[redacted]

Biodiversity Net Gain and Natural Capital

The content of this document is draft and relates to material [or data] which is still in the course of completion in travel to Gate 2 and should not be relied upon at this early stage of development. We continue to develop our thinking and our approach to the issues raised in the document in preparation for Gate 2.

Severn Trent Sources SRO

Severn Trent Water

Creating a world fit for the future

Severn Trent Water Sources SRO

Environmental report: Biodiversity Net Gain and Natural Capital

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Report for Severn Trent Water

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Customer:

Severn Trent Water

Contact:

[redacted]Bright Building, First Floor
Manchester Science Park, Pencroft Way,
Manchester M15 6GZ

Customer reference:

[redacted]

[redacted]

[redacted]

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1 Introduction

1.1 Background and purpose of report

Ofwat, through the PR19 Final Determination, has identified the potential for companies to jointly deliver strategic regional water resources solutions. These strategic resource solutions aim to secure long-term resilience on behalf of customers while protecting the environment and benefiting wider society. As part of the assessment of companies' PR19 business plans, Ofwat introduced proposals to support the delivery of Strategic Regional Water Resource Options over the next 5 to 15 years with solutions required to be 'construction ready' for the 2025-2030 period. Ofwat's Final Determination[1] in December 2019 set out a gated process for development of Strategic Resource Options (SROs) for the co-ordination and development of a consistent set of SROs.

This gated process provides a mechanism for the industry, regulators, stakeholders, and customers to input into the development and scheduling of these strategic solutions through a combined set of statutory and regulatory processes. These include the National Framework, Drinking Water Safety Plans, Business Plans and Water Resource Management Plans (WRMPs). The strategic regional working group (consisting of Affinity Water, Anglian Water, Severn Trent Water, Southern Water, South West Water, Thames Water, United Utilities and Wessex Water) published a joint company statement reiterating a commitment to continue working with the Regulators' Alliance for Progressing Infrastructure Development (RAPID), the Environment Agency (EA), Natural Resources Wales (NRW), Ofwat and the Drinking Water Inspectorate (DWI) to make all of the planning processes and statutory timetables a success.

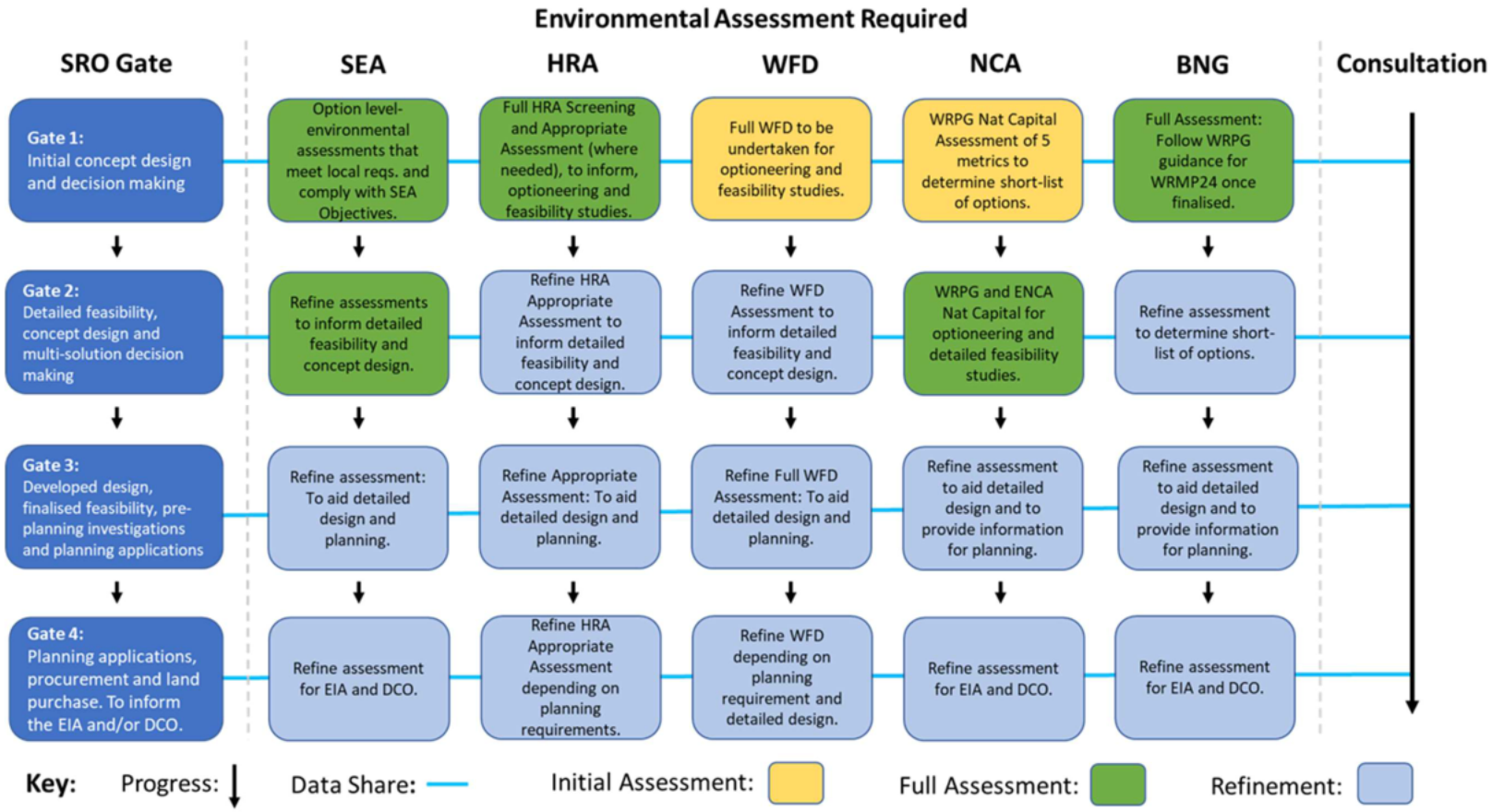
The Severn Trent Water (STW) Sources has been identified as an SRO in the PR19 Final Determination, with funding provided to STW as an individual company. Although the STW Sources SRO is considered a company solution with no identified partner this has potential to benefit other companies and interact with joint solutions, therefore its delivery will benefit from development funding and RAPID facilitation.

In October 2020, the group of Water Companies involved in developing SROs (known as the All Company Working Group - ACWG), published guidance[2] for environmental assessment methods for SROs which is aligned to the draft Water Resources Planning Guideline (WRPG): Working Version for Water Resource Management Plan 2024 (WRMP24) to increase the consistency of environmental assessment and the evaluation of impacts on environmental water quality in particular.

The ACWG guidelines indicate that the process requires Water Companies to provide the following information related to each SRO at the stage outlined (**see Figure 1.1**).

[1] Ofwat (2019), PR19 Final Determinations, Strategic regional water resource solutions appendix
[2] Mott MacDonald Limited (2020). All Companies Working Group WRMP environmental assessment guidance and applicability with SROs. Published October 2020

Figure 1.1 Environmental Assessment Integration with SRO Gates



In line with Ofwat's PR19 Final Determination the following is required at gate-1 in the context of a Natural Capital Assessment (NCA) and associated Biodiversity Net Gain (BNG):

- *"Initial environmental, social and economic valuations (or metric benefits) consistent with principles in the National Planning Statement and Water Resources Planning Guidelines"*

Therefore at gate-1, a high level assessment of NC and BNG opportunities and benefits has been applied to the STW Sources SRO to inform an overall assessment of the environmental feasibility and deliverability of the solution. Neither NCA nor BNG is required at this stage as a statutory requirement but is built into the ACWG and other associated Water Resource Management Planning guidance.

This report provides initial option-level Natural Capital and associated BNG assessment of the STW Sources SRO. The report sets out the objectives and methodologies used to support and inform an overall assessment of the feasibility of the schemes, from an environmental perspective.

The environmental assessment of the STW Sources SRO schemes has been undertaken in the context of the ACWG guidance. This approach has been adopted to assess the various schemes within the STW Sources SRO thus determining the environmental impacts, and potential NC opportunities where BNG opportunities have been identified as part of the STW Sources SRO. This has been delivered in a manner consistent with the assessments undertaken for the regional and individual water company WRMPs.

The overall aim of this report is to provide a summary of the natural capital that is likely to be affected related to the construction of the STW Sources SRO and to provide an assessment of the potential habitat and NC opportunities related to BNG areas. The approach therefore provides for a NC baseline that is underpinned by habitats assessment within a construction zone of influence as identified by construction diagrams (as they currently stand – see **section 4.4.1.2** for more detail). It is this mix of habitats that may be affected. Therefore the approach identifies the area of different habitats and then assigns a NC assessment via a range of key ecosystem services using a combination of, quantifiable and monetised data where this exists: at this stage (gate-1) it should be noted that some ecosystem services can only be assessed qualitatively given the level of data available and scheme uncertainty. In terms of BNG opportunities, this has at this stage, been assessed based on open source data and run through the Defra metric as discussed in more detail below (**section 3.1.2**). The assessment and outputs therefore provides a high level assessment of the type and amount of habitat that would need to be improved/ added to in order to achieve a 10% BNG and the likely associated NC benefit for each ecosystem services where feasible.

1.1.1 Area under consideration

The area under consideration for the assessment reflects the spatial scope of the STW Sources SRO schemes which includes specific areas of the River Severn catchment area. The area comprises the River Severn corridor, from the existing STW abstraction licence at its Mythe intake in the lower River Severn to the Severn Estuary.

1.2 Structure of this report

The report is divided into the following sections:

- Section 1: This introduction
- Section 2: Provides a background to the STW Sources SRO
- Section 3: Provides the methodology adopted for the NCA and BNG
- Section 4: Provides the results of the scheme assessments
- Section 5: Conclusions and recommendations to inform gate-2 assessments
- Appendices: Assumptions and associated spreadsheet

2 Severn Trent Water Sources SRO

2.1 Introduction

The STW Sources SRO schemes are considered integral to a Severn to Thames Transfer (STT) System.

A STT conveying raw water from the lower River Severn into the upper or middle River Thames via an interconnector would increase the catchment area from which water resources can be drawn to the south-east of England. In addition to any flows that may be available to be abstracted under licence from the River Severn, a range of raw water Source Support Elements for the STT System are under consideration to provide additional resource.

The STT SRO comprises 2 principal aspects:

1. Severn to Thames Conveyance – Deerhurst to Culham pipeline or Cotswold canal conveyance, including piping to Culham – to convey the water from the River Severn to the River Thames; and
2. STT Source Support Elements which comprise water resources that can be added, or not abstracted (redeployed), from the rivers Vyrnwy, Severn and Avon.

In order for some of the STT Source Support Elements to be able to deliver the water into the STT System, there is a requirement for these water supplies to be replaced with other water sources. The provision of this additional water is covered under separate SROs that provide the facilities to enable supporting flows for the STT. These SROs are: STW Sources SRO, STW Minworth SRO, UU Sources SRO and UU Vyrnwy Aqueduct SRO.

STW Sources SRO include three schemes:

1. Mythe abstraction licence transfer (15 Ml/d)

2A. Netheridge Wastewater Treatment Works (WwTW) discharge diversion, Deerhurst pipeline (35 Ml/d)

2B. Netheridge WwTW discharge diversion, Cotswold canals (35 Ml/d)

A more detailed description of each scheme is provided in the sections below.

2.2 Mythe abstraction licence transfer (15 Ml/d)

This scheme provides support to STT abstraction from the Severn catchment by redeploying 15 Ml/d of the existing STW abstraction licence at its Mythe intake in the lower River Severn. This infrequently used licensed volume would remain in the River Severn for abstraction downstream at Deerhurst or Gloucester Docks. The Mythe intake is located on the River Severn near Tewkesbury, 5km northeast of Deerhurst. STW has advised that no construction works would be required to redeploy the spare licence volume for abstraction by TW.

It is understood from STW that no specific additional resource to replace this current abstraction licence volume has been determined to date and would require consideration at gate-2.

2.3 Netheridge WwTW discharge diversion, Deerhurst Pipeline (35 Ml/d)

Currently, treated discharge from the Netheridge WwTW is input to the upper Severn Estuary. It is proposed to divert a 35 Ml/d portion of this treated discharge to a new outfall on the freshwater River Severn. This new outfall will support STT abstraction from the River Severn at Deerhurst. The outfall location to the River Severn has been identified during studies undertaken at gate-1. The outfall is to be located just downstream of the proposed intake from the River Severn at Deerhurst. The discharge diversion from Netheridge WwTW would be pumped by a new pumping station, located at the WwTW [redacted]

WwTW discharge transfer for STT support would not be continuous and would only be discharging to the freshwater river outfall according to an operating regime when support is required. This is to enable abstraction from the River Severn. The discharge would be a flow replacement for river water abstracted locally upstream. The scheme will result in a relocation of discharge of up to 35 Ml/d.

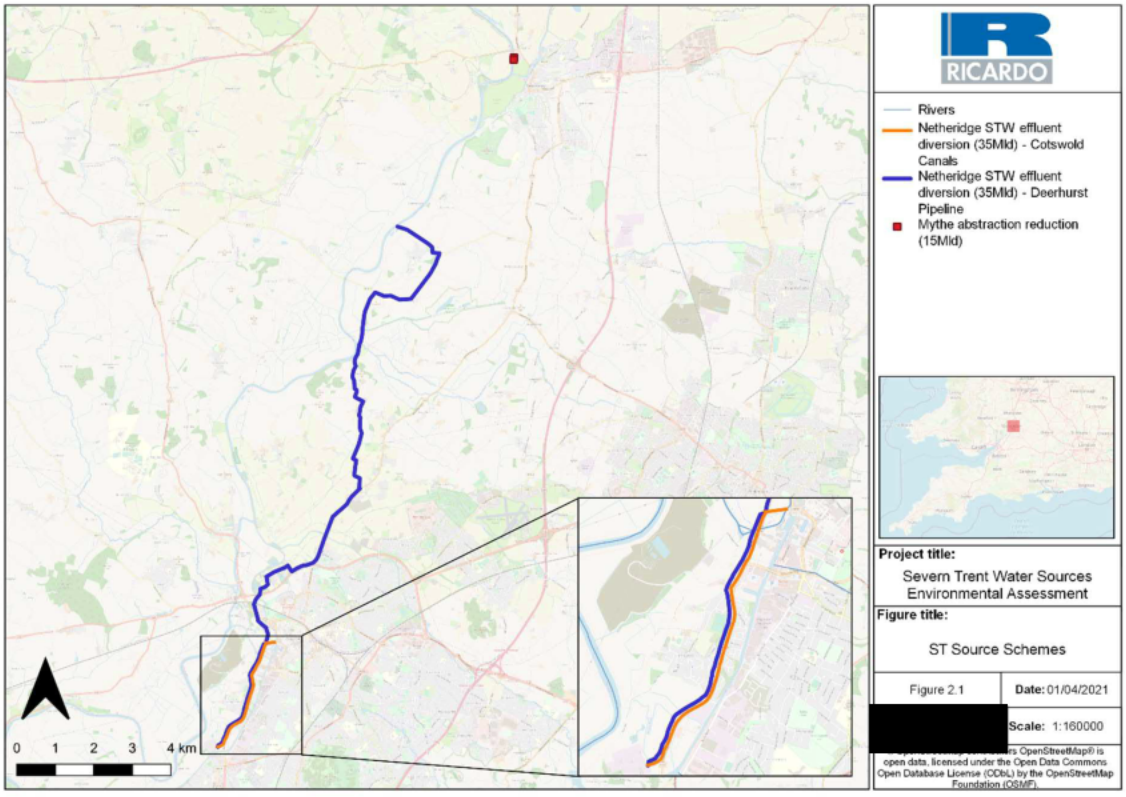
2.4 Netheridge WwTW discharge diversion, Cotswold Canals (35 Ml/d)

Currently, treated discharge from Netheridge WwTW is input to the upper Severn Estuary. It is proposed to divert a 35 Ml/d portion of this treated discharge to a new outfall on the freshwater River Severn. This would support STT abstraction from the River Severn at Gloucester and Sharpness Canal. The discharge location is into the East Channel of the River Severn, just downstream of the proposed abstraction discharging to Gloucester & Sharpness Canal. The diversion from Netheridge WwTWs would be pumped by a new pumping station, located at the WwTWs via [redacted]

WwTW discharge transfer for STT support would not be continuous, only discharging to the freshwater river outfall according to an operating regime when support is required to enable abstraction from the River Severn. The discharge would be a flow replacement for river water abstracted locally upstream. The scheme will result in a relocation of up to 35 Ml/d.

The locations of these three schemes are shown on **Figure 2.1**.

[redacted]Location of STW Sources SRO Schemes



3 Methodology

3.1 Methodologies for gate-1

3.1.1 Natural Capital Assessment (NCA)

A NCA has been carried out to identify the potential Natural Capital benefits and disbenefits of the STW Sources. The primary aim of this work is to assess Natural Capital, related to the BNG opportunities and construction impacts to support decision making. BNG is a measurable approach to development which aims to increase (10%) biodiversity of the existing natural environment. We have accounted for socioeconomic aspects (recreation and amenity) to provide a more holistic view of natural and associated social capital. This socioeconomic element highlights the relationships between people and the affected environments and identifies how these relationships could change as a result of the elements.

Following a high level screening assessment to identify the potential benefits and disbenefits of each STW Sources component (based on expert judgement and key data sources), the approach taken has been designed to satisfy the requirements of the key regulator (i.e. Environment Agency (EA)) requirements as stated in the Water Resources Planning Guideline (WRPG)[3].

The following provides a summary for key legislation/guidance, country applicability and our summary approach related to each for NCA and also BNG since the later underpins the NCA biodiversity outputs as outlined in **Section 2**.

- WRMP24 Supplementary Guidance: Environment and society in decision-making, taking into account the assessment of five minimum ecosystem services (England) namely biodiversity, climate regulation (carbon storage); water purification and natural hazard regulation.
- Environment Bill when announced, is supported by the BNG assessment via the Defra biodiversity metric (England).

As a result the approach follows that outlined by the All Company Working Group (ACWG) environmental assessment guidance for Strategic Resource Options (SROs)[4] (hereafter referred to as ACWG Guidance) whilst taking account of the key requirements above and draws on the WRSE Regional Plan Environmental Assessment guidance[5] and EA[6] and NRW's[7] Water Resources Planning Guideline (WRPG) WRMP24 Supplementary Guidance on Environment and Society in Decision-Making. RAPID gate-1 expectations for NCA have been incorporated which include:

- Desktop baseline assessment of the five key metrics as included in the WRPG[3] (plus the additional socioeconomic metric);
- List of assumptions made during the assessment including but not limited to: a theory-based Zone of Influence (ZoI); the use of landcover data derived from satellite imagery and;
- The application of a Gross Domestic Product (GDP) inflator for monetised value adjustment (where applicable).

The NCA output at gate-1 is high-level and intrinsically linked to the BNG (i.e. provides the Natural Capital biodiversity assessment). Where feasible, valuations (both spatially quantitative and monetised) have been provided, noting key assumptions/limitations especially in the context of outline design related limitations as detailed in 0 At gate-1 the required focus is to provide a Natural Capital baseline.

[3] Environment Agency, Ofwat & Natural Resources Wales (2020) Water Resources Planning Guideline (draft for consultation – July 2020)
[4] All Company Working Group (2020). WRMP environment assessment guidance and applicability with SROs
[5] Mott MacDonald (2020) WRSE Regional Plan Environmental Assessment Methodology Guidance
[6] Environment Agency (2020) Water resources planning guideline 2024 supplementary guidance- Environment and society in decision-making (England).
[7] Natural Resources Wales (2020) Water resources planning guideline 2024 supplementary guidance- Environment and society in decision-making (Wales).

The assessment has therefore focused on construction related losses and potential gain related to a 10% BNG uplift based on open source data currently available.

3.1.1.1 Data sources and gaps

The NCA has been completed using the following data sources, as recommended by the ACWG Guidance[4] and the EA and NRW's Natural Capital Assessment Guidance[3] (including Annex 1 of the WRPG Supplementary Guidance[3]).

3.1.1.2 Natural Capital stocks

The ACWG Guidance for a Natural Capital Approach advises that land use should be grouped into eight distinct types of broad habitat (urban; enclosed farmland; mountains, moors and heath; freshwater; woodland; marine; and semi-natural grassland), from which ecosystem services and benefits to society can be attributed and then monetised. The Copernicus CORINE Land Cover 2018 dataset was used to identify land cover types. This dataset is derived from satellite imagery, predominantly Sentinel-2 but additionally Landsar-8 for gap filling[8]. CORINE Land Cover 2018 identifies 44 different types of land cover and spans the entirety of Europe. These 44 land use types were initially grouped into the eight broad habitat types as recommended in the ACWG Environmental Assessment Guidance to give the total area of each broad habitat within each element's ZoI. The marine habitat was then removed from this assessment as not applicable within the boundaries of the STW Sources area.

The conversion from Corine Land Cover to broad habitat was undertaken and outlined in **Table** .

Table 3-1: Conversion from Corine Land Cover to seven broad habitat types

Corine Land Cover	Broad habitat type
Airports	Urban
Construction site	Urban
Continuous urban fabric	Urban
Discontinuous urban fabric	Urban
Dump sites	Urban
Green urban areas	Urban
Industrial or commercial units	Urban
Mineral extraction sites	Urban
Road and rail networks and associated land	Urban
Sport and leisure facilities	Urban
Complex cultivation patterns	Enclosed farmland
Land occupied by agriculture with significant areas of natural vegetation	Enclosed farmland
Non-irrigated arable land	Enclosed farmland
Pastures	Enclosed farmland
Moors and heathland	Mountains, moors and heath
Natural grasslands	Semi-natural grassland
Coniferous forest	Woodland
Mixed forest	Woodland
Transitional woodland-scrub	Woodland
Water bodies	Freshwater
Estuaries	Coastal margins

[8] Copernicus (2020) Evolution of CORINE Land Cover. Accessed: https://land.copernicus.eu/pan-european/corine-land-cover

3.1.1.3 Ecosystem Services

Stocks of Natural Capital underpin the provision of ecosystem services, i.e. the goods and services provided by nature that benefit humans and society. Some ecosystem services can be valued in monetary terms based on the benefits they provide. The data sources used to value ecosystem services are described below, these have been taken from the WRPG[3], ACWG Guidance[4] and Defra's Enabling a Natural Capital Approach (ENCA) Guidance[9].

3.1.1.4 Biodiversity and Habitat

Assessment of biodiversity has been based on the habitat data used in the BNG assessments (see BNG Evidence Report). The lengths of river within the ZoI of each element have also been calculated using WFD Waterbody data. Further incorporation of these into the NCA will be included at gate-2 (see **Section 5).**

3.1.1.5 Climate Regulations (carbon sequestration)

The carbon sequestration rates for Natural Capital stocks have been taken from the EA WRPG Supplementary Guidance (from JBA Consulting)[10] as shown in **Table 3-2**:. 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) Interim Non-Traded Carbon Values. Non-traded carbon values have been applied to carbon sequestered as these emissions are not captured by the EU Emissions Trading Scheme. As the prices published by BEIS are in £2018, GDP deflators were used to adjust them to the 2019 base year of modelling.

Table 3-2: 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
Peatland – Undamaged	4.11
Peatland – Overgrazed	-0.1
Peatland – Rotationally burnt	-3.66
Peatland – Extracted	-4.87
Grassland	0.39
Heathland	0.7
Shrub	0.7
Saltmarsh	5.19
Urban	0
Green urban	0.40

[9] Defra, Enabling a Natural Capital Approach (2020). https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca
[10] Table 7 of the EA Supplementary Guidance: Environment and Society in Decision-Making (2020).

3.1.1.6 Natural Hazard Regulation

For the purposes of this assessment, flooding was determined to be the most significant natural hazard risk. This is because although the options are likely to be operational during drought periods only, the physical changes to Natural Capital stocks may impact the capacity of habitats to slow the flow of flood water year-round. 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 Databook[11] where the associated studies were evaluated to ensure their suitability for benefit transfer. A value for semi-natural grasslands was not available. Additional studies were identified with the final best estimate for semi-natural grasslands derived from a benefit function from an existing ecosystem services assessment (Christie et al, 2011[13]) noting however, that this value is mainly applicable to lowland meadows (Holzinger & Haysom, 2017[14]).

An annual monetary value was only derived for the flood regulating services of woodland, semi-natural grassland, and wetland/ floodplain assets (see **Table 3-2:**). Robust monetary values for the urban and enclosed farmland broad habitat types are not currently available and hence it was not possible to provide a monetised estimate of these services at gate-1. As a result, the overall value of the NCA is likely to be understated at this stage.

Table 3-3: Benefit Transfer Values: Natural Hazard Regulation

Broad habitat type	Annual Value	Reference	Additional Comments
Woodland	115 (£2018/ha)	Forest Research (2018)[12] & ENCA Services Databook	These results are experimental noting no semi-grassland value
Semi-natural grasslands	197 (£2015/ha)	Christie et al (2011)[13] & Holzinger & Haysom (2017)[14]	Appear applicable to lowland meadow only. Based on an ecosystem services assessment of Chimney Meadows Reserve (UK)
Freshwater (Open waters/ wetlands/ floodplains)	407 (£2011/ha)	Morris & Camino (2011)[15] & ENCA Services Databook	

3.1.1.7 Water Purification

Since, the WRPG[3] does not require the monetisation of Water Purification Services (p. 36) because these services are highly dependent on local factors and there are limited tools available to provide accurate monetised assessment have, at this stage, only undertaken a qualitative and quantitative rather than a monetised assessment of this service based on habitat data, WFD status information from the EA's Catchment Explorer[16] and outputs at the river basin scale from the Natural Environment Valuation Online (NEVO) tool.[17]

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[11] https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca#enca-services-databook
[12] Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts. Accessed via: file:///C:/Users/se17/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/Final_report_valuing_flood_regulation_services_051218%20(3).pdf
[13] Christie, Mike, Tony Hyde, Rob Cooper, Ioan Fazey, Petter Dennis, John Warren, Sergio Colombo, and Nick Hanley. 2011. Economic Valuation of the Benefits of Ecosystem Services delivered by the UK Biodiversity Action Plan. Report to Defra, London: Aberystwyth University.
[14] Holzinger, Oliver, and Karen Haysom. 2017. Chimney Meadows Ecosystem Services Assessment: An Assessment of how the new management of Chimney Meadows Nature Reserve by Bers, Bucks and Oxon Wildlife Trust impacts on the value of ecosystem services. Oxford: Berks, Bucks and Oxon Wildlife Trust.
[15] Morris & Camino (2011) UK National Ecosystem Assessment Economic Analysis Report, School of Applied Sciences, Cranfield University.
[16] https://environment.data.gov.uk/catchment-planning/
[17] https://sweep.ac.uk/portfolios/natural-environment-valuation-online-tool-nevo/

3.1.1.8 Water Regulation

The WRPG[3] does not require the monetisation of Water Regulation Services (p. 42). The main benefit of the STW sources is the deployable output, therefore this is not considered as an additional Natural Capital benefit to avoid double counting, and Water Regulation has been screened out of the assessment.

3.1.1.9 Recreation and Tourism

The Outdoor Recreation Valuation Tool (ORVal)[18] was used to estimate recreation demand from existing or new greenspace as a proxy for recreation value. The values derived from the ORVal[18] tool are estimated using a Random Utility Model of travel cost estimates[19]. The values represent the total welfare lost if the site in question were to be removed. In cases where elements consist of more than one site, the marginal values of each site are aggregated based on the assumption that other sites that exist outside of the element scope, are substitutes[20].

3.1.1.10 Air quality

Air Quality is a required assessment within the WRSE guidance and hence has been included in this NCA. Airborne pollutants represent a serious threat to human health and wellbeing: assessment of air quality regulation services is therefore also relevant to the well-being goals set out by the Welsh Government[Error! Bookmark not defined.]. Natural habitats are able to reduce these harmful effects by absorbing air pollution providing ecosystem service benefit to society. To quantify this benefit, values provided by Jones et al. (2019)[21] have been used to convert land cover types into estimates of monetary value for pollutant absorption per hectare per year. This has been used to assess the baseline value of the habitats within Air Quality Management Areas that fall within a defined ZoI surrounding each element. Where habitats do not fall within an Air Quality Management Area they have not been included in the assessment of this Natural Capital metric. Monetary values are provided in **Table .**

Table 3-4: Air pollutant value by habitat type

Habitat group	Value (£2019 per hectare per year)
Urban Woodland	871
Rural Woodland	277
Urban grassland	168
Enclosed farmland	16
Coastal margins	29

[18] https://www.leep.exeter.ac.uk/orval/
[19] Day & Smith (2017) The ORVal Recreation Demand Model: Extension Project. Accessed via: https://www.leep.exeter.ac.uk/orval/pdf-reports/ORValII_Modelling_Report.pdf
[20] https://www.leep.exeter.ac.uk/orval/pdf-reports/ORVal2_User_Guide.pdf
[21] Laurence Jones, Massimo Vieno, Alice Fitch, Edward Carnell, Claudia Steadman, Philip Cryle, Mike Holland, Eiko Nemitz, Dan Morton, Jane Hall, Gina Mills, Ian Dickie & Stefan Reis (2019) Urban natural capital accounts: developing a novel approach to quantify air pollution removal by vegetation, Journal of Environmental Economics and Policy, 8:4, 413-428

3.1.2 Biodiversity Net Gain (BNG)

Whilst currently BNG is not yet mandatory, it is likely to become a legal requirement for development once the Environment Bill has become an Act of Parliament. Delivering net gain for the environment has become a policy requirement. Additionally, the **25-Year Environment Plan** speaks of embedding an environmental net gain principle for development, including infrastructure.

The BNG assessment required for gate-1 is carried out in line with the All Company Working Groups (ACWG) current guidance to SRO Environmental Assessment. The requirements and outputs of the assessment are also consistent with WRPG guidance for WRMP24.

The outputs provide both an assessment of losses and potential net gain opportunities and the data upon which the NCA is compiled related to habitat type (both losses and Net Gain uplift opportunities) for the NC biodiversity metric.

The guidance states that BNG should be demonstrated for each element/option to "**look to maximise biodiversity net gain**" and that "**supply options should incorporate BNG into design and therefore provides a biodiversity optimised programme"**. If significant BNG can be achieved but at significant additional cost this should be included as a separate option. Therefore, BNG calculations should be carried out at long-list stage, gate-1, and that early identification of opportunities and constraints is essential to design and consideration of any requirement for additional options.

In accordance with the guidance, our approach has been to use a **GIS-based system** to allow for rapid assessment of multiple elements and the application of **Defra's Biodiversity tool 'The Biodiversity Metric 2.0' (Defra BNG Metric)** as a means of scoring the biodiversity gain or loss of each element. The baseline will be developed from spatial data sets of habitat inventories and scored through the Defra BNG Metric.

3.1.2.1 Achieving Biodiversity Commitments

Our approach assesses whether the ST Sources meets with the 25 Year Environment Plan commitments and statutory environmental duties for biodiversity through considering the **biodiversity commitments** (listed below).

The assessment applies the principles of Net Gain, by taking a hierarchical approach to mitigation seeking to avoid loss of key habitats, and therefore species, and strategic identification of opportunities for biodiversity benefits to protect, enhance and provide resilience:

1. Conserving and enhancing SSSIs (Wildlife and countryside Act, 1981 as amended):
2. Furthering the purposing of the Habitats Directive (and regulations) Conservation of Habitats and Species Regulations 2017 (as amended).
3. Achieving the conservation objectives for Marine Protected Areas (Marine and Coastal Access Act)
4. BNG for habitats and species of principle importance for the conservation of biodiversity – (Natural environment and rural communities Act).

Key to this, is timely identification of the possible requirement for compensation for likely impacts, such as those to 'irreplaceable habitats' and identify lower impact alternatives.

For gate-1, the BNG assessment comprised a full assessment for each element. Gate-2 will be a refined assessment to determine the short list of options. Further details of our approach are provided below.

3.1.2.2 Data collection and review

The first stage is collection of data and review of relevant, available information to inform of key BNG constraints and opportunities. All the data sets use open source data that is readily available and can be uploaded to a centralised GIS database.

3.1.2.3 Identifying the biodiversity baseline conditions

The Defra BNG metric is a habitats-based assessment. To demonstrate best outcome (% BNG) will require a **baseline calculation** of current biodiversity value/score. This tool quantifies each habitat type into 'units' based on a number of factors, including habitat distinctiveness, area (or linear equivalent), condition, ecological connectivity and strategic significance. At gate-1, the assessment of BNG options

is a high-level assessment based on available open source data. For this, a range of open source and assessable data will be used to gain a comprehensive understanding of habitats present within the ZoI that can provide a robust baseline.

Firstly, the habitat data has been provided by using existing habitat inventories, such as Corine Land Cover and areas measured in GIS. Secondly, the identification of habitat distinctiveness, condition and baseline extent for habitats, including priority habitats and designated and non-designated sites, has been determined through mapping on the Priority Habitat Inventory and open data on designated sites noting that where data on habitat quality is not available for a habitat, 'moderate' condition will be assumed to avoid an over precautionary assessment. Such assumptions will be defined and addressed at gate-2.

The baseline scores are adjusted for the associated habitat impacts (gains or losses) related to the construction and operation of each element as area of habitat loss, taking into account the assumption of good practice construction methods and re-instatement. This part of the assessment identifies high risk areas where the proposals will result in a significant loss of biodiversity and offsetting will be more onerous or may identify an 'irreplaceable habitats' that should be avoided, such as certain priority habitats.

The output is the tool spreadsheet, a table of baseline unit scores for each element, and a map of constraint areas and impact areas, RAG-rated to provide early warming of elements with high scores where offsetting would be onerous. The criteria definitions will align with those for SEA and NC within the WRSE for designated sites. The results will feedback into engineering design of elements to identify opportunities to reduce their impact.

3.1.2.4 Identifying BNG opportunities and calculating the benefit score

Enhancement measures can include the provision of new habitats, provision of new habitat features and the improved management of existing habitats which will result in a net benefit to biodiversity, over and above the measures required to mitigate and compensate for the impacts of a proposed scheme. Enhancement opportunities are added to the Metric as a habitat area and the Metric re-calculates the quantity or balance of (units) of BNG provided, which is also given as a % change from the baseline.

Opportunities for biodiversity gain will be linked with those within SEA, WFD, HRA mitigation measures where applicable and NC approaches and will require working in parallel to identify solutions to provide best outcomes across these assessments.

The output of this stage is the tool spreadsheet and a table of the habitats and areas required for enhancement/creation to offset the impacts of each element and provide a minimum 10% BNG. Representation of the BNG opportunities, habitat enhancements or creation, would be represented in GIS with areas shown within possible suitable locations based on habitat type only. The purpose is to represent the area of enhancement /creation required for a rapid assessment of achievability and flag any unmitigable impacts.

3.1.2.5 Strategic assessment of opportunity areas

The metric takes into account habitat distinctiveness and risk parameters associated with habitat creation and restoration. This means that a 1:1 replacement will not score 0 in terms of gains and losses but a negative number of units, as additional enhancements will be required, for example, to take account of time lag of the establishment of created/restored habitat. Therefore, if additional habitat area is required to offset losses and provide BNG, it is possible that insufficient land may be available on site. A strategic assessment of off-site opportunity areas has been undertaken to identity suitable parcels of land where the best biodiversity gain could be achieved. These opportunity areas will interface with the Natural Capital approach to identify where benefits can be achieved and are described further below.

3.1.2.6 Identifying BNG opportunity areas

Our approach follows the mitigation hierarchy of avoiding, minimising and mitigating the habitat lost/deteriorated and local compensation. Maximum credits can be achieved through identifying opportunities for enhancing the habitat that is lost/degraded rather than replacement. However, where

insufficient habitat lies on site to deliver what's required for net gain, alternative locations will be sought. A review has been undertaken of Biodiversity Opportunity Areas.

Using the principles of Biodiversity Opportunity Areas, core areas for biodiversity, such as designated and non-designated sites and priority habitats, have been identified. The opportunities will be assessed for their suitability for specific net gain features, connectivity opportunities and achievability. Values will then be assigned against areas of mitigation opportunity with potential condition improvement for each feature and opportunity including specific mitigations recommendations.

4 Assessments Results

4.1 Introduction

The STW Source SRO schemes are presented in **Table 4-1.**

Table 4-1: STW Sources SRO Schemes

Reference Number	Scheme Name
Mythe_15	Mythe abstraction licence transfer (15 Mld)
NetheridgePipelineDeerhurst_35	Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline
NetheridgePipelineCotswold_35	Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals

In order to measure the Natural Capital benefits and disbenefits of each element, the assessment first requires knowledge of the likely changes in habitat extent and quality. This is the basis of the BNG assessment. The NCA relies on the BNG outputs to understand extent of change. The data sources used to carry out monetary valuation of the baseline Natural Capital stock (see **Section 3)** can then be applied to the future change scenario, to provide an ecosystem service valuation (in monetary terms)) for the future Natural Capital stock. The difference between the baseline and future scenarios is then been used as the Natural Capital valuation for each element. For those elements that are only assessed qualitatively, a description of the future change scenario is necessary which outlines the likely changes in ecosystem service provision following STW source implementation for each element.

Calculation of the overall impact on Natural Capital and ecosystem service provision need to consider the mitigation and enhancement opportunities that will be incorporated in scheme design, particularly the biodiversity uplift requirements outlined in the BNG assessment. To account for this, a further assessment needs to be carried out of the STW sources to provide a high level BNG uplift. At gate-1 BNG enhancement opportunities have not been agreed so an estimated uplift of 10% for each impacted habitat is included in the NCA. This is critical as BNG is expected to become a requirement of planning permission, and therefore the STW sources selected for development will be required to include a BNG uplift in the final design.

The assessment at gate-1 focusses primarily on the terrestrial habitats and impacts with commentary only related to aquatic environments: more detail will be necessary at gate-2 once there is more information regarding STW sources and associated groupings design including agreed Ml/d variant taken forward. At gate-2 understanding flow dynamic change on all key Natural Capital aquatic-related metrics should be feasible but this is not expected at gate-1.

The habitats within the ZoIs for each STW source have been mapped and a high-level analysis of likely effects following each element's implementation has been performed. An assessment of the likely risks posed to the Natural Capital metrics is provided in **Table 4-2** below. This provides that basis for the assessment work to be completed for gate-1.

Note:

- Each 'element' associated with the STW sources is split out for the assessment below and for the baseline (see section 4.2 and 4.4)
- Groupings as shown in table 4-1 areas completed as part of the full assessments (see sections (4-3 and 4-5)

Table 4-2: Risks posed to Natural Capital/Net Gain metrics per element

Referemce	Metric	Risk	Impacts
Mythe abstraction licence transfer	Biodiversity	Medium	Freshwater most likely habitat to be affected due to changes in river flow dynamics. Moderate risk of disbenefits to recreation and biodiversity due to changes in flow. *Further investigation required at gate-2.* Loss to other stocks likely to be low therefore limited ecosystem risk.
	Water regulation	Low	
	Carbon	Low	
	Air quality	Medium	
	Water purification	Low	
	Natural hazard regulation	Low	
	Recreation & tourism	Medium	
Netheridge WwTW discharge diversion - Deerhurst Pipeline	Biodiversity	Medium	Stocks lost mainly arable agriculture with some from urban areas. Will lead to carbon sequestration and air quality disbenefits. Biodiversity disbenefits related mainly to hedgerow loss: mitigation options through BNG uplift which can have offsetting opportunities for carbon and air quality. *Further investigation required at gate-2.*
	Water regulation	Low	
	Carbon	Medium	
	Air quality	Low	
	Water purification	Low	
	Natural hazard regulation	Low	
	Recreation & tourism	Low	
	Water regulation	Low	
	Carbon	Medium	
	Air quality	Medium	
	Water purification	Low	
	Natural hazard regulation	Low	
	Recreation & tourism	Low	
Deerhurst Pipeline	Biodiversity	Medium	Stocks lost mainly arable agriculture with some from urban areas and some areas of woodland. Will lead to carbon sequestration and air quality disbenefits. Biodiversity disbenefits related mainly to hedgerow loss: mitigation options through BNG uplift which can have offsetting opportunities for carbon and air quality noting longer term recovery for woodland. *Further investigation required at gate-2.*
	Water regulation	Low	
	Carbon	Medium	
	Air quality	Medium	
	Water purification	Low	
	Natural hazard regulation	Low	
	Recreation & tourism	Low	
Netheridge WwTW discharge diversion - Cotswold Canals	Biodiversity	Medium	Stocks lost mainly arable urban with some from agricultural and heathland areas. Moderate risk of disbenefits to recreation and biodiversity due to changes in river flow. *Further investigation required at gate-2.* Input of effluent into canals may also reduce water quality.
	Water regulation	Low	
	Carbon	Low	
	Air quality	Low	
	Water purification	Medium	
	Natural hazard regulation	Low	
	Recreation & tourism	Low	
Cotswold Canals	Biodiversity	Medium	Stocks lost mainly arable agriculture with some from urban and woodland areas. Will lead to carbon sequestration and air quality disbenefits. Biodiversity disbenefits related mainly to hedgerow loss: mitigation options through BNG uplift which can have offsetting opportunities for carbon and air quality noting the longer term recovery for woodland. *Further investigation required at gate-2.*
	Water regulation	Low	
	Carbon	Medium	
	Air quality	Medium	
	Water purification	Low	
	Natural hazard regulation	Low	
	Recreation & tourism	Low	

4.2 Baseline assessment results - NCA

The NCA tables for each of the three schemes plus the Netheridge WwTW discharge are provided in associated Appendices as outlined below. A breakdown of the qualitative and quantitative baseline assessment results are detailed in the Excel workbooks accompanying the Environmental Assessment report (STW **A1 – A5**). The workbooks also include a series of figures for each element depicting the ZoI and the distribution of land cover and other features of relevance to ecosystem service assessment. A baseline assessment of Natural Capital stocks and ecosystem service provision has been carried out to inform the assessment of each option. This has been based on a 1km ZoI using habitat data as a proxy for Natural Capital stocks. The flow of ecosystem services under baseline conditions has been assessed using the data outlined in **Section 3.**

4.2.1 Biodiversity and habitat

Table summarises the areas of each broad habitat within the 1km ZoI for each element. Only habitats that are present within the ZoI are included. Length of river has also been calculated.

The baseline indicates that the majority of land use for the STW Sources is urban or enclosed farmland with relatively low biodiversity value noting more detailed analysis local biodiversity features will be required at gate-2.

Several of the elements have significant areas of higher biodiversity value habitat, such as woodland and semi-natural grassland, which support a range of wider ecosystem services.

Table 4-3: Summary of broad habitat types for elements

Reference	Based on 1km radius = Total zone of influence (ha)	Habitat type	Ha per habitat: based on 1km radius ZoI	Length of river within buffer zone, km
Mythe abstraction licence transfer (STW A1 Mythe Abstraction License Transfer)	331.28	Urban	62.77	7.94
		Enclosed farmland	268.51	
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline (STW A2 Netheridge to Deerhurst pipeline)	3725.59	Urban	901.78	20.76
		Enclosed farmland	2613.14	
		Mountains, moors and heath	178.59	
		Woodland	32.07	
Deerhurst Pipeline (STW A3 Deerhurst Pipeline)	17769.23	Urban	629.53	11.77
		Enclosed farmland	16024.43	
		Mountains, moors and heath	47.57	
		Freshwater	28.67	
		Woodland	1032.14	
		Semi-natural grassland	6.90	
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals (STW A4 Netheridge to Cotswold Canals pipeline)	963.45	Urban	648.80	9.05
		Enclosed farmland	218.39	
		Mountains, moors and heath	96.26	
Cotswold Canals (STW A5 Cotswold Canals)	14118.07	Urban	2926.50	71.77
		Enclosed farmland	9959.01	
		Mountains, moors and heath	67.07	
		Freshwater	369.69	
		Woodland	793.98	
		Coastal margins	1.82	

4.2.2 Climate regulation

Table summarises the baseline land use types within the 1km ZoI of each STW source and the monetary value of the climate regulation ecosystem services they provide. The conveyance STW Source elements provide the greatest carbon sequestration value under baseline conditions; this is

related to the large ZoI as well as the presence of high value habitats within the that ZoI (e.g. woodland (both deciduous and coniferous) – see **Table**).

Table 4-4: Summary of baseline non-traded carbon sequestration values per element

Reference	Baseline non-traded carbon sequestration value (£2019)
Mythe abstraction licence transfer	4,597
Netheridge WwTW discharge diversion - Deerhurst Pipeline	70,974
Deerhurst Pipeline	706,646
Netheridge WwTW discharge diversion - Cotswold Canals	9,258
Cotswold Canals	501,727

4.2.3 Natural hazard regulation

Table presents the baseline assessment of natural hazard regulation. Only areas located within flood plain and close to urban areas (where impacts of flooding are likely to be more costly) have been scoped into the assessment. The areas susceptible to flooding were identified using Flood Zone 2 and 3 definitions outlined in National Planning Policy[22].

Baseline land cover was converted to monetary value based on data outlined in **Section 3.** A benefit transfer value has not been identified at this stage for farmland, therefore this has not been accounted for in the baseline assessment.

Table 4-5: Summary of the Natural Capital baseline for natural hazard regulation

Reference	Baseline value of natural hazard regulation (£2019)
Netheridge WwTW discharge diversion - Deerhurst Pipeline	3,758
Deerhurst Pipeline	135,797
Cotswold Canals	265,887

4.2.4 Water purification

Baseline provision of water purification services is dependent on the following:

- Land cover (habitat)
- Proximity to receptor (i.e. a water body)
- Current water quality of receptors

Baseline water purification provision has not been quantified at gate-1. A brief summary of the baseline is included below in **Table .**

[22] https://www.gov.uk/government/publications/national-planning-policy-framework--2

Table 4-6: Summary of baseline water purification service provision per element

Reference	Baseline water purification ecosystem service provision
Mythe abstraction license transfer	Water purification services are currently provided by bankside habitats which have a purifying effect on water entering the River Severn. The Severn - conf R Teme to conf R Avon WFD waterbody is currently achieving Moderate status and therefore has potential to improve or decline if water purification services are affected.
Netheridge WwTW discharge diversion - Deerhurst Pipeline	Water purification services are currently provided by arable, pasture, woodland and grassland habitats. The element involves construction of an approximately 20km pipeline which runs parallel to the Gloucester and Sharpness Canal for approximately 4km, runs close to the Severn - conf R Avon to conf Upper Parting (both currently Moderate status), and crosses several other WFD waterbodies.
Deerhurst Pipeline	Water purification services are currently provided by arable, pasture, woodland, coastal and floodplain grazing marsh and semi-improved grassland habitats. The element involves construction of an approximately 85km pipeline which crosses or runs within 100m of several waterbodies, including the Swilgate – source to conf R Avon (status Moderate), Isbourne – source to R Avon (status Poor), Coln (source to Coln Rogers) (status Moderate), Leach (Source to Thames) (status Poor), Radcot Cut (status Moderate), Ock and tributaries (status Poor) and Thames (Evenlode to Thame) (status Moderate).
Netheridge WwTW discharge diversion - Cotswold Canals	Water purification services are currently provided by pasture and heathland habitats. The element involves construction of an approximately 3.3km pipeline which runs parallel to the Gloucester and Sharpness Canal before feeding into it, runs close to the Severn – source to conf R Severn (Moderate status), and crosses the Horsebere Bk to Severn Est WFD waterbody.
Cotswold Canals	Water purification services are currently provided by arable, pasture, woodland, mixed forest, coastal and floodplain grazing marsh and grassland habitats. The element involves construction of seven new rising mains bypassing the canal network, which run close to or intersect several waterbodies including; Frome – Ebley Mill to conf R Severn (status Moderate), Frome – source to Ebley Mill (status Moderate), Radcot Cut (status Moderate), Thames (Leach to Evenlode (status Poor), Wadley Stream (Source to Thames at Duxford) (status Bad), Ock and tributaries (status Poor), Childrey Brook and Norbrook at Common Barn (status Poor) and Thames (Evenlode to Thame) (status Moderate).

Table depicts baseline values for water purification, extracted from the NEVO[17] tool. This is broken down on a river basin basis and provided a high-level view of baseline water quality in the potentially impacted rivers. Where the ST Source elements cross multiple catchments, an average has been provided.

Table 4-7: NEVO outputs

Reference	Basin	Dissolved Oxygen Conc. (mg/l)	Nitrogen Conc. (mg/l)	Phosphorus Conc. (mg/l)
Mythe abstraction license transfer	Severn	9.94	9.88	0.40
Netheridge WwTW discharge diversion - Deerhurst Pipeline	Severn	9.94	9.88	0.40
Deerhurst Pipeline	*Severn*	*9.94*	*9.88*	*0.34*
	Thames	*10.49*	*9.35*	*0.33*
	Average	10.22	9.62	0.39
Netheridge WwTW discharge diversion - Cotswold Canals	Severn	9.94	9.88	0.40
Cotswold Canals	*Severn*	*9.94*	*9.88*	*0.67*
	Thames	*10.49*	*9.35*	*0.33*
	Average	10.25	9.518	0.37

4.2.5 Tourism and recreation

Table depicts the baseline welfare value for each element, as well as the estimated visitation on a given year and the total area designated for recreational use. This data is derived from the ORVal[18] tool as described in **Section 2**.

Table 4-8: ORVal outputs

Reference	Estimated Welfare Value (£ per year)[23]	Estimated visits (per year)	Total Recreation Land Cover (m^2)
Mythe abstraction license transfer	150,153	52437	521390
Netheridge WwTW discharge diversion - Deerhurst Pipeline	4,368,960	1389887	2673708
Deerhurst Pipeline	2,879,822	960209	7155770
Netheridge WwTW discharge diversion - Cotswold Canals	3,062,741.00	1052610	2422800
Cotswold Canals	12,022,661.80	3934994	11204350

The following text provides a high level summary related to the key sites for each of the STW sources that contribute to the values provided in **Table.**

4.2.6 Mythe abstraction licence transfer

Partially included within the ZoI is Severn Ham, the portion of this site counted contributes towards the majority of the total welfare value. The buffer also includes a small section of Tewkesbury Abbey Grounds.

4.2.7 Netheridge WwTW discharge diversion

This STW source crosses through Gloucester and so there is also a relatively high welfare and recreation value for this scheme. Sites of note encompassed within the ZoI include Alney Island Local Nature Reserve, Gloucester Cathedral Grounds, Gloucester Park and multiple paths that follow the stretch of the Severn potentially impacted by this scheme.

[23] Typically, the monetary value attributed to a recreation site is high. This might lead to overrepresentation of these sites in assessment of natural capital. An awareness of this area of bias will be important when interpreting the results of the assessment.

4.2.8 Deerhurst pipeline

Much of the land cover surrounding the Deerhurst to Culham interconnector is enclosed farmland, this is reflected in the welfare value for this element as paths and trails are the main features accounted for. Other notable sites encompassed by the 1km buffer include Shipton Golf Course, Chedworth Roman Villa Drayton Millennium Green and two sports clubs in Abingdon.

4.2.9 Cotswold Canals

The baseline welfare value for the Cotswold Canal STW source is much higher than the value attached to the other elements; this can be attributed to both its scale and route. The interconnector crosses through Gloucester where there are a number of sites with a high welfare value, these include but are not limited to Alney Island Local Nature Reserve, St Oswald's Priory, Gloucester Cathedral Grounds. Other sites worth noting along the route include Quedgeley Arboretum, Three Groves Wood Nature Reserve and Dimore Brook Recreation Ground. In addition there are several paths and trails which contribute substantially towards the total welfare value.

4.2.10 Air quality

Only sites with Air Quality Management Areas present within the 1km ZoI have been considered. The results from the baseline NCA of air quality are presented in **Table** with only habitats featuring habitats with air pollutant removal value shown.

Table 4-9: Air pollutant Natural Capital values of relevant elements

Element	Corine Land Cover	Habitat type	Area (ha)	Value of area (£ per year)
Mythe abstraction license transfer	Pastures	Enclosed farmland	0.81	13

4.3 Assessment NCA

The following tables present the natural capital and ecosystem service losses and gains resulting from each of the proposed STW source groups through construction and estimated (at this gate) biodiversity enhancement and habitat creation opportunity areas for each proposed grouping (i.e. BNG). These groups are shown in **Table 1-2.**

Ecosystem service loss is calculated based on the area of natural capital stock lost through implementation of each STW Sources grouping compared to the baseline.

The tables below present:

1. Change related to construction of the options without any BNG mitigation in place.
2. Change related to construction of the options assuming incorporation of BNG mitigation (i.e. habitat creation) within option design.

Note: this comparison, i.e. with and without BNG mitigation, is not the same as comparing construction and operational effects. At this stage it is not possible to determine all of the effects of the operation of the scheme as there is insufficient detail. This information will be generated as the development of the scheme progresses, and it will be used in a subsequent consideration of the impact of the scheme upon natural capital stocks.

These **Tables 4-10 - 4-15** together with **sections 4.3.1 – 4.3.6** provide overall assessment of the STW sources groupings for each of the key ecosystem services (i.e. Biodiversity and habitats; climate regulation; natural habitat regulation; tourism and recreation and; air quality). **Table 4-16** and **section 4.3.7** then provides the final overall natural capital account for each group.

Only habitat creation BNG mitigation measures are included in the NCA as these represent a permanent change in extent of natural capital stock. Other BNG mitigation measures include habitat improvement (e.g. from poor to moderate status). It should be noted that it has not been possible to monetise the

benefits of habitat condition improvement as there is not enough information available on how ecosystem service provision is affected by changes to habitat quality.

4.3.1 Biodiversity and Habitat

The change in biodiversity and habitat ecosystem services resulting from the four STW source groups, with and without mitigation, is presented in **Table 5-10** below**.** The assessment shows that there is some loss to urban and freshwater habitats that will not be mitigated through the currently proposed BNG uplift. This is reflective of the Defra Biodiversity Metric which requires a net gain in overall habitat units rather than a net gain for each habitat type.

Within the current version of the Defra River Metric mitigation/compensation for 10% BNG cannot to be calculated for river habitat loss due to errors in the multipliers of the River Metric 2.0 and therefore are not included within the BNG assessment. Therefore, a bespoke solution would need to be agreed with the regulators to mitigate for freshwater habitat losses; however, version 3.0 is due for release in 2021 and is likely to resolve this issue.

Table 5-10: Summary of biodiversity and habitat ecosystem service changes with and without BNG uplift for each STW Sources group*

Group	Summary	Habitat change (without BNG uplift)	Habitat change (with BNG uplift)
Mythe abstraction licence transfer (15 Mld))	No habitat is lost through element implementation, so no uplift has been proposed at this stage.	0	0
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	Majority of habitat lost is farmland, which provides relatively little biodiversity benefit compared to freshwater and woodland habitats. Potential habitat creation areas consist of farmland (traditional orchards), heathland and deciduous woodland to compensate losses in biodiversity.	-10.43 Ha urban -387.17 Ha farmland -2.24 Ha heathland -0.017 Ha freshwater -0.73 Ha woodland	-10.43 Ha urban -0.017 Ha freshwater 6 Ha farmland 5 Ha heathland 60 Ha woodland
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	Smaller construction area due to smaller size of Netheridge option. Majority of habitat lost is farmland. Potential habitat creation areas consist of farmland (traditional orchards), heathland and deciduous woodland to compensate losses in biodiversity.	-70.27 Ha urban -292.29 Ha farmland -0.89 Ha Heathland -6.54 Ha freshwater -10.48 Ha woodland	-70.27 Ha urban -6.54 Ha freshwater 1 Ha farmland 0.5 Ha heathland 75 Ha woodland

**Note: Habitats that make up the 10% minimum uplift are based on the BNG assessment (see B2.8 and B3.8). These have been assessed via the Defra Biodiversity metric 2.0 which provides for an assessment of which combination of habitats (and condition improvement) will result in the greatest BNG uplift.*

4.3.2 Climate regulation

Table 4-11: Summary of climate regulation ecosystem service changes with and without BNG uplift for each STW source group

Group	Summary	Carbon value (£/year) (without BNG)	Carbon value (£/year) (with BNG)
Mythe abstraction licence transfer (15 Mld))	No habitat is lost through element implementation, so no uplift has been proposed at this stage.	0	0
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	Proposed uplift considerably outweighs the stocks lost through construction.	-£8075	£18,061
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	Proposed uplift is proportionally larger, providing a greater long-term benefit.	-£6317	£22,295

4.3.3 Natural hazard regulation

Table 4-12: Summary of floor regulation ecosystem service changes with and without BNG uplift for each STW source group

Group	Summary	Flood regulation value (£/year) (without BNG uplift)	Flood regulation value (£/year) (with BNG uplift)
Mythe abstraction licence transfer (15 Mld))	No habitat is lost through element implementation, so no uplift has been proposed at this stage.	0	0
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	Flood regulation value gained through BNG uplift far outweighs the stocks lost.	-£91	£6900
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	Stocks lost are considerably larger than other options with only a moderate increase in regulation value gained through BNG.	-£3868	£8,625

4.3.4 Water purification

Table 4-13: Summary of water purification ecosystem service changes with and without BNG uplift for each STW source group*

Group	Summary	Impact without BNG	Impact with BNG
Mythe abstraction licence transfer (15 Mld))	Increased dilution of pollutants in the Severn due to reduced abstraction	0	+ve
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	Slight disbenefit due to influx of treated water from Netheridge WwTW which has been identified as having a potential WFD deterioration impact.	-ve	0
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	Slight disbenefit due to influx of treated water from Netheridge WwTW which has been identified as having a potential WFD deterioration impact.	-ve	0

*Water purification impacts are described in **Section 4.2.4**

4.3.5 Tourism and Recreation

Table 4-14: Summary of tourism and recreation ecosystem service changes with and without BNG uplift for each STW source group

Group	Summary	Recreation (without BNG, during construction)	Recreation (with BNG – qualitative only*)
Mythe abstraction licence transfer (15 Mld))	This source does not require any construction zone, as such it is unlikely that any recreation sites will be affected.	0	Provision of additional woodland habitat as part of required BNG uplift may improve tourism and recreation if visitor facilities are included in woodland scheme design (e.g. footpaths, information boards).
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	Figures represent the worst-case-scenario revenue impact where affected recreation sites close down entirely, with potential resulting impacts on physical health and well-being. In reality the majority will be able to remain operational throughout construction. Impacts on recreation from BNG uplift are not possible to quantify until definitive uplift sites have been selected	-£1,361,624	Provision of additional woodland habitat as part of required BNG uplift may improve tourism and recreation if visitor facilities are

Group	Summary	Recreation (without BNG, during construction)	Recreation (with BNG – qualitative only*)
			included in woodland scheme design (e.g. footpaths, information boards).
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	Figures represent the worst-case-scenario revenue impact where affected recreation sites close down entirely, with potential resulting impacts on physical health and well-being. In reality the majority will be able to remain operational throughout construction. Impacts on recreation from BNG uplift are not possible to quantify until definitive uplift sites have been selected	-£2,213,389	Provision of additional woodland habitat as part of required BNG uplift may improve tourism and recreation if visitor facilities are included in woodland scheme design (e.g. footpaths, information boards).

4.3.6 Air quality regulation

Table 4-15: Summary of air quality regulation ecosystem service changes with and without BNG uplift for each STW source group

Group	Summary	Air quality regulation value (£/year) (without BNG uplift)	Air quality regulation value (£/year) (with BNG uplift)
Mythe abstraction licence transfer (15 Mld)	No construction work is required so no disbenefits to Air Quality Management Areas are predicted. Locations for uplift have yet to be finalised so impacts on these areas are as of yet unknown.	£0	N/A
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	No stocks are lost from valued habitats within Air Quality Management Areas. Locations for uplift have yet to be finalised so impacts on these areas are as of yet unknown.	£0	N/A
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	No stocks are lost from valued habitats within Air Quality Management Areas. Locations for uplift have yet to be finalised so impacts on these areas are as of yet unknown.	£0	N/A

4.3.7 Summary for NC.

Table 4.16 summarises the total change in ecosystem service benefits for each of the four STW source groups. This does not include recreation and tourism impacts as these are applicable during the

construction period only, and there is a high level of uncertainty around the impacts of construction on access to local recreation sites (see also **section 4.6** re overall summary)

Table 4-16: Summary of overall natural capital impacts of each STW Sources groupings

Group	Summary	Overall ecosystem service change (without BNG) (£/year[24])	Overall ecosystem service change (with BNG) (£/year)
Mythe abstraction licence transfer (15 Mld))	No impact predicted through current metrics	0	0
Netheridge WwTW discharge diversion (35 Mld) - Deerhurst Pipeline	Large uplift far outweighs the stocks lost. Less destructive than Cotswold Canals source option.	-£8,166	£24,961
Netheridge WwTW discharge diversion (35 Mld) - Cotswold Canals	Slightly more destructive than Deerhurst source option but far greater value from mitigation measures.	-£10,185	£32,070

4.4 BNG Baseline

A BNG assessment has been carried out to identify the potential biodiversity loss of the elements and what replacement habitat could be required to achieve a 10% BNG. For this high-level assessment, certain assumptions have been made to quantify the potential net loss and therefore net gain opportunities, which are based on a worst-case scenario, assuming all habitat within the working easement will be lost during construction and re-instated. For net gain, we have also considered spatially where mitigation and offsetting opportunities exist in relation to each element. The assessment identifies the quantity of each habitat type required to make this improvement elsewhere (off-site) to provide this and identifies strategic locations of where these opportunities may lie at a county level.

Section 4.4 addresses the gate-1 expectations for BNG in providing:

- the data sources and how they have been used to assess BNG;
- data gaps and assumptions; and
- baseline conditions for each element;

Section 4.5 provides:

- the assessment results; and
- a scope for further work on BNG to gate-2.

The assessment (Section 4.5) highlights which elements present the greatest biodiversity loss and elements which can achieve mitigation and/or offsetting with the least amount of required land. This information will feed into the design process to ensure that net gain requirements are met and opportunities for enhancement are maximised. At this conceptual design stage, the metric calculations are based on certain assumptions. Gate-1 is focused on providing the foundations for more detailed quantitative calculations at gate-2

The methodology for this assessment has been developed to accommodate the current uncertainty surrounding the elements (design/precise location etc). It is a high-level assessment that is proportional

[24] This includes a temporary loss of recreation benefit during the construction period only.

to scale and data availability. As certainty surrounding the schemes increases, the assessment will be updated accordingly with latest available data. A full list if assumptions is given in **Section 4.4.8**. At gate-1, the assessment of BNG is a high-level assessment based on open-source data, uploaded to a centralised GIS database. To provide a more robust baseline, habitat surveys will be required at gate-2. Specific detail is given in **A7** where data from these reports have been used to fill data gaps due to lack of survey data.

The BNG requirement for the ACWG (Section 3.4.2.5 of the guidance[25]) stipulates that each option should look to maximise BNG and any required mitigation should be included to enable identification of any significant costs. The ACWG requires a full assessment of BNG using the Defra metric and that BNG calculations would take place at Gate 1 and be further refined throughout the gateway process. In accordance with the ACWG guidance, at gate-1 a biodiversity baseline has been developed from spatial data of habitat inventories and assessed in line with the Defra Metric 2.0, to calculate the change in biodiversity score for each element to include agreed mitigation. The open source habitat data can be supplemented with local data sets or Phase I (habitat) site data to increase the accuracy for each option at gate-2. Therefore, where data gaps arose at gate-1, these should be addressed at gate-2 through the following actions, as set out within section 2.9 below. At gate-2, the BNG assessment would be refined through the inclusion of concept designs into the assessment, in accordance with section 3.4.3.5 of the ACWG guidance.

The BNG assessment needs to be refined through greater detail on the construction methods and construction easement to provide great clarity on the impact pathways and habitat scores through the Biodiversity Metrics.

Further assessment on the hydrological impacts on ecology will be undertaken that will inform the assessment of operational BNG losses/gains.

Stakeholder consultation is essential to identify opportunities. This will be critical to the opportunity assessment related to mitigation and enhancement. We propose a series of short workshops for key stakeholder to discuss opportunities. This will include key water company representatives and stakeholders (as agreed by the STW steering group). The opportunities which may be discussed include:

- Landowners' land and landownership constraints
- Local wildlife sites
- Whether local councils have allocated land for BNG
- Criteria for prioritisation
  Consideration of specific species targets for net gain options

The improvement of baseline data is required to support gate-1 through site habitat surveys (condition assessment), ground truthing and habitat scoring. Survey locations will be targeted to sensitive areas and to ground truth the variation across the working easements

Table 4.1 of the ACWG guidance includes the requirement to include data on Local Wildlife Sites, which would need to be obtained from the Local Records Centre. Priority habitat layers for hedgerows/arable field margins are not open-source information and will be purchased from the Local Records Centre to improve baseline information.

A more detailed review should be undertaken of National and Local plans and policies, such as River Basin Management Plans, catchment or WFD objectives to identify any specific objectives for BNG that can be delivered. Using the principles of Nature Recovery Networks, core areas for biodiversity have been identified within BOAs. Opportunities for connecting these through habitat restoration/creation should be explored in gate-2, including those already identified within Local Plans/LBAPs/strategies. The opportunities should be assessed for their suitability for specific net gain features, connectivity opportunities and achievability. Values will then need to be assigned against areas of mitigation

[25] All Companies Working Group WRMP Environmental Assessment Guidance and Applicability with SROs, October 2020

opportunity with potential condition improvement for each feature and opportunity using the principles of the scoring of the River Biodiversity Metric tool.

The current Biodiversity Metric tool (2.0) has calculation issues when working out river mitigation and units gained. It is anticipated that a 3.0 version of the tool will be released in summer 2021 in which previous errors within the tool will be updated. If available, the Biodiversity Metric calculations will be re-entered into the 3.0 version at gate-2, and this should also allow river mitigation to be calculated.

STW Sources ambition is provided within **Section 4.1**. The BNG assessment was undertaken on the individual elements and combined for the groupings.

The Biodiversity Metric is a habitats-based assessment and is divided into assessments for terrestrial habitats (Habitats), and linear habitats (Hedgerows and Rivers). The baseline has been developed from existing spatial data sets of habitat inventories and identifying impact pathways (Zone of Influence (ZoI)) using data from the SEA, HRA and WFD assessments. The habitat baseline is scored through the tool, which quantifies each habitat type into 'units' (or 'River Biodiversity Unit' (RBU) for rivers and streams) based on a number of factors, including habitat distinctiveness, area (or linear equivalent), condition, ecological connectivity and strategic significance.

4.4.1.1 Baseline mapping

The construction area (easement) of the elements were mapped using QGIS so that habitat analysis could be conducted on the construction area and operational impact pathways. To allow full habitat coverage, four data sources were combined in GIS: Priority Habitat Inventory, Corine Land Cover 2018, National Forest Inventory 2017 and OS Zoomstack (surface water). Habitat types were converted into the UK Hab classifications using the conversation table within the Technical Data tab in the Metric. The area (ha) of each habitat type within the buffer was measured in GIS.

4.4.1.2 Working Width Calculations

GIS data provided by Jacobs on 01/02/2021 contained descriptions of the working width on different sections of each element. Based on these descriptions a dynamic buffer for each STW Sources has been mapped with a variable width between 20m to 40m dependant on location and habitat. Aerial imagery was used to locate sections where the working width changed based on descriptions provided by Jacobs, such as along roads and hedgerows. The specific construction zone will be refined in the run up to gate-2 once STW Sources designs have been developed further and environmental impacts are better understood; however, this provides a reasonable approximation at this stage.

4.4.1.3 Woodland and trees

Within the working width GIS layer particular sections of pipeline have descriptions listed as '*trees avoided where possible'*. The majority of areas with high tree cover are usually classified as a woodland habitat. Due to the uncertainty associated with the number of trees which may be retained a worst-case scenario will be assumed of total habitat loss in these areas, which will be refined at gate-2.

4.4.1.4 Arable Field Margins

Arable field margin priority habitat is not currently mapped within the Natural England Priority Habitat Inventory dataset. In order to capture all potential habitat loss, assumptions were made on the location of arable field margins to allow the habitat loss to be quantified with the DEFRA Biodiversity Metric. The JNCC UK Biodiversity Action Plan described arable field margins as '*usually sited on the outer 2–12m margin of the arable field, although when planted as blocks they occasionally extend further into the field centre*.' Aerial imagery combined with the CORINE land cover data was used to approximately calculate the number of arable fields each element intersected. A 4m arable field margin was assumed which was then then multiplied by the working width and number of element intersections. This provided an area which could be added into the DEFRA Biodiversity Metric and classified as '*Cropland - Arable field margins pollen & nectar*' within the tool.

4.4.1.5 Rivers and streams

In the Biodiversity Metric 2.0, rivers and streams are defined as those classified as 'Main River' or 'Ordinary Watercourse'. This classification includes all types of watercourses, including canals, canalised rivers and rivers with an ephemeral (temporary) nature, such as Chalk Streams. Coastal, tidal

and inter-tidal reaches are not measured within the rivers and streams component of the biodiversity metric. The data to populate the Biodiversity Metric 2.0 tool is normally based on the assessment outputs obtained through a Modular River Survey and the River Condition Assessment Tool[26]. In the absence of field data at gate-1, a bespoke approach was developed to estimate the river type and condition. Certain characteristics were assumed, and open-source data used, such as Priority Habitat mapping for rivers and aerial imagery. **Section 4.4** sets out the data obtained and what assumptions have been made to facilitate a high-level assessment of BNG for gate-1.

The construction baseline usually comprises the river types within the construction (redline) boundary and the principles can be applied for the purpose of this assessment. The construction area is based on GIS data of the element pipeline locations and other structures. In order to calculate approximate temporary river length loss during construction, aerial imagery and WFD waterbody data was used to count the number of watercourses intersected for each element. Number of structures for discharges/abstractions were also counted. Main rivers >2m in width were discounted, as the construction methods would use directional drilling, avoiding habitat loss. Watercourses <2m assumed temporary habitat loss along an 20m easement and re-instatement. Outfalls would result in permanent bank loss along an assumed 15m section. Further detail on land take for these structures will be required at gate-2. The baseline data is provided in the Excel spreadsheet in **A6.6 Rivers Data and Opportunities** of this report. The total length of river impacted per STW Sources elements are broken down by reach and provided in column L of the 'Classifications' tab.

Condition data, required for the Biodiversity Metric, is usually based on data obtained through the River Metric Survey, a sub-reach scale field survey (the Monitoring of River Physical habitat (MoRPh) survey). As this survey is not possible for gate-1, a bespoke approach was developed where a pragmatic assessment of condition was developed based on adopting the Water Framework Directive (WFD) overall condition score as the baseline[27], described in **Section 4.4.4.1**. The Biodiversity Metric for rivers is also not currently designed to account for operational degradation, only direct impacts from construction. In order to account for this at gate-1, a bespoke assessment was developed for assessing change in condition and the zone of influence, whereby the metric score for the degraded condition was subtracted from the baseline condition score manually. A bespoke method for approximating degradation in condition was developed using flow data. As a full WFD assessment of the change in ecological condition is not applicable/proportional at gate-1, a BNG approach related to operational impact was developed based on the hydrological assessment and further details are provided in **Section 4.4.5.2**.

4.4.2 Habitats

The Biodiversity Metric requires the assessment of the following characteristics of the habitats for site habitat baseline:

4.4.2.1 Distinctiveness

- Condition
- Ecological connectivity
- Strategic significance

The Biodiversity Metric requires the assessment of the following characteristics of the habitats for habitat creation:

- Distinctiveness
- Condition
- Ecological connectivity
- Strategic significance

[26] https://modularriversurvey.org/
[27] Data source: Water watch wales (https://waterwatchwales.naturalresourceswales.gov.uk/en/) and catchment explorer (https://environment.data.gov.uk/catchment-planning/WaterBody/GB109054039800)

- Temporal risk
- Difficulty risk
- Spatial risk

The data sources and how they are used for the assessment are described in the sections below.

4.4.2.2 Distinctiveness

Each UK Habitat category is automatically assigned a distinctiveness score by the biodiversity Metric tool (see **Table 4-17**) which is based on an assessment of the habitat type's features, including species richness, rarity, percentage of habitat protected within Sites of Special Scientific Interest (SSSIs) (the less protected the higher the distinctiveness) and the capability of the habitat to support rare species which may not be found in other habitat types.

Table 4-17 Distinctiveness categories (Natural England, 2019[28])

Category	Score	Example of habitat type
Very High	8	Priority habitats as defined in Section 41 of the Natural Environment and Rural Communities (NERC) Act that are highly threatened, internationally scarce and require conservation action e.g. blanket bog
High	6	Priority habitats as defined in Section 41 of the NERC Act requiring conservation action e.g. lowland fens
Medium	4	Semi-natural vegetation not classed as a priority habitat e.g. hazel scrub
Low	2	Semi-natural or modified vegetation not classed as a priority habitat and of lower relative value to most wildlife e.g. temporary grass and clover ley; intensive orchard; rhododendron scrub
Very Low	0	Habitats and land cover or little or no value to wildlife e.g. hardstanding or sealed surface

4.4.2.3 Condition

Normally, the condition of each habitat type is assessed against specific requirements listed within the guidance documents from field survey data. For the purpose of gate-1, open-source data has been used, which is described in Section 2.8.2. These requirements are specific to each habitat type and relate to physical characteristics, structural attributes, typical species present and positive and negative indicators, such as the presence of invasive species. See **Table 4-18** below.

Table 4-18 Condition categories (Natural England, 2019)

Category	Multiplier
Good	3
Fairly good	2.5
Moderate	2
Fairly poor	1.5
Poor	1
N/A - Agriculture	1
N/A - Other	0

For the high-level assessment at gate-1, the lack of survey data on baseline habitat condition means that habitat condition is assumed to be 'moderate' in all cases. This provides a multiplier of 2 which equates to the average condition score between poor and good and therefore is the best estimate thus holding this variable constant and allowing comparison between elements.

[28] http://publications.naturalengland.org.uk/publication/5850908674228224

4.4.2.4 Ecological connectivity

Each habitat type is assessed for its connectivity to other surrounding similar semi-natural habitats, which could enable the movement of species throughout the wider environment (see **Table 4-19**). Connectivity is automatically assigned in the Biodiversity Metric tool based on distinctiveness. Low and Medium distinctiveness habitats are always low connectivity. High or very high distinctiveness are medium connectivity.

Table 4-19 Connectivity categories (Natural England, 2019)

Category	Multiplier
Medium connectivity	1.1
Low connectivity	1

4.4.2.5 Strategic significance

Strategic significance is measured at a landscape scale, taking into consideration local plans for green infrastructure and biodiversity, national character areas and national objectives. This category gives value to habitats that are situated within optimal locations which could enable biodiversity objectives to be met (see **Table 4-20**). For the purposes of this gate-1 strategic significance is assumed to be 'medium' in all cases where habitat is lost, thus holding this variable constant. Where mitigation is required Biodiversity Opportunity Areas were identified and therefore assessed as 'high'.

Table 4-20 Strategic significance categories (Natural England, 2019)

Category	Multiplier	Point applied to calculation	
		Pre-impact	Post-impact
High strategic significance Within an area formally identified as being of good environmental potential in local policy	1.15	Yes	Yes
Medium strategic significance Good environmental potential but not in an area formally identified as being of good environmental potential in local policy	1.1	Yes	Yes
Low strategic significance Low environmental potential and not in an area formally identified as being of good environmental potential in local policy	1	Yes	Yes

4.4.2.6 Temporal risk

Temporal and difficulty multipliers are automatically applied to the biodiversity unit calculation in the case of habitat creation, restoration, or enhancement in order to consider the time it will likely take to achieve the target condition and how difficult it will be to achieve the desired result. This gives some weighting to the level of uncertainty that these factors create (see **Table 4-21**).

There can be a negative impact on biodiversity for a period of time whilst newly created or enhanced habitat is establishing to its required level of maturity. The temporal risk accounts for this time lag.

Table 4-21 Temporal risk multipliers (Natural England, 2019b)

Time to Target Condition (years)	Time to Target Multiplier
30	0.343
20	0.49
10	0.7
5	0.837

Time to Target Condition (years)	Time to Target Multiplier
1	0.965
0	1

4.4.2.7 Difficulty risk

The Biodiversity Metric considers how difficult (**Table 4-22**) it is to create or restore different habitat types and applies a multiplier to account for the uncertainty of achieving the target state.

Table 4-22 Difficulty Categories (Natural England, 2019)

Difficulty of Creation Category	Difficulty of Creation Multiplier
Very High	0.1
High	0.33
Medium	0.67
Low	1

4.4.2.8 Spatial risk

Compensatory habitat created at a greater distance from the site of habitat loss will deplete a local area of natural habitat, risking reduced habitat connectivity and limiting available food sources for a variety of wildlife. As all compensatory habitat discussed is within the Local Planning Authority (LPA), a multiplier of 1 is used in all cases (see **Table 4-23**).

Table 4-23 Spatial risk categories (Natural England, 2019)

Local Risk Category	Spatial Risk Multiplier
Compensation inside LPA, or deemed to be sufficiently local to site of biodiversity loss	1
Compensation outside LPA of impact site but in neighbouring LPA	0.75
Compensation outside LPA of impact site and beyond neighbouring LPA	0.5

4.4.3 Hedgerows

Habitat loss and hedgerow loss are two separate assessments within the DEFRA Biodiversity Metric. In order to calculate approximate hedgerow loss aerial imagery was used to count the number of hedgerows intersected by each STW Sources. The number of hedgerow intersections was then multiplied by the working width to give an overall length of hedgerow loss. This was then entered into the DEFRA Biodiversity Metric and classified as '*Native species rich hedgerow*' which then quantified the hedgerow loss.

The current working width for all elements is reduced to 20m where hedgerows are impacted based on the information provided by Jacobs; however, as the detail of the STW Sources evolves, this width and number of hedgerows that may be avoided may change as a result of the use of direction drilling techniques during STW Sources construction.

4.4.4 Rivers

The Biodiversity Metric requires the assessment of the following characteristics of rivers/streams and canals.

- River type and condition
- Distinctiveness
- Strategic significance
- Risk multipliers
- Time to target condition
- Difficulty of creation

The data sources and how they are used for the assessment are described in the sections below. The baseline data for river type, condition and strategic significance is provided for each element in the Excel spreadsheet in **A6.6 Rivers Data and Opportunities**.

4.4.4.1 River Type and Condition

The rivers and streams condition (**Table 4-24**) assessment for the Biodiversity Metric is usually based on the extent and diversity of observed physical features in the river channel and riparian zone (including the physical structure of vegetation) as well as the extent and types of any human modifications. The rivers and streams condition assessment, called the River Metric Survey, is based on geomorphic principles and comprises a largely desk-based reach-scale assessment, which indicates the current hydro-geomorphological river type, and a sub-reach scale field survey to inform the river type and assess its baseline condition (the Monitoring of River Physical habitat (MoRPh) survey).

The survey is not possible for gate-1 given the timing constraints and would also be too onerous for high level assessment. Instead, a bespoke approach was used where river type has been based solely on open-source data and a pragmatic assessment of condition was developed based on adopting the Water Framework Directive (WFD) overall condition score as the baseline[29]. WFD condition is based on a larger reach than is assessed for the River Metric Survey. As such, survey and more detailed assessment will be required at gate-2.

Table 4-24 Condition categories (Natural England, 2019)

Category	Multiplier
Good	5
Fairly good	4
Moderate	3
Fairly poor	2
Poor	1

The river type is based on two classifications: Priority Habitats, as defined under section 41 of the Natural Environmental and Rural Communities Act 2006, and 'River Naturalness'. The data sources for river type are provided in **A6.6 Rivers Data and Opportunities**. Priority River Habitat mapping focuses on naturalness as the principal criterion in recognition of the vital importance of natural processes in delivering sustainable riverine habitats and supporting characteristic biodiversity.

4.4.4.2 Distinctiveness

By nature, rivers have a high biological diversity. Their distinctiveness is assessed within the Biodiversity Metric tool by entering the river type, which is automatically assigned a distinctiveness score (see **Table 4-25**).

Table 4-25 Distinctiveness categories (Natural England, 2019)

Category	Score	River type
Very High	8	On Priority Rivers Map Class I River Naturalness Assessment
High	6	Class 2 or 3 River Naturalness Assessment Is a Priority River Habitat sub-type: • Headwater Streams • Chalk Rivers • River – Abundance of Water crowfoot • Active Shingle Rivers
Medium	4	Class 4 or 5 river Naturalness Assessment Rivers and Streams (other) Canals

[29] Data source: Water watch wales (https://waterwatchwales.naturalresourceswales.gov.uk/en/) and catchment explorer (https://environment.data.gov.uk/catchment-planning/WaterBody/GB109054039800)

4.4.4.3 Strategic significance

Strategic significance of each river/stream/canal within the ZoI considers whether it is present within local and catchment plans, Catchment Planning Systems, River Basin Management Plans and Priority Habitats for Restoration. This category gives value to watercourses that are identified for action, which could enable biodiversity objectives to be met (see **Table 4-26**). A review was undertaken of these plans for each watercourse within the ZoI and the data sources provided in provided for each element in the Excel spreadsheet in **A6.6 Rivers Data and Opportunities** in column M of the 'Classifications' tab.

Table 4-26 Strategic significance categories (Natural England, 2019)

Category	Multiplier	Point applied to calculation	
		Pre-impact	Post-impact
High strategic significance Within local and catchment plans, Catchment Planning Systems, River Basin Management Plans and Priority Habitats for Restoration	1.15	Yes	Yes
Low strategic significance Low environmental potential and not formally identified in any local plan	1	Yes	Yes

4.4.4.4 Risk multipliers

The Biodiversity Metric for rivers includes risk multipliers to take account of uncertainty and difficulty of restoration/enhancement and creation of offsets.

A temporal multiplier (**Table 4-27**) accounts for the time to target condition follow re-instatement or creation and a difficulty of creation multiplier for all rivers and streams. However, there are errors in this multiplier within the metric, which have been recognised by Defra and will be addressed for version 3.0, whereby the multipliers are reversed. Therefore, assessing the units delivered through enhancements and habitat creation is not possible with version 2.0.

Table 4-27 Temporal multiplier (Natural England, 2019)

Condition	Time to target condition (years)	Multiplier
Good	10	0.7
Fairly good	8	0.752
Moderate	5	0.837
Fairly poor	2	0.931
Poor	1	0.965

4.4.5 Net gains/Losses

4.4.5.1 Construction

The calculation of net loss/gain within the Biodiversity Metric 2.0 only considers direct impacts resulting in habitat loss, whether permanent or temporary. The baseline habitat scores are then adjusted for the associated habitat impacts (gains or losses) related to the construction of each element. This is assessed following construction and prior to habitat re-instatement and assumes typical good practice construction methods and mitigation will be used, such that potential for downstream effects of construction will be fully mitigated. This part of the assessment identifies high risk areas where the proposals will result in a significant loss of biodiversity and offsetting will be more onerous or may identify an 'irreplaceable habitat' that should be avoided, such as certain priority habitats. These

irreplaceable habitats are flagged by the Metric as 'unacceptable loss 'and require a bespoke mitigation strategy if unable to be avoided. These habitats are then removed from the mitigation calculations which can account for a difference between onsite area lost and onsite habitat creation.

The gains and losses are calculated assuming all habitat within the ZoI from construction impacts will be lost and reinstated with the same habitat. This is assessed as on-site habitat creation within the Biodiversity Metric. Due to the risk factors in habitat creation, such as time lags and difficulty in creation, the habitat units for reinstatement will not equally compensate for the units lost. The results of the deficit 'net loss' for each habitat type per element are provided in the Assessment Report (B3.8) in table format in habitat units and hectares or linear meters of river/hedgerow. The number of units/hectares to provide 10% net gain are also given. The outputs are presented as:

- Summary data tables of habitat gains/losses
- Maps of constraint areas and impact areas

4.4.5.2 Operation

The Biodiversity Metric tool is not specifically developed for assessing long-term habitat degradation, such as that which may occur through operational use of these STW Sources elements. However, certain STW Sources are likely to have significant operational impacts alterations to the flow regime and therefore geomorphology downstream of abstractions and releases. This in turn has the potential to alter habitat structure and function and associated aquatic ecological communities. Therefore quantifying these impacts in biodiversity terms and the offsets/net gain needed is valuable at gate-1 to support decision making. Therefore, using the principles of the Biodiversity Metric, a bespoke approach was developed to assess operational impacts to rivers. The operational impact is a change in habitat condition and the net loss/gain is the difference in habitat condition. This is reflected as a change in the RBU score between the river baseline and the operational condition. This provides the potential loss of RBU required for offsetting/net gain. Data is therefore required on potential change in condition and the extent of the ZoI. As a full WFD assessment of the change in ecological condition is not applicable/proportional at gate-1 since there is not sufficient data at this stage. Since ecological condition change is related to deviation away from its existing structure and function (i.e. a habitat rather than species change) hydrological change has been used based on the STW Sources WFD assessment as a surrogate for likely physical process change and hence provide a predictor of ecological risk of change. For the purpose of this assessment, incremental alterations to the hydrological regime (significant changes in flow) were assimilated to provide incremental ecological change in the baseline.

Flow data over a 10-year period was used to predict the change in flows for each reach and corresponding change in flow band. The hydrological assessment identifies the % of records (days) the band changes during the operation of the STW Sources. The hydrological band changes were used to develop a simplistic scoring system for high-level assessment at gate-1. This scoring system will be refined for the options assessment at gate 2. An example of the data used is presented in **Table 4-28** which provides the results for hydrological band changes (10-year period) for an example reach showing the impact of an STW Sources on flows. Green represents a positive benefit and yellow to red negative changes. The example below shows a limited change during low flows from 'notably low' to 'below normal'. At 'exceptionally low' flow, this is cancelled out by positive benefits.

Table 4-28 Table of results for hydrological band changes (number of records within a 10-year period).

No. of Days		Existing						
		Exepctionally High	Notably high	Above normal	Normal	Below normal	Notably low	Exceptionally low
Proposed	Exepctionally High	246	1	0	0	0	0	0
	Notably high	0	301	2	0	0	0	0
	Above normal	0	0	543	2	0	0	0
	Normal	0	0	0	1575	74	0	0
	Below normal	0	0	0	0	425	34	6
	Notably low	0	0	0	0	0	209	20
	Exceptionally low	0	0	0	0	0	0	214

Table 4-28 shows an example of the existing flow conditions and the proposed conditions under the operation of an STW Sources. The colour relate to flow bands and numbers are the number of records within a 10-year period. For example, existing 'notably low' flows would increase under the proposed scenario into the yellow band, where by 34 records are 'below normal'. These data were used to estimate significance bands for biodiversity change, as indicated in **Table 4-29**.

Based on these data it is not possible to identify a specific ecological impact, but it does identify if a hydrological change could result in a corresponding biodiversity impact. The assumed changes in biodiversity scores have been adjusted according to any benefits that may outweigh negative impacts from the hydrological data. For example, where flow records show a positive effect, with proposed records within the green flow band.

Table 4-29 Scoring system developed for hydrological and corresponding ecological change

A change of flow band to:	Estimated change in biodiversity condition score	Rational
Positive	+1	A discernible change in flows with an overall minor benefit to biodiversity condition possible
Negligible	0	Negligible, unlikely to change overall condition score.
Minor	0	A discernible change with a very minor risk to biodiversity but unlikely to change overall condition score
Moderate	-1	Moderate change in flows – risk of minor change in biodiversity condition possible, mitigation and net gain requirements likely
Major	2	Very large change in flows – risk of significant change in biodiversity condition possible, significant mitigation and net gain requirements likely

At gate-1 there are limitations in determining the significance of this hydrological change in biodiversity terms. There is no current scoring system for assessing the significance of this hydrological change. As the scoring used for this high-level assessment uses operational data it is likely to be an over-estimate of the ecological risk. However, this is sufficient for its purpose for comparing STW Sources elements at gate-1. The evidence provided for the STW Sources to feed into the grouping's assessment. Therefore, these bands are subject to change. The refined scoring will give a better assessment of risk of long-term impacts and give % change for 1 CEH band (not very significant); 2 CEH bands (potentially significant); 3 or more CEH bands (potentially highly significant) will be given. Each reach has a stated length, which will give a ZoI for each type of change. Consideration will also be given to criteria given to other guidance for adjusting the significance bands.

Flow data for each reach within each element is presented in **Table 4-30**, colour coded according to the scoring in **Table 4-29** and adjusted to offset any positive benefits (offsetting the flow band change).

Table 4-30 Flow data (Ml/d) for operation with flow band change indicating possible risk to biodiversity, per element per reach

Evidence report:		Vyrnwy to Banwy confluence	Vyrnwy: Banwy confluence to Severn confluence	Severn: Vyrnwy confluence to d/s Shrewsbury	Severn: d/s Shrewsbury to Avon confluence		Severn: Avon confluence to tidal limit	Avon: d/s Warwick to Severn confluence		Thames: Culham to Windsor		Thames: Windsor to Teddington	
Representative flow gauge:		Vyrnwy @ Vyrnwy Res	Vyrnwy @ Llanymynech	Severn @ Montford	Severn @ Bewdley	Severn @ Saxons Lode	Severn @ Deerhurst	Avon @ Warwick + Longbridge STW	Avon @ Evesham	Thames @ Sutton Courtenay	Thames @ Reading	Thames @ Royal Windsor Park	Thames @ Walton
4	Mythe_15	no change	no change	no change	no change	15	15	no change	no change	no change	no change	no change	no change
5a	NetheridgePipeline Deerhurst_35	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change
5b	NetheridgePipeline Cotswold_35	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change	no change
7a	DeerhurstPipeline_300	no change	no change	no change	no change	no change	-300 but not below HoF	no change	no change	300	300	300	300
7b	DeerhurstPipeline_400	no change	no change	no change	no change	no change	-400 but not below HoF	no change	no change	400	400	400	400
7c	DeerhurstPipeline_500	no change	no change	no change	no change	no change	-500 but not below HoF	no change	no change	500	500	500	500
8	CotswoldCanals_300	no change	no change	no change	no change	no change	-300 but not below HoF	no change	no change	300	300	300	300

Note: this is a summary of the information. For full details and explanation it is recommended that this is cross referenced to the WFD and associated hydrology reports.

The output is the Biodiversity Metric 2.0 tool spreadsheet which provides an output of RBU for offsetting and identifies how many units are required for net gain. The units are correlated into linear meters of river that would require either enhancement or creation.

The results of the assessment are presented in **Section 4.5**.

4.4.6 Strategic assessment of Biodiversity Opportunity Areas

Enhancement measures can include the provision of new habitats, provision of new habitat features and the improved management of existing habitats which will result in a net benefit to biodiversity, over and above the measures required to mitigate and compensate for the impacts of a proposed scheme. Enhancement opportunities are added to the Biodiversity Metric as a habitat area and the Metric re-calculates the quantity or balance of (units) of BNG provided, which is also given as a % change from the baseline. This stage will require significant manipulation of habitat restoration/creation options to identify the best outcome at gate-2. For gate-1, the mitigation hierarchy was followed to identify like for like replacement habitat opportunities. Opportunities for biodiversity gain were linked with those within SEA, WFD and Natural Capital approaches provide the outputs that directly feed into the biodiversity ecosystem service for the later of these assessments.

The output of this stage is a summary of the Biodiversity Metric output and a table of the habitats and areas required for enhancement/creation (**Section 4.5**). Due to risk parameters associated with habitat creation and restoration a 1:1 replacement in habitat type and area will not score 0 in terms of gains and losses but a negative number of units. Where additional habitat area is required to offset losses, it is possible that insufficient land may be available on-site.

For rivers, offsetting within the same waterbody is the preferred option. However, this may not be possible and therefore, the mitigation hierarchy would be followed, so the number of units required for three scenarios were assessed:

1. Enhancement within the impacted waterbody (same country).
2. Enhancement within the catchment (same country)
3. Enhancement within the wider area but with a strategically identified area, such as Biodiversity Opportunity Areas (BOAs) in England.

BOA maps are open source and produced from a review of countywide strategies and Local plans. This high-level assessment provides an estimate of the scale (ha/km) of mitigation/offsetting needed to achieve net gain and a tool for comparison of the element's biodiversity impact. A strategic assessment of off-site opportunity was undertaken to identity suitable parcels of land where the best biodiversity gain could be achieved. Specific detail of possible mitigation measures and the identification of specific objectives within National and Local plans and policies within is not assessed for gate-1, as this level is detail is not meaningful given the assumptions in the data. For a high-level assessment, firstly the area/length of habitat required for offsetting/net gain was identified and whether this land take is available within the surrounding area and supported by local plans.

4.4.6.1 Habitats

To identify land parcels with opportunities for habitat creation or enhancement a review of county biodiversity plans and Local Planning Authorities policies was undertaken. Certain elements cross multiple counties, therefore, plans or policies which focused on landscape scale biodiversity opportunity areas were prioritised. The main sources which provided landscape scale strategies for a variety of habitat types were Local Nature Partnerships. **Table 4-31** below highlights the relevant plan identified for each element which provides a variety of BOAs that could be utilised for mitigation and compensation.

Table 4-31 STW Sources elements and Biodiversity Opportunity Areas for terrestrial habitats

Component	Biodiversity Opportunity Areas
River Vyrnwy Mitigation - Vyrnwy release and Bypass	Shropshire Environmental Network[30]
River Vyrnwy Mitigation – Vyrnwy Bypass release	Shropshire Environment Network
Pipeline conveyance, Deerhurst to Culham	Biodiversity South West[31] and Oxfordshire Nature Recovery Network[32]
Canal conveyance, including piping to Culham	Biodiversity South West[2]

Each Biodiversity Opportunity plan within **Table 4-31** was reviewed and either the specific GIS shapefiles downloaded for the BOAs if available or individual areas were mapped from maps provided online. BOAs chosen to be mapped were either adjacent to an element or the closest BOA available where there were no adjacent opportunities. Where data on specific recommendations for habitat creation were provided these were included within the GIS attribute table allowing a total area to be calculated for each habitat and assessed against the area needed for mitigation on each element. This gives an overview of where opportunities exist and whether there is sufficient opportunity within the local area.

The output is a habitat map with core biodiversity features and strategic areas (allocations). The exact location would be subject to consultation at gate-2.

4.4.6.2 Rivers

To ensure no net loss / net gain, riparian improvements and in-channel; enhancements can be considered. In gate-2 would we recommend the use of MoRPH and stakeholder consultation to identify areas of river than can be modified and enhanced. For gate-1, a strategic assessment was undertaken to identify the availability of suitable river habitats for restoration within the vicinity of the watercourses. For river enhancement, quality and risk are considered within the calculator whereby the strategic

[30] https://www.shropshire.gov.uk/environment/biodiversity-ecology-and-planning/shropshire-environmental-network/
[31] http://www.biodiversitysouthwest.org.uk/index.html
[32] https://www.wildoxfordshire.org.uk/biodiversity/oxfordshires-nature-recovery-network/

significance is given a multiplier of 0.15 if the waterbody lies within a local plan, River Basin Management Plan etc and a spatial multiplier accounts for distance of offsets (0.75 for outside the waterbody and 0.5 for outside the catchment) and time taken to reach to the target (restored) condition. For offsetting/net gain, the closer the restoration is to the impacted area, the greater number of biodiversity units can be obtained. An example is provided in **Table 4-32** to show the greatest number of units that can be obtained for different river types and locations/distance from the impacted reach.

Table 4-32 Example BNG unit change per river type

River type	Condition (operation)	Condition (proposed following enhancement)	Strategic location of enhancement	km	BNG units achievable
Rivers and streams	Fairly poor	Moderate	On-site enhancement	20	243.48
Rivers - Abundance of Water-Crowfoots	Fairly poor	Moderate	On-site enhancement	20	365.22
Priority river habitat	Fairly poor	Moderate	On-site enhancement	20	486.97
Rivers and streams	Fairly poor	Moderate	Off-site enhancement (within waterbody)	20	178.45
Rivers - Abundance of Water-Crowfoots	Fairly poor	Moderate	Off-site enhancement (within waterbody)	20	267.87
Priority river habitat	Fairly poor	Moderate	Off-site enhancement (within waterbody)	20	356.9
Rivers and streams	Fairly poor	Moderate	Off-site enhancement (outside the waterbody)	20	44.61
Rivers - Abundance of Water-Crowfoots	Fairly poor	Moderate	Off-site enhancement (outside the waterbody)	20	66.92
Priority river habitat	Fairly poor	Moderate	Off-site enhancement	20	89.22

There are many factors to take into consideration when prioritising rivers for action. Rivers that are of types relevant to the UK BAP definition (chalk rivers and active shingle rivers) but are not sufficiently natural to feature on the priority habitat map should be considered a priority for natural process restoration in England (there is currently no equivalent online data for Wales). Action on these rivers should be considered of equal importance to the protection and enhancement of rivers on the priority habitat map. Data on Priority River Habitats for Restoration[33] was analysed to identify reaches within 1km of the element components. The data also provided the restoration target. These data are summarised in **Table 4-33**.

Table 4-33 Priority Habitats for Restoration that occur within 1km of the Elements that Comprise the ST Sources Groupings

STW Sources element/option component ID	Priority river habitats for restoration (within 1km of option component or reach)	WFD reference	Targeted Restoration	Priority river habitats length (km)
Deerhurst Pipeline	Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	Hydrological	0.88
Deerhurst Pipeline	Chalvey Ditches	GB106039023550	Hydrological	1.39
Cotswold Canals	Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	Hydrological	0.88
Cotswold Canals	Chalvey Ditches	GB106039023550	Hydrological	1.39
Cotswold Canals	Thames (Waterhaybridge to Cricklade) and Chelworth Brook	GB106039022960	Hydrological	1.69

[33] https://data.gov.uk/dataset/e0165747-8368-4ff7-a644-df9aeb27bb0b/priority-habitat-creation-and-restoration

For opportunities in England, BOA GIS shape files for habitat BOAs were used to identify river habitats within each county within 1km of each STW Sources elements (**Table 4-34**). Additional shape files were analysed for opportunities within Gloucestershire and Wiltshire[34] to complete the data set. This provided an overview of the possible lengths of river available for restoration within 1km of each element. Further refinement of these data will be required at gate-2, once the length and location of the impacted habitat is known, to identify whether opportunities lie within the waterbody, within the catchment or outside of the water body.

Table 4-34 Biodiversity Opportunity Areas – Rivers within 1km

Element/Option Component ID	Waterbody (1km of option component)	Length (km)	Counties
Netheridge Pipeline Deerhurst_35	Severn (E Channel) - Horsebere Bk to Severn Est	1.14	Gloucestershire
Netheridge Pipeline Deerhurst_35	Leadon - conf Preston Bk to conf R Severn (W Channel)	0.39	Gloucestershire
Netheridge Pipeline Deerhurst_35	Severn - conf R Avon to conf Upper Parting	6.68	Gloucestershire
Netheridge Pipeline Deerhurst_35	Horsebere Bk - source to conf R Severn	2.53	Gloucestershire
Netheridge Pipeline Deerhurst_35	Wotton Bk - source to conf Horsebere Bk	0.96	Gloucestershire
Netheridge Pipeline Deerhurst_35	Hatherley Bk - source to conf R Severn	3.03	Gloucestershire
Netheridge Pipeline Deerhurst_35	Chelt - M5 to conf R Severn	1.42	Gloucestershire
Netheridge Pipeline Deerhurst_35	Leigh Bk - source to conf R Chelt	0.65	Gloucestershire
Netheridge Pipeline Deerhurst_35	Combe Hill Canal	2.66	Gloucestershire
Netheridge Pipeline Canal_35	Gloucester and Sharpness Canal	5.4	Gloucestershire
Netheridge Pipeline Canal_35	Severn – Tekewsbury	3.1	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Severn - conf R Avon to conf Upper Parting	2.12	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Isbourne - source to conf R Avon	0.58	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Coln (Source to Coln Rogers)	8.46	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Radcot Cut	0.39	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Thames (Leach to Evenlode)	1.49	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Childrey Brook and Norbrook at Common Barn	1.5	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Ock and tributaries (Land Brook confluence to Thames)	2.438	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Cow Common Brook and Portobello Ditch	0.414	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Frilford and Marcham Brook	0.54	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Thames (Evenlode to Thame)	0.5	Oxfordshire
Cotswold Canals_300	Gloucester and Sharpness Canal	8.89	Gloucestershire
Cotswold Canals_300	Epney Rhyne - source to conf R Severn Estuary	2.19	Gloucestershire
Cotswold Canals_300	Frome - Ebley Mill to conf R Severn	8.12	Gloucestershire
Cotswold Canals_300	Stroudwater Navigation (Pike Lock to Ebley)	1.98	Gloucestershire
Cotswold Canals_300	Thames and Severn Canal	3.59	Gloucestershire
Cotswold Canals_300	Frome - source to Ebley Mill	5.15	Gloucestershire
Cotswold Canals_300	Churn (Baunton to Cricklade)	8.16	Wiltshire
Cotswold Canals_300	Thames (Waterhaybridge to Cricklade) and Chelworth Brook	2.4	Wiltshire
Cotswold Canals_300	Ampney and Poulton Brooks (Source to Thames)	2.71	Wiltshire

[34] Biodiversity South West Shapefiles http://www.biodiversitysouthwest.org.uk/nm_dwd.html; Warwickshire and Solihull: 'WCS LNP Local NIA Designation' - opportunity map on page 5 used to identify rivers that were BOAs https://www.warwickshirewildlifetrust.org.uk/LNP

Element/Option Component ID	Waterbody (1km of option component)	Length (km)	Counties
Cotswold Canals_300	Thames (Churn to Coln)	13.05	Wiltshire
Cotswold Canals_300	Share ditch	0.3	Wiltshire
Cotswold Canals_300	Coln (from Coln Rogers) and Thames (Coln to Leach)	4.093	Wiltshire
Cotswold Canals_300	Dudgrove Brook	1.6	Wiltshire
Cotswold Canals_300	Thornhill Ditch and Tributaries at Cotswolds Water Park	1.46	Wiltshire
Cotswold Canals_300	Cole (Bower Bridge to Thames) including Coleshill	0.19	Wiltshire
Cotswold Canals_300	Radcot Cut	0.75	Oxfordshire
Cotswold Canals_300	Thames (Leach to Evenlode)	1.51	Oxfordshire
Cotswold Canals_300	Childrey Brook and Norbrook at Common Barn	1.53	Oxfordshire
Cotswold Canals_300	Ock and tributaries (Land Brook confluence to Thames)	2.39	Oxfordshire
Cotswold Canals_300	Frilford and Marcham Brook	0.48	Oxfordshire
Cotswold Canals_300	Thames (Evenlode to Thame)	0.5	Oxfordshire
TOTAL		**117.44**	

Mitigation for WFD compliance can be used to account for 'no net loss' but not 'net gain'. Net gain needs to be additional to count and not part of a statutory requirement. More detailed assessment will be undertaken at gate-2 to identify:

a. Actions within the river basin /catchment plans can be offsets (to be agreed with the Regulators); and
b. Mitigation for WFD compliance.

4.4.7 Biodiversity Net Gain and Natural Capital

Taking a habitats-based assessment approach, the outputs from the BNG assessment for the STW Sources were linked back to the Natural Capital (NC) metrics and the BNG outputs were used to support quantify the Biodiversity and Habitats ecosystem service (**Section 4.2).**

4.4.8 Data Gaps and Assumptions

Due to the high-level nature of the gate-1 assessment and the lack of available detailed design information, several assumptions have been made, which have been described within the above text. The key assumptions, however, are summarised in **A6.**

4.5 BNG Assessment

4.5.1 Biodiversity Loss

The following tables present the BNG results of the Defra Biodiversity Metric calculations for the elements, summarised into the ST source groupings. These groupings are as follows in **Table 4-35**:

Table 4-35 ST source groupings

	Group	Elements included
ST sources	**Group 1**	• Mythe abstraction licence transfer (15 Ml/d)
	Group 2A	• Netheridge Wastewater Treatment Works (WwTW) discharge diversion (*Netheridge Pipeline Deerhurst*), Deerhurst pipeline (35 Ml/d)
	Group 2B	• Netheridge WwTW discharge diversion (*Netheridge Pipeline Canal)*), Cotswold canals (35 Ml/d)

Not all elements within each grouping have terrestrial construction impacts. Elements within each group which have terrestrial impacts were combined to provide an overall unit loss, for each grouping, post-mitigation. A detailed breakdown of habitat loss per element is provided in **A6.7 BNG Assessment** and the metric outputs in **A6.7 i-iv** and the breakdown of river loss is within **A6.8 Rivers BNG Assessment**. There are no operational impacts on habitats, all habitat loss will be during construction and mitigated through habitat re-instatement (other than for permanent structures). Therefore, the calculation of loss within the tables below is post-mitigation, as we already know habitat will be re-instated. This then gives the deficit for offsite compensation and opportunities for BNG. Therefore, the post-mitigation (pre-compensation) calculations provide a more useful calculations of biodiversity loss than pre-mitigation, particularly as habitat loss is temporary.

For rivers, there are construction and operational impacts. The construction impacts take account of open cut methods for pipeline installation, for example, and operational impacts are in regard to habitat degradation of reaches downstream of abstraction and discharge locations.

Tables 4-36 represents the biodiversity deficit for offsite compensation following re-instatement (mitigation) as % loss of biodiversity units and **Table 4-37** of the overall units lost following re-instatement (mitigation).

Table 4-36 Summary of the percentage loss (post re-instatement and pre off-site compensation) for habitats, hedgerow and rivers for each grouping

Percentage Biodiversity Change						
Group	**Loss of habitat units (construction)**	**Loss of habitat units (operation)**	**Loss of hedgerow units (construction)**	**Loss of hedgerow units (operation)**	**Loss of river units (construction)**	**Loss of river units (operation)**
1	0	0	0	0	0	0
2A	32.33	0	43.93	0	71.53	31.06
2B	32.08	0	43.96	0	74.18	31.02

For terrestrial loss (habitats and hedgerows) the assessment is based on construction impacts only as there will be no operational impacts. The river units are assessed on construction and operational impacts. The overall percentage loss for each STW Sources was combined to provide the loss for each grouping, see **A6.7 BNG Assessment and A6.8 Rivers BNG Assessment** for individual STW Sources percentage loss.

Certain priority habitats are unable to be assessed within the DEFRA Metric owing to their uniqueness and difficulty of re-creation and compensation. If lost they require a bespoke compensation strategy. The hectarage of this loss is shown in **Table 4-37** and these habitats should be avoided at the design stage where possible. The unacceptable loss habitats and their individual areas are given within the baseline metric data, provided within the Annexes for each element.

Table 4-37 Summary of the overall unit loss (post re-instatement and pre off-site compensation) for habitats, hedgerow and rivers for each grouping

Net Biodiversity Unit Loss					
Group	**Loss of habitat units (construction)**	**Unacceptable habitat losses (hectares) (construction)**	**Loss of hedgerow units (construction)**	**River units (construction)**	**River units (operation)**
1	0	0	0	0	0
2A	-615.91	-8.01	-29.38	-3.9*	-824.06
2B	-546.28	-4.64	-4.33	-0.55	-859.95

* For Deerhurst 0.02km of river are lost within a Priority River Habitat from construction.

4.5.2 Biodiversity Opportunities

To achieve biodiversity net-gain there are opportunities locally for the following habitat enhancement and creation. **Table 4-38** shows for each habitat type impacted by the scheme, the offsite hectarage /km of habitat enhancement or creation required for a minimum 10% net gain in habitats and hedgerows and the metric units that this achieves. As stated in the methodology the majority of habitats were assumed to be in moderate condition. Hectarage required can be halved if habitats are assumed to be in poor condition. The individual requirements per STW Sources are provided in **5.7 BNG Assessment** and highlights the specific percentage gain. It is important to also consider the need for bespoke mitigation / compensation or 'unacceptable loss habitats' (refer to **5.7 BNG Assessment**).

Table 4-38 Summary of the offsetting requirements to achieve an approximate 10% net gain for habitats and hedgerows for each grouping

Offsetting Requirements for 10% BNG				
Habitat	**Enhancement or Creation**	**Group 1**	**Group 2A**	**Group 2B**
Neutral grassland	Enhancement	-	160ha	133.4ha
Broadleaved woodland	Creation (grassland succession)	-	60ha	75ha
Traditional Orchard	Creation	-	6ha	1ha
Lowland heathland	Creation	-	7ha	0.5ha
Lowland calcareous grassland	Enhancement	-	5ha	-
Native species rich hedgerow	Creation	-	7.4km	1.04km
Total (ha)	**Habitat**	**-**	**238ha**	**209.9ha**
	Hedgerow	**-**	**7.4km**	**1.04km**
Total (units)	**Habitat**	**-**	**+1,826.75**	**+1,517.91**
	Hedgerows	**-**	**+38.17**	**+5.36**

The overall habitat requirement for a 10% net gain is very similar for groups 2A and 2B with regard to hectarage required, with a slightly higher requirement for group 2A (Deerhurst and NetheridgePipelineDeerhurst). As noted in Table 4-37 the Deerhurst Pipeline options have 3.37ha more habitats which are categorised as 'unacceptable losses' which is a major consideration due to the requirement for a bespoke mitigation strategy. The Canal grouping (group 2B) requires approximately 15ha more woodland creation which is likely attributed to the higher abundance of woodland along the route compared to the Deerhurst pipeline. The Canal groupings however are not impacting lowland calcareous grassland whereas the loss within the Deerhurst grouping (group 2A) requires 5ha of enhancement. The Deerhurst grouping requires more hedgerow creation than the Canal grouping which is likely attributed to the higher number of field boundaries being intersected by the Deerhurst / Netheridge pipeline compared to the Netheridge / Canal route.

Within the current version of the Defra River Metric mitigation/compensation for 10% BNG cannot to be calculated for river habitat loss due to errors in the multipliers of the River Metric 2.0 and therefore are not included within our assessment. Therefore, a bespoke solution would need to be agreed with the regulators; however, version 3.0 is due for release in 2021 and is likely to resolve this issue.

Availability of land for offsetting per element has been summarised in **A6.6 Rivers Data and Opportunities** (rivers) **and A6.7 BNG Assessment** (terrestrial habitats). Where available, the location of compensation (offsetting) land has been mapped with an example of this in **A6.9**.

For each element, a desk study was undertaken to review any policies or mapped areas in relation to land that has been identified as providing opportunities for terrestrial habitat enhancement or creation. All terrestrial habitat impacts lie within England, and therefore Welsh strategic opportunities were not considered for terrestrial habitats. If an element crossed multiple counties a review was undertaken in each local authority it fell in along with search engine key word searches. These areas can have varying

names and can be summarised as Biodiversity Opportunity Areas (BOAs) in England. Not all county's and local authorities had relevant policies or maps in relation to BOAs, so they are not necessarily found along the entire length of an element. Instead, BOAs were mapped where the fell within the same county as an element and were considered in close proximity to provide offsetting. In most cases this was between 0-5km from the element, however in some cases more than 5km where BOAs were less abundant. The main focus was not on how close the BOAs were to each element but availability within the same county or landscape along with variety of habitat types. The main source of BOA information used for gate-1 came from Local Nature Partnerships as these groups usually map at a landscape scale for habitat creation and connectivity and provide a high-level assessment of availability of land which could be utilised for mitigation. Where the information was available the specific habitat type was also noted, such as area for woodland creation, however in some cases such as in Oxfordshire the specific habitat type was not available. For all groupings there are enough BOAs to provide the required mitigation to achieve a 10% net gain. As the study continues into gate-2 these specific BOAs will be refined and surveyed to identify the optimal areas to focus on.

Opportunities for delivering BNG for rivers was identified from published information on Priority Rivers for Restoration[35] and BOAs for relevant counties within England. The data set for Priority Rivers for Restoration identifies reaches targeted for restoration. The length and location of reaches located within 1km of the elements are given in **A6.6 Rivers Data and Opportunities and A6.7 BNG Assessment** and summarised by their group in **Table 4-39**. The data also provided information on whether the restoration related to physical or hydrological opportunities. Rivers within BOAs also present potential opportunities for restoration and the length of rivers within 1km of the impacted reaches for each element were measured and given in **A6.6 Rivers Data and Opportunities and A6.7 BNG Assessment** and summarised by their groupings in **Table 4-39.** Groups 2B (canal) shows greater opportunities for restoration, with the canal grouping providing double that of the Deerhurst grouping (2B). These opportunities lie within 1km and so and extended search can be undertaken if required. There are advantages in terms of units scored for identifying restoration within the same waterbody and therefore gate-2 will investigate suitable locations as well as proximity.

Table 4-39 Summary of the offsetting opportunities for BNG for rivers for each grouping, within 1km

Offsetting Opportunities for BNG				
		Group 1	**Group 2A**	**Group 2B**
Priority Rivers for Restoration (within 1km)				
Hydrological restoration requirements		-	2.27km	3.96km
Rivers within BOAs (within 1km)				
River length for restoration	-	37.89km	79.54km	
Total		**-**	**40.19km**	**83.50km**

4.6 Summary Conclusion for BNG and NC

The Canal group (2B) has a slightly lower impact on biodiversity in total and affects fewer priority habitats types than the Deerhurst group (2A). Referring to Table 4-38, when comparing the offsetting requirement to reach a minimum 10% net gain, the Canal group affects less hedgerow lengths (1.04km compared to 7.4km) and requires fewer biodiversity units in compensation for terrestrial habitat loss (1,517.91 compared to 1,826.75). The Canal group also present greater opportunities for net gain. However, the Canal group requires 15ha more woodland creation (75ha verses 60ha) than the Deerhurst group. 15ha will likely have to be found offsite which may make this option less economically

[35] https://data.gov.uk/dataset/e0165747-8368-4ff7-a644-df9aeb27bb0b/priority-habitat-creation-and-restoration

viable than the other options. From an ecological perspective, woodland plantations can take 30 years to become functioning, measurable ecosystems whereas habitats such as grassland can take around 5 years.

However, in the context of the wider Natural capital assessment there is a more negative impact during construction related to the Canals group with potentially a greater gain overall when all NC elements are considered related to BNG opportunities. It should however, be noted that this is related to the key ecosystem services that can be monetised (carbon sequestration and natural hazard for flood management). It should be noted that at this stage other ecosystem services including recreation cannot be quantified due to the limited information on opportunities related to any habitat and associated recreation benefits. Recreation benefits could have a significant impact on the current gate-1 assessment.

At this stage of the assessment, it cannot therefore be concluded as to which option is the best from a NCA or BNG perspective. It has however, enabled an assessment in terms of gap analysis and what is will be needed to support gate-2 and hence provide a more informed details assessment. It has also identified that there benefits and disbenefits related to BNG and NC for all groupings.

5 Recommendations for Gate -2

5.1 Gate 2 - Natural Capital

The following section outlines key gate-2 requirement and associated next steps. These are based on what has been identified within the overall assessment and delivery of outputs. It also takes account of OFWAT's requirements for gate-2 especially related to multi-solution decision making and improving on gate-1 activities related to detail and breadth of studies for a key decision point for strategic solutions. OFWAT states that the solution (in this case the STW sources) should be developed to a standard suitable for submitting into final regional plans or final water resources management plans based on refined and consistent costs and benefits. The following key gate-2 requirement are identified to support this requirement and to build on any new regulatory guidance that may be developed throughout the gate-2 process.

The following sections outlines key gate-2 requirement and associated next steps.

5.1.1 Refining the zone of influence

The current ZoI for the assessed elements extends to 1 km from any likely construction zones. Whilst acceptable for a high-level approach as required for gate-1, greater detail will be necessary for gate-2. Once the STW source groupings have been developed further, more in-depth analysis of likely effects on factors such as water quality, bankside habitats or groundwater flow will be possible, and may highlight a necessity to expand or reduce our chosen zones. This will ensure that calculations derived from areas of habitat are more accurate, without over/underestimating the areas that may be affected. It will also allowing for a greater understanding of the impact on the freshwater environment, as rivers and groundwater are likely to have a different zone of interest to terrestrial impacts.

5.1.2 Better representation of recreational areas

ORVal[18], used in this assessment to value recreation and tourism, derives site values from a statistical model. This model does not account for individual characteristics which may determine the site's welfare benefit. In future assessments it would be beneficial to capture site specific features and a less generalised figure for visitor numbers to enable accurate valuation of recreation services. In addition at gate-1 it has not been possible to monetise the recreation and tourism benefits of the scheme with BNG uplift as details of habitat creation opportunities have not been agreed. These will need to be further assessed and monetised at gate-2.

5.1.3 Better natural hazard regulation

The assessment currently takes flooding into account as the primary natural hazard, but further investigation into the impact that drought has on habitats ability to slow-flow and provide natural flood resilience. This would help to more accurately identify any risk to natural habitat regulation. In order to accomplish this will require a greater breadth of data than currently available.

5.1.4 Climate change predictions

Habitat type and land usage may change in the future due to changes in global climate, creating disparity between the predicted changes caused by element implementation and the observed changes in the future. Given the longevity of the STW sources, predicted climate induced change in Natural Capital will provide a more accurate assessment of benefits to support climate change resilience.

5.1.5 Land use predictions

The vast majority of our NCA is based on land cover. Upcoming changes in land use will therefore introduce discrepancies in our calculations, making it imperative that we account for planned changes such as large-scale building developments.

5.1.6 Confirming element impacts

It will be important in gate-2 to look at how the elements will affect their surrounding habitats in closer detail to confirm our current assessment and develop it further, ultimately giving a more accurate predicted change in Natural Capital values.

5.1.7 Incorporating Net Gain into element design and Natural Capital Assessment

The BNG assessment focusses on quantifying disbenefits to biodiversity and providing the guidelines to not only mitigate them but to create a 10% increase in biodiversity with the implementation of the chosen element(s). It will be necessary to incorporate the quantified values and mitigation plans so that changes in Natural Capital can be calculated with them in mind including air quality and carbon assessment.

5.1.8 Accounting for habitat condition improvement

The BNG assessment considers options to increase the biodiversity metric score through both habitat creation and enhancement. It has not been possible to account for the natural capital benefits related to habitat enhancement at gate-1 as habitat extent has been used as a proxy for natural capital stock. For gate-2 it will be important to consider how habitat condition contributes to delivery of ecosystem services and assess how habitat enhancement measures will affect natural capital values.

5.1.9 Inclusion of abiotic features

Whilst our study considers a variety of biotic factors, WRSE guidance also recommends the assessment of abiotic factors (i.e. minerals, fossil fuels and renewable energy). At present, this study has not valued abiotic services in its assessment of Natural Capital due to limited availability of robust data to represent these features for a project of this scale. At gate-2, and following increased certainty of the element routes and the (ZoI) better representation of abiotic factors should be sought. This will require a review on data availability and potential data collection at that stage.

5.1.10 Key partners collaboration

At gate-1 this NCA has focused on the base line Natural Capital within a 1km ZoI, an assessment of the potential opportunities for uplift related to BNG and predicted Natural Capital loss as a result of construction/operation of the STW sources and groupings. This has been a desked based study using open source data and outputs from the associated SEA, WFD, and HRA assessments as part of this work. At gate-2 there is a need to review this work in light of the wider more locally focused Natural Capital work being completed by local partners (especially associated with the Severn and Cotswolds Canal Rivers Trusts) to ensure synergy between approaches and avoid any double counting.

5.1.11 Refinement of biodiversity and habitat assessment, including aquatic habitats

For gate-1, the biodiversity and habitats assessment has focussed primarily on high-level broad habitats using CORINE data. The resolution of CORINE data does not allow us to understand local aquatic and terrestrial habitats in detail and what Natural Capital benefits may be related to them. Understanding of impacts will be improved at gate-2 following detailed aquatic and terrestrial field surveys to confirm habitat condition and extent for BNG assessment, as well as hydrological modelling and detailed WFD assessment. This can then feed into a more detailed assessment of biodiversity ecosystem services.

5.1.12 Accounting for Biodiversity and Habitat Ecosystem Services

At gate-1 Natural Capital benefits have been aligned with overall high level BNG opportunity areas which have been based on Priority Habitats etc where information has been gained from online sources. There has been no ground truthing of this information to establish where opportunity is likely to be greatest on-the-ground. Ground-truthed BNG and mitigation options (informed by BNG surveys) together with stakeholder engagement (to better understand local authorities) will enable a more refined Natural Capital account to be provided at gate-2.

5.2 Gate 2 - Biodiversity Net Gain

The BNG requirement for the ACWG (Section 3.4.2.5 of the guidance[36]) stipulates that each option should look to maximise BNG and any required mitigation should be included to enable identification of any significant costs. The ACWG requires a full assessment of BNG using the Defra metric and that BNG calculations would take place at Gate 1 and be further refined throughout the gateway process. In accordance with the ACWG guidance, at gate-1 a biodiversity baseline has been developed from spatial data of habitat inventories and assessed in line with the Defra Metric 2.0, to calculate the change in biodiversity score for each element to include agreed mitigation. The open source habitat data can be supplemented with local data sets or Phase I (habitat) site data to increase the accuracy for each option at gate-2. Therefore, where data gaps arose at gate-1, these should be addressed at gate-2 through the following actions, as set out within section 2.9 below. At gate-2, the BNG assessment would be refined through the inclusion of concept designs into the assessment, in accordance with section 3.4.3.5 of the ACWG guidance.

The BNG assessment needs to be refined through greater detail on the construction methods and construction easement to provide great clarity on the impact pathways and habitat scores through the Biodiversity Metrics.

Further assessment on the hydrological impacts on ecology will be undertaken that will inform the assessment of operational BNG losses/gains.

Stakeholder consultation is essential to identify opportunities. This will be critical to the opportunity assessment related to mitigation and enhancement. We propose a series of short workshops for key stakeholder to discuss opportunities. This will include key water company representatives and stakeholders (as agreed by the STW steering group). The opportunities which may be discussed include:

- Landowners' land and landownership constraints
- Local wildlife sites
- Whether local councils have allocated land for BNG
- Criteria for prioritisation
  Consideration of specific species targets for net gain options

The improvement of baseline data is required to support gate-1 through site habitat surveys (condition assessment), ground truthing and habitat scoring. Survey locations will be targeted to sensitive areas and to ground truth the variation across the working easements

Table 4.1 of the ACWG guidance includes the requirement to include data on Local Wildlife Sites, which would need to be obtained from the Local Records Centre. Priority habitat layers for hedgerows/arable

[36] All Companies Working Group WRMP Environmental Assessment Guidance and Applicability with SROs, October 2020

field margins are not open-source information and will be purchased from the Local Records Centre to improve baseline information.

A more detailed review should be undertaken of National and Local plans and policies, such as River Basin Management Plans, catchment or WFD objectives to identify any specific objectives for BNG that can be delivered. Using the principles of Nature Recovery Networks, core areas for biodiversity have been identified within BOAs. Opportunities for connecting these through habitat restoration/creation should be explored in gate-2, including those already identified within Local Plans/LBAPs/strategies. The opportunities should be assessed for their suitability for specific net gain features, connectivity opportunities and achievability. Values will then need to be assigned against areas of mitigation opportunity with potential condition improvement for each feature and opportunity using the principles of the scoring of the River Biodiversity Metric tool.

The current Biodiversity Metric tool (2.0) has calculation issues when working out river mitigation and units gained. It is anticipated that a 3.0 version of the tool will be released in summer 2021 in which previous errors within the tool will be updated. If available, the Biodiversity Metric calculations will be re-entered into the 3.0 version at gate-2, and this should also allow river mitigation to be calculated.

Appendices

Appendix	Title	
A1	STW A1 Mythe Abstraction Licence	See accompanying spreadsheet
A2	STW A2 Netheridge to Deerhurst pipeline	See accompanying spreadsheet
A3	STW A3 Deerhurst Pipeline	See accompanying spreadsheet
A4	STW A4 Netheridge to Cotswold Canals pipeline	See accompanying spreadsheet
A5	STW A5 Cotswold Canals	See accompanying spreadsheet
A6	Summary of Key Issues	A6 – page 50
A6.6	Rivers Data and Opportunities	See accompanying spreadsheet
A6.7	BNG Assessment	See accompanying document
A6.7.i	DeerhurstPipeline_v1	See accompanying spreadsheet
A6.7.iii	CotswoldCanals_300_v1	See accompanying spreadsheet
A6.7.iv	NetheridgePipelineCanal_35	See accompanying spreadsheet
A6.7.ii	NetheridgePipelineDeerhurst_35_v1	See accompanying spreadsheet
A6.8	CotswoldCanals_300_v1	See accompanying spreadsheet
A6.9	Example of mapped BOA	See accompanying spreadsheet
A6.7.iv	NetheridgePipelineCanal_35	See accompanying spreadsheet
A6.8	Rivers_BNG assessment	See accompanying spreadsheet
A7	Data Sources	A7 – page 53

Assessment cover	
Element ID	Mythe_15
[redacted]	
Customer	ST
Date	23/04/2021

Data	Source
Habitat area	Corine 2018 dataset
Carbon sequestration	Table 7 of the EA Supplementary Guidance: Environment and Society in Decision-Making (2020). Department for Business, Energy, and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values ENCA guidance
Natural hazard regulation	Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts.
Water purification	Natural Environment Valuation Online (NEVO) tool
Air quality management	Jones et al (2019) Urban natural capital accounts: developing a novel approach to quantify air pollution removal by vegetation, Journal of Environmental Economics and Policy, 8:4, 413-428
Recreation	Day & Smith (2017) The ORVal Recreation Demand Model: Extension Project

Element ref	4
Element ID	Mythe_15
Element Name	[redacted]
Description	15 Ml/d (Covered under STW Severn Trent Sources SRO developed by STW)
Zone of interest area (m^2)	1,312,821

High level screening

Element	Biodiversity Benefits		Disbenefits		Water regulation Benefits		Disbenefits		Carbon Benefits		Disbenefits		Water purification Benefits		Disbenefits		Natural hazard regulation Benefits		Disbenefits		Recreation & tourism Benefits		Disbenefits	
	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score
Mythe Water Treatment Works (WTW) abstraction Licence Transfer (unused part of) - 15 Ml/d	Priority habitats along riverbank may be better supported during low flow conditions due to increased river flow during drought periods.	1	Priority habitats along the Severn riverbank are likely to experience higher water levels than usual, although no impact anticipated as element will only be operational during drought periods.	0	No impact beyond DO benefits	0	15 Ml/d less water available to Severn Trent if needed	-1	No benefits without confirmed enhancement/BNG	0	No disbenefits anticipated	0	Increased dilution of any pollutants already in the River Severn	1	No disbenefits anticipated	0	Increased drought resistance along the Thames	2	Increased water flow through a high flood risk area	-1	No benefits without confirmed enhancement/BNG	0	No recreation grounds present on riverbanks downstream of Mythe.	0

Stocks and BNG

Broad habitat	Ecosystem services	Area within zone of interest (m^2)	% of total zone of interest	Area lost during construction (m^2)	Area planned for habitat creation (m^2)	Area planned for habitat uplift (m^2)
Urban	No environmental benefits	627695	18.9474469	0	0	0
Enclosed farmland	Crops, livestock, carbon sequestration, air quality management	2685126	81.0525531	0	0	0
Mountains, moors and heath	Livestock, carbon sequestration, recreation	0	0	0	0	0
Freshwater	Water abstraction, recreation, flood regulation	0	0	0	0	0
Woodland	Timber, carbon sequestration, air quality management, recreation	0	0	0	0	0
Coastal margins	Livestock, recreation	0		0	0	0
Marine	Fisheries, recreation	0	0	0	0	0
Semi-natural grassland	Ecosystem services, carbon sequestration, air quality management, recreation	0	0	0	0	0

Calculations located within Ricardo (2021) 'STT Area Calculations' spreadsheet

Carbon sequestration - baseline

Land use type	Cumulative area (m^2)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Urban	627694	0	0	0
Arable land	1387706	514	1,029	1,543
Pastoral land	1297421	1,784	3,568	5,352
	Total	2,298	4,597	6,895

Calculations located within Ricardo (2021) 'STT Carbon sequestration' spreadsheet

Water purification (baseline only)

Basin	Dissolved Oxygen Conc. (mg/l)	Nitrogen Conc. (mg/l)	Phosphorus Conc. (mg/l)
Severn	9.936	9.884	0.399

Air quality management - baseline

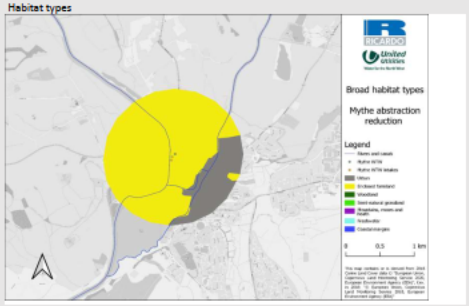
Corine Land Cover	Jones et al (2017) habitat type	Area (m^2)	Value per hectare per year	Value per m^2 per year	Value of area per year
Discontinuous urban fabric	Urban	325097	0	0	0
Pastures	Enclosed farmland	8084	16	0	13
	Total		32	0	895

Recreation baseline

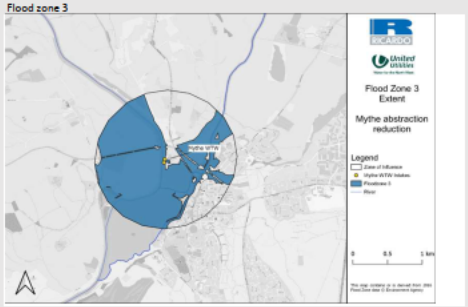
Welfare Value (per year)	Estimated visits (per year)	Total Recreational Land Cover (m^2)
£150,152.86	52436.72	521390

Calculations located within Ricardo (2021) 'ORVal outputs' spreadsheet

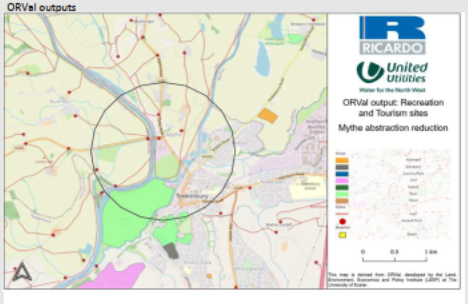
Habitat types



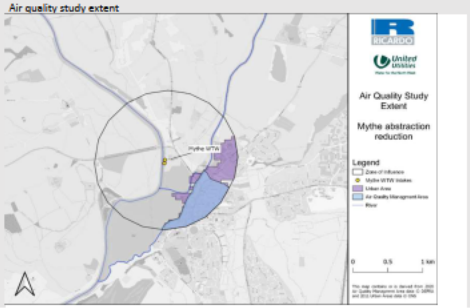
Flood zone 3



ORVal outputs



Air quality study extent



Assessment cover	
Element ID	Netheridge Pipeline Deerhurst_35, Netheridge Pipeline Cotswold_35
Element title	Netheridge Sewage Treatment Works
	[redacted]
Customer	ST
Date	23/04/2021

Data	Source
Habitat area	Corine 2018 dataset
Carbon sequestration	Table 7 of the EA Supplementary Guidance: Environment and Society in Decision-Making (2020). Department for Business, Energy, and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values ENCA guidance
Natural hazard regulation	Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts.
Water purification	Natural Environment Valuation Online (NEVO) tool
Air quality management	Jones et al (2019) Urban natural capital accounts: developing a novel approach to quantify air pollution removal by vegetation, Journal of Environmental Economics and Policy, 8:4, 413-428
Recreation	Day & Smith (2017) The ORVal Recreation Demand Model: Extension Project

Element ref	5a, 5b
Element ID	Netheridge Pipeline Deerhurst_35, Netheridge Pipeline Cotswold_35
Element Name	Netheridge Sewage Treatment Works
Description	35 Ml/d - Difference between Element 5a and 5b relates to the length of discharge pipe only (Covered under STW Severn Trent Sources SRO developed by STW), 35 Ml/d - Difference between Element 5a and 5b relates to the length of discharge pipe only (Covered under STW Severn Trent Sources SRO developed by STW)
Zone of interest area (m²)	37,255,858

High level screening

Element	Biodiversity				Water regulation				Carbon				Water purification				Natural hazard regulation				Recreation & tourism			
	Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits	
	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score
Netheridge WwTW treated effluent diversion to the freshwater River Severn - 35 Ml/d	No benefits without confirmed enhancement/BNG	0	primarily coastal floodplain and grazing marsh which may be affected by construction and/or groundwater impedance caused by pipeline. Multiple ancient woodlands fall within 1km of the route and may be temporarily affected by	-2	No impact beyond CO2 benefits	0	No disbenefits anticipated	0	No benefits without confirmed enhancement/BNG	0	Disruption to habitats may reduce their capacity to sequester and store carbon	-1	No benefits without confirmed enhancement/BNG	0	No disbenefits anticipated	0	Increased drought resistance along the Thames	2	No disbenefits anticipated	0	No benefits without confirmed enhancement/BNG	0	Pipeline passes through multiple footpaths, one playing field and then borders another. Numerous other recreational grounds lie close to the pipeline which may get affected during construction. Multiple other recreation grounds fall within 10km but are unlikely to be affected	-1

Stocks and BNG

Broad habitat	Ecosystem services	Area within zone of interest (m²)	% of total zone of interest	Area lost during construction (m²)	Area planned for habitat creation (m²)	Area planned for habitat uplift (m²)
Urban	No environmental benefits	9,017,787	24.21	85,691	0	0
Enclosed farmland	Crops, livestock, carbon sequestration, air quality management	26,131,399	70.14	357,041	10,000	0
Mountains, moors and heath	Livestock, carbon sequestration, recreation	1,785,939	4.79	22,480	50,000	0
Freshwater	Water abstraction, recreation, flood regulation	0	0.00	0	0	0
Woodland	Timber, carbon sequestration, air quality management, recreation	320,733	0.86	0	100,000	0
Coastal margins	Livestock, recreation	0		0	0	0
Marine	Fisheries, recreation	0	0.00	0	0	0
Semi-natural grassland	Ecosystem services, carbon sequestration, air quality management, recreation	0	0.00	0	0	250,000

Calculations located within Ricardo (2021) 'STT Area Calculations' spreadsheet

Carbon sequestration - baseline

Land use type	Cumulative area (m²)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Urban	8,957,340	0	0	0
Green urban	60,447	83	166	249
Arable land	18,839,704	6,982	13,965	20,947
Pastoral land	7,291,695	10,027	20,054	30,080
Woodland (coniferous)	320,733	14,064	28,129	42,193
Heathland	1,785,939	4,330	8,660	12,991
	Total	35,487	70,974	106,461

Calculations located within Ricardo (2021) 'STT Carbon sequestration' spreadsheet

Carbon sequestration - post-construction (no BNG)

Land use type	Cumulative area lost through construction (m²)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Arable land	2,106,242	£88	£176	£263
Pastoral land	805,535	£96	£192	£288
Heathland	104186	£47	£94	£141
	Total	£231	£461	£692

Calculations located within Ricardo (2021) 'CO2 stocks lost' spreadsheet

Carbon sequestration - post-construction (with BNG)

Land use type	Cumulative area gained through BNG (m²)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Arable land	10,000	£3	£6	£10
Mountains, moors and heath	50,000	£105	£209	£314
Woodland (deciduous)	100,000	£1,484	£2,968	£4,453
Total		£1,592	£3,184	£4,777

Calculations located within Ricardo (2021) 'CO2 stocks lost' spreadsheet

Natural hazard regulation - baseline

Broad habitat	Zone of influence (m²)	Baseline (£2019)
Urban	0	0
Enclosed farmland	0	0
Mountains, moors and heath	0	0
Freshwater	0	0
Woodland	320733	3,758
Coastal margins	0	0
Marine	0	0
Semi-natural grassland	0	0
	Total	3,758

Calculations located within Ricardo (2021) 'ED16382 UUSTT_hazard baseline value calcs' spreadsheet

Natural hazard regulation - post-construction (no BNG)

Broad habitat	Area lost through construction	Change in value
Urban	85,691	£0
Enclosed farmland	357,041	£0
Mountains, moors and heath	22,480	£0
Freshwater	0	£0
Woodland	0	£0
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	0	£0
Total		£0

Calculations located within Ricardo (2021) 'STT hazard regulation uplift workings' spreadsheet

Natural hazard regulation - post-construction (no BNG)

Broad habitat	Area gained through BNG	Change in value
Urban	0	£0
Enclosed farmland	10,000	£0
Mountains, moors and heath	50,000	£0
Freshwater	0	£0
Woodland	100,000	£1,150
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	0	£0
Total		£1,150

Calculations located within Ricardo (2021) 'STT hazard regulation uplift workings' spreadsheet

Water purification - baseline only

Basin	Dissolved Oxygen Conc. (mg/l)	Nitrogen Conc. (mg/l)	Phosphorus Conc. (mg/l)
Severn	9.936	9.884	0.099

Air quality management - baseline only

Corine Land Cover	Jones et al (2017) habitat type	Area (m2)	Value per hectare per year	Value per m2 per year	Value of area per year
Discontinuous urban fabric	Urban	4757	£0.00	£0.00	£0.00

Recreation

Zone of interest

Welfare Value (per year)	Estimated visits (per year)	Total Recreational Land Cover (m²)
£6,968,960.30	1,389,837	2,673,708

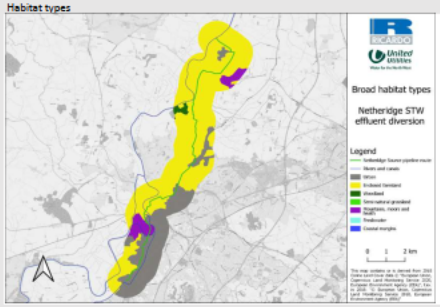
Calculations located within Ricardo (2021) 'ORVal outputs' spreadsheet

Stocks lost from construction

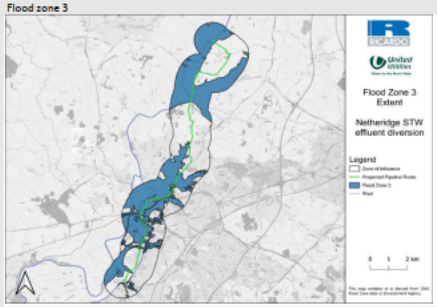
Change in welfare value (per year)	Estimated visits affected (per year)
£795,561	217,222

Calculations located within Ricardo (2021) 'STT Recreation stocks lost' spreadsheet

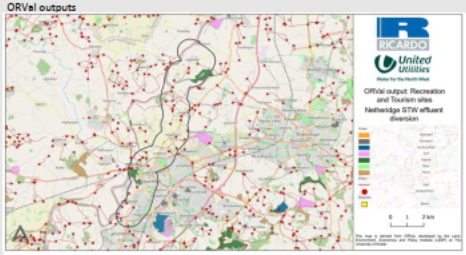
Habitat types



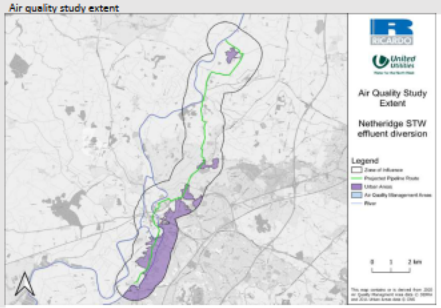
Flood zone 3



ORVal outputs



Air quality study extent



Assessment cover	
Element ID	Deerhurst Pipeline_300, Deerhurst Pipeline_400, Deerhurst Pipeline_500
Element title	Deerhurst Pipeline [redacted]
Customer	ST
Date	24/04/2021

Data	Source
Habitat area	Corine 2018 dataset
Carbon sequestration	Table 7 of the EA Supplementary Guidance: Environment and Society in Decision-Making (2020). Department for Business, Energy, and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values ENCA guidance
Natural hazard regulation	Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts.
Water purification	Natural Environment Valuation Online (NEVO) tool
Air quality management	Jones et al (2019) Urban natural capital accounts: developing a novel approach to quantify air pollution removal by vegetation, Journal of Environmental Economics and Policy, 8:4, 413-428
Recreation	Day & Smith (2017) The ORVal Recreation Demand Model: Extension Project

Element ref	7a, 7b, 7c
Element ID	Deerhurst Pipeline_300, Deerhurst Pipeline_400, Deerhurst Pipeline_500
Element Name	Deerhurst Pipeline
Description	300 Ml/d, 400 Ml/d, 500 Ml/d
Zone of interest area (m²)	177692301

High level screening

Element	Biodiversity – Benefits – Description	Score	Biodiversity – Disbenefits – Description	Score	Water regulation – Benefits – Description	Score	Water regulation – Disbenefits – Description	Score
Deerhurst to Culham interconnector - 300, 400 & 500 Ml/d variants	No benefits without confirmed enhancement/BNG	0	Pipeline passes through numerous priority habitats and areas of ancient woodland. Two SSSIs and large numbers of priority habitats and ancient woodlands fall within 1km of route and may be affected during construction due to noise and air pollution. Pipeline passes through multiple WFD groundwater bodies. These, and nearby priority habitats that rely on them may be negatively affected by pipeline.	-2	No impact beyond DO benefits	0	No disbenefits anticipated	0

Element	Carbon – Benefits – Description	Score	Carbon – Disbenefits – Description	Score	Water purification – Benefits – Description	Score	Water purification – Disbenefits – Description	Score
Deerhurst to Culham interconnector - 300, 400 & 500 Ml/d variants	No benefits without confirmed enhancement/BNG	0	Disruption to habitats may reduce their capacity to sequester and store carbon	-1	No benefits without confirmed enhancement/BNG	0	No disbenefits anticipated	0

Element	Natural hazard regulation – Benefits – Description	Score	Natural hazard regulation – Disbenefits – Description	Score	Recreation & tourism – Benefits – Description	Score	Recreation & tourism – Disbenefits – Description	Score
Deerhurst to Culham interconnector - 300, 400 & 500 Ml/d variants	Increased drought resistance along the Thames	2	No disbenefits anticipated	0	No benefits without confirmed enhancement/BNG	0	Multiple parks and playing fields fall within 1km. Buckland House park within 200m and may be affected during construction. Pipeline also crosses a National Trail which would be affected by construction	-1

Stocks and BNG

Broad habitat	Ecosystem services	Area within zone of interest (m²)	% of total zone of interest	Area lost during construction (m²)	Area planned for habitat creation (m²)	Area planned for habitat uplift (m²)
Urban	No environmental benefits	6,295,316	3.54	-18,636	0	0
Enclosed farmland	Crops, livestock, carbon sequestration, air quality management	160,244,278	90.18	-3,514,623	50,000	0
Mountains, moors and heath	Livestock, carbon sequestration, recreation	475,695	0.27	0	0	20,000
Freshwater	Water abstraction, recreation, flood regulation	286,692	0.16	-177	0	0
Woodland	Timber, carbon sequestration, air quality management, recreation	10,321,361	5.81	-7,312	500,000	0
Coastal margins	Livestock, recreation	0	0.00	0	0	0
Marine	Fisheries, recreation	0	0.00	0	0	0
Semi-natural grassland	Ecosystem services, carbon sequestration, air quality management, recreation	68,959	0.04	0	0	1,400,000

Calculations located within Ricardo (2021) 'STT Area Calculations' spreadsheet

Carbon sequestration - baseline

Land use type	Cumulative area (m²)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Urban	6295316	£0	£0	£0
Arable land	102853943	£37,971	£75,943	£113,914
Pastoral land	57790335	£79,468	£158,935	£238,403
Woodland (deciduous)	6044759	£104,059	£208,118	£312,177
Mixed woodland (average decid-conif)	4276602	£130,577	£261,153	£391,730
Grassland	68959	£95	£190	£284
Heathland	475695	£1,153	£2,307	£3,460
	Total	£353,323	£706,646	£1,059,969

Calculations located within Ricardo (2021) 'STT Carbon sequestration' spreadsheet

Carbon sequestration - post-construction (no BNG)

Land use type	Cumulative area lost through construction (m²)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Arable land	53,570	£2,210	£4,420	£6,630
Pastoral land	380,312	£1,488	£2,976	£4,463
Woodland (deciduous)	7312	£108	£216	£325
Woodland (average deci-coni)	20	£1	£1	£2
	Total	£3,807	£7,613	£11,420

Calculations located within Ricardo (2021) 'CO2 stocks lost' spreadsheet

Carbon sequestration - post-construction (with BNG)

Land use type	Cumulative area gained through BNG (m²)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Arable land	50,000	£16	£32	£48
Woodland (deciduous)	500,000	£7,422	£14,845	£22,267
	Total	£7,438	£14,877	£22,315

Calculations located within Ricardo (2021) 'CO2 stocks lost' spreadsheet

Natural hazard regulation - baseline

Broad habitat	Zone of influence (m²)	Baseline (£2019)
Urban	0	£0
Enclosed farmland	0	£0
Mountains, moors and heath	0	£0
Freshwater	286692	£13,406
Woodland	10321361	£120,921
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	68959	£1,471
	Total	£135,797

Calculations located within Ricardo (2021) 'SD54382 UUSTT_hazard baseline value calcs' spreadsheet

Natural hazard regulation - post-construction (no BNG)

Broad habitat	Area lost through construction (m²)	Change in value (£2019)
Urban	18636	£0
Enclosed farmland	3514623	£0
Mountains, moors and heath	0	£0
Freshwater	177	£7
Woodland	7312	£86
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	0	£0
	Total	£93

Calculations located within Ricardo (2021) 'STT hazard regulation uplift workings' spreadsheet

Natural hazard regulation - post-construction (with BNG)

Broad habitat	Area gained through BNG uplift (m²)	Change in value (£2019)
Urban	0	£0
Enclosed farmland	50,000	£0
Mountains, moors and heath	0	£0
Freshwater	0	£0
Woodland	500,000	£5,750
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	0	£0
	Total	£5,750

Calculations located within Ricardo (2021) 'STT hazard regulation uplift workings' spreadsheet

Water purification (baseline only)

Basin	Dissolved Oxygen Conc. (mg/l)	Nitrogen Conc. (mg/l)	Phosphorus Conc. (mg/l)
Severn	**9.936**	**9.884**	**0.399**
Thames	**10.49**	**9.365**	**0.326**
Average	**10.741**	**9.518**	**0.39**

Recreation

Zone of interest

Welfare Value (per year)	Estimated visits (per year)	Total Recreational Land Cover (m²)
£2,879,822	960208.8	7155770

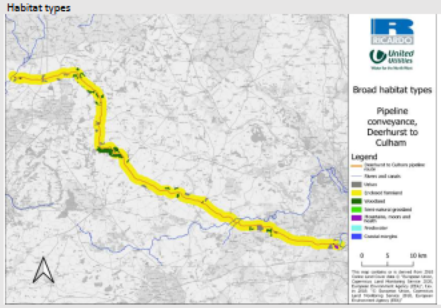
Calculations located within Ricardo (2021) 'ORVal outputs' spreadsheet

Stocks lost from construction

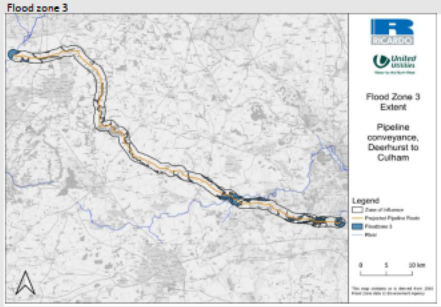
Change in welfare value (per year)	Estimated visits affected (per year)
-£616,063	210,878

Calculations located within Ricardo (2021) 'STT Recreation stocks lost' spreadsheet

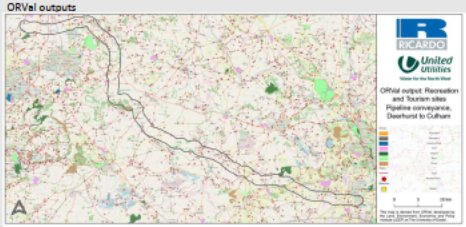
Habitat types



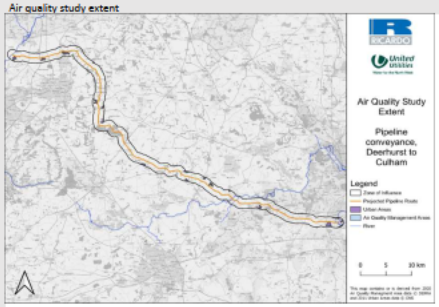
Flood zone 3



ORVal outputs



Air quality study extent



Assessment cover	
Element ID	Cotswold Canals_300
Element title	Cotswold Canals [redacted]
Customer	ST
Date	24/04/2021

Data	Source
Habitat area	Corine 2018 dataset
Carbon sequestration	Table 7 of the EA Supplementary Guidance: Environment and Society in Decision-Making (2020). Department for Business, Energy, and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values ENCA guidance
Natural hazard regulation	Forest Research (2018). Valuing flood regulation services of existing forest cover to inform natural capital accounts.
Water purification	Natural Environment Valuation Online (NEVO) tool
Air quality management	Jones et al (2019) Urban natural capital accounts: developing a novel approach to quantify air pollution removal by vegetation, Journal of Environmental Economics and Policy, 8:4, 413-428
Recreation	Day & Smith (2017) The ORVal Recreation Demand Model: Extension Project

Element ref	8
Element ID	Cotswold Canals_300
Element Name	Cotswold Canals
Description	300 Ml/d
Zone of interest area (m^2)	141,180,661

High level screening

Element	Biodiversity				Water regulation				Carbon				Water purification				Natural hazard regulation				Recreation & tourism			
	Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits		Benefits		Disbenefits	
	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score	Description	Score
Cotswold Canals interconnector option (100 and 300 Ml/d), including stretches of Rivers Severn, Avon and Vyrnwy that are affected by the transfer	Potential enhancement to aquatic habitats in the canals as the transfer may support low flows when operational during drought periods	1	Multiple SSSIs fall within 1km of the proposed route which may be affected by construction noise. Proposed route passes through numerous priority habitats which may be affected by construction or by groundwater impedance	-1	No impact beyond CiD benefits.	0	No disbenefits anticipated	0	No benefits without confirmed enhancement/BNG.	0	Disruption to habitats may reduce their capacity to sequester and store carbon	-1	No benefits without confirmed enhancement/BNG	0	No disbenefits anticipated	0	Increased flood resistance to the Gloucestershire region.	2	No disbenefits anticipated	0	Increased flow down the Cotswold Canals will support navigation and recreational use of the waterbodies (e.g. for sailing, rowing)	1	Route cuts through a playing field and borders a golf course. Both are likely to be affected during construction.	-1

Stocks and BNG

Broad habitat	Ecosystem services	Area within zone of interest (m^2)	% of total zone of interest	Area lost during construction (m^2)	Area planned for habitat creation (m^2)	Area planned for habitat uplift (m^2)
Urban	No environmental benefits	29,264,968	20.73	-646,336	0	0
Enclosed farmland	Crops, livestock, carbon sequestration, air quality management	99,590,120	70.54	-2,911,777	10,000	0
Mountains, moors and heath	Livestock, carbon sequestration, recreation	670,667	0.48	0	0	0
Freshwater	Water abstraction, recreation, flood regulation	3,696,911	2.62	-65,439	0	0
Woodland	Timber, carbon sequestration, air quality management, recreation	7,939,789	5.62	-104,765	750,000	0
Coastal margins	Livestock, recreation	18,206	0.01	0	0	0
Marine	Fisheries, recreation	0	0.00	0	0	0
Semi-natural grassland	Ecosystem services, carbon sequestration, air quality management, recreation	0	0.00	0	0	1,800,000

Calculations located within Ricardo (2021) 'STT Area Calculations' spreadsheet

Carbon sequestration - baseline

Land use type	Cumulative area (m^2)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Urban	29126865	0	0	0
Green urban	138603	191	381	572
Arable land	67675131	25,008	50,015	75,023
Pastoral land	32116989	44,161	88,323	132,484
Woodland (deciduous)	5081837	86,794	173,588	260,382
Woodland (coniferous)	365498	15,150	30,301	45,451
Mixed woodland (average decid-conif)	2553054	77,934	155,867	233,801
Heathland	670667	1,626	3,252	4,878
	Total	250,864	501,727	752,591

Calculations located within Ricardo (2021) 'STT Carbon sequestration' spreadsheet

Carbon sequestration - post-construction (no BNG)

Land use type	Cumulative area lost through construction (m^2)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Arable land	2,106,262	£629	£1,258	£1,887
Pastoral land	805,535	£938	£1,877	£2,815
Woodland (deciduous)	104386	£1,550	£3,099	£4,649
Woodland (average deci-coni)	379	£10	£20	£30
	Total	£3,127	£6,254	£9,381

Calculations located within Ricardo (2021) 'CO2 stocks lost' spreadsheet

Carbon sequestration - post-construction (with BNG)

Land use type	Cumulative area gained through BNG uplift (m^2)	Low non-traded carbon (£2019)	Medium non-traded carbon (£2019)	High non-traded carbon (£2019)
Arable land	10,000	£3	£6	£10
Woodland (deciduous)	750,000	£11,134	£22,267	£33,401
	Total	£11,137	£22,273	£33,411

Calculations located within Ricardo (2021) 'CO2 stocks lost' spreadsheet

Natural hazard regulation

Broad habitat	Zone of influence (m^2)	Baseline (£2019)
Urban	29,264,968	£0
Enclosed farmland	99,590,120	£0
Mountains, moors and heath	670,667	£0
Freshwater	3,696,911	£172,868
Woodland	7,939,789	£93,019
Coastal margins	18,206	£0
Marine	0	£0
Semi-natural grassland	0	£0
	Total	£265,887

Calculations located within Ricardo (2021) 'SD16882 UUSTT_hazard baseline value calcs' spreadsheet

Natural hazard regulation - post-construction (no BNG)

Broad habitat	Area lost through construction (m^2)	Change in value (£2019)
Urban	646,336	£0
Enclosed farmland	2,911,777	£0
Mountains, moors and heath	0	£0
Freshwater	65,439	£2,663
Woodland	104,765	£1,205
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	0	£0
	Total	£3,868

Calculations located within Ricardo (2021) 'STT hazard regulation uplift workings' spreadsheet

Natural hazard regulation - post-construction (with BNG)

Broad habitat	Area gained through BNG uplift (m^2)	Change in value (£2019)
Urban	0	£0
Enclosed farmland	10,000	£0
Mountains, moors and heath	0	£0
Freshwater	0	£0
Woodland	750,000	£8,625
Coastal margins	0	£0
Marine	0	£0
Semi-natural grassland	0	£0
	Total	£8,625

Calculations located within Ricardo (2021) 'STT hazard regulation uplift workings' spreadsheet

Water purification

Basin	Dissolved Oxygen Conc. (mg/l)	Nitrogen Conc. (mg/l)	Phosphorus Conc. (mg/l)
Severn	**9.936**	**9.884**	**0.099**
Thames	**10.49**	**9.165**	**0.326**
Average	**10.741**	**9.518**	**0.39**

Air quality management

Corine Land Cover	Jones et al (2017) habitat type	Area (m2)	Value per hectare per year	Value per m2 per year	Value of area per year
Discontinuous urban fabric	Urban	5097	£0.00	£0.00	£0.00

Recreation

Welfare Value (per year)	Estimated visits (per year)	Total Recreational Land Cover (m^2)
£12,022,661.80	3934994	11204350

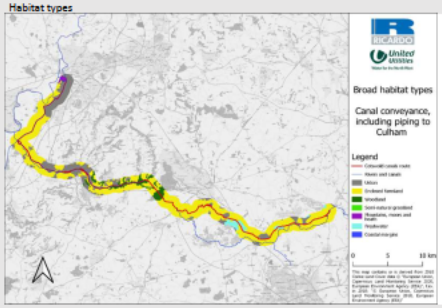
Calculations located within Ricardo (2021) 'ORVal outputs' spreadsheet

Stocks lost from construction

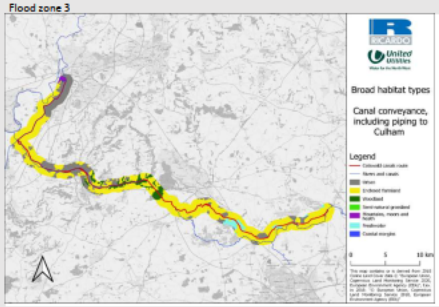
Change in welfare value (per year)	Estimated visits affected (per year)
-£1,980,380	587,356

Calculations located within Ricardo (2021) 'STT Recreation stocks lost' spreadsheet

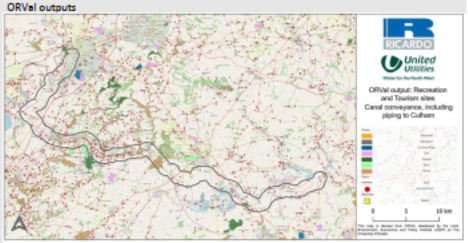
Habitat types



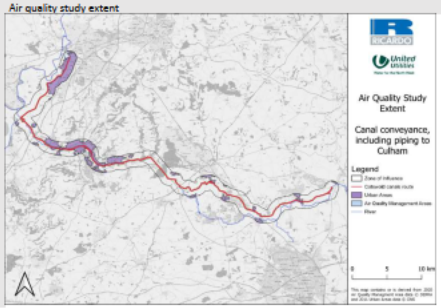
Flood zone 3



ORVal outputs



Air quality study extent



A6 Summary of Key Issues

Key gaps and assumptions

The methodology for this assessment has been developed to accommodate the current uncertainty surrounding the STW sources (design/precise location etc). It has provided a high-level assessment that is proportional to scale and data availability. We have relied on satellite imagery data sets (CORINE) to assess land cover and a statistical model (ORVal[16]) to obtain values. As certainty surrounding the STW sources increases, the assessment will be updated accordingly with latest available data. See **Section 5** for details of further requirements for gate 2. Gate-1 assumptions are outlined below:

A6.1 Baseline data

Corine land cover terrain types as a proxy for broad habitat types

Best judgment has been used to determine how Corine Land Cover types map to the broad habitats types (see **Table**) based on the Corine Land Cover description.

Habitat baseline

ACWG guidance recommends the use of the Natural Habitat Atlas for baseline habitat data; however, the data lacks the detail required for this assessment and is better provided by the Priority Habitats Inventory, supplemented with Corine Landcover where there are data gaps.

The Corine Land Cover and Priority Habitat Inventory data does not provide detailed Phase I level of mapping for the whole area and some assumptions have been made on habitat type. The Biodiversity Metric 2.0 uses habitat types as described in the UK Habs. Where the data identifies pasture grassland, this has been translated into the UK Habs type 'Grassland - Other neutral grassland'.

It is assumed the working easement involved total habitat loss and re-instatement and more detailed construction methods and design is required to avoid over estimation of impacts. The STW Sources information provides further detail on land take for certain STW sources; however only those locations mapped within the GIS shapefiles provided were assessed.

Condition data is not available for habitats with no designations. For these we have assumed a 'moderate' condition score for terrestrial habitats and used Catchment Explore data to assume river condition for each reach. This data lacks the level of detail required for assessing each reach and survey data will be required for the gate-2 assessment.

The STW source pipe elements cross various minor roads, for which we have assumed open cut construction methods. Roads are classified as 'Urban - built linear features', which scores 0 and therefore they are excluded from the assessment.

A6.2 Zone of influence (ZoI) and Data Scale

At gate-1 it has not been feasible to determine a bespoke ZoI for each element as design details are not confirmed and impact pathways are not fully understood. We have used a one-kilometre ZoI for the baseline assessment, which is consistent with that used to determine biodiversity impacts in the Strategic Environmental Assessment (SEA).

For assessment of habitat change, we have used the construction working widths, as this represents the likely area of physical habitat change. This is consistent with the approach taken in the BNG assessment.

It is unlikely that the ZoI will be affected evenly by environmental changes brought about by the construction/operation of the final STW source groupings. At this stage however, we have assumed that the changes will be uniform across the affected areas. To do otherwise at this stage (gate-1) would be infeasible due to the scale of the proposed projects and the lack of detailed design information.

The Corine Land Cover data used to generate broad habitat area data has too low a resolution to detect individual rivers or streams. Therefore, the freshwater habitat is likely to be underrepresented. In order to compensate for this, the lengths of rivers that lie within the 1 km buffer zone around each STW source have been calculated and included as a reflection of that habitat type.

A6.3 Monetisation assumptions

All calculations are set up using real 2019 prices[37]. The benefit transfer values have been converted to £2019 by applying a GDP deflator consistent with the ENCA guidance (**Table**). A GDP deflator is considered more appropriate than adjusting for inflation using the Consumer Price Index (CPI) for this assessment, as the GDP deflator only reflects goods and services produced in the UK.

Table A1: GDP Deflators to update historic values to current prices.

Year	Index (2019 = 100)	% Change on previous year
2010	85.30	1.53
2011	87.04	2.04
2012	88.49	1.66
2013	90.16	1.89
2014	91.81	1.83
2015	92.35	0.58
2016	94.32	2.14
2017	96.11	1.89
2018	98.16	2.14
2019	100.00	1.88
2020	-	2.05

Source: ENCA Services Databook July 2020.

A6.4 Designated and non-designated sites

The baseline data is a habitat assessment based on identifying risks to Priority Habitats. Risks to designated sites is dealt with in the Habitats Regulations Assessments. Risks to wildlife sites have not been included in this level of assessment for gate-1, as national datasets are not available and are mapped at a county level with data held by individual record centres. From assessing data on the Shropshire Environmental Network interactive map, the pipeline for the Vyrnwy mitigation by-pass appears to cut through a local wildlife site and associated wetland habitats.

Classification and condition of rivers and streams has been taken from the Environment Agency Catchment Explorer website, as survey data is not available for gate-1.

A6.5 BNG

Habitat loss

All habitats within the construction easement are assumed to be lost and re-instated with the same habitat type and restored to the same condition. There is no information at this stage on whether some of the habitat along the STW Sources overall routes will be retained but degraded from vehicle access and restored (temporary degradation).

[37] 2020 data not currently available

Priority habitat layers for hedgerows/arable field margins are not open source information. However, the hedgerow intersections have been identified through aerial photography and an estimate made of habitat loss based on a working easement of 20m, as provided by Jacobs. Arable field margins were identified from mapped Countryside Stewardship areas from MAGIC with the assumption that all are Mid-tier (6m wide) and in Higher level Stewardship.

Construction methods are unknown for small watercourses (<2m) and an assumption was made of open cut methods with a 20m easement will be subject to habitat loss. 15m loss of habitat long riverbanks has been assumed for all outfall structures.

Application of the Biodiversity Metric

The Biodiversity Metric is not specifically designed to address habitat degradation, rather than loss. However, as our approach to all STW Sources elements is the same, it is inconsequential in comparing each of these elements at a strategic level. The River Metric 2.0 also has errors that prevent accurate calculation of the uplift required to offset biodiversity losses, which is likely to be resolve in the next version 3.0, due for issue in 2021 and could therefore be used for further assessment at gate-2.

Biodiversity Opportunity Areas

The Berkshire BOAs are located over 50km from the STW sources. Good coverage is provided by the BOA's for Gloucestershire and Oxford; therefore the Berkshire BOA's were excluded from further assessment. A small proportion of the pipeline will go through Berkshire, so the net gain requirements can be covered elsewhere.

Watercourse name	WFD reference	Reach Reference	Element Reference	Element/Option Component ID	>2m wide (Y/N)	No. of intersections	No. of bank structures (outfalls)	Length impacted (m)	River classification type	WFD ecological condition	Length of reach impacted (km)	Strategic significance (Rivers and Streams)	Flow data (flow band change, adjusted for beneficial effects)	Assumed change in WFD condition on a 5 point scale from Good to Very Poor (surrogate for Biodiversity Metric condition) based on flow data
Severn - conf R Avon to conf Upper Parting	GB109054044404	4/5 (Severn reaches)	7a	Deerhurst Pipeline_300	Y	0	1	15	River and streams (other)	Moderate	11.93	Local, catchment and basin; Worcestershire and Gloucestershire BAP, River Severn CFMP, Severn RBMP		0
Swilgate - source to conf R Avon	GB109054039780	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	River with Water crow-foot	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Isbourne - source conf R Avon	GB109054039631	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	Priority river habitat - headwater areas (1065); Urban classification 1; semi natural classification 4.	Poor	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Coln (Source to Coln Rogers)	GB106039029991	N/A	7a	Deerhurst Pipeline_300	Y	11	0	0	Priority river habitat - headwater areas (1005); Urban classification 1; semi natural classification 4.	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Leach (Source to Thames)	GB106039030040	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	River and streams (other)	Poor	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Radcot Cut	GB106039030231	2 (Thames reaches)	7a	Deerhurst Pipeline_300	N	1	0	20	River and streams (other)	Moderate	0	Local plan; Oxfordshire Wildlife and Landscape Study (conservation target areas)	n/a	
Thames (Leach to Evenlode)	GB106039030333	2 (Thames reaches)	7a	Deerhurst Pipeline_300	Y	2	0	0	River with Water crow-foot	Poor	0	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP	n/a	
Wadley Stream (Source to Thames at Duxford)	GB106039023770	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	River with Water crow-foot	Bad	0	Thames RBMP	n/a	
Unknown watercourse; Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	River and streams (other)	Poor	0	Thames RBMP	n/a	
Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	N/A	7a	Deerhurst Pipeline_300	Y	2	0	0	River and streams (other)	Poor	0	Priority habitats for restoration	n/a	
Childrey Brook and Norbrook at Common Barn	GB106039023380	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	River and streams (other); hydrologically connected chalk river.	Poor	0	Local plan; Oxfordshire Wildlife and Landscape Study (landscape types map)	n/a	
Cow Common Brook and Portobello Ditch	GB106039023360	N/A	7a	Deerhurst Pipeline_300	N	1	0	20	River and streams (other)	Poor	0	Local plan; Oxfordshire Wildlife and Landscape Study (Landscape types map)	n/a	
Thames (Evenlode to Thame)	GB106039030334	2 (Thames reaches)	7a	Deerhurst Pipeline_300	N	1	1	35	River with Water crow-foot	Moderate	13.11	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames Wallingford to Caversham	GB106039030331	3 (Thames reaches)	7a	Deerhurst Pipeline_300	Y	0	0	0	River with Water crow-foot	Moderate	38.51	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Reading to Cookham)	GB106039023233	3 (Thames reaches)	7a	Deerhurst Pipeline_300	Y	0	0	0	River with Water crow-foot	Moderate	35.04	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Cookham to Egham)	GB106039023231	3/4 (Thames reaches)	7a	Deerhurst Pipeline_300	Y	0	0	0	River with Water crow-foot	Moderate	30.06	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Egham to Teddington)	GB106039023232	4 (Thames reaches)	7a	Deerhurst Pipeline_300	Y	0	0	0	River with Water crow-foot	Poor	27.93	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032760	6A (Severn reaches)	7a	Deerhurst Pipeline_300	Y	0	0	0	River and streams (other)	Moderate	3.92	Local, catchment and basin; Worcestershire and Gloucestershire BAP, River Severn CFMP, Severn RBMP		-1
Severn - conf R Avon to conf Upper Parting	GB109054044404	4/5 (Severn reaches)	7b	Deerhurst Pipeline_400	Y	0	1	15	River and streams (other)	Moderate	11.93	Local, catchment and basin; Worcestershire and Gloucestershire BAP, River Severn CFMP, Severn RBMP		0
Swilgate - source to conf R Avon	GB109054039780	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	River with Water crow-foot	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Isbourne - source conf R Avon	GB109054039631	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	Priority river habitat - headwater areas (1065); Urban classification 1; semi natural classification 4.	Poor	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Coln (Source to Coln Rogers)	GB106039029991	N/A	7b	Deerhurst Pipeline_400	Y	11	0	0	Priority river habitat - headwater areas (1005); Urban classification 1; semi natural classification 4.	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Leach (Source to Thames)	GB106039030040	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	River and streams (other)	Poor	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Radcot Cut	GB106039030231	2 (Thames reaches)	7b	Deerhurst Pipeline_400	N	1	0	20	River and streams (other)	Moderate	0	Local plan; Oxfordshire Wildlife and Landscape Study (conservation target areas)	n/a	
Thames (Leach to Evenlode)	GB106039030333	2 (Thames reaches)	7b	Deerhurst Pipeline_400	Y	2	0	0	River with Water crow-foot	Poor	0	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP	n/a	
Wadley Stream (Source to Thames at Duxford)	GB106039023770	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	River with Water crow-foot	Bad	0	Thames RBMP	n/a	
Unknown watercourse; Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	River and streams (other)	Poor	0	Thames RBMP	n/a	
Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	N/A	7b	Deerhurst Pipeline_400	Y	2	0	0	River and streams (other)	Poor	0	Priority habitats for restoration	n/a	
Childrey Brook and Norbrook at Common Barn	GB106039023380	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	River and streams (other); hydrologically connected to chalk river.	Poor	0	Local plan; Oxfordshire Wildlife and Landscape Study (landscape types map)	n/a	
Cow Common Brook and Portobello Ditch	GB106039023360	N/A	7b	Deerhurst Pipeline_400	N	1	0	20	River and streams (other)	Poor	0	Local plan; Oxfordshire Wildlife and Landscape Study (Landscape types map)	n/a	
Thames (Evenlode to Thame)	GB106039030334	2 (Thames reaches)	7b	Deerhurst Pipeline_400	N	1	1	35	River with Water crow-foot	Moderate	13.11	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames Wallingford to Caversham	GB106039030331	3 (Thames reaches)	7b	Deerhurst Pipeline_400	Y	0	0	0	River with Water crow-foot	Moderate	38.51	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Reading to Cookham)	GB106039023233	3 (Thames reaches)	7b	Deerhurst Pipeline_400	Y	0	0	0	River with Water crow-foot	Moderate	35.04	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Cookham to Egham)	GB106039023231	3/4 (Thames reaches)	7b	Deerhurst Pipeline_400	Y	0	0	0	River with Water crow-foot	Moderate	30.06	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Egham to Teddington)	GB106039023232	4 (Thames reaches)	7b	Deerhurst Pipeline_400	Y	0	0	0	River with Water crow-foot	Poor	27.93	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032760	6A (Severn reaches)	7b	Deerhurst Pipeline_400	Y	0	0	0	River and streams (other)	Moderate	3.92	Local, catchment and basin; Worcestershire and Gloucestershire BAP, River Severn CFMP, Severn RBMP		-1
Severn - conf R Avon to conf Upper Parting	GB109054044404	4/5 (Severn reaches)	7c	Deerhurst Pipeline_500	Y	0	1	15	River and streams (other)	Moderate	11.93	Local, catchment and basin; Worcestershire and Gloucestershire BAP, River Severn CFMP, Severn RBMP		0
Swilgate - source to conf R Avon	GB109054039780	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	River with Water crow-foot	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Isbourne - source conf R Avon	GB109054039631	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	Priority river habitat - headwater areas (1065); Urban classification 1; semi natural classification 4.	Poor	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	

Coln (Source to Coln Rogers)	GB106039029991	N/A	7c	Deerhurst Pipeline_500	Y	11	0	0	Priority river habitat - headwater areas (1005); Urban classification 1; semi natural classification 4.	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Leach (Source to Thames)	GB106039030040	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	River and streams (other)	Poor	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Radcot Cut	GB106039030231	2 (Thames reaches)	7c	Deerhurst Pipeline_500	N	1	0	20	River and streams (other)	Moderate	0	Local plan; Oxfordshire Wildlife and Landscape Study (conservation target areas)	n/a	
Thames (Leach to Evenlode)	GB106039030333	2 (Thames reaches)	7c	Deerhurst Pipeline_500	Y	2	0	0	River with Water crow-foot	Poor	0	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP	n/a	
Wadley Stream (Source to Thames at Duxford)	GB106039023770	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	River with Water crow-foot	Bad	0	Thames RBMP	n/a	
Unknown watercourse; Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	River and streams (other)	Poor	0	Thames RBMP	n/a	
Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	N/A	7c	Deerhurst Pipeline_500	Y	2	0	0	River and streams (other)	Poor	0	Priority habitats for restoration	n/a	
Childrey Brook and Norbrook at Common Barn	GB106039023380	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	River and streams (other); hydrologically connected to chalk river.	Poor	0	Local plan; Oxfordshire Wildlife and Landscape Study (landscape types map)	n/a	
Cow Common Brook and Portobello Ditch	GB106039023360	N/A	7c	Deerhurst Pipeline_500	N	1	0	20	River and streams (other)	Poor	0	Local plan; Oxfordshire Wildlife and Landscape Study (Landscape types map)	n/a	
Thames (Evenlode to Thame)	GB106039030334	2 (Thames reaches)	7c	Deerhurst Pipeline_500	N	1	1	35	River with Water crow-foot	Moderate	13.11	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames Wallingford to Caversham	GB106039030331	3 (Thames reaches)	7c	Deerhurst Pipeline_500	Y	0	0	0	River with Water crow-foot	Moderate	38.51	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Reading to Cookham)	GB106039023233	3 (Thames reaches)	7c	Deerhurst Pipeline_500	Y	0	0	0	River with Water crow-foot	Moderate	35.04	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Cookham to Egham)	GB106039023231	3/4 (Thames reaches)	7c	Deerhurst Pipeline_500	Y	0	0	0	River with Water crow-foot	Moderate	30.06	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Egham to Teddington)	GB106039023232	4 (Thames reaches)	7c	Deerhurst Pipeline_500	Y	0	0	0	River with Water crow-foot	Poor	27.93	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032760	6A (Severn reaches)	7c	Deerhurst Pipeline_500	Y	0	0	0	River and streams (other)	Moderate	3.92	Local, catchment and basin; Worcestershire and Gloucestershire BAP, River Severn CFMP, Severn RBMP		-1
Thames (Evenlode to Thame)	GB106039030334	2 (Thames reaches)	8	Cotswold Canals_300	Y	0	0	0	River with Water crow-foot	Moderate	13.11	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames Wallingford to Caversham	GB106039030331	3 (Thames reaches)	8	Cotswold Canals_300	Y	0	0	0	River with Water crow-foot	Moderate	38.51	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Reading to Cookham)	GB106039023233	3 (Thames reaches)	8	Cotswold Canals_300	Y	0	0	0	River with Water crow-foot	Moderate	35.04	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Cookham to Egham)	GB106039023231	3/4 (Thames reaches)	8	Cotswold Canals_300	Y	0	0	0	River with Water crow-foot	Moderate	30.06	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Thames (Egham to Teddington)	GB106039023232	4 (Thames reaches)	8	Cotswold Canals_300	Y	0	0	0	River with Water crow-foot	Poor	27.93	Local, catchment and basin; Oxfordshire Wildlife and Landscape Study, Reading BAP (etc.) River Thames CFMP, Thames RBMP		-1
Gloucester and Sharpness Canal	GB70910509	6B (Severn reaches)	8	Cotswold Canals_300	Y	0	0	0	Canal	Moderate	12.87	Not identified in any plan		-1
Frome - Source to Ebley Mill	GB109054032470	N/A	8	Cotswold Canals_300	Y	0	1	15	Canal	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Frome - Ebley Mill to conf R Severn	GB109054032450	N/A	8	Cotswold Canals_300	Y	0	0	0	Canal	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Stroudwater Navigation (Pike Lock to Ebley)	GB70910526	N/A	8	Cotswold Canals_300	Y	0	0	0	Canal	Moderate	0	Not identified in any plan	n/a	
Stroudwater Navigation (Dudbridge east)	GB70910525	N/A	8	Cotswold Canals_300	Y	0	0	0	Canal	Good	0	Not identified in any plan	n/a	
Thames and Severn Canal	GB70910060	N/A	8	Cotswold Canals_300	Y	0	0	0	Canal	Moderate	0	Not identified in any plan	n/a	
Ampney and Poulton Brooks (Source to Thames)	GB106039030300	N/A	8	Cotswold Canals_300	N	1	0	20	River and streams (other)	Moderate	0	Local plan; Gloucestershire Strategic Nature Areas	n/a	
Marston Meysey Brook	GB106039023860	N/A	8	Cotswold Canals_300	N	1	0	20	River and streams (other)	Good	0	Severn RBMP	n/a	
Horsebere Bk - source to conf R Severn	GB109054032760	6A (Severn reaches)	8	Cotswold Canals_300	Y	0	0	0	River and streams (other)	Moderate	0.62	Local plan; Gloucestershire Strategic Nature Areas		-1

Element/Option Component ID	Waterbody (1km of option component)	Length (km)	Counties
Netheridge Pipeline Deerhurst_35	Severn (E Channel) - Horsebere Bk to Severn Est	1.14	Gloucestershire
Netheridge Pipeline Deerhurst_35	Leadon - conf Preston Bk to conf R Severn (W Channel)	0.39	Gloucestershire
Netheridge Pipeline Deerhurst_35	Severn - conf R Avon to conf Upper Parting	6.68	Gloucestershire
Netheridge Pipeline Deerhurst_35	Horsebere Bk - source to conf R Severn	2.53	Gloucestershire
Netheridge Pipeline Deerhurst_35	Wotton Bk - source to conf Horsebere Bk	0.96	Gloucestershire
Netheridge Pipeline Deerhurst_35	Hatherley Bk - source to conf R Severn	3.03	Gloucestershire
Netheridge Pipeline Deerhurst_35	Chelt - M5 to conf R Severn	1.42	Gloucestershire
Netheridge Pipeline Deerhurst_35	Leigh Bk source to conf R Chelt	0.65	Gloucestershire
Netheridge Pipeline Deerhurst_35	Combe Hill Canal	2.66	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Severn - conf R Avon to conf Upper Parting	2.12	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Isbourne - source to conf R Avon	0.58	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Coln (Source to Coln Rogers)	8.46	Gloucestershire
Deerhurst Pipeline_300, 400, 500	Radcot Cut	0.39	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Thames (Leach to Evenlode)	1.49	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Childrey Brook and Norbrook at Common Barn	1.5	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Ock and tributaries (Land Brook confluence to Thames)	2.438	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Cow Common Brook and Portobello Ditch	0.414	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Frilford and Marcham Brook	0.54	Oxfordshire
Deerhurst Pipeline_300, 400, 500	Thames (Evenlode to Thame)	0.5	Oxfordshire
Cotswold Canals 300	Gloucester and Sharpness Canal	8.89	Gloucestershire
Cotswold Canals 300	Epney Rhyne source to conf R Severn Estuary	2 19	Gloucestershire
Cotswold Canals_300	Frome - Ebley Mill to conf R Severn	8.12	Gloucestershire
Cotswold Canals_300	Stroudwater Navigation (Pike Lock to Ebley)	1.98	Gloucestershire
Cotswold Canals_300	Thames and Severn Canal	3.59	Gloucestershire
Cotswold Canals_300	Frome - source to Ebley Mill	5.15	Gloucestershire
Cotswold Canals_300	Churn (Baunton to Cricklade)	8.16	Wiltshire
Cotswold Canals 300	Thames (Waterhaybridge to Cricklade) and Chelworth Brook	2 4	Wiltshire
Cotswold Canals_300	Ampney and Poulton Brooks (Source to Thames)	2.71	Wiltshire
Cotswold Canals_300	Thames (Churn to Coln)	13.05	Wiltshire
Cotswold Canals_300	Share ditch	0.3	Wiltshire
Cotswold Canals_300	Coln (from Coln Rogers) and Thames (Coln to Leach)	4.093	Wiltshire
Cotswold Canals_300	Dudgrove Brook	1.6	Wiltshire
Cotswold Canals_300	Thornhill Ditch and Tributaries at Cotswolds Water Park	1.46	Wiltshire
Cotswold Canals 300	Cole (Bower Bridge to Thames) including Coleshill	0.19	Wiltshire
Cotswold Canals_300	Radcot Cut	0.75	Oxfordshire
Cotswold Canals_300	Thames (Leach to Evenlode)	1.51	Oxfordshire
Cotswold Canals_300	Childrey Brook and Norbrook at Common Barn	1.53	Oxfordshire
Cotswold Canals_300	Ock and tributaries (Land Brook confluence to Thames)	2.39	Oxfordshire
Cotswold Canals_300	Frilford and Marcham Brook	0.48	Oxfordshire
Cotswold Canals_300	Thames (Evenlode to Thame)	0.5	Oxfordshire

*Waterbodies within biodiversity opportunity areas and within 1km of option components.

Element/Option Component ID	Priority river habitats for restoration (within 1km of option component or reach)	WFD reference	Targeted Restoration	Priority river habitats length (km)
Deerhurst Pipeline_300, 400 and 500; Cotswold Canals_300	Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	Hydrological	0.88
Deerhurst Pipeline_300, 400 and 500; Cotswold Canals_300	Chalvey Ditches	GB106039023550	Hydrological	1.39
Cotswold Canals_300	Thames (Waterhaybridge to Cricklade) and Chelworth Brook	GB106039022960	Hydrological	1.69

Appendix A6.7

Canal conveyance – Net Loss

Canal conveyance, including piping to Culham (300Mld)

Table 11 - Estimated maximum areas of direct terrestrial habitat loss

Habitat	Translated habitat to UKHab	Loss to pipeline (ha)
Non-irrigated arable land	Cropland - Cereal crops	136.7
Pastures	Grassland - Other neutral grassland	64.05
Broadleaved woodland	Woodland and forest - Other woodland; broadleaved	36.09
Mixed forest	Woodland and forest - Other woodland; mixed	1.25
Conifer woodland	Woodland and forest - Other coniferous woodland	0.10
Coastal and floodplain grazing marsh*	Grassland - Other neutral grassland	38.99
Lowland meadows*	Grassland - Lowland meadows	4.64
Land principally occupied with agriculture with significant areas of natural vegetation	Cropland - Temporary grass and clover leys	0.71
Industrial or commercial units	Urban - Developed land; sealed surface	5.47
Discontinuous urban fabric	Urban - Suburban/ mosaic of developed/ natural surface	12.70
Urban	Urban - Suburban/ mosaic of developed/ natural surface	10.99
Sport and leisure facilities	Urban - Amenity grassland	0.96
Young trees	Woodland and forest - Other woodland; Young Trees planted	1.65
Traditional orchard*	Cropland – Traditional Orchard	0.64
Mineral extraction sites	Urban - Sand pit quarry or open cast mine	1.50
Arable field margins	Cropland - Arable field margins pollen & nectar	0.50
TOTALS		**316.44**

*Priority Habitat

Table 13- Estimated maximum km of direct hedgerow loss

Habitat	Translated habitat to UKHab	Loss to pipeline (km)
Hedgerow	Native species rich hedgerow	1.08
TOTALS		**1.08**

Applying the DEFRA Biodiversity Metric to the habitat areas in **Table 11 & 12** results in the following biodiversity units (**see Annex 1iii**) that could be lost to development in the absence of any mitigation (**Table 13**). Where priority habitats could be added into the metric calculations a habitat condition of 'good' was used to distinguish between non-priority habitats with an overlapping metric habitat.

Table 14 - Indicative biodiversity units potentially lost within pipeline (post re-instatement)

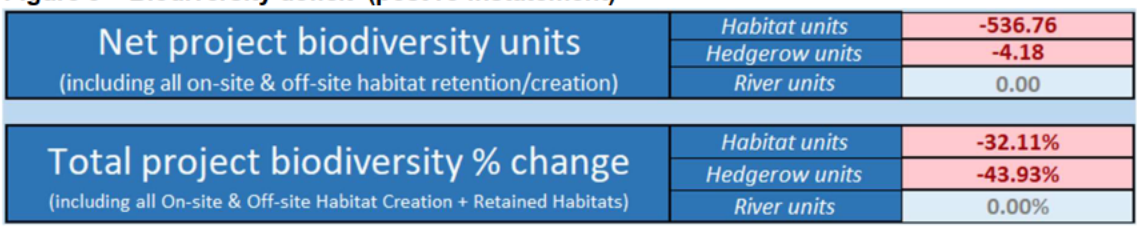
Habitat	Translated habitat to UKHab	Metric units	Proposed habitat mitigation
Non-irrigated arable land	Cropland - Cereal crops	300.74	Neutral grassland enhancement
Pastures	Grassland - Other neutral grassland	563.64	Neutral grassland enhancement
Broadleaved woodland	Woodland and forest - Other woodland; broadleaved	317.59	Grassland succession
Mixed forest	Woodland and forest - Other woodland; mixed	11.00	Grassland succession
Conifer woodland	Woodland and forest - Other coniferous woodland	0.44	Grassland succession
Coastal and floodplain grazing marsh*	Grassland - Other neutral grassland	343.11	Neutral grassland enhancement
Lowland meadows*	Grassland - Lowland meadows	N/A (bespoke mitigation required)	N/A
Land principally occupied with agriculture with significant areas of natural vegetation	Cropland - Temporary grass and clover leys	1.56	Neutral grassland enhancement
Industrial or commercial units	Urban - Developed land; sealed surface	0.00	N/A
Discontinuous urban fabric	Urban - Suburban/ mosaic of developed/ natural surface	55.88	Neutral grassland enhancement
Urban	Urban - Suburban/ mosaic of developed/ natural surface	48.36	Neutral grassland enhancement
Sport and leisure facilities	Urban - Amenity grassland	4.22	Neutral grassland enhancement
Young trees	Woodland and forest - Other woodland; Young Trees planted	7.26	Grassland succession

Habitat	Translated habitat to UKHab	Metric units	Proposed habitat mitigation
Traditional orchard*	Cropland – Traditional Orchard	9.29	Traditional orchard creation
Mineral extraction sites	Urban - Sand pit quarry or open cast mine	6.60	Neutral grassland enhancement
Arable field margins	Cropland - Arable field margins pollen & nectar	2.20	Neutral grassland enhancement
Hedgerow	Native species rich hedgerow	3.78	Hedgerow creation

*Priority Habitat

One assumption made during the calculation was that all pipeline habitat loss would be temporary and habitat would be reinstated after construction, either naturally or re-created. **Figure 3** shows the net biodiversity unit lost based on this assumption. Mitigation will be still required to achieve biodiversity net gain

Figure 3 – Biodiversity deficit (post re-instatement)



Lowland meadows are identified as being an unacceptable loss within the DEFRA Metric. It is therefore not considered further within the Metric calculations. However a bespoke compensation strategy will need to be provided if these habitats are lost with consultation with Natural England. This can present challenges in habitat creation and identifying suitable locations. The first stage of the mitigation hierarchy is to avoid and therefore this should be a key consideration within the design.

The results for the river metric calculations are within the summary table in Annex A1vii.

Canal conveyance – Net Gain Opportunities

To achieve 10% biodiversity net-gain there are opportunities locally for the following habitat enhancement and creation shown in Tables 15-17. Tables 15 and 16 show for each habitat type impacted by the scheme, the area (hectares/km) of habitat enhancement or creation required, the metric units that this achieves and the strategic location of where this could be delivered. As stated in the methodology the majority of habitats were assumed to be in moderate condition for a 10.68% for habitats. Hectarage required can be halved if habitats are assumed to be in poor condition. To achieve an 10.34% hedgerow net gain the following creation will be required, see Table 16.

Table 15. Required mitigation for 10% BNG

Habitat	Creation or Enhancement	Hectarage	Metric Units Gained	Strategic land identified for delivery
Grassland - Other neutral grassland	Enhancement (poor condition to good condition)	130	1088.81	944ha of neutral grassland identified in 'Biodiversity South West' nature map.

Woodland and forest - Other woodland; broadleaved	Creation (grassland succession)	75	391.95	Over 1000ha of woodland identified in 'Biodiversity South West' nature map.
Cropland – Traditional Orchard	Creation	1	7.44	944ha of neutral grassland identified for orchard planting in 'Biodiversity South West' nature map.

Table 16. Required mitigation for 10% BNG

Habitat	Creation or Enhancement	Km	Metric Units Gained	Strategic land identified for delivery
Native species rich hedgerow	Creation	1	5.16	944ha of neutral grassland identified in 'Biodiversity South West' nature map.

Tables 17 and 18 identify opportunities for delivering BNG for rivers, from published information on Priority Rivers for Restoration[1] and Biodiversity Opportunity Areas for relevant counties. Priority Rivers for Restoration are reaches targeted for restoration and the location and length of river reaches within 1km of the scheme are given in Table 17. The data also provided information on whether the restoration related to physical or hydrological opportunities. Table 18 identifies the length of river reaches within BOAs within 1km of the impacted reach. The number of units/km required for 10% BNG for rivers cannot be calculated at present due to errors in the metric 2.0 and in advance of version 3.0, a bespoke solution would need to be agreed with the regulators.

Table 17. Priority River Habitats for Restoration

Priority river habitat for restoration	WFD reference	Targeted restoration	Length (km)
Thames (Waterhaybridge to Cricklade) and Chelworth Brook	GB106039022960	Hydrological	1.69

Table 18. River Biodiversity Opportunity Areas

Waterbody (within 1km)	Length (km)	County
Gloucester and Sharpness Canal	8.89	Gloucestershire
Epney Rhyne - source to conf R Severn Estuary	2.19	Gloucestershire
Frome - Ebley Mill to conf R Severn	8.12	Gloucestershire
Stroudwater Navigation (Pike Lock to Ebley)	1.98	Gloucestershire
Thames and Severn Canal	3.59	Gloucestershire
Frome - source to Ebley Mill	5.15	Gloucestershire
Churn (Baunton to Cricklade)	8.16	Wiltshire
Thames (Waterhaybridge to Cricklade) and Chelworth Brook	2.4	Wiltshire
Ampney and Poulton Brooks (Source to Thames)	2.71	Wiltshire
Thames (Churn to Coln)	13.05	Wiltshire
Share ditch	0.3	Wiltshire
Coln (from Coln Rogers) and Thames (Coln to Leach)	4.093	Wiltshire
Dudgrove Brook	1.6	Wiltshire

[1] https://data.gov.uk/dataset/e0165747-8368-4ff7-a644-df9aeb27bb0b/priority-habitat-creation-and-restoration

Waterbody (within 1km)	Length (km)	County
Thornhill Ditch and Tributaries at Cotswolds Water Park	1.46	Wiltshire
Cole (Bower Bridge to Thames) including Coleshill	0.19	Wiltshire
Radcot Cut	0.75	Oxfordshire
Thames (Leach to Evenlode)	1.51	Oxfordshire
Childrey Brook and Norbrook at Common Barn	1.53	Oxfordshire
Ock and tributaries (Land Brook confluence to Thames)	2.39	Oxfordshire
Frilford and Marcham Brook	0.48	Oxfordshire
Thames (Evenlode to Thame)	0.5	Oxfordshire

Pipeline conveyance, Deerhurst to Culham – Net Loss

Pipeline conveyance, Deerhurst to Culham

Table 19 - Estimated maximum areas of direct terrestrial habitat loss within pipeline

Habitat	Translated habitat to UKHab	Loss to pipeline (ha)
Non-irrigated arable land	Cropland - Cereal crops	219.33
Pastures	Grassland - Other neutral grassland	106.10
Broadleaved woodland	Woodland and forest - Other woodland; broadleaved	3.1
Mixed forest	Woodland and forest - Other woodland; mixed	1.21
Conifer	Woodland and forest - Other coniferous woodland	0.02
Coastal and floodplain grazing marsh*	Grassland - Other neutral grassland	5.56
Deciduous woodland*	Woodland and forest - Other woodland; broadleaved	0.05
Good quality semi-improved grassland*	Grassland - Other neutral grassland	5.55
Lowland calcareous grassland*	Grassland - Lowland calcareous grassland	0.76
Lowland meadows*	Grassland - Lowland meadows	1.42
Traditional orchard*	Cropland - Traditional orchards	0.50
Fens*	Wetland - Fens (upland and lowland)	0.54
Lowland Meadow and Pastures*	Grassland - Lowland meadow	6.21
Industrial or commercial units	Urban - Developed land; sealed surface	0.50

Habitat	Translated habitat to UKHab	Loss to pipeline (ha)
Discontinuous urban fabric	Urban - Suburban/ mosaic of developed/ natural surface	0.54
Sport and leisure facilities	Urban - Amenity grassland	1.7
Moors and heathland	Heathland and shrub - Lowland Heathland	0.18
Arable field margins	Cropland - Arable field margins pollen & nectar	2.65
TOTALS		**355.5**

*Priority Habitat

Satellite imagery was used to approximately calculate the number of hedgerows the pipeline route intersects. The estimated intersections were calculated at 288 which was multiplied by the proposed work area of $8m^2$.

Table 20 - Estimated maximum km of direct hedgerow loss within pipeline

Habitat	Translated habitat to UKHab	Loss to pipeline (km)
Hedgerow	Native species rich hedgerow	5.76
TOTALS		**5.76**

Applying the DEFRA Biodiversity Metric to the habitat areas in **Table 16 & 17** results in the following biodiversity units that could be lost to development in the absence of any mitigation (**Table 18**). Where priority habitats could be added into the metric calculations a habitat condition of 'good' was used to distinguish between non-priority habitats with an overlapping metric habitat.

Table 21 - Indicative biodiversity units potentially lost within pipeline (post re-instatement)

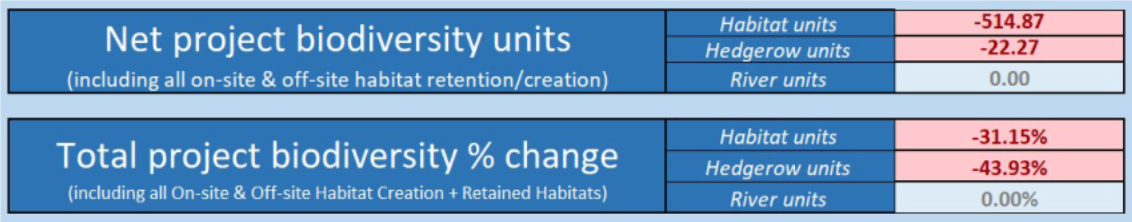
Habitat	Translated habitat to UKHab	Metric Units	Proposed habitat mitigation
Non-irrigated arable land	Cropland - Cereal crops	482.53	Neutral grassland enhancement
Pastures	Grassland - Other neutral grassland	933.68	Neutral grassland enhancement
Broadleaved woodland	Woodland and forest - Other woodland; broadleaved	27.28	Grassland succession
Mixed forest	Woodland and forest - Other woodland; mixed	10.65	Grassland succession
Conifer	Woodland and forest - Other coniferous woodland	0.09	Grassland succession
Coastal and floodplain grazing marsh*	Grassland - Other neutral grassland	73.4	Neutral grassland enhancement
Deciduous woodland*	Woodland and forest - Other woodland; broadleaved	0.66	Grassland succession

Habitat	Translated habitat to UKHab	Metric Units	Proposed habitat mitigation
Good quality semi-improved grassland*	Grassland - Other neutral grassland	73.26	Neutral grassland enhancement
Lowland calcareous grassland*	Grassland - Lowland calcareous grassland	16.55	Calcareous grassland enhancement
Lowland meadows*	Grassland - Lowland meadows	N/A Bespoke Compensation Strategy Required	N/A
Traditional orchard*	Cropland - Traditional orchards	10.89	Traditional orchard creation
Fens*	Wetland - Fens (upland and lowland)	N/A Bespoke Compensation Strategy Required	N/A
Lowland Meadow and Pastures*	Grassland - Lowland meadow	N/A Bespoke Compensation Strategy Required	N/A
Industrial or commercial units	Urban - Developed land; sealed surface	0.00	N/A
Discontinuous urban fabric	Urban - Suburban/ mosaic of developed/ natural surface	2.38	Neutral grassland enhancement
Sport and leisure facilities	Urban - Amenity grassland	7.48	Neutral grassland enhancement
Moors and heathland	Heathland and shrub - Lowland Heathland	2.38	Heathland creation
Arable field margins	Cropland - Arable field margins pollen & nectar	11.66	Neutral grassland enhancement
Hedgerow	Native species rich hedgerow	50.69	Hedgerow creation

*Priority Habitat

One assumption made during the calculation was that all pipeline habitat loss would be temporary and habitat would be reinstated after construction, either naturally or re-created. **Figure 4** shows the net biodiversity unit lost based on this assumption. Mitigation will be still required to achieve biodiversity net gain

Figure 4 – Biodiversity deficit (post re-instatement)



Lowland meadows and fens are identified as being an unacceptable loss within the DEFRA Metric. It is therefore not considered further within the Metric calculations. However a bespoke compensation strategy will need to be provided if these habitats are lost with consultation with Natural England. This can present challenges in habitat creation and identifying suitable locations. The first stage of the mitigation hierarchy is to avoid and therefore this should be a key consideration within the design.

The results for the river metric calculations are within the summary table in Annex A1vii.

Pipeline conveyance, Deerhurst to Culham – Net Gain Opportunities

To achieve 10% biodiversity net-gain there are opportunities locally for the following habitat enhancement and creation shown in Tables 22-24. Tables 22 and 23 show for each habitat type impacted by the scheme, the area (hectares/km) of habitat enhancement or creation required, the metric units that this achieves and the strategic location of where this could be delivered. As stated in the methodology the majority of habitats were assumed to be in moderate condition for an 10% for habitats. Hectarage required can be halved if habitats are assumed to be in poor condition. To achieve a 14.07% hedgerow net gain the following creation will be required, see Table 23.

Table 22. Required habitat mitigation for 10% BNG

Habitat	Creation or Enhancement	Hectarage	Metric Units Gained	Strategic land identified for delivery
Grassland - Other neutral grassland	Enhancement (poor condition to moderate condition)	135	1130.69	944ha of neutral grassland identified in 'Biodiversity South West' nature map.
Heathland and shrub - Lowland Heathland	Enhancement (moderate condition to good condition)	2	36.32	Over 1000ha of upland heathland identified in 'Biodiversity South West' nature map.
Grassland - Lowland calcareous grassland	Enhancement (moderate condition to good condition)	5	83.24	Suitable grassland available in Oxfordshire Nature Recovery Network (Over 1600ha of habitat creation land identified)
Traditional Orchard	Creation (moderate condition)	5	33.84	Suitable habitat available for orchard planting in Oxfordshire Nature Recovery Network (Over 1600ha

Habitat	Creation or Enhancement	Hectarage	Metric Units Gained	Strategic land identified for delivery
				of habitat creation land identified)
Woodland and forest - Other woodland; broadleaved	Creation (grassland succession)	50	261.29	Suitable grassland available in Oxfordshire Nature Recovery Network (Over 1600ha of habitat creation land identified)

Table 23. Required hedgerow mitigation for 10% BNG

Habitat	Creation or Enhancement	Km	Metric Units Gained	Strategic land identified for delivery
Native Species Rich Hedgerow	Creation	5.7	29.40	944ha of neutral grassland identified in 'Biodiversity South West' nature map

Tables 24 and 25 identify opportunities for delivering BNG for rivers, from published information on Priority Rivers for Restoration[2] and Biodiversity Opportunity Areas for relevant counties. Priority Rivers for Restoration are reaches targeted for restoration and the location and length of river reaches within 1km of the scheme are given in Table 24. The data also provided information on whether the restoration related to physical or hydrological opportunities. Table 25 identifies the length of river reaches within BOAs within 1km of the impacted reach. The number of units/km required for 10% BNG for rivers cannot be calculated at present due to errors in the metric 2.0 and in advance of version 3.0, a bespoke solution would need to be agreed with the regulators.

Table 24. Priority River Habitats for Restoration within 1km of impacted reach

Priority river habitat for restoration	WFD reference	Targeted restoration	Length (km)
Ock and tributaries (Land Brook confluences to Thames)	GB106039023430	Hydrological	0.88
Chalvey Ditches	GB106039023550	Hydrological	1.39

Table 25. River Biodiversity Opportunity Areas

Waterbody (within 1km)	Length (km)	County
Severn - conf R Avon to conf Upper Parting	2.12	Gloucestershire
Isbourne - source to conf R Avon	0.58	Gloucestershire
Coln (Source to Coln Rogers)	8.46	Gloucestershire
Radcot Cut	0.39	Oxfordshire
Thames (Leach to Evenlode)	1.49	Oxfordshire
Childrey Brook and Norbrook at Common Barn	1.5	Oxfordshire
Ock and tributaries (Land Brook confluence to Thames)	2.438	Oxfordshire
Cow Common Brook and Portobello Ditch	0.414	Oxfordshire
Frilford and Marcham Brook	0.54	Oxfordshire
Thames (Evenlode to Thame)	0.5	Oxfordshire

[2] https://data.gov.uk/dataset/e0165747-8368-4ff7-a644-df9aeb27bb0b/priority-habitat-creation-and-restoration

Netheridge STW effluent diversion – Net Loss

Netheridge STW effluent diversion (35Mld)

Table 33 - Estimated maximum areas of direct terrestrial habitat loss within pipeline

Habitat	Translated habitat to UKHab	Loss to pipeline (ha)
Non-irrigated arable land	Cropland - Cereal crops	23.09
Pastures	Grassland - Other neutral grassland	5.08
Broadleaved woodland	Woodland and forest - Other woodland; broadleaved	5.29
Coastal and floodplain grazing marsh*	Grassland - Other neutral grassland	4.32
Deciduous woodland*	Woodland and forest – Lowland mixed deciduous woodland	0.30
Good quality semi-improved grassland*	Grassland - Other neutral grassland	0.59
Traditional orchard*	Cropland - Traditional orchards	0.52
Industrial or commercial units	Urban - Developed land; sealed surface	2.71
Discontinuous urban fabric	Urban - Suburban/ mosaic of developed/ natural surface	4.81
Moors and heathland	Heathland and shrub – lowland heathland	1.81
Arable field margins	Cropland - Arable field margins pollen & nectar	0.5
TOTALS		**49.02**

*Priority Habitat

Satellite imagery was used to approximately calculate the number of hedgerows the pipeline route intersects. The estimated intersections were calculated at 92 which was multiplied by the proposed work area of 20m^2.

Table 34 - Estimated maximum km of direct hedgerow loss within pipeline

Habitat	Translated habitat to UKHab	Loss to pipeline (km)
Hedgerow	Native species rich hedgerow	1.84
TOTALS		**1.84**

Applying the DEFRA Biodiversity Metric to the habitat areas in **Table 26 & 27** results in the following biodiversity units that could be lost to development in the absence of any mitigation (**Table 28**). Where priority habitats could be added into the metric calculations a habitat condition of 'good' was used to distinguish between non-priority habitats with an overlapping metric habitat.

Table 35 - Indicative biodiversity units potentially lost within pipeline (post re-instatement)

Habitat	Translated habitat to UKHab	Metric Units	Proposed habitat mitigation
Non-irrigated arable land	Cropland - Cereal crops	55.88	Neutral grassland enhancement
Pastures	Grassland - Other neutral grassland	44.70	Neutral grassland enhancement
Broadleaved woodland	Woodland and forest - Other woodland; broadleaved	46.55	Grassland succession
Coastal and floodplain grazing marsh*	Grassland - Other neutral grassland	38.02	Neutral grassland enhancement
Deciduous woodland*	Woodland and forest – Lowland mixed deciduous woodland	4.36	Grassland succession
Good quality semi-improved grassland*	Grassland - Other neutral grassland	5.19	Neutral grassland enhancement
Traditional orchard*	Cropland - Traditional orchards	7.55	Traditional orchard creation
Industrial or commercial units	Urban - Developed land; sealed surface	0.00	N/A
Discontinuous urban fabric	Urban - Suburban/ mosaic of developed/ natural surface	21.16	Neutral grassland enhancement
Moors and heathland	Heathland and shrub – lowland heathland	26.28	Heathland creation
Arable field margins	Cropland - Arable field margins pollen & nectar	2.20	Neutral grassland enhancement
Hedgerow	Native species rich hedgerow	16.19	Hedgerow creation

*Priority Habitat

One assumption made during the calculation was that all pipeline habitat loss would be temporary and habitat would be reinstated after construction, either naturally or re-created. **Figure 6** shows the net biodiversity unit lost based on this assumption. Mitigation will be still required to achieve biodiversity net gain.

Figure 6 – Biodiversity deficit (post re-instatement)

Net project biodiversity units (including all on-site & off-site habitat retention/creation)		
	Habitat units	-101.04
	Hedgerow units	-7.11
	River units	0.00
Total project biodiversity % change (including all On-site & Off-site Habitat Creation + Retained Habitats)		
	Habitat units	-40.11%
	Hedgerow units	-43.93%
	River units	0.00%

The results for the river metric calculations are within the summary table in Annex A1vii.

Netheridge STW effluent diversion – Net Gain Opportunities

To achieve 10% biodiversity net-gain there are opportunities locally for the following habitat enhancement and creation shown in Tables 39-38. Tables 36 and 37 show for each habitat type impacted by the scheme, the area (hectares/km) of habitat enhancement or creation required, the metric units that this achieves and the strategic location of where this could be delivered. As stated in the methodology the majority of habitats were assumed to be in moderate condition for an 11.33% for habitats. Hectarage required can be halved if habitats are assumed to be in poor condition. To achieve an 10.22% hedgerow net gain the following creation will be required, see Table 37.

Table 36. Required habitat mitigation for 10% BNG

Habitat	Creation or Enhancement	Hectarage	Metric Units Gained	Strategic land identified for delivery
Grassland - Other neutral grassland	Enhancement (poor condition to good condition)	25	209.39	Over 1000ha of grassland identified in 'Biodiversity South West' nature map.
Traditional Orchard	Creation (moderate condition)	1	7.44	944ha of neutral grassland identified for orchard planting in 'Biodiversity South West' nature map.
Woodland and forest - Other woodland; broadleaved	Creation (grassland succession)	10	52.26	Over 1000ha of grassland identified in 'Biodiversity South West' nature map.
Heathland and shrub – lowland heathland	Creation (moderate condition)	5	12.28	Over 1000ha of upland heathland identified in 'Biodiversity South West' nature map.

Table 37. Required hedgerow mitigation for 10% BNG

Habitat	Creation or Enhancement	Km	Metric Units Gained	Strategic land identified for delivery
Native Species Rich Hedgerow	Creation	1.7	8.77	944ha of neutral grassland identified in 'Biodiversity South West' nature map

Table 38 identifies opportunities for delivering BNG for rivers, from published information on Biodiversity Opportunity Areas. No Priority Rivers for Restoration[3] were identified within 1km of the impacted reaches. The number of units/km required for 10% BNG for rivers cannot be calculated at present due to errors in the metric 2.0 and in advance of version 3.0, a bespoke solution would need to be agreed with the regulators.

Table 38. River Biodiversity Opportunity Areas

Waterbody (within 1km)	Length (km)	County
Severn (E Channel) - Horsebere Bk to Severn Est	1.14	Gloucestershire
Leadon - conf Preston Bk to conf R Severn (W Channel)	0.39	Gloucestershire
Severn - conf R Avon to conf Upper Parting	6.68	Gloucestershire
Horsebere Bk - source to conf R Severn	2.53	Gloucestershire
Wotton Bk - source to conf Horsebere Bk	0.96	Gloucestershire
Hatherley Bk - source to conf R Severn	3.03	Gloucestershire
Chelt - M5 to conf R Severn	1.42	Gloucestershire
Leigh Bk - source to conf R Chelt	0.65	Gloucestershire

[3] https://data.gov.uk/dataset/e0165747-8368-4ff7-a644-df9aeb27bb0b/priority-habitat-creation-and-restoration

A7 Data Sources

Priority River Habitat:

Natural England maps: https://naturalengland-defra.opendata.arcgis.com/datasets/priority-river-habitat-rivers-england/data?geometry=-3.756%2C52.469%2C-1.615%2C52.761

River with water crowfoot:

NBN data for records of water crowfoot was used, from data sources for the 3 habitats (stream, river, floating). https://nbn.org.uk/the-national-biodiversity-network/archive-information/nbn-gateway/ JNCC holds data on SACs H3260 - Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation but this cannot be readily linked to watercourses and Defra Open Data holds information on the WFD macrophyte classification UK distribution maps, which lack the detail required for the River Cycle 2 River Macrophyte Classification

Naturalness:

River Naturalness Assessment - this interactive map shows locations of priority river habitats and overall naturalness score on a scale of 1-5. The data for Naturalness classes is provided for a range of attributes, such as hydrological integrity, ecological integrity. For Naturalness classes 1 and 2 the data includes an 'overall naturalness score', which has been used for this assessment. The Naturalness classes 3 and 4, which are for headwater streams, do not have an overall score. The data is provided as an urban class and semi-natural class, where the data for the semi-natural class has been used for this assessment, as we are assessing loss of natural habitat:

Class 1 and 2 River Naturalness Assessment within the Priority River Habitat layer: https://environment.data.gov.uk/dataset/39c267c0-5014-4e34-85f8-2318c4c74787 .

Class 3 - 5: In attribute table of headwater areas shapefile https://naturalengland-defra.opendata.arcgis.com/datasets/priority-river-habitat-headwater-areas-england/data?geometry=-2.987%2C51.802%2C-0.846%2C52.099

Headwater streams:

headwater areas shapefile https://naturalengland-defra.opendata.arcgis.com/datasets/priority-river-habitat-headwater-areas-england/data?geometry=-2.987%2C51.802%2C-0.846%2C52.099

Chalk rivers:

Chalk rivers layer on the Defra data portal: https://data.gov.uk/dataset/f478556e-9eb5-4d4a-a0c6-78654860ebda/chalk-rivers .

Shingle rivers:

Active shingle river (Headwater streams). Used the Priority river habitat in England - mapping and targeting measures report. Overlaid image onto Google Earth and converted to shapefile for use in QGIS:
http://publications.naturalengland.org.uk/publication/6266338867675136#:~:text=Priority%20river%20habitat%20in%20England%20%E2%80%93%20mapping%20and,naturalness%20and%20natural%20processes%20as%20the%20primary%20criterion .

River and streams (other)

Everything that doesn't qualify for the above.

Canals.

WFD classifications and CRT data portal: https://data-canalrivertrust.opendata.arcgis.com/

T: +44 (0) 1235 753000
E: enquiry@ricardo.com
W: ee.ricardo.com