75	2.7718	-21.64
██████	37.6926	36.8953	-177.7	0.7973	-4.65
██████	22.5896	20.489	-87.28	2.1006	-19.66
██████	74.443	67.641	-249.84	6.802	-53.82
██████	49.5252	47.706	-191.85	1.8192	-19.4
██████	49.5252	47.706	-191.85	1.8192	-14.41
██████	73.8884	69.607	-314.45	4.2814	-35.11
██████	0.53	0	0	0.53	-2.77
██████	0	0	0	0	0
██████	19.682	18.425	-81.08	1.257	-11.06
██████	2.11	0	0	2.11	-29.48
██████	11.8359	0	0	11.8359	-201.3
██████	44.6616	42.5	-129.09	2.1616	-18.91
██████	22.8122	0	0	22.8122	-140.077
██████	20.406	19.811	-47.00	6.323	-13.93
██████	0.487	0	0	0.487	-5.17
██████	0.574	0	0	0.574	-4.47
██████	0.574	0	0	0.574	-4.47
██████	4.1481	3.4	-13.02	0.7481	-5.31
██████	4.1717	3.4	-13.02	0.7717	-5.42
██████	4.1914	3.4	-13.02	0.7914	-5.5
██████	4.2119	3.4	-13.02	0.8119	-5.59
██████	82.5711	72.895	-335.87	9.676097	-64.29

Option ID	Total Area (ha)	Temporary impacts		Permanent impacts	
		Temporary area (ha)	Total units lost (ABHU)	Permanent area	Total units lost (ABHU)
██████	32.6205	32.521	-184.01	0.0995	-0.68
██████	2.765	2.765	-7.94	0	0
██████	3.691	3.502	-15.67	0.189	-0.91
██████	0	0	0	0	0
██████	0.6	0.34	-0.27	0.23	-0.78
██████	1.2	0	0	1.2	-5.28
██████	13.704	12.746	-15.29	0.958	-7.29
██████	32.358	31.489	-70.48	0.869	-7.65
██████	0.1201	0	0	0.1201	-0.53
██████	0.1201	0	0	0.1201	-0.53
██████	25.1685	22.517	-52.13	2.6515	-22.82
██████	25.1685	22.517	-52.13	2.6515	-22.82
██████	18.0004	14.97	-54.59	3.0304	26.27
██████	18.0004	14.97	-54.59	3.0304	26.27
██████	11.4588	11.249	-27.79	0.2098	-0.46
██████	11.4588	11.249	-27.79	0.2098	-0.46
██████	77.05	75.013	-124.02	2.037	-2.15
██████	0.231	0	0	0.231	-0.89
██████	8.42	8.098	-1.61	0.322	-2.83
██████	0.1	0	0	0.13	0
██████	0.1	0	0	0.13	0
██████	0	0	0	0	0
██████	0	0	0	0	0
██████	0.03	0	0	0.03	-0.13

Option ID	Total Area (ha)	Temporary impacts		Permanent impacts	
		Temporary area (ha)	Total units lost (ABHU)	Permanent area	Total units lost (ABHU)
██████	0	0	0	0	0
██████	22.26	21.5922	-88.15	0.6678	-5.88
██████	42.014	41.601	-134.47	0.413	-3.08
██████	6.1029	6.047	-25.5	0.0559	-0.25
██████	6.8534	5.8335	-23.32	1.0199	-9.35
██████	6.851	4.95	-9	1.901	-16.73
██████	31.958	29.894	-115.01	2.064	-18.97
██████	33.225	32.282	-96.9	0.943	-8.04
██████	8.693	6.137	-21.47	2.556	-11.25
██████	17.006	12.731	-46.16	4.275	-26.94
██████		0	0	0	0
██████	0.05	0	0	0.05	-0.31
██████	0.05	0	0	0.05	-0.13
██████	3.0659	2.886811	-13.53	0.179089	-0.79
██████	7.2672	6.0736	-11.7	1.1936	-9.76
██████	32.7964	30.8476	-125.39	1.9488	-13.93
██████	26.577	25.6466	-114.11	0.9304	-5.07
██████	20.3562	18.505	-77.58	1.8512	-15.51
██████		0	0	0	0
██████	25.239	24.292	-92.46	0.947	-7.89
██████	137.3	128.2	-1007.8	9.1	-111.3
██████	170.1216	155.106	-1216.12	15.0156	-140.13
██████	65.168	60.198	-683.76	4.97	-58.92
██████	302.7304	255.427	-1573.93	47.3034	-318.59

Option ID	Total Area (ha)	Temporary impacts		Permanent impacts	
		Temporary area (ha)	Total units lost (ABHU)	Permanent area	Total units lost (ABHU)
██████	388.5854	325.59	-1980.33	62.9954	-384.16
██████	535.1474	459.942	-2580.65	75.2054	-465.91
██████	15.5754	14.099	-61.64	1.4764	-12.74
██████	0.245	0	0	0.245	-1.08
██████	130.08	120.428	-544.29	9.652	-76.05
██████	22.7466	21.13	-102.25	1.6166	-7.78
██████	6.1847	5.404	-19.77	0.7807	-6.11
██████	20.8728	20.6	-78.05	0.2728	-0.65
██████	20.8728	20.6	-80.15	0.2728	-0.65
██████	61.155	55.962	-397.01	5.193	-41.49
██████	0.1112	0	0	0.1112	-0.84

* Option 149 has subsequently been discounted due to concerns re water quality deterioration in the wider groundwater unit, difficult to treat water quality issues and limited water availability.

Appendix D

Results of Stage 3 (feasible options) Natural Capital calculations

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-54.90	-£ 250	-£ 40	-£ 270,938	-£ 8,427	-1.89	-£ 622	-£ 209	£ 0	-£ 15
██████	-19.91	-£ 136	-£ 157	-£ 18,537	-£ 4,033	-0.83	-£ 246	-£ 83	£ 0	-£ 25
██████	-3.66	-£ 20	-£ 368	-£ 91,671	-£ 597	-1.98	-£ 84	-£ 11	£ 0	-£ 392
██████	-10.56	-£ 90	-£ 264	-£ 422,541	-£ 1,923	-0.15	-£ 1	£ 0	£ 0	-£ 31
██████	-14.54	-£ 101	-£ 169	-£ 105,076	-£ 2,207	-1.29	-£ 229	£ 76	£ 0	-£ 175
██████	-44.51	-£ 183	-£ 122	-£ 124,818	-£ 5,445	-2.18	-£ 486	-£ 162	£ 0	-£ 175
██████	-24.00	-£ 168	£ 0	-£ 159,742	-£ 5,846	-0.10	-£ 1	£ 0	£ 0	-£ 27
██████	-105.0	-£ 2,224	-£ 527	-£ 281,889	-£ 22,898	-0.62	-£ 4	£ 0	£ 0	-£ 147

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-105.0	-£ 2,224	-£ 527	-£ 281,889	-£ 22,898	-0.62	-£ 4	£ 0	£ 0	-£ 147
██████	-105.0	-£ 2,224	-£ 527	-£ 281,889	-£ 22,898	-0.62	-£ 4	£ 0	£ 0	-£ 147
██████	-35.04	-£ 210	-£29	-£ 180,790	-£ 7,519	-1.20	-£ 356	-£ 120	£ 0	-£ 36
██████	-60.72	-£ 393	-£ 369	-£ 18,537	-£ 11,678	-7.20	-£ 3,157	-£ 785	£ 0	-£ 105
██████	-15.90	-£ 104	-£ 305	-£ 183,079	-£ 933	-7.92	-£ 2,704	-£ 910	£ 0	-£ 31
██████	-4.50	-£ 36	-£ 38	-£ 34,661	-£ 884	-1.04	-£ 362	-£ 122	£ 0	-£ 1
██████	-60.65	-£ 469	-£ 687	-£ 87,089	-£ 10,828	-4.29	-£ 1,475	-£ 422	£ 0	-£ 142
██████	-21.79	-£ 151	-£ 112	-£ 72,459	-£ 4,468	-1.15	-£ 164	-£ 54	£ -	-£ 144
██████	-21.79	-£ 151	-£ 112	-£ 72,459	-£ 4,468	-1.15	-£ 164	-£ 54	£ -	-£ 144
██████	0.00	£ 0	£ 0	£ 0	£ 0	-15.91	-£ 3,337	-£ 739	-£ 14,603	-£ 759
██████	0.00	£ 0	£ 0	£ 0	£ 0	-31.82	-£ 6,673	-£ 1,477	-£ 14,603	-£ 1,517
██████	-19.59	-£ 134	£ 0	-£ 7,643	-£ 4,025	-5.40	-£ 3,201	-£ 614	£ 0	-£ 31
██████	-26.67	-£ 187	£ 0	-£ 51,776	-£ 5,651	-2.78	-£ 823	-£ 261	£ 0	-£ 124

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-36.90	-£ 226	£ 0	-£ 63,030	-£ 7,250	-0.70	-£ 64	-£ 19	£ 0	-£ 110
██████	-20.49	-£ 133	£ 0	-£ 21,859	-£ 4,108	-2.10	-£ 655	-£ 192	£ 0	-£ 96
██████	-67.64	-£ 388	-£ 211	-£ 810,288	-£ 11,195	-6.80	-£ 1,829	-£ 721	£ 0	-£ 271
██████	-47.71	-£ 296	-£ 213	-£ 503,402	-£ 8,756	-1.82	-£ 510	-£ 171	£ 0	-£ 75
██████	-47.71	-£ 296	-£ 213	-£ 503,402	-£ 8,756	-1.82	-£ 510	-£ 171	£ 0	-£ 75
██████	-69.61	-£ 443	-£ 1,411	-£ 400,523	-£ 12,405	-4.28	-£ 1,293	-£ 434	£ 0	-£ 120
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0 -	£ 0	£ 0	£ 0
██████	-18.43	-£ 126	-£ 375	-£372,906	-£ 3,560	-1.26	-£ 437	-£ 147	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	-2.11	-£ 101	-£ 33	-£ 14,348	-£ 83
██████	0.00	£ 0	£ 0	£ 0	£ 0	-11.84	-£ 3,194	-£ 54	-£ 28,815	£ 0
██████	-42.50	-£ 231	-£ 189	-£ 342,046	-£ 5,527	-2.16	-£ 743	-£ 250	£ 0	-£ 6
██████	0.00	£ 0	£ 0	£ 0	-£ 100	-22.81	-£ 924	-£ 1,218	-£ 10,924	-£ 3,809

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-19.81	-£ 104	-£ 19	-£ 114,907	-£ 3,681	-6.32	-£ 44	£ 0	£ -	-£ 1,769
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.49	-£ 18	£ 0	-£ 192,097	-£ 30
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.57	-£ 277	-£ 45	-£ 110,982	-£ 34
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.57	-£ 277	-£ 45	-£ 241,440	-£ 34
██████	-3.42	-£ 19	-£ 9	£ 0	£ 0	-0.74	-£ 241	-£ 81	£ 0	£ 0
██████	-3.42	-£ 19	-£ 9	£ 0	£ 0	-0.76	-£ 242	-£ 81	£ 0	£ 0
██████	-3.43	-£ 19	-£ 9	£ 0	£ 0	-0.78	-£ 242	-£ 81	£ 0	£ 0
██████	-3.43	-£ 19	-£ 9	£ 0	£ 0	-0.80	-£ 242	-£ 81	£ 0	£ 0
██████	-72.89	-£ 474	-£ 22	-£ 37,463	-£ 14,671	-9.68	-£ 5,893	-£ 1,130	£ 0	-£ 6
██████	-32.59	-£ 388	-£ 44	-£ 28,085	-£ 356	-0.10	-£ 20	-£ 7	£ 0	-£ 8
██████	-2.77	-£ 12	-£ 9	£ 0	-£ 366	0.00	£ 0	£ 0	£ 0	£ 0
██████	-3.50	-£ 24	-£ 28	-£ 4,354	-£ 714	-0.19	-£ 158	-£ 22	£ 0	£ 0
██████	0.00	£ 0	£ -	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-0.34	£ 0	£ 0	£ 0	-£ 13	-0.23	-£ 29	-£ 10	£ 0	-£ 3
██████	0.00	£ 0	£ 0	£ 0	£ 0	-1.20	-£ 8	£ 0	£ 0	-£ 249
██████	-12.75	-£ 25	-£ 2	-£ 146,368	-£ 731	-0.96	-£ 290	-£ 97	£ 0	-£ 3
██████	-31.49	-£ 161	-£ 377	-£ 282,013	-£ 5,939	-0.87	-£ 302	-£ 102	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.12	£ 0	-£ 2	£ 0	-£ 12
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.12	£ 0	-£ 2	£ 0	-£ 12
██████	-22.52	-£ 94	-£ 23	-£ 258,808	-£ 3,554	-2.65	-£ 883	-£ 297	£ 0	-£ 24
██████	-22.52	-£ 94	-£ 23	-£ 258,808	-£ 3,554	-2.65	-£ 883	-£ 297	£ 0	-£ 24
██████	-14.97	-£ 98	-£ 106	-£ 184,405	-£ 3,260	-3.04	-£ 1,022	-£ 344	£ 0	-£ 21
██████	-14.97	-£ 98	-£ 106	-£184,405	-£ 3,260	-3.04	-£ 1,022	-£ 344	£ 0	-£ 21
██████	-11.25	-£ 78	£ 0	£ 0	-£ 2,988	-0.21	-£ 1	£ 0	£ 0	-£ 43
██████	-11.25	-£ 78	£ 0	£ 0	-£ 2,988	-0.21	-£ 1	£ 0	£ 0	-£ 43
██████	-76.76	-£328	-£ 45	-£ 198,069	-£ 12,429	-0.29	-£ 78	-£ 26	£ 0	-£ 8

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.23	-£ 2	£ 0	£ 0	-£ 48
██████	-8.10	-£ 2	-£ 27	-£ 90,898	-£ 52	-0.32	-£ 112	-£ 38	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.13	£ 0	£ 0	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.13	£ 0	£ 0	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.03	£ 0	£ 0	£ 0	-£ 6
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0
██████	-21.59	-£ 140	£ 0	-£ 30,391	-£ 4,154	-0.67	-£ 232	-£ 78	£ 0	-£ 28
██████	-41.60	-£ 252	-£ 7	£ 0	-£ 1,104	-0.41	-£ 101	-£ 34	£ 0	-£ 153
██████	-6.05	-£ 37	-£ 110	£ 0	-£ 1,104	-0.06	-£ 5	-£ 22	£ 0	-£ 153
██████	-5.83	-£ 35	-£ 59	£ 0	-£ 1,047	-1.07	-£ 367	-£ 124	£ 0	-£ 3
██████	-4.95	-£ 16	-£ 41	-£ 134,178	-£ 34	-1.90	-£ 661	-£ 223	£ 0	-£ 331

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-29.94	-£ 194	-£ 144	-£ 13,374	-£ 6,095	-2.02	- £ 682	-£ 222	£ 0	-£ 2
██████	-32.28	-£ 178	-£ 45	-£ 222,289	-£ 5,901	-0.94	-£ 309	-£ 104	£ 0	-£ 12
██████	-6.14	-£ 25	£ -	-£10,443	-£ 870	-2.56	-£ 813	-£ 274	£ 0	-£ 46
██████	-12.73	-£ 88	-£ 7	-£ 18,772	-£ 2,915	-4.28	-£2,563	-£ 477	£ 0	-£ 21
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.05	-£ 7	-£ 2	£ 0	-£ 6
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.05	£ 0	£ 0	£ 0	-£ 6
██████	-2.89	-£ 19	-£ 27	£ 0	£ 0	-0.18	-£ 159	-£ 21	£ 0	£ 0
██████	-6.07	-£ 13	-£ 181	-£ 34,661	-£ 391	-1.19	-£ 357	-£ 120	£ 0	-£ 35
██████	-30.85	-£ 193	-£ 202	-£ 170,352	-£ 5,321	-1.95	-£ 922	-£ 208	£ 0	-£ 6
██████	-25.65	-£ 180	-£ 26	-£ 135,691	-£ 4,946	-0.93	-£ 576	-£ 92	£ 0	-£ 31
██████	-18.54	-£ 140	-£ 399	-£ 72,638	-£ 2,675	-1.82	-£ 595	-£ 200	£ 0	-£ 23

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	0.00	£ 0	£ 0	£ 0	£ 0	0.00	£ 0	£ 0	£ 0	£ 0
██████	-24.29	-£ 145	-£ 185	-£ 24,528	-£ 4,384	-0.95	-£ 295	-£ 99	£ 0	-£ 21
██████	-128.2	-£ 8,235	-£ 310	-£ 50,386	-£ 16,961	-9.10	-£ 3,801	-£ 574	£ 0	-£ 266
██████	-149.2	-£ 9,270	-£ 488	-£ 91,221	-£ 20,168	-20.91	-£ 7,352	-£ 1,643	£ 0	-£ 688
██████	-28.91	-£ 8,212	-£ 465	-£ 12,279	-£ 4,941	-2.34	-£ 1,042	-£ 74	£ 0	-£ 355
██████	-255.4	-£ 4,735	-£ 2,413	-£ 88,942	-£ 40,475	-47.30	-£ 30,552	-£ 5,473	£ 0	-£ 277
██████	-325.6	-£ 6,143	-£ 2,674	-£ 252,919	-£ 51,719	-63.00	-£ 34,382	-£ 6,417	£ 0	-£ 1,705
██████	-421.0	-£ 7,059	-£ 3,091	-£ 259,906	-£ 78,861	-100.07	-£ 45,627	-£ 10,101	£ 0	-£ 2,872
██████	-14.11	-£ 96	-£ 97	-£ 188,065	-£ 2,451	-1.46	-£ 496	-£ 167	£ 0	-£ 8
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.25	-£ 2	£ 0	£ 0	-£ 51
██████	-120.4	-£ 989	-£ 435	-£ 346,978	-£ 23,116	-9.65	-£ 4,226	-£ 1,101	£ 0	-£ 52
██████	-21.13	-£ 143	-£ 168	£ 0	-£ 4,125	-1.62	-£ 1,200	-£ 169	£ 0	-£ 36
██████	-5.40	-£ 36	-£ 43	£ 0	-£ 1,875	-0.66	-£ 174	-£ 260	£ 0	-£ 277

Option ID	Temporary impacts					Permanent impacts				
	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture	Area	Climate Regulation	Natural Hazard Regulation	Recreation and Tourism	Agriculture
	Ha	£2019/year	£/year	£2019/year	£2019/year	Ha	£2019/year	£/year	£2019/year	£2019/year
██████	-20.64	-£ 139	-£ 254	-£ 49,638	-£ 4,469	-0.27	-£ 2	£ 0	£ 0	-£ 70
██████	-20.59	-£ 138	-£ 94	-£ 49,638	-£ 4,485	-0.27	-£ 2	£ 0	£ 0	-£ 70
██████	-55.96	-£ 1,105	-£ 632	-£81,879	£ 0	-5.19	-£ 2,278	-£ 603	£ 0	-£ 10
██████	0.00	£ 0	£ 0	£ 0	£ 0	-0.11	-£ 33	-£ 11	£ 0	£ 0

* Option 149 has subsequently been discounted due to concerns re water quality deterioration in the wider groundwater unit, difficult to treat water quality issues and limited water availability.

Appendix E

Qualitative assessment of water purification service (Preferred and Reasonable Alternative options)

Option ID	WFD water body physico-chemical status (2019)	Habitats present- extent of woodland and wetland	Proximity to watercourse (using FZ2/3 as proxy)	Summary of losses	Qualitative score (-1 to -5)
PREFERRED OPTIONS					
█	Moderate (various pressures contributing to Phosphate failures)	Pipeline crosses predominantly modified grassland and cropland	Pipeline route starts on Bollin floodplain, then crosses minor channels (with no mapped floodplain) a couple of times, for short distances	Limited impact on high-value habitats, and limited extent in proximity to surface watercourses	-1
REASONABLE ALTERNATIVE OPTIONS					
█	Moderate. due to a change in monitoring site- previously Good- no Reasons for Not Achieving Good attributed	Pipeline crosses predominantly modified grassland, with small amount of woodland and wetland	Pipeline crosses Ribble floodplain, and multiple minor channels	Some impact on high-value habitats, and in proximity to minor and major watercourses	-3
█	n/a- no impact on habitat condition or extent				0
█	Moderate (agriculture, urban, water industry and other industry pressures)	Minor extent of modified grassland and woodland	Not within floodplain	Limited impact on high-value habitats, and not in proximity to surface watercourses	-1
█	n/a- no impact on habitat condition or extent				0

