Strategic Regional Water Resource Solutions: Annex B4.2: Informal Habitats Regulation Assessment (HRA)

Standard Gate Two Submission for River Severn to River Thames Transfer (STT)

Date: November 2022

Severn to Thames Transfer

Informal habitats regulation assessment (HRA)

STT-G2-S3-121

November 2022

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to Thames Water's, Severn Trent Water's and United Utilities' statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Thames Water, Severn Trent Water and United Utilities will be subject to the statutory duties pursuant to the necessary consenting processes, including environmental assessment and consultation as required. This document should be read with those duties in mind.

SEVERN THAMES TRANSFER (STT) SOLUTION

Informal Habitats Regulations Assessment Report

Ricardo ref. ED15323 Issue: 005 11/10/2022

Ricardo Energy & Environment, Gemini Building, Fermi Avenue, Harwell, Oxfordshire, OX11 0QR, UK | +44(0)1235 75 3000 | ee.ricardo.com
Registered company no. 08229264 | VAT no. GB 212 8365 24

CONTENTS

List of Figures

List of Tables

Glossary and Abbreviations

Glossary and Abbreviations	
Glossary	
Cotswold Canals	Partially refurbished canal network and associated infrastructure (including pumping stations, bypass pipework, treatment plant and pipeline) with design capacity of 300Ml/d to convey river water from River Severn to River Thames.
Deerhurst Pipeline	Pipeline and associated infrastructure (including pump station, treatment plant, break pressure tank) with design capacity of 300/400/500Ml/d to convey river water from River Severn to River Thames.
Hands off Flow	This is the flow below which abstractions from the River Severn are restricted or not permitted
Interconnector	Term used to describe infrastructure required to convey river water from River Severn to River Thames. The Interconnector options are the Deerhurst Pipeline or Cotswold Canals.
Interconnector design capacity	Raw water volume abstracted from the River Severn at the start of the Interconnector. Not the volume delivered to the River Thames at the end of the Interconnector and not the Deployable Output of the STT system.
Minworth SRO	Minworth WwTW effluent transfer to the River Avon (covered under Severn Trent Water (STW) Minworth SRO developed by Severn Trent and Affinity Water). This has the capacity to release up to 115Ml/d into the River Avon.
Mythe Abstraction Licence	Mythe Water Treatment Works (WTW) source support element (covered under Severn Trent Sources SRO developed by STW). Unused abstraction licence transfer has the capacity to release 15Ml/d into the River Severn.
Netheridge Wastewater Treatment Works	Netheridge Wastewater Treatment Works (WwTW) source support element (covered under Severn Trent Sources SRO developed by STW). Effluent diversion has the capacity to release up to 35Ml/d into the River Severn.
Plan pathway	A pathway within an adaptive plan.
Preferred options	The set of water resources options included in the preferred plan.
Preferred plan	Comprises a set of options and a schedule of dates for implementing these options. These options have been selected through the planning process and evidence provided as to why they perform better against the objectives of the plan. Sometimes also referred to as the preferred programme of options.
Revised feasible options	A subset of the feasible options, post AIC cuts which are considered in more detail through the decision making process. The list of revised feasible options is generated by high level screening.
Shrewsbury Redeployment	Shrewsbury Redeployment is facilitated by a supply from the Oswestry WTW. This allows the reduction in the abstraction at Shelton WTW of 25Ml/d.
Source support elements	Elements which have the potential to make additional raw water resources available for abstraction at the start of the Interconnector.
STT partners	The three companies promoting this SRO i.e. Severn Trent Water, United Utilities and Thames Water
STT SRO	Comprises the Interconnector, the River Vyrnwy Bypass Pipeline, Shrewsbury Redeployment and conveyance of the source support elements through the river systems (Vyrnwy, Severn, Avon, and Thames).
STT system	Comprises the STT SRO plus STT source support elements that together form an operational system.
STT system operating strategy	Description of contribution/operation of source support elements and river systems to form an operational system.
Supported flow	When the flow in the River Severn is below the hands-off flow rate at which point abstraction from the River Severn may lead to unacceptable environmental impacts downstream. To mitigate these environmental impacts a permitting strategy is being developed whereby additional water put into the River Severn can be abstracted for a Severn to Thames transfer. The additional water is referred to as Supported flow

Unconstrained list of options	All the possible options that could reasonably be used in the plan. This will include all the options considered in the previous planning round, as well as any options that have been identified since.
Unsupported flow	Unsupported flow occurs when the flow in the River Severn is above the hands-off flow rate and raw water can be freely abstracted from the River Severn for transfer to the River Thames
Vyrnwy Mitigation – River Vyrnwy Bypass Pipeline	Pipeline from the Oswestry Water Treatment Works to the River Severn. The release of partially treated water via the bypass pipeline is a mitigation measure to the River Vyrnwy from the Vyrnwy Release source support element. The pipeline has the capacity to convey up to 155Ml/d.
Vyrnwy Release	Lake Vyrnwy source support element (covered under North West Transfer SRO developed by United Utilities). This source has a capacity of up to 180Ml/d. A direct release of 25Ml/d into River Vyrnwy.
Water Resource Zone	Section 4.4. of the draft WRPG defines a water resource zone as “an area within which the abstraction and distribution of water to meet demand is largely self-contained (with the exception of agreed bulk transfers)”.
Abbreviations	
1880 Act	The Liverpool Corporation Act 1880 which authorises the discharge of compensation water from the Vyrnwy Reservoir into the River Vyrnwy
ACWG	All Company Working Group
AEoI	Adverse Effect on Integrity
AMP	Asset Management Plan
BNG	Biodiversity Net Gain
CAPEX	Capital Expenditure
DCO	Development Consent Order
DO	Deployable Output
DWI	Drinking Water Inspectorate
EA	Environment Agency
EIA	Environmental Impact Assessment
HoF	Hands off Flow
HRA	Habitats Regulations Assessment
IEA	Initial Environmental Appraisal
INNS	Invasive Non-Native Species
Ml	Mega litres
Ml/d	Mega litres per day
NC	Natural Capital
NE	Natural England
NPV	Net Present Value
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
NWT	North West Transfer SRO
OPEX	Operational Expenditure
RAPID	Regulatory Alliance for Progressing Infrastructure Development
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SMNR	Sustainable Management of Natural Resources
SRO	Strategic Resource Option
STT	River Severn to River Thames Transfer
STW	Severn Trent Water
SWQRA	Strategic Water Quality Risk Assessment
T2AT	Thames to Affinity Transfer
T2ST	Thames to Southern Transfer
TW	Thames Water
UU	United Utilities
WFD	Water Framework Directive
WRMP	Water Resource Management Plan
WRSE	Water Resources South East
WRW	Water Resources West
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works

1. INTRODUCTION

1.1 BACKGROUND AND DESCRIPTION OF THE STT SCHEME

1.1.1 The River Severn to River Thames Transfer Description

The aim of this strategic resource solution is to provide additional raw water resources of 300 to 500Ml/d to the South East of England during drought, with 500Ml/d preferred by the Water Resource South East (WRSE) regional plan public consultation. The water would be provided from flows in the River Severn and transferred via an interconnector to the River Thames. For the completion of the Gate 2 assessment, a pipeline "Interconnector" has been selected as the preferred option to transfer water from the River Severn to the River Thames.

Due to the risk of concurrent low flow periods in both river catchments, additional sources of water, apart from those naturally occurring in the River Severn, have been identified to augment the baseline flows. These multiple diverse sources of additional water provide resilience in the provision of raw water transfer to the River Thames. A 'put and take' arrangement has been agreed in principle with the Environment Agency (EA) and Natural Resources Wales (NRW) which means that if additional source water is 'put' into the river, then the Interconnector can 'take' that volume, less catchment losses, regardless of the baseline flows in the River Severn itself.

The regional planning process will determine the volume, timing, and utilisation of water to be transferred. The diversity of sources means they can be developed in a phased manner to meet the ultimate demand profile as determined by the regional planning. These additional sources of water are being provided by United Utilities (UU) and Severn Trent Water (STW) who are working in collaboration with Thames Water (TW) to develop STT solution. The additional sources are:

- **Vyrnwy Reservoir**: Release of 25Ml/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy;
- **Vyrnwy Reservoir**: Utilisation of 155Ml/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline ("Vyrnwy Bypass") to the River Severn;
- **Shrewsbury**: Diversion of 25Ml/d treated water from UU's Oswestry Water Treatment Works (WTW) via an existing emergency transfer (the Llanforda connection), thus enabling a reduction in abstraction from the River Severn at Shelton WTW to remain in the River Severn for abstraction at Deerhurst;
- **Mythe**: 15Ml/d of the STW licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst;
- **Minworth**: The transfer of 115Ml/d of treated wastewater discharge from STW's Minworth Wastewater Treatment Works (WwTW) via a pipeline, to the River Severn via the River Avon at Stoneleigh; and
- **Netheridge**: The transfer of 35Ml/d of treated wastewater discharge at STW's Netheridge WwTW to the River Severn at Haw Bridge, via a pipeline, upstream of the current discharge to the River Severn.

The STT Gate 1 submission was assessed by the Regulators' Alliance for Progressing Infrastructure Development (RAPID) who concluded that it should progress to Gate 2. The recommendations and actions received from RAPID and feedback from Stakeholders from the Gate 1 process have been reflected in the scheme development and environmental assessments.

1.1.2 Gate 2

RAPID issued a guidance document[1] in April 2022 to describe the Gate 2 process and set out the expectations for solutions at standard Gate 2.

[1] RAPID (2022) Strategic regional water resource solutions guidance for gate two

The guidance stated the environmental assessment methodologies should be consistent with any relevant legislation and guidance and follow best practice. This includes, where relevant, WRMP24, All Company Working Group (ACWG) guidance[2] and the EA Invasive Non-native Species risk assessment tool.

Figure 1.1 shows the investigations undertaken for STT Gate 2 and their interactions, in order to show the full scope of work across both environmental and engineering disciplines. Reporting for the environmental investigations has been undertaken in a phased way to account for, and incorporate all previous assessments, data collection and feedback: (i) the evidence reports were produced first, and set out the data and evidence to be used in the assessment; (ii) assessment reports were then produced using the evidence to determine the potential effect of the STT solution on the physical environment, water quality and ecological receptors (dark blue box in in Figure 1.1); (iii) based on the evidence and assessments, the statutory reports and assessments required to meet the RAPID and regulatory expectations for solutions at Gate 2 were produced.

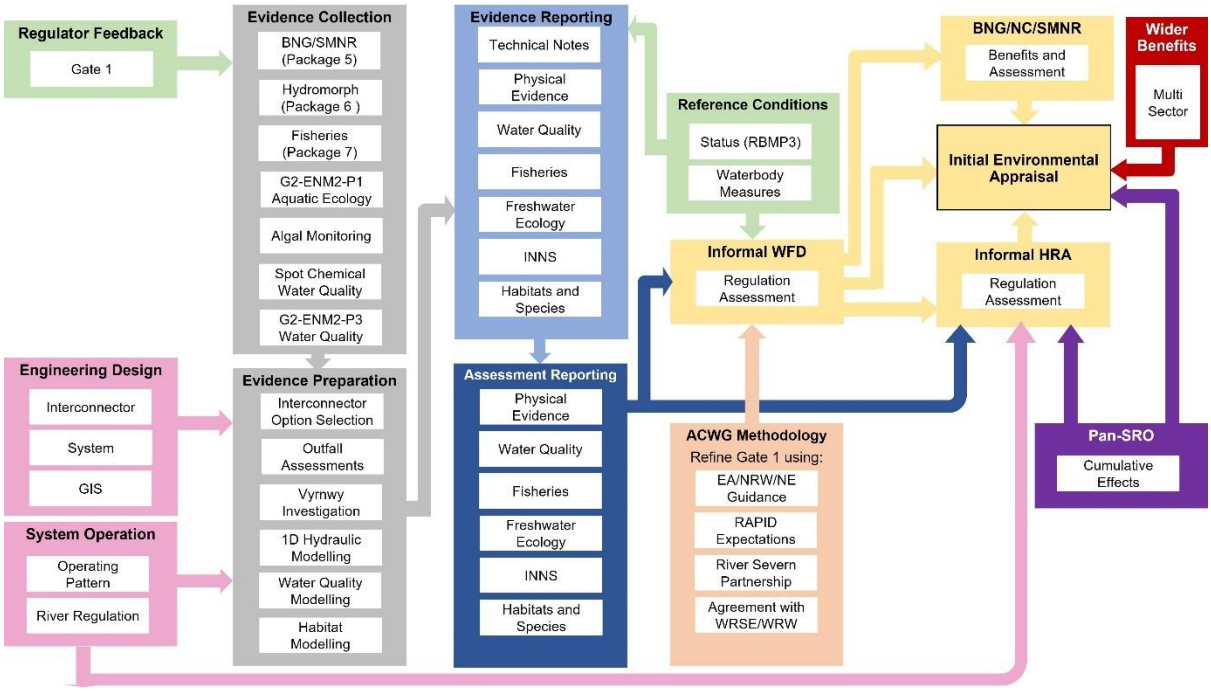

Figure 1.1 Flow chart showing the scope of investigations for STT Gate 2 and their interactions

1.2 STUDY AREA

The operational study area for the STT solution for Gate 2 assessment covers specific reaches, as shown in **Figure 1.2**:

1. The River Vyrnwy catchment (River Vyrnwy from Vyrnwy Reservoir to the confluence with the River Severn);
2. The River Severn catchment (River Severn from the confluence with the River Vyrnwy to the Severn Estuary), as well as those tributaries of the River Severn which could indirectly be affected by the operation of the STT solution;
3. The Warwickshire River Avon upstream of Warwick to the River Severn confluence; and
4. The River Thames catchment (River Thames from Culham to Teddington Weir)

[2] All Companies Working Group (2020) WRMP environmental assessment guidance and applicability with SROs

It should be noted that the consideration of impacts in the River Tame and Trent, from the transfer of treated discharge from Minworth WwTW to the River Avon, is included in STW's Minworth SRO and therefore excluded from the STT solution assessment.

Similarly, the STT solution assessment accounts for the effects from the relevant SROs related to the supply of water into the STT system (UU and STW Sources) and therefore includes an assessment of the potential effects of the outfalls from the transfers (Minworth and Netheridge) not the impact of infrastructure construction as included in STW's Minworth and Sources SROs.

The study area of the construction of STT solution at Gate 2 focussed on Vyrnwy Bypass (option 27) and Deerhurst to Culham Interconnector only. The construction of Netheridge and Minworth pipelines are not considered in this HRA as are included in STW's Minworth and Sources SROs.

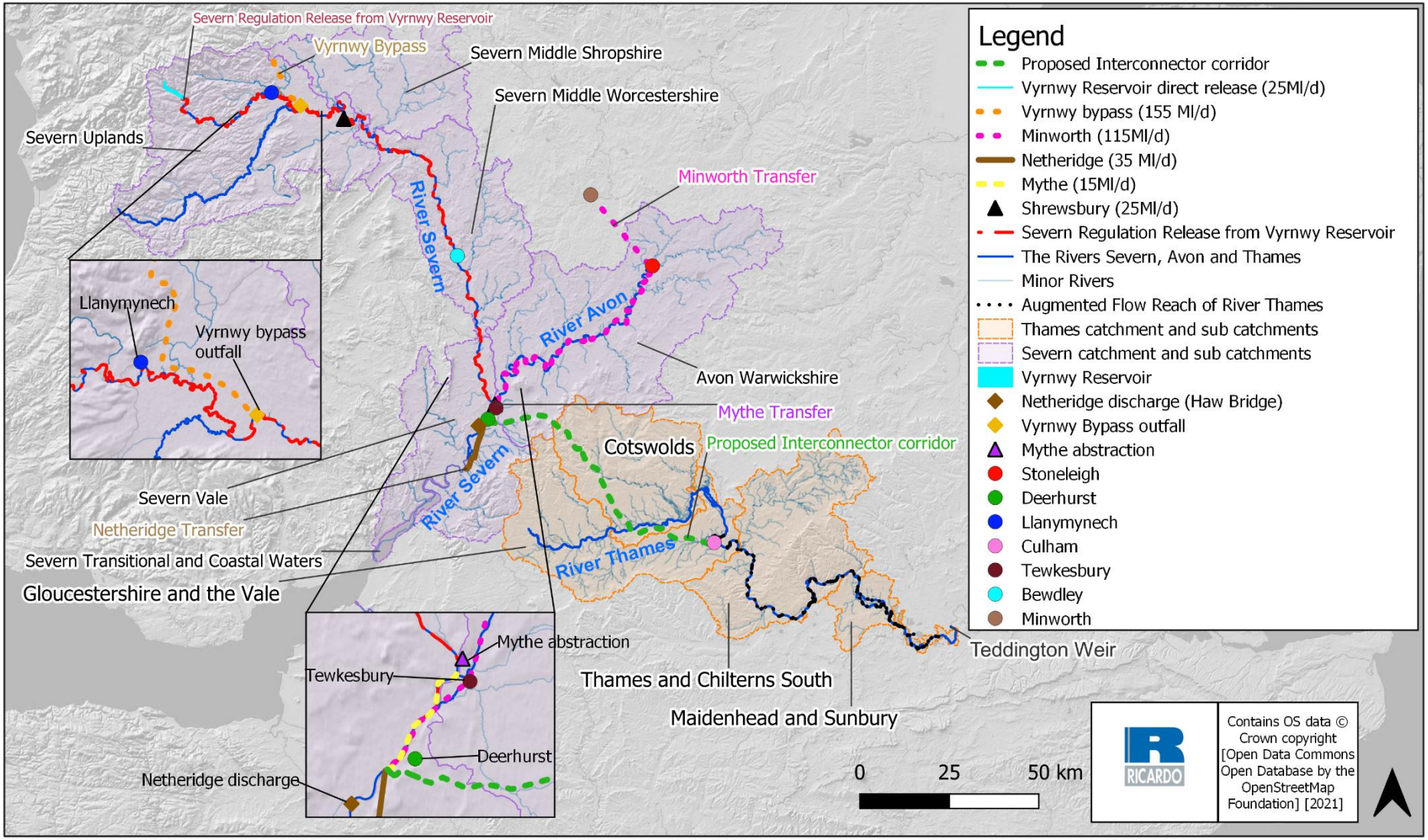

Figure 1.2 Map showing the proposed interconnector corridor

1.3 SUMMARY OF THE SOLUTION COMPONENTS AND OPERATION

The STT solution developed for Gate 2 is described through its engineering components in the Conceptual Design Report. For environmental assessment purposes, as these relate to in-river physical environment effects, the solution has been split into two phases, with and without support, described as (i) an *early phase* of the STT solution, which is without the inclusion of most of the support options that augment flow in the River Severn, and (ii) a *full STT* solution, which includes all the support options. The river flow changes that comprise these two phases are set out in Table 1-1.

Supporting options would be operational at those times when the STT is transferring water from the River Severn to the River Thames, and when flows in the River Severn are lower than hands-off flow (HoF) thresholds in the River Severn. The EA has advised that a STT abstraction licence would be imposed so flows at Deerhurst flow gauging station do not drop below 2,568Ml/d. Above this HoF, there is a maximum abstraction limit of 172Ml/d, up to the next HoF condition of 3,333Ml/d, where 335Ml/d can be abstracted, in addition to the available 172Ml/d unsupported[3]. This is summarised in Table 1-2.

The EA has advised the STT Group of appropriate values of "in-river losses" to include in the hydraulic modelling[4] and subsequent environmental assessments. The advised values[5] include a 20% loss in the River Vyrnwy and a 10% loss for water transferred into the River Avon, in the augmented flow reach between Stoneleigh and the River Severn confluence at Tewkesbury, with the loss occurring evenly over the distance. As such, of the total 370Ml/d augmenting flows into the River Severn catchment for full STT, the equivalent re-abstraction value at Deerhurst used for the environmental assessment is 353Ml/d as represented in Figure 1.3

Table 1-1 Components of Early Phase and Full STT Operation

Early Phase STT	Full STT
500Ml/d interconnector pipeline.	500Ml/d interconnector pipeline
Part-time, *unsupported* abstraction up to 500Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, subject to hands-off flow (HoF) conditions identified by the EA.	Part-time, *unsupported* abstraction up to 500Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, subject to HoF conditions identified by EA
Part-time, *supported* abstraction up to 35Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, at flows constrained by HoF conditions, provided by 35Ml/d flow volume from the Netheridge Transfer.	Part-time, supported abstraction up to 353Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, at flows constrained by HoF conditions, and accounting for assumed river transfer losses. Flow provided by UU and STW sources. The order in which these sources are utilised has been determined by optimising the engineering solution and through the regional water resilience modelling by Water Resource South East (WRSE): 1. **Vyrnwy Reservoir:** Release of 25Ml/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy; 2. **Vyrnwy Reservoir**: Utilisation of 155Ml/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline ("Vyrnwy Bypass") to the River Severn; 3. **Shrewsbury**: Diversion of 25Ml/d treated water from UU's Oswestry Water Treatment Works (WTW) via an existing emergency transfer (the Llanforda connection), thus enabling a reduction in abstraction from the River Severn at Shelton WTW to remain in the River Severn for abstraction at Deerhurst; 4. **Mythe**: 15Ml/d of the Severn Trent Water (STW) licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst;

[3] Email from Caroline Howells (Environment Agency Environment Planning Officer) to Peter Blair (Thames Water, Water Resources Modelling Specialist) 27 February 2020.

[4] Email from Alison Williams (Environment Agency Senior Water Resources Officer) to Helen Gavin (Ricardo) and Valerie Howden (HRW) on 10 February 2022.

[5] Note that these are temporary values: further work to explore the factors affecting loss is ongoing.

Early Phase STT	Full STT
	5. **Minworth**: The transfer of 115Ml/d of treated wastewater discharge from STW's Minworth Wastewater Treatment Works (WwTW) via a pipeline, to the River Severn via the River Avon at Stoneleigh; and 6. **Netheridge**: 15Ml/d of the STW licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst.
Continuous abstraction from River Severn at Deerhurst of 20Ml/d to provide a pipeline maintenance flow, with continuous transfer to River Thames at Culham: • Either unsupported abstraction when not limited by HoF conditions; or • Supported abstraction by flow volume matching from Netheridge Transfer	Continuous abstraction from River Severn at Deerhurst of 20Ml/d to provide a pipeline maintenance flow, with continuous transfer to River Thames at Culham: • Either unsupported abstraction when not limited by HoF conditions; or • Supported abstraction by flow volume matching from Netheridge Transfer

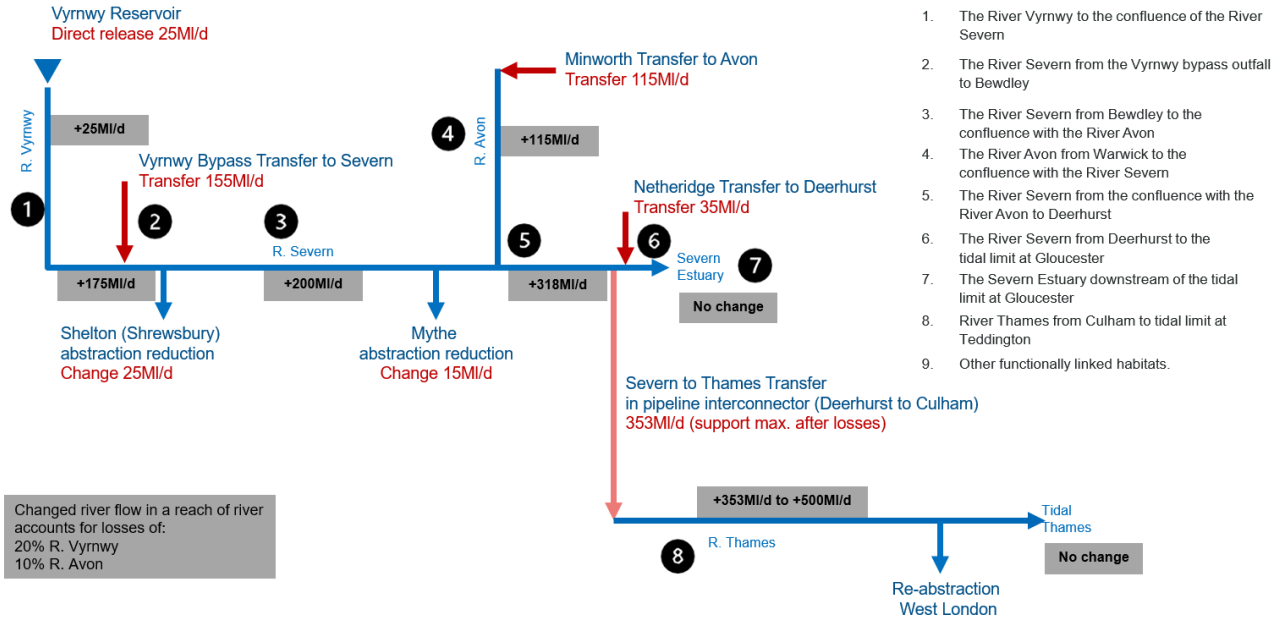

Figure 1.3 Schematic representing flow changes (accounting for losses) of STT Solution

Table 1-2 River Severn at Deerhurst: HoF conditions

HoF	Flow threshold (Ml/d)	Maximum abstraction value at flows greater than the threshold (Ml/d)
1	2,568	172
2	3,333	527

To support the environmental assessments at Gate 2, an indicative operating pattern has been developed. The approach uses the 19,200 year stochastic flow series developed separately for the River Severn catchment for the Water Resources West (WRW) group and for the River Thames catchment for the WRSE group. The stochastic flow series represent contemporary climate conditions and provide information on the return frequency, or regularity, of both the likely river flow conditions and STT operation. The stochastic years have been made available as 48-year continuous periods, and one of those has been selected as having representative flow characteristics to inform the environmental assessments. The selected 48-year series[6]

[6] Note these are 48 calendar years. The environmental assessment period has been selected as a water resources year (1 April to 31 March) and as such the selected period includes 47 water resources years from the 48 calendar years,

includes a suitable range of regular low and moderate low flow periods. It does not include extreme low flows that are considered to be less regular than once every fifty years. This is described further in Section 1.2 of the Physical Environment Assessment Report, with the derived representation of dates with the full STT in operation (for water resources purposes) as used in environmental assessment shown in Figure 1.4. It should be noted that this operating pattern is for the STT solution used on its own for TW, without conjunctive use with other TW SROs (such as SESRO). It also uses the controlling triggers developed by Thames Water for SESRO based on lower River Thames flows and TW's total London reservoir storage.

The general description in Figure 1.4 identifies periods in purple when early phase STT would be in operation, with the combined purple and blue periods associating with full STT. The review of river flows and operating patterns for the environmental assessment has identified that all support options would be on at the same time, rather than any selective or preferential use of support sources. These patterns of river flow and operational need inform the range of likely environmental effects of the scheme. Within these patterns, selected return frequencies have been selected for the detailed assessment including modelling used extensively in the assessments presented for Gate 2. These are a 1:5 return frequency year with moderate-low flows in the River Severn at Deerhurst with a 1:5 return frequency operating pattern in terms of duration and season (model reference A82). Also a 1:20 return frequency year with very low flow years in the River Severn at Deerhurst with a 1:20 return frequency operating pattern in terms of duration and season (model reference M96). Noting the scheme would only be used on a 1:2 return frequency, these capture a suitable range of circumstances and have been discussed and reviewed with the regulators during Gate 2. In addition, a 1:50 return frequency year of extremely low flows in the River Severn at Deerhurst and with a 1:20 return frequency operating pattern in terms of duration and season (model reference N17), has been prepared and reviewed for consideration of scheme resilience.

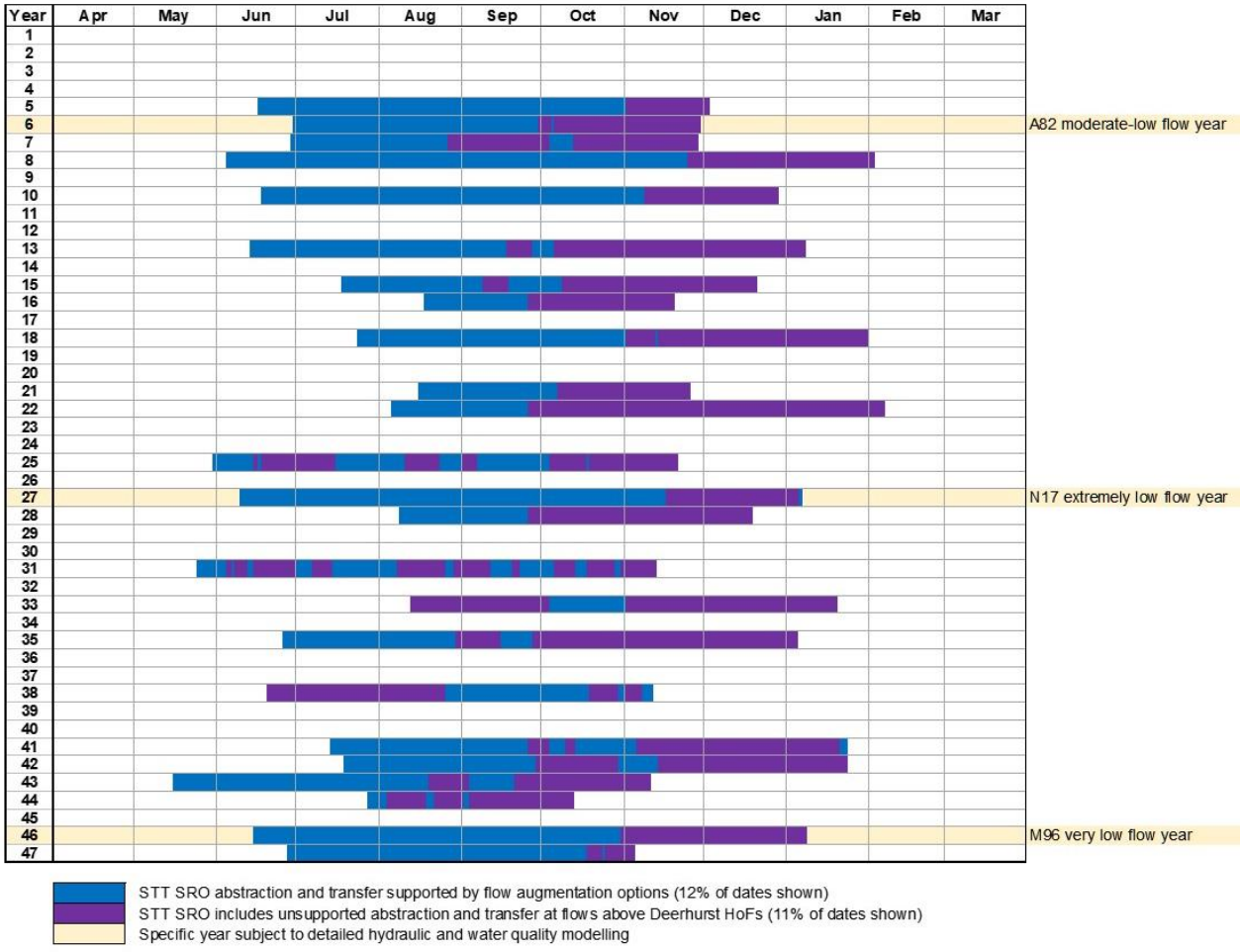

Figure 1.4 Representation of dates full STT solution would be on (for water resources purposes) as used in environmental assessment.

Where: purple indicate periods when the early phase STT would be in operation; and the combined purple and blue periods indicate the full STT.

1.4 LINKS TO OTHER REPORTS

The findings in this report have been informed by Physical Environment Assessment Report[7] (and associated Annex) and the Water Quality Assessment Report[8]. Together, these reports provide an assessment of the impacts on flow, water level, velocity changes and water quality as a result of the operation of the STT solution. The impacts on flow, water level, velocity changes and water quality on the fish, macroinvertebrate and other freshwater ecological features, protected habitats and protected species have also been considered in separate reports and the outcomes of these assessments have also informed this report. Where applicable, the results of the assessments are summarised and/or included in this report.

1.5 SCOPE AND STRUCTURE OF THIS REPORT

This report presents the results of the informal Habitats Regulations Assessment (HRA) screening of Likely Significant Effects (LSE) and information to inform the informal appropriate assessment of the whole STT system, using the best available information from desk studies including modelling outputs, data searches and survey results since Gate 1.

The report is divided into the following sections:

Section 1: This introduction

Section 2: Provides a summary of the requirements for a HRA

Section 3: Provides the methodology adopted for the HRA

Section 4: Provides the results of the informal screening of the whole STT system

Section 5: Provides the information to inform the informal appropriate assessment of the whole STT system

Section 6: Provides an in-combination assessment with other plans and projects

Section 7: Provides conclusions and Recommendations

[7] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Physical Environment Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

[8] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Water Quality Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

2. REQUIREMENTS FOR A HABITATS REGULATIONS ASSESSMENT

In October 2020, the group of Water Companies involved in developing SROs (ACWG), published guidance[9] 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 guidance states that the informal HRA for each SRO should be undertaken in accordance with available guidance for England and Wales and should be based on a precautionary approach as required under the HRA process. The requirement for a HRA is established through the Conservation of Habitats and Species Regulations 2017 (as amended), commonly referred to as the Habitats Regulations, and the Conservation of Offshore Marine Habitats and Species Regulations 2017. These Regulations state that any plan or project which is likely to have a significant effect on a European site (either alone or in-combination with other plans or projects) and is not directly connected with, or necessary for the management of the site, must be subject to an Appropriate Assessment to determine the implications for the site in view of its conservation objectives.

As competent authorities and Plan making authorities[10,11], STW, TW and UU are responsible for undertaking a HRA of STT SRO, to determine if it could have LSEs (in stage 1 *informal* screening) on European sites. Where LSEs cannot be ruled out, a Stage 2 Appropriate assessment has been undertaken. As the STT SRO is not considered as a Plan at Gate 2, the principles of HRA have been adopted and a full HRA will be required for the WRMP24 (plan level) and the consenting process for STT SRO before implementation.

The amended 2017 Habitats Regulations have created a national site network on land and at sea, including both the inshore and offshore marine areas in the UK. The national site network includes:

- existing Special Areas of Conservation (SACs)[12] and Special Protection Areas (SPAs) [13]
- new SACs and SPAs designated under these Regulations

Designated Wetlands of International Importance (known as Ramsar sites[14]) do not form part of the national site network. Many Ramsar sites overlap with SACs and SPAs and may be designated for the same or different species and habitats. For ease of reference through this HRA report, these designations are collectively referred to as “European sites”.

As per Natural England (NE) guidance[15], any HRA should also consider any European Marine Protected Areas within England’s inshore waters (out to 12 nautical miles) to support sites in achieving conservation objectives and to guide effective management. No MPAs of European importance or Marine Conservation Zones are associated with the study area and therefore, no further consideration is required.

As per the latest RAPID guidance a full HRA for a solution is not required until a planning and/or permit application is made (or its equivalent, for example, a Development Consent Order). However, the *principles* of the HRA process are applied during the gated process to identify *risks* to feasibility and deliverability of

[9] Mott MacDonald Limited (2020). All Companies Working Group WRMP environmental assessment guidance and applicability with SROs. Published October 2020

[10] UK Government (2021). Habitats regulations assessments: protecting a European site. Accessed from: Habitats regulations assessments: protecting a European site - GOV.UK (www.gov.uk)

[11] Defra (2012). Statement of Obligations, Information for Water and Sewerage Undertakers and Regulators on Statutory Environmental and Drinking Water Provisions Applicable to the Water Sector in England. 1 – 41. Accessed from: www.defra.gov.uk/environment/quality/water/industry/

[12] Special Areas of Conservation (SACs) are strictly protected sites designated under the EC Habitats Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). www.jncc.org.uk

[13] Special Protection Areas (SPAs) are strictly protected sites classified in accordance with Article 4 of the EC Directive on the conservation of wild birds (79/409/EEC), also known as the Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds, listed in Annex I to the Birds Directive, and for regularly occurring migratory species. www.jncc.org.uk

[14] Ramsar sites are wetlands of international importance designated under the Ramsar Convention

[15] Help Note: Tips and advice on how to assess potential impacts of water company statutory plans on the marine environment – Focussing on Marine Conservation Zones.

the schemes (alone and in-combination), as part of an informal HRA. As such, there is no competent authority undertaking the integrity test.

HRA Guidance for the appraisal of Plans[16] summarises the Habitats Regulations. As the *principles* of the HRA process have been applied to STT SRO, Regulation 63 is considered relevant. Regulation 63 states that the Plan making authority (in this case STW, TW and UU) shall adopt, or otherwise give effect to, the Plan only after having ascertained that it will not adversely affect the integrity of a European site, subject to Regulation 64 of the Habitats Regulations.

Regulation 64 of the Habitats Regulations states:

64. — (1) If the competent authority is satisfied that, there being no alternative solutions, the plan or project must be carried out for imperative reasons of overriding public interest (which, subject to paragraph (2), may be of a social or economic nature), they may agree to the plan or project notwithstanding a negative assessment of the implications for the European site or the European offshore marine site (as the case may be).

(2) Where the site concerned hosts a priority natural habitat type or a priority species, the reasons referred to in paragraph (1) must be either —

(a) reasons relating to human health, public safety or beneficial consequences of primary importance to the environment; or

(b) (b) any other reasons which the competent authority, having due regard to the opinion of the Appropriate Authority, consider to be imperative reasons of overriding public interest.

Best practice guidance[17], as well as RAPID's gate-2 guidance for the environmental assessments of SROs, recommends that if there are no alternative solutions and if, in exceptional circumstances, it is proposed that a Plan be adopted despite the fact that it may adversely affect the integrity of a European site, the HRA will need to address and explain the Imperative Reasons of Overriding Public Interest (IROPI) which the Plan making authority considers to be sufficient to outweigh the potentially adverse effects on the European site(s). Necessary compensatory measures will need to be identified and agreed with the statutory nature conservation body in advance of the Plan being authorised to ensure that the overall coherence of the National Site Network is protected.

3. METHODOLOGY

3.1 INTRODUCTION

The ACWG guidelines indicate that an informal HRA should be undertaken in accordance with available guidance[1819202122232425] and should be based on a precautionary approach as required under the Conservation of Habitats and Species Regulations 2017 (as amended).

The informal HRA required for Gate 2 has been carried out in line with the ACWG current guidance for SRO Environmental Assessment. The requirements and outputs of the assessment are consistent with those in the

[16] Tyldesley, D. & Chapman, C. (2013) The Habitats Regulations Assessment Handbook, November 2020 edition UK: DTA Publications Limited.

[17] Tyldesley, D. & Chapman, C. (2013). The Habitats Regulations Assessment Handbook, February 2021 edition UK: DTA Publications Limited..

[18] Court of Justice for the European Union's ruling on People Over Wind and Sweetman ('Sweetman II') vs Coillte Teoranta, Case C-323/17.

[19] UK Government (2019). Guidance on the use of Habitats Regulations Assessment.

[20] UK Government (2019). Conservation of Habitats and Species Regulations (Amendment) (EU Exit).

[21] Natural England (2020). Guidance on how to use Natural England's Conservation Advice Packages in Environmental Assessments.

[22] Tyldesley, D. & Chapman, C. (2013). The Habitats Regulations Assessment Handbook, February 2021 edition UK: DTA Publications Limited.

[23] Environment Agency and Natural Resources Wales (2017). Water resources planning guideline – April 2017

[24] European Commission (2018). Managing Natura 2000 sites - The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. European Union, 1-86.

[25] Defra (2012). The Habitats and Wild Birds Directives in England and its seas: Core guidance for developers, regulators & land/marine managers.

WRSE Regional Plan Environmental Assessment Methodology Guidance, as well as the WRPG guidance for WRMP24. From Gate 3 onwards the assessment approach will follow the planning and consenting process.

The objective of this informal HRA is to establish whether any of the elements for the STT SRO are likely to have a significant effect on European sites (alone and in combination with each other when forming the STT SRO) before a formal assessment is undertaken as part of the planning and consenting process. In-combination assessments with other SROs, non-SRO options and other plans and projects in regional plans and WRMP24 will be undertaken as part of the relevant regional plan or WRMP24 assessment processes.

As the Gate 2 submission does not form a statutory plan or project, the principles of the HRA process were applied to help identify *risks to feasibility* and deliverability of the elements. A Stage 1 (informal screening) assessment was undertaken as part of the initial screening exercise for each of the elements, and the *risk* of failing the integrity test was reviewed for each element, using the principles of the Stage 2 (informal appropriate) assessment.

3.1.1 Regulator Engagement

In order to engage with regulators over the approach, evidence collection, monitoring programmes, and data analysis for Gate 2, the environmental assessment team have held monthly meetings with the EA, NRW and NE, in addition to topic-specific sessions and workshops with technical specialists. The regulators are asked to provide insights and inputs on specific aspects where needed in order to ensure the work undertaken is as robust as possible.

In the monthly meetings, the programme, progress and deliverables are reviewed; issues are raised for clarification and resolution, and the regulators are asked for their views and advice on different topics or issues.

In the sessions with technical specialists, each of the proposed approaches to the topics and statutory reports have been set out and explained. Drafts of documents have been issued, plus other technical notes, to the regulators to solicit feedback on the proposed approaches. Feedback on the drafts has been used to inform the wider environmental assessment for Gate 2 and finalise the approach and reporting.

3.2 MODELLING

Both the Stage 1 (informal screening) and Stage 2 (informal appropriate assessment) considered the outcomes of the detailed modelling that was undertaken for the Gate 2 assessment of the STT by specialist consultancies. A common set of scenarios across the STT solution was applied to both the River Severn and River Thames catchments for consistency. The selected scenarios enable a comparison of the effects of the operation of the STT solution against the reference condition of no STT solution, including the effects on flow, water level, velocity, depth and water quality.

Following the incorporation of feedback from the environmental regulators in Gate 1, scenarios were selected to address STT solution operation in the following way:

- In a range of increasing severity of low flow years
- Under a range of future climate conditions
- Showing change from natural flow conditions
- For a pattern of STT solution operation, as identified by WRSE.

For hydraulic and in-channel habitat modelling, each model scenario covered 365 days from 1 April to 31 March (a water year).The in-river environmental modelling assessments have been undertaken through a range of different scenarios representing (a) appropriate reference conditions without STT, and (b) with the inclusion of the Gate 2 STT scheme components based on the understanding of the likely operational pattern presented in Section 1.3 above. The scenarios, reference conditions and purpose of the modelling work is summarised in Table 3-1.

The 1D hydraulic model output, available throughout the study reaches, includes location-specific daily flow, water level, wetted area and depth-average velocity. Model output locations are throughout the modelled study area of the River Vyrnwy, River Severn, River Avon, River Thames and River Severn flows to the Severn Estuary.

Table 3-1 Scenarios performed across different return periods for current and future scenarios

Scenario	Flow (baseline without solution)	Purpose	Stochastic year code

1	Moderate-low flow (1:5-1:10 return period)	Represents current meteorological patterns, current demands and abstractions, current sewage returns and representative Severn Regulation pattern	Central to Gate 2 environmental assessments, WFD etc	A82
2	Very low flow (1:20 return period)		Central to Gate 2 environmental assessments, WFD etc	M96
3	Extremely low flow (1:50-1:100 return period)		Assists resilience understanding Not used in Gate 2 environmental assessments.	N17
4	**Future** (2070s) version of "moderate low flow" or 'very low flow'	Represents a selected version of 2070s meteorological patterns using RCP8.5. Demands and abstractions set at RCM08 scenario 1 in 500 deployable output level. Representative Severn Regulation pattern set by water resource model.	Central to Gate 2 environmental futures assessments, IEA etc	A82F (Severn) M96F (Thames)
5	**Natural** version of "moderate-low flow"	Represents current meteorological patterns, without abstractions or discharges	Assists discussions of environmental significance with regulators	A82N

3.3 STAGE 1 INFORMAL SCREENING

For Gate 2, each element associated with the STT solution was considered as a whole to determine whether there are any *risks* of LSEs arising from construction or implementation activities and/or operation on one or more European sites, including SPAs[26], SACs[27] and Ramsar sites (also known as National Site Network) adopting the *principles* of HRA.

Updated GIS and design information was used to map the locations and boundaries of European sites in relation to the STT solution. The attributes of the European sites, which contribute to and define their integrity, current conservation status, and the specific sensitivities of the site were considered, with reference to:

- Standard Data Forms for SACs and SPAs and Information Sheets for Ramsar sites. An analysis of these information sources that identify the site's qualifying features;
- Article 12 reporting under the European Birds Directive (which includes general information about the implementation of the Directive and the bird species' status and trends) and 17 reporting which captures the status and trends of Annex I habitat types and Annex II species;
- Site conservation objectives;
- Supplementary advice to the conservation objectives (SACO) where available;
- Site Improvement Plans;
- Core Management Plans (Wales); and
- the supporting Site of Special Scientific Interest's (SSSIs) favourable condition tables where relevant and no SACOs applicable to the features were available.

This information was used to analyse how potential impacts of the STT solution could affect the European sites.

The qualifying habitats and species of European sites are vulnerable to a wide range of impacts such as physical loss or damage of habitat, disturbance from noise, light, human presence, changes in hydrology (e.g. changes in water levels/flow, flooding), changes in water or air quality and biological disturbance (e.g. direct mortality, introduction of disease or non-native species). The review of the Gate 1 assessment considered any updates to the potential construction and operational effects as a result of monitoring and modelling data available in Gate 2 as well as any changes in scheme design.

In reviewing the probability of significant effects on European sites, particular consideration was given to the possible source-receptor pathways through which effects may be transmitted from activities associated with

[26] SPAs are classified under the European Council Directive 'on the conservation of wild birds' (2009/147/EC; 'Birds Directive') for the protection of wild birds and their habitats (including particularly rare and vulnerable species listed in Annex 1 of the Birds Directive, and migratory species).

[27] SACs are designated under the Habitats Directive (92/43/EEC) and target particular habitats (Annex 1) and/or species (Annex II) identified as being of European importance.

the STT solution, to features contributing to the integrity of the European sites (e.g. surface water catchments, air, etc.).

Screening for LSEs in Gate 1 was determined on a proximity basis for many of the types of impacts, based on the potential closeness of the element locations, to each European site. Where impact pathways were identified at greater distances (>10 km) as a result of hydrological connectivity for example, European sites were screened in as appropriate. Consideration was also given to the NE SSSI Impact Risk Zone (IRZ) datasets. The IRZs are reviewed regularly to ensure they reflect the current understanding of specific site sensitivities and potential risks posed to SSSIs. Where the notified features of a European site and SSSI are different, the SSSI IRZs have been set so that they reflect both. As such, these IRZs were used in Gate 1 to help determine the probability of significant effects from a particular development on the interest features of the European site.

Schemes that will not have LSE alone, but may be affected by in-combination effects with other plans and projects, are taken forward for further assessment.

The Gate 2 review considered updated monitoring and modelling data to confirm the conclusions of the Gate 1 assessments, including the conclusion of no LSE on the Severn Estuary European sites as a result of unsupported and supported abstractions. The Gate 2 assessment also considered any changes in scheme design (construction and operation) as part of the review of the conclusions of LSE and adverse effects completed in Gate 1.

3.4 STAGE 2 INFORMAL APPROPRIATE ASSESSMENT

Where a *risk* of LSE is identified at Stage 1 Screening (noting the precautionary principle), the scheme was subject to the *principles* of the Stage 2 informal appropriate assessment. The informal appropriate assessment considered the potential impact pathways of the STT solution, both during construction and operation, that could impact on attribute targets associated with a European site's qualifying features.

3.4.1 Impact Pathways

Where required, the potential impact pathways associated with the STT solution were considered in the context of their potential adverse effects on the qualifying features for the sites under consideration. To determine if identified impact pathways could have an adverse effect on site integrity, the following parameters were used as appropriate to define the impact (i.e. mechanism by which effects are caused):

- Impact type - direct or indirect, positive or negative;
- Probability – the likelihood of an impact occurring based on the change in physical environment
- Magnitude of impact – the 'amount' or intensity of an impact. This may sometimes be synonymous with 'extent' (see below) for certain impacts, such as habitat loss;
- Extent of impact – the area over which the impact will be felt;
- Duration of impact – how long it will occur. The guidelines suggest that ecological impact durations should be described in terms of ecological characteristics (e.g. species lifecycles/longevity) rather than human timeframes;
- Timing of impact – when it will occur, taking note of seasonality;
- Frequency of impact – how often it will occur; and
- Reversibility of impact – whether recovery or reinstatement is possible.

The significance of probable impact pathways that have been included for further assessments have been considered in the context of the conservation objectives. The probability of any impacts during the operation of STT solution considered, in the first instance, the results from modelling outputs. Further information regarding the approach to considering impact pathways are also provided in Section 5.

3.4.2 Adverse Effect on Site Integrity

An adverse effect on integrity is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature. In addition, an adverse effect would be one which

causes a detectable reduction of the features for which a site was designated, at the scale of the site rather than the location of the impact.

The Habitats Directive defines the conservation status of habitats as 'favourable' when:

- Its natural range and area it covers within that range are stable or increasing; and
- The species structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future.

The Habitats Directive defines the conservation status of species as 'favourable' when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
- The natural range of the species is neither being reduced for the foreseeable future; and
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The assessment of adverse effects considered the current condition of the associated site in line with the relevant judgements in European Court of Justice and UK courts (e.g. the Waddenzee Judgement).

The integrity test is the conclusion of an appropriate assessment and requires the competent authority to ascertain whether the proposed STT solution (either alone or in-combination with other plans or projects), will have no adverse effect on site integrity. The following definition is provided by Defra: the integrity of the site is "*the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the level of populations of the species for which it was classified*"[28].

3.4.3 Mitigation Measures

The assessment considered measures that may be available to reduce the probability, magnitude, scale, and duration of the effect to a lower level, which can be applied at the appropriate assessment stage to inform the overall integrity test[29]. This includes costed mitigation (typically following best practice guidelines) and additional mitigation, recommended to reduce the probability of adverse effects on site integrity. These measures included both avoidance and reduction measures, with the former being preferred.

3.5 STAGE 3 (ASSESSMENT OF ALTERNATIVE SOLUTIONS AND STAGE 4 (IROPI AND COMPENSATION MEASURES)

As per the updated Gate 2 guidance, should the informal appropriate assessment identify that any of the STT activities (construction and operation) could result in adverse effects on site integrity and no mitigation measures are available (e.g. will cause a direct loss of habitat) an informal Assessment of Alternative Solutions (Stage 3 HRA) will be considered. If sufficient evidence is available to suggest no alternatives, then consideration will be given to commencing developing plans for a case for IROPI and compensatory measures (informal stage 4).

In accordance with the Habitats Regulations, Stage 3 of the HRA process requires the consideration of feasible alternatives to the STT solution. The consideration of alternatives was, however, limited to options which are technically feasible and which achieve the project objectives. As such, only alternatives that would provide a similar deployable output and at a similar frequency as the STT were considered as alternative solutions.

For the Gate 2 informal HRA it is proposed that, if required, Alternative Solutions will be identified through the regional planning process to ensure that schemes are compliant with the requirements of the Habitats Regulations (i.e. to avoid the consideration of schemes with a similar or greater impact on European sites).

In the absence of any reasonable or feasible alternative solutions, where a plan or project may have adverse effects on a European site, a Competent Authority can only consent to a plan or project if there are IROPI for

[28] Defra Circular 01/2005. *Government Circular: Biodiversity and Geological Conservation – Statutory Obligations and Their Impact Within The Planning System.* August 2005.

[29] The "People over Wind" or "Sweetman" judgment ruled that Article 6(3) of the Habitats Directive must be interpreted as meaning that mitigation measures should be assessed within the framework of an appropriate assessment and that it is not permissible to take account of mitigation measures at the screening stage.

the plan or project to proceed and **all** necessary compensatory measures has been secured to ensure that the overall coherence of the network of European sites is protected. Where a public interest which is in principle capable of being classed as “overriding” has been identified, it must be weighed against the damage caused to the European site by the plan or project in question. Accordingly, applying the IROPI derogation involves, for example, a balancing exercise between the human health and public safety interests versus the implications for the European site in view of its relevant conservation objectives. This derogation assessment exercise is fact specific.

Should the Gate 2 assessment identify adverse effects on site integrity for any European site and no Alternative Solutions can be identified from the regional planning process, an informal IROPI assessment will be required. A high level, informal assessment of the of the different elements of the derogation will be assessed:

- Imperative: the STT it must be essential (whether urgent or otherwise), weighed in the context of the other elements below, that the project proceeds.
- Overriding: the interest served by the STT outweighs the harm (or risk of harm) to the integrity of the European site as identified in the appropriate assessment.
- Public Interest: a public benefit must be delivered rather than a solely private interest. Public interest can occur at national, regional or local level.

Should no Alternative solutions be identified in the regional plan and should there be a demonstrable case for IROPI, compensation measures will be required. It is proposed that for the Gate 2 process the principles of selecting compensation measures will be agreed with regulators and that compensatory measures will not be fully developed at Gate 2.

Based on previous experience, the compensation measures should be selected based on the following:

1. There must be realistic mechanisms available for appropriate and guaranteed long-term management of the designated interests/compensation site, and no risk of damage to other features as a result of the compensation measures plan.
2. Compensation measures should specifically and proportionately compensate for the loss/degradation of the relevant qualifying feature caused by the effect of the STT solution whilst considering uncertainty with regards to the probability and the physical extent of adverse effects. Ultimately, it must maintain the coherence of the National Site Network.
3. Compensation measures should be able to be implemented in a timely manner, prior to effects occurring as a result of scheme implementation.
4. Compensation measures do not need to be restricted to within the relevant European site boundaries. (i.e. non-designated and/or SSSI water bodies could be identified, enhanced and protected as compensation habitat to then be protected as a fully European site of similar (or better quality).
5. Compensation measures should be separate and additional to measures that already form part of the intended management of a site (for example, measures already contained within a draft or agreed management plan for a European site). Therefore, measures cannot be counted if there is a reasonable chance they will happen anyway.
6. Within a legal context, measures to address harmful activity that is clearly in breach of regulation cannot be considered.

If required, Stage 3 and Stage 4 of the HRA (including the detailed development of compensatory measures and associated costs and feasibility) will be further considered at Gate 3. However, it is noted that these stages are unlikely to be required as the gated process aims to avoid the promotion of schemes that will result in adverse effects on site integrity. .

3.6 IN-COMBINATION ASSESSMENTS

It should be noted that the in-combination assessment of the STT solution HRA only considers local plans and projects within the Zone of Influence (ZoI). The in-combination assessment with WRMPs, Drought Plans (DPs) and other SROs will be considered within the relevant Regional Plan.

The ZoI, and the plans or projects that are applicable to the in-combination assessment for the STT solution include:

1. The proposed construction route of the Vyrnwy Bypass (pipeline) to the River Severn and the proposed construction route for the interconnector (pipeline) from Deerhurst to Culham.
2. The impacts on flow, velocity, depths, water level and flooding risk and subsequent impacts on the watercourses associated with a supported and unsupported STT. This includes the Severn Estuary, tributaries associated with the River Severn and the Severn Estuary and the reaches of the River Thames downstream of Culham to the Teddington Weir.
3. The impacts on water quality and subsequent impacts on the watercourses associated with a supported and unsupported STT (as listed above)

4. HRA SCREENING OF SEVERN TO THAMES TRANSFER

4.1 RISK OF LIKELY SIGNIFICANT EFFECTS OF SEVERN TO THAMES TRANSFER

The STT solution is associated with a number of European and Internationally European sites including SACs, SPAs and Ramsar sites as identified in **Table 4-1** below.

As described in Section 3, this HRA has screened all of the elements located within a 10 km radius of any of the European sites in the study area and 500 m of rivers transferring water. The SSSI IRZ has also been considered when selecting European sites that require assessment. As indicated in **Section 3.3**, to further inform the probability of any impacts on European sites the NE SSSI IRZ datasets were also applied.

The informal screening assessments of the associated European sites for potential LSE is summarised in **Table 4-1** with detailed assessments provided in **Annex 1.**

Where uncertainty has been identified, this uncertainty indicates that a confident conclusion of no risk of LSE is not yet possible, in most cases due to the very early stage of option development (meaning specific design and location information may not be available to allow a full appraisal of the risk of likely effects). Where uncertainty remains, an informal appropriate assessment is required to either confirm a risk of LSE related to a scheme or to confirm that no risks of LSE are expected.

It should be noted that the risk of LSE has been updated following consultation with NE and NRW on the Gate 1 informal HRA. As such, several additional sites have been identified for an informal appropriate assessment.

The informal screening identified the risk of LSE associated with the construction of the interconnector and Vyrnwy Bypass for:

- Dixton Wood SAC
- Severn Estuary/ Môr Hafren SAC
- Severn Estuary SPA
- Severn Estuary Ramsar
- Midland Meres and Mosses Phase 2 Ramsar

The informal screening identified the risk of LSE associated with the operation of the STT SRO (unsupported and full STT) for:

- Severn Estuary SAC
- Severn Estuary SPA
- Severn Estuary Ramsar
- River Clun SAC
- River Usk SAC
- River Wye SAC

For the purpose of the informal screening, it has been assumed that the reaches of the River Vyrnwy and the River Severn provide functionally linked habitat for the Severn Estuary and River Clun SAC in relation to migratory fish with several life stages of the qualifying species dependent on the freshwater habitats.

The potential impact pathways that were identified during the informal screening forms the scope of the informal appropriate assessment) as summarised in **Section 5**. As noted in **Section 3**, the potential for impact pathways to result in the risk of LSE were identified using the results for bespoke modelling that was undertaken for the STT solution.

The following impact pathways were excluded from this HRA and any in-combination assessments:

- The construction activities associated with the pipelines for the advanced treated effluent from Netheridge and Minworth WwTWs as included in STW's Minworth and Sources SROs.
- Any impacts on flow, velocity, depths, levels and water quality as a result of a decrease in the volume of the effluent being discharged from the Minworth SRO into the River Tame and associated waterbodies as included in STW's Minworth SRO.

- Any impacts associated with other SROs that are linked to or depended on the STT solution (e.g., the North West Transfer SRO, the Thames to Affinity Transfer SRO, etc.) as included at a WRMP and Regional Plan level.

Table 4-1 European sites potentially affected by Severn to Thames Transfer Elements

European site	Associated components	Risk of LSE (alone or in-combination)
Berwyn and South Clwyd Mountains SAC	Vyrnwy Bypass	No
Berwyn SPA	Vyrnwy Bypass	No
Bredon Hill SAC	Deerhurst to Culham Interconnector Mythe abstraction licence transfer	No
Chilterns Beechwoods SAC	Deerhurst to Culham Interconnector	No
Cothill Fen SAC	Deerhurst to Culham Interconnector	No
Cotswold Beechwoods SAC	Netheridge Transfer	No
Dixton Wood SAC	Deerhurst to Culham Interconnector Mythe abstraction licence transfer	Yes, risk of LSE alone
Hartslock Wood SAC	Deerhurst to Culham Interconnector	No
Little Wittenham SAC	Deerhurst to Culham Interconnector	No
Montgomery Canal SAC	Vyrnwy Bypass	No
Midland Meres and Mosses Phase 1 Ramsar	Vyrnwy Bypass Shrewsbury redeployment	No
Midland Meres and Mosses Phase 2 Ramsar	Vyrnwy Bypass	Yes, risk of LSE alone
River Clun SAC	All components (including unsupported)	Yes, risk of LSE alone
River Dee and Bala Lake SAC	Vyrnwy Bypass	No
River Usk SAC	All components (including unsupported)	Yes, risk of LSE alone
River Wye SAC	All components (including unsupported)	Yes, risk of LSE alone
Severn Estuary SAC	All components (including unsupported)	Yes, risk of LSE alone
Severn Estuary SPA	All components (including unsupported)	Yes ,risk of LSE alone
Severn Estuary Ramsar	All components (including unsupported)	Yes, risk of LSE alone
South West London Waterbodies SPA	All components (including unsupported)	No
South West London Waterbodies Ramsar	All components (including unsupported)	No
Tanat and Vyrnwy Bat sites SAC	Vyrnwy Bypass	No
Walmore Common SPA	Netheridge Transfer	No
Walmore Common Ramsar	Netheridge Transfer	No

5. INFORMATION TO INFORM STAGE 2 INFORMAL APPROPRIATE ASSESSMENT

5.1 SCOPE OF THE INFORMAL APPROPRIATE ASSESSMENT

Screening of LSE (see Section 4) has identified the requirement for an informal appropriate assessment of a number of European sites. The scope of the informal appropriate assessment is summarised in Table 5-1.

Table 5-1 Scope of the informal appropriate assessment

Phase	Scope of informal appropriate assessment	Relevant European site
Construction	• The assessment needs to consider the potential adverse effects from changes in air and dust emissions on qualifying features of the Dixton Wood SAC (Deerhurst to Culham interconnector) and the Midlands Meres and Mosses Phase 2 Ramsar site (Vyrnwy Bypass). • The assessment needs to consider the potential adverse effects due to changes in hydrological regime/ groundwater supply as a result of the Vyrnwy Bypass pipeline installation on Midland Meres and Mosses Phase 2 Ramsar site. • The assessment needs to consider the potential adverse effects due to the loss and deterioration of functionally linked habitat for qualifying features of the Severn Estuary SAC, SPA and Ramsar site due to the construction of Vyrnwy Bypass and Deerhurst to Culham interconnector. This includes direct loss of functionally linked habitat, increases in suspended sediment and exposure to pollution incidents. • The assessment needs to consider the potential adverse effects due direct mortality of ammocoetes and anthropogenic disturbance of qualifying features of the Severn Estuary SAC, SPA and Ramsar (if present) during construction works proposed for Vyrnwy Bypass and Deerhurst to Culham interconnector. •	• Dixton Wood SAC • Midland Meres and Mosses Phase 2 Ramsar • Severn Estuary SAC • Severn Estuary SPA • Severn Estuary Ramsar site
Operation	• The assessment needs to consider the potential impacts of increased flows on upstream and downstream migration in the River Severn (including barrier passability and fish pass functionality). This includes migration into tributaries of the River Severn (e.g., the River Teme). • The assessment needs to consider the impacts on supporting habitats for freshwater life stages of the migratory fish of the Severn Estuary within the River Severn (and any tributaries directly affected by support flows). This needs to consider the unsupported and full STT and the impacts of changes in flow and water quality. As such, the increase in flows upstream of Deerhurst and any decrease in flow downstream of Deerhurst should be considered. • The assessment needs to consider the potential changes in flow and water quality within the Severn Estuary as a result of the operation of the STT (both supported and unsupported) and the risk to supporting habitats in the estuary. • The assessment needs to consider the risk to hydrological cues for migration as well as changes in olfactory cues and/or increase in concentrations of olfactory inhibitors that could impact on migration into the River Severn (and consequently the River Teme), the River Wye and the River Usk and reproduction.	• Severn Estuary SAC • Severn Estuary SPA • Severn Estuary Ramsar site • River Wye SAC • River Usk SAC • River Clun SAC

5.2 SUMMARY OF IMPACT ASSESSMENT APPROACH

As noted in **Section 3**, to determine whether any impact pathways that were identified could have an adverse effect on site integrity, several parameters were used as appropriate to define the impact (i.e., mechanism by which effects are caused). Where an impact pathway was considered as not probable, further assessment has

not been undertaken. The probability of an impact pathway was informed by the bespoke modelling completed for the STT solution. For example, where the STT solution operation will result in a change in water quality that is not considered to be distinct from the baseline pattern or substantial in magnitude, the assessment has not considered the other parameters/mechanism (e.g., timing or duration of the impact). However, where the potential probability of a pathway occurring has been identified (e.g., a distinct pattern of change or substantial magnitude of change in nutrient concentrations), the pathway has been further assessed to determine the magnitude, extent, duration, etc.

The significance of those impact pathways that were considered probable in relation to the risk of adverse effect on site integrity have been considered in the context of site specific attributes and targets, the underpinning condition of relevant SSSIs (where the qualifying features align) and the European sites conservation objectives (see section below).

5.3 CONDITION ASSESSMENT AND CONSERVATION OBJECTIVES

The informal appropriate assessment has been completed in view of the available condition status and the conservations objectives for all European sites, including the Severn Estuary European Marine Site. The overall condition status of underpinning SSSIs associated with each European site assessed in the Stage 1 Screening assessment are provided in **Annex 1**.

NE and NRW use the term “favourable condition” for the condition represented by the achievement of the conservation objectives, in other words the desired condition for a designated habitat or a species on an individual site. On many terrestrial European sites sufficient information is usually available regarding the required condition of qualifying habitats to be able to define favourable condition with confidence. In contrast, understanding the functioning of large, varied, dynamic marine and estuarine sites, which experience a variety of pressures resulting from historic and current activities, is much more difficult. Consequently, it is much harder to precisely define favourable condition in sites like the Severn Estuary.

The indicative condition status for the Severn Estuary SAC (which also provides the supporting habitats for the feature of the SPA) is provided in Table 5-2.

Table 5-2 Summary of NRW indicative feature condition assessment of the Severn Estuary/Môr Hafren SAC (2018)[30]

Qualifying feature	Indicative condition assessment	Confidence in assessment
Estuaries	Unfavourable	Medium
Mudflats and sandflats not covered by seawater at low tide	Unfavourable	Medium
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Unfavourable	Medium
Sandbanks which are slightly covered by seawater all the time	Favourable	Low
Reefs	Unknown	Not Applicable
Sea lamprey (*Petromyzon marinus*)	Unfavourable	High
River lamprey (*Lampetra fluviatilis*)	Unfavourable	High
Twaite shad (*Alosa fallax*)	Unfavourable	High

NE have also provided a position statement regarding the condition assessment of the Severn Estuary[31]. NE have indicated that for the estuaries, mudflats and sandflats not covered by seawater at low tide, and Atlantic salt meadows features, the two factors contributing to unfavourable condition were: (i) coastal squeeze impacts; and (ii) water quality impacts. The Regulation 33 advice for the site highlights the vulnerability of habitat and fish features to toxic contamination and nutrient loading; and identifies a number of relevant

[30] NRW (Natural Resources Wales (2018). Severn Estuary / Môr Hafren Special Area of Conservation: Indicative site level feature condition assessments 2018. NRW Evidence Report Series, Report No: 235, 41pp, NRW, Bangor

[31] Natural England (2022). Position Statement: Indicative Condition Assessment of the Severn Estuary/Môr Hafren Special Area of Conservation (SAC). May 2022

attributes that contribute to the favourable condition of these features. As such, these targets and attributes will require consideration in the informal appropriate assessment

Detailed information is also available regarding the measures, attributes and targets that may be used during site monitoring to determine whether favourable condition is being achieved.

The relevant attributes and targets associated with the conservation objectives for each qualifying feature of the European site have been considered in this informal appropriate assessment. A summary of the assessment against each attribute is provided in the accompanying Excel Workbook (*STT HRA Conservation Objective Summary.xlsx*)

In particular, the assessments considered the relevant attributes and targets associated with each feature:

- Attributes: particular characteristics of the features or sub-features which provide an indication of the condition of the feature (e.g. total population size, extent of a habitat type).
- Targets: These define the attribute values that equate to favourable condition.

Where impact pathways are considered probable, the other parameters (magnitude, duration, extent, etc) have been considered to determine whether the impact pathway will prevent the relevant targets in the favourable condition table being achieved and hence could result in a change in condition from favourable status or preventing a feature from attaining favourable condition. As noted in the sections above, the probability was assessed in the context of the results of the bespoke modelling that was undertaken for the STT solution.

5.4 ASSESSMENT OF POTENTIAL ADVERSE EFFECTS

5.4.1 Impacts associated with construction activities

Table 5-3 provides a summary of the probability, magnitude, extent, duration, timing, frequency and reversibility of impact pathways identified during construction of the STT solution. Overall, **no** risk of adverse effects on site integrity is predicted due to construction works with the implementation of mitigation measures.

Table 5-3 Summary of impact pathway assessment for the construction of Deerhurst to Culham Interconnector and Vyrnwy Bypass (option 27) on European sites.

Parameter	Summary
Impact type	Midland Meres and Mosses Phase 2 Ramsar site (Vyrnwy Bypass) - changes to the hydrological regime/ groundwater supply to the Ramsar site and exposure to pollution incidents if the pipeline is installed at a depth where groundwater is present. In addition, exposure to air and dust emissions. Severn Estuary SAC and Ramsar (Vyrnwy Bypass and Deerhurst to Culham Interconnector) - direct mortality and injury of ammocoetes if present, loss of functionally linked habitat, noise, visual and vibration disturbance, spawning habitat deterioration via localised increases in suspended sediment from bank erosion and in-channel sediment disturbance and exposure to pollution incidents. Dixton Wood SAC (Deerhurst to Culham interconnector) – Loss of functionally linked habitat for violet click beetle, where open cut installation is proposed in deciduous woodland and direct mortality/ injury and exposure to air and dust emissions. Severn Estuary SPA and Ramsar (Deerhurst to Culham Interconnector) - direct loss of suitable functionally linked habitat (coastal and floodplain grazing marsh priority habitat) and if construction works are conducted during the overwintering period (September – March inclusive) there is potential for noise, visual and vibration disturbance if qualifying birds are present within 1 km.
Probability	The impact is likely to occur in the absence of mitigation measures due to the extent of the construction activities and the presence of qualifying features within the impacted area.
Magnitude	Magnitude of impact deemed to be low based on temporary construction impacts to potentially functionally linked habitat. No direct impacts identified to European sites.
Extent	The extent of the impact along watercourses intersected by a pipeline <2 m is anticipated to be 20 m. The working area for the intake on the River Severn associated with the Deerhurst to Culham Interconnector will be approximately 50m x 50m. Dimensions of the intake containing an array of passive Johnson screens is 20 m x 7 m. The River Severn is approximately 78 m wide at the location of the Deerhurst to Culham intake. An area of deciduous woodland has been identified

Parameter	Summary
	within the footprint of the proposed Deerhurst to Culham interconnector that could be functionally linked habitat for violet click beetle *Limoniscus violaceus* (within 1 km from Dixton Wood SAC). Little is known about the dispersal dynamics of violet click beetle, therefore, an assumed dispersal distance of 1 km has been applied based on stag beetle *Lucanus cervus* radio-telemetric monitoring[32]. Extent of temporary habitat loss is 2,747 m² within deciduous woodland that could provide suitable decaying veteran trees for violet click beetle. For the Vyrnwy bypass (option 27), an approximate 15 m x 15 m working area will be required to install the outfall pipe and a 1 m pipe cover. The River Severn is approximately 23 m wide at the location of Vyrnwy bypass (option 27).
Duration	Total construction time for Deerhurst to Culham interconnector is estimated at 5 - 6 years and for Vyrnwy Bypass (option 27) is 3 years. Note that the total construction time includes construction of the water treatment works, pipeline, pumping stations and abstraction/ discharge infrastructure. Therefore, the duration of construction works on a local scale that could lead to impact pathways to European Sites is less than the total estimate.
Timing	Timing of construction is unknown at this stage, however, construction works will be timed to prevent impacts to species during sensitive life stages such as during fish migration and spawning. In addition, mitigation measures will be included as appropriate to prevent impacts to potential functionally linked habitats such as juvenile and nursery habitats for fish.
Frequency	Once constructed, no additional works anticipated.
Reversibility	Habitat loss and changes to hydrological regime are not considered reversible. It is noted that where possible habitats will be reinstated. Short term impacts from anthropogenic disturbance, air pollution and increases in suspended sediment are considered reversible.
Summary	No adverse effects on site integrity anticipated with the implementation of mitigation measures.

5.4.1.1 Context

Infrastructure associated with the STT solution includes the installation of two pipeline routes (Vyrnwy Bypass option 27 and Deerhurst to Culham Interconnector) with associated intakes and outfalls, pumping stations and a new water treatment works. The construction works do not overlap with European sites, however, impact pathways have been identified via hydrological connectivity and potentially functionally linked habitat that require further consideration to determine if adverse effects on site integrity are likely. In the context of European sites identified (Dixton Wood, Midland Meres and Mosses Phase 2 and the Severn Estuary SAC, SPA and Ramsar), impact pathways include permanent and temporary loss of functionally linked habitat (latter based on habitat reinstatement post construction), exposure to increased air pollution from construction vehicles, exposure to accidental pollution incidents from fuel, increased suspended sediment and anthropogenic disturbance via noise, vibration and visual and changes to hydrological regime. Potential functionally linked habitat identified within the footprint of the proposed construction works include the River Severn/ Severn Estuary (bank face, bank top and channel) and deciduous woodland.

5.4.1.2 Construction of the Vyrnwy Bypass

Midland Meres and Mosses Phase 2 Ramsar site

Midland Meres and Mosses Phase 2 Ramsar site and the underpinning SSSI, Morton Pool and Pasture, is approximately 1.1 km west of the proposed Vyrnwy Bypass (option 27).

The potential adverse effects of air emissions on qualifying features as a result of non-road mobile machinery, generators and combustion plants was considered where ecological receptors are present within 500 m of construction works. The degree of impact will depend on the NOx emissions rate from <5 mg/s - >50 mg/s[33]. The potential adverse effects of air emissions on qualifying features due to proximity to main access roads has been considered when ecological receptors are present within 200 m. This is based on guidance developed by Highways England (LA105 Air Quality) which highlights that ecological receptors should be considered within 200 m of the affected road network (roads which experience a significant change in traffic). The use of 200 metres is therefore, informed by this guidance and professional judgement on distances that significant impacts could occur. The Natural England advice to competent authorities considering air impacts in HRAs

[32] Rink, M. and Sinsch, U. (2007) Radio-telemetric monitoring of dispersing stag beetles: implications for conservation. *Journal of Zoology*, 272 (3), pp. 235-243

[33] EPUK / IAQM (2017) Land-Use Planning & Development Control: Planning for Air Quality v1.2

also uses this distance[34]. The potential adverse effects of dust exposure to ecological receptors was considered within 50 m of the construction footprint and highways used by construction vehicles.

Due to the distance between the proposed construction works and the European site and short-term nature of construction works within approximately 1 km of Midland Meres and Mosses Phase 2 Ramsar site, no impact pathways as a result of air and dust emissions have been identified. However, there is a risk of changes to the hydrological regime/ groundwater supply to the Ramsar site and exposure to pollution incidents if the pipeline is installed at a depth where groundwater is present and hydrologically connected to Morton Pool and Pasture SSSI. As the Midland Meres and Mosses Phase 2 Ramsar at Morton Pool is not hydrologically dependent on the River Vyrnwy or River Severn for maintenance of the water level or condition of adjacent wetland habitats, no impact pathways have been identified during operation of STT SRO.

Morton Pool and Pasture SSSI is in favourable condition and broadly consists of standing open water, fen, marsh and swamp, neutral grassland and broadleaved, mixed and yew woodland. Morton Pool and Pasture SSSI is not identified as supporting waterfowl populations of national importance, for which other units of the Midland Meres and Mosses Ramsar site are designated. The specific designated feature relevant to the Midland Meres and Mosses Phase 2 Ramsar site present at Morton Pool and Pasture SSSI is the A5 rigid hornwort *Ceratophyllum demersum* community in standing open water habitat and S13 lesser bulrush *Typha angustifolia* swamp in the reedbed habitat[35]. As S13 is considered to have a low dependence on groundwater[36] and with the implementation of mitigation measures to prevent pollution incidents during pipeline installation, no adverse effects on S13 lesser bulrush swamp are anticipated. Further assessment is required for A5 rigid hornwort community present in standing open water habitat.

The pipeline and Ramsar site are both located on a highly productive aquifer, on Kinnerton sandstone formation with peat superficial deposits present at the SSSI and Devensian sand and gravel deposits present in the footprint of the pipeline. The trench depth of the Vyrnwy Bypass pipeline is estimated to be between 2 – 6 m. Borehole records approximately 175 m east of the proposed pipeline route (north-west of Crickheath) has recorded water at 10 m below the well-top. Based on the permeable bedrock, high water table and maximum depth of pipeline installation there is potential for hydrological connectivity between the standing open waterbody present at Morton Pool and Pasture SSSI and groundwater that may be impeded during pipeline installation. Potential adverse effects from pollution incidents will be mitigated via following best practice accident prevention. Based on the location of the SSSI and hydrological connectivity to the River Morton it is likely that water supply and dynamics is largely controlled by surface water interactions. As the site is upstream of watercourses being intersected by the pipeline, no impacts on the surface water interactions are anticipated. In addition, any changes to the hydrological regime/ groundwater supply as a result of pipeline installation are deemed to be localised and will not impact on qualifying features of Midland Meres and Mosses Phase 2 Ramsar site.

Severn Estuary SAC and Ramsar site

The Severn Estuary SAC and Ramsar site is located approximately 115 km south-east of the Vyrnwy Bypass (option 27). Due to the distance of proposed construction works to qualifying habitats (sandbanks, estuary, mudflats and sandflats, reefs and Atlantic salt meadows), no impact pathways from construction have been identified for these features. However, there is potential for direct mortality and injury of ammocoetes if present, loss of functionally linked habitat, noise, visual and vibration disturbance, spawning habitat deterioration via localised increases in suspended sediment from bank erosion and in-channel sediment disturbance and exposure to pollution incidents for twaite shad, river lamprey, sea lamprey and Atlantic salmon. This is relevant to the following attributes and targets within the SACO for the Severn Estuary SAC[37]:

- Twaite shad: migratory access (water quality), population size and prey species
- River and sea lamprey: migratory access (water quality), population size, prey species and ammocoete population in tributary rivers.

[34] Natural England (2018) Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations.

[35] Natural England (2009). Conservation Objectives and definitions of favourable condition for designated features of interest, Morton Pool and Pasture SSSI. 1 – 27.

[36] UK Technical Advisory Group on the Water Framework Directive (2003). Guidance on the identification and risk assessment of groundwater dependent terrestrial ecosystems. TAG Work Programme, 1 – 11.

[37] Natural England & Countryside Council for Wales (2009). Severn Estuary European Marine Site advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. Countryside Council for Wales, 1 – 175.

The upper River Severn provides spawning and nursery habitat for Atlantic salmon, nursery habitat for twaite shad, river and sea lamprey and a migration route to upstream habitats for each species. At the location of the proposed outfall, flows are largely classified as glide with deeper channel depths unsuitable for spawning of twaite shad, river lamprey and sea lamprey. Therefore, no functionally linked spawning habitat for twaite shad, river lamprey and sea lamprey has been identified within the construction footprint. However, it would be pertinent to note, for instance, that underwater noise, which can originate from both ground and water-borne sources, attenuates less and thereby travels farther than in air. Therefore, the potential spatial impact of construction related noise and vibration on fish, could be wide reaching. As a precautionary measure, construction works should be timed outside of qualifying fish spawning periods to prevent potential disruption. Mitigation measures will also be implemented to prevent large sediment input into the river via runoff, bank erosion and excessive in-channel sediment resuspension. As ammocoetes may be present if suitable silt beds are within the footprint of construction works, mitigation measures have been recommended to prevent direct loss of ammocoetes and adverse effects on population size of river and sea lamprey. and Based on the likely short-term construction period based on the size of the works, small in-channel area of impact in relation to the River Severn and with the implementation of proposed mitigation measures (see **Section 5.4.1.4**), no adverse effects on qualifying fish of the Severn Estuary SAC and Ramsar are anticipated.

5.4.1.3 Construction of the Interconnector

Dixton Wood SAC

Potential impact pathways have been identified on violet click beetle *Limoniscus violaceus* populations associated with Dixton Wood SAC. The proposed pipeline route is approximately 900 m south of Dixton Wood SAC. Due to limited information on the dispersal dynamics of violet click beetle, radio-telemetric monitoring of stag beetles *Lucanus cervus* has been used to inform this assessment. The study concluded that the colonisation of new nest sites depended on the dispersal ability of female stag beetles, as male dispersal was directed by reproductive females. The maximum dispersal distance recorded for female stag beetles was 727 m[38]. Adopting a precautionary approach, a 1 km buffer of Dixton Wood SAC was used to identify potential functionally linked habitat affected by the Deerhurst to Culham Interconnector. There is potential for the temporary loss of 2,747 m²/ 0.27 ha of functionally linked habitat for violet click beetle, where open cut installation is proposed in deciduous woodland. In addition to temporary habitat loss, there is potential for violet click beetles to be present during construction works and direct mortality to occur during removal of trees, grassland and soil.

This is relevant to the following attributes and targets within the SACO for Dixton Wood SAC[39] in relation to violet click beetles:

- Extent of supporting habitat
- Distribution of supporting habitat
- Adaption and resilience
- Soils, substrates and nutrient cycling
- Hydrology
- Abundance of standing decaying-wood
- Continuity of ancient trees and decaying habitat
- Occupation of wood-mould trees

Violet click beetle are primarily associated with ancient trees, showing preference for both ash (National Vegetation Classification (NVC) W8) and beech woodland, with suitably decaying veteran trees and nectar providing plants[39]. Dixton Wood SAC is comprised of ash *Fraxinus excelsior*, field maple *Acer campestre* and dog's mercury *Mercuralis perennis* and classed as ancient and semi-natural woodland. Woodland identified within the footprint of the proposed pipeline is a mix of deciduous and coniferous woodland and is not classified as ancient woodland or a Local Wildlife Site. Due to the low habitat suitability of the woodland present within the footprint of the proposed pipeline, the probability of the construction area supporting violet click beetle populations is deemed as low. In addition, there are no publicly available records of violet click beetle within

[38] Rink, M. and Sinsch, U. (2007) Radio-telemetric monitoring of dispersing stag beetles: implications for conservation. *Journal of Zoology*, 272 (3), pp. 235-243

[39] Natural England (2018). Dixton Wood Special Area of Conservation (SAC), Site code: UK0030135. European Site Conservation Objectives: Supplementary advice on conserving and restoring site features. Natura 2000, 1 – 12.

the woodland. On that basis, no adverse effects on functionally linked habitat for violet click beetle have been identified.

During construction works, there is potential for habitats associated with Dixton Wood SAC to be exposed to increased air and dust pollution, particularly nitrogen oxides (NOx) from construction vehicles. The primary pollutant, directly emitted, is nitric oxide (NO) which is oxidised to nitrogen dioxide NO_2. Dixton Wood SAC is currently above its nitrogen critical load target of 10 – 20 kg N/ ha/ year, at approximately 32 kg N/ ha/ year. As the European site is currently exceeding its nitrogen critical load target, any increase in nitrogen critical load anticipated from construction works associated with the interconnector may undermine the conservation objectives of the site and hence the probability of the site reaching Favourable Conservation Status. Currently, the Dixton Wood SSSI is in 100 % unfavourable – recovering condition. This is due to the ground flora generally being in poor condition, with little regeneration in the canopy gaps and high growth of nettle and bramble which is potentially affecting young tree growth[40]. This could be a result of N deposition as this can modify the chemical status of the substrate, altering the floral structure and composition of the understory.

For the entire pipeline route, an estimated 20,000 ± 4,000 heavy goods vehicle (HGV) movements will be required. The length of pipeline within 1 km of Dixton Wood SAC is approximately 800 m and therefore, the number of HGV movements producing emissions within range of the European site will be significantly lower. The pipeline is ~ 88 km in total. Therefore, for each 1 km length of pipeline, approximately 227 HGV movements will occur. According to air quality guidance, a 500 m buffer distance from ecological receptors is deemed a sufficient distance to prevent adverse effects on qualifying features as a result of non-road mobile machinery, generators and combustion plants[41], a 200 m buffer distance from increased construction traffic[42] and 50 m from dust emissions[43]. Based on the distance (900 – 1,000 m) between construction works and the European site and temporary nature of construction works proposed, it is not anticipated that NOx released from HGVs will result in an increase to the annual critical load of nitrogen within Dixton Wood SAC.

Severn Estuary SAC and Ramsar site

The Deerhurst to Culham interconnector is approximately 24 km north of the Severn Estuary SAC and Ramsar site and approximately 46 km north via hydrological connectivity. Due to the distance between qualifying habitats and proposed construction works, large tidal range and high flow rates within the Severn estuary, no impact pathways have been identified on intertidal mudflats and sandflats, Atlantic salt meadows, subtidal sandbanks, reefs and estuaries.

Potential impact pathways have been identified on qualifying fish of the Severn Estuary SAC and Ramsar site as the area proposed for construction could provide functionally linked habitat for qualifying fish. This is due to noise, visual and vibration disturbance, increases in suspended sediment from in-channel construction during intake installation, vegetation and sediment removal from the river bank causing bank erosion and exposure to potential pollution incidents.

This is relevant to the following attributes and targets within the SACO for the Severn Estuary SAC[44]:

- Twaite shad: migratory access (water quality), population size and prey species
- River and sea lamprey: migratory access (water quality), population size and prey species

At the location of the proposed outfall of the Vyrnwy Bypass, flows in the River Severn have largely classified as glide during Acoustic Doppler Current Profiler (ADCP) surveys and the river is wide and deep. Therefore, this reach of the river is unsuitable spawning habitat for qualifying fish species that largely require gravel substrate that is well aerated associated with shallow depths. However, this region of the River Severn provides nursery habitat and a migration corridor for anadromous fish such as Atlantic salmon, sea trout, sea lamprey, river lamprey, allis shad and twaite shad. European eel are also likely to be present. It is noted that the Severn Estuary Ramsar also includes the whole fish assemblage of the estuary including over 110 species. As the impact pathways will be similar between fish species when considering construction, the fish assemblage will not be assessed separately. Permanent infrastructure on the river bank will be approximately

[40] Natural England (2010). Condition of SSSI Units for Site Dixton Wood SSSI. European sites View. Accessed from: European sites View (naturalengland.org.uk)

[41] EPUK / IAQM (2017) Land-Use Planning & Development Control: Planning for Air Quality v1.2

[42] Natural England (2018) Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations.

[43] Institute of Air Quality Management IAQM (2017) Guidance on the Assessment of Dust from Demolition and Construction v1.1

[44] Natural England & Countryside Council for Wales (2009). Severn Estuary European Marine Site advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. Countryside Council for Wales, 1 – 175.

20 m in length and the working area will be 50 m. Mitigation measures will also be implemented to prevent large sediment input into the river via runoff, bank erosion and excessive in-channel sediment resuspension. Based on the short term nature of proposed construction works and small area of impact in relation to the River Severn, no adverse effects on qualifying fish of the Severn Estuary SAC and Ramsar are anticipated.

Severn Estuary SPA

In addition, the proposed pipeline route and intake infrastructure is located on coastal and floodplain grazing marsh which is suitable supporting habitat for qualifying bird species of the Severn Estuary SPA and Ramsar site. Therefore, there is potential for the direct loss of suitable functionally linked habitat to the Severn Estuary SPA and Ramsar site. In addition, if construction works are conducted during the overwintering period (September – March inclusive) there is potential for noise, visual and vibration disturbance if qualifying birds are present within 1 km.

This is relevant to the following attributes and targets within the SACO for the Severn Estuary SPA[45]:

- All qualifying birds: habitat extent, unimpeded sightlines at feeding and roosting sites, distribution and disturbance in feeding and roosting areas.

Of the qualifying birds associated with the Severn Estuary SPA and Ramsar site, teal *Anas crecca* (126 peak count), wigeon *Anas penelope* (16 peak count) and common shelduck *Tadorna tadorna* (2) have been recorded during BTO Wetland Bird Surveys (WeBS) conducted in 2019/20 near the outfall (River Severn – Hawk Bridge to Tewkesbury, 15323). Pochard *Aythya ferina* and tufted duck *Aythya fuligula* were also recorded there in 2010/11. Therefore, if construction works are conducted during the winter, mitigation measures will need to be implemented such as fitting silencers/ noise dampening equipment, screening and maintenance of a buffer zone via an Ecological Clerk of Works to prevent adverse effects on qualifying birds, particularly teal that may be present in large numbers. Coastal and floodplain grazing marsh priority habitat will also be reinstated where possible. Based on the implementation of appropriate mitigation measures, no adverse effects on qualifying bird species are anticipated.

It is noted that in the SACO, maintaining the extent of saltmarsh habitat is stated for The Dumbles only (located at NGR: SO 71540 04994) which is an area within the boundaries of the Severn Estuary SPA and Ramsar site. Therefore, there is uncertainty as to whether the qualifying bird populations recorded previously at River Severn – Hawk Bridge to Tewkesbury are functionally linked to habitats of the Severn Estuary SPA and Ramsar site.

5.4.1.4 Mitigation measures

The following mitigation measures relevant to impact pathways to European sites are listed in Concept Design Report (CDR) for Deerhurst to Culham interconnector[46]:

- Air quality - Well maintained plant to be used. Plant will be modern and in good condition to minimise emissions. Dust will be controlled through dampening haul roads and earthworks and aggregate processing plant.
- Water quality - Measures will be taken to protect any temporary exposure of bare soil from runoff during heavy rainfall events. Earthworks drainage will be controlled including use of temporary settlement ponds. All vehicle and chemical/ oil storage will be fully bunded to prevent any accidental pollution of groundwater or watercourses. The mitigation measures will be set out in the applications for Flood Defence Consents where these are required for any river construction works.
- Noise - Construction working hours will be limited as agreed during the planning process. Plant to be used will be modern and in good condition with silencers fitted when near to key noise receptors. Any landscaping bunds around perimeter at permanent sites will be provided at the start of construction (which can provide noise barrier benefits).

[45] Natural England & Countryside Council for Wales (2009). Severn Estuary European Marine Site advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. Countryside Council for Wales, 1 – 175.

[46] ST Classification (2022). Information Requirements for Environmental Assessments on Interconnector 500, Concept Design Report, 250322.

Mitigation measures listed in the CDR for Vyrnwy Bypass (option 27)[47] relevant to impact pathways to European sites:

- Water quality - Measures will be taken to protect any temporary exposure of bare soil from runoff during heavy rainfall events such as use of straw bales. All vehicles and any chemical/ oil storage will be fully bunded to prevent any accidental pollution of groundwater or watercourses. Minimise removal of riparian vegetation to avoid damage to bank stability and sediment loading in the river. If necessary to remove, reinstate riparian vegetation. Minimise duration of any necessary in-channel working to avoid compaction, disruption of flow processes and bank erosion.
- Hydrology/ groundwater - The pipeline route will have a number of major crossings including rivers. Mitigation measures including the use of trenchless crossings will be adopted to minimise impacts. Sections of the route will also be within the flood plain where high groundwater levels are soil permeability are expected. Adequate methods of construction will be adopted to minimise the impact to groundwater.
- Noise, vibration and visual disturbance – timing of in-channel works to avoid key periods of upstream migration and spawning for twaite shad, river lamprey and sea lamprey.
- A detailed construction method statement and all river works will follow the GPP series[48]: The method statement will be reviewed at the appropriate time.

The informal appropriate assessment considered mitigation measures when assessing the probability, magnitude and significance of the risk of adverse effects on site integrity.

This includes measures to protect flows (i.e., HoF). The EA has advised that a STT abstraction licence would be imposed so flows at Deerhurst flow gauging station do not drop below 2,568 Ml/d. Above this HoF, there is a maximum abstraction limit of 172 Ml/d, up to the next HoF condition of 3,333 Ml/d, where 335 Ml/d can be abstracted, in addition to the available 172 Ml/d unsupported[49].

This also includes advanced treatment of final effluent from the Minworth and Netheridge WwTWs prior to discharge into the River Avon and the River Severn respectively. The Gate 2 engineering conceptual design of the Severn Trent Sources SRO states the inclusion of ferric dosing, CoMAG cloth filter filtration, and granular activated carbon (GAC) prior to discharge, as presented in the Conceptual Design Report.

It is noted that the quality of discharge would be far superior to standard treated wastewater.

5.4.2 Impacts of changes in flow and water quality on supporting habitat for freshwater life stages of migratory fish in the River Vyrnwy, River Severn and relevant tributaries

The following section reviews the potential operational impacts of the STT solution. The potential impacts on supporting habitat for freshwater life stages of migratory fish in the River Vyrnwy, River Severn and relevant tributaries are summarised in **Table 5-4**. Overall, **no** risk of adverse effects on site integrity is predicted as changes in flow, velocity, depth and water quality are not considered to be distinct from the baseline pattern or substantial in magnitude.

Table 5-4 Summary of impact pathway assessment for the impacts of changes in flow and water quality on supporting habitat for freshwater life stages of migratory fish in the River Vyrnwy, River Severn and relevant tributaries.

Parameter	Summary
Impact type	Changes in flow and water quality could have a **direct** impact on the habitats that provide the structure and function (supporting habitats) for the freshwater life stages of the migratory fish of the River Vyrnwy, River Severn and relevant tributaries.
Probability	STT SRO would only be operational during low flows. Therefore, the probability of impact will vary on an annual basis.
Magnitude	Based on available information, the impacts associated with changes in flow, velocity, depth are not considered to be distinct from the baseline pattern or substantial in magnitude (details provide below). The impact associated with changes in water quality due to increased concentrations of selected chemical determinands is considered to have a minor impact however, there is low

[47] ST Classification (2022). Information requirements, Concept Design Report for Option 27.

[48] https://www.netregs.org.uk/environmental-topics/guidance-for-pollution-prevention-gpp-documents/guidance-for-pollution-prevention-gpps-full-list/

[49] Email from Caroline Howells (EA Environment Planning Officer) to Peter Blair (Thames Water) on 27/02/2020.

Parameter	Summary
	confidence in the assessment due to limited information on the efficacy and operational reliability for the planned treatment processes.
Extent	The extent of the impact includes the River Vyrnwy, River Severn and the Severn Estuary.
Duration	Impacts are likely to be intermittent and will not occur every year (scheme only operational on 15% of dates in the modelled 47-year period). The impacts will not be observed in April and will be limited in May and June.
Timing	Impacts are most likely to occur in July to October, peaking in September at 46% of dates in September in the modelled 47-year period.
Frequency	Impacts are likely to be occasional as will not occur every year (scheme only operational in 24 of the 47 years, and on 16% of days overall.
Reversibility	Changes in flow is deemed as a reversible impact as the flows will return to 'natural' regime when the SRO is not operational and the overall viability of the receptors will not be impacted. In addition, water quality changes from the River Vyrnwy to the River Avon will be within current variability within the watercourse and therefore, deemed as a reversible impact. However, from the River Avon to the Severn Estuary there is a EQS failure associated with the Minworth discharge for three determinands and therefore, the impact pathway cannot be deemed as reversible at this stage.
Summary	Overall, risk of adverse effects on site integrity is considered to be low. This is in consideration of the minor increase in load of selected determinands following advanced treatment of the Minworth final effluent, the length of river that will be affected, and the structure and function of the River Severn that will be affected. There is low confidence in the assessment due to limited information on the efficacy and operational reliability for the planned treatment processes.

5.4.2.1 Context

The importance of the River Severn as a supporting habitat for migratory fish associated with the Severn Estuary European site is well understood[50]. Advice on compliance with the conservation objectives[51] clearly states that the migratory fish of the Severn Estuary sites depend on habitat in the River Usk SAC, River Wye SAC and River Severn. The habitats in these rivers, including spawning and nursery areas, are essential for the fulfilment of the species' lifecycle and therefore the Severn Estuary migratory fish feature can only be in favourable condition if the conservation objectives pertaining to the River Usk SAC and River Wye SAC features are also met in full and there is a continued recorded presence of the species in the River Severn.

Areas of key spawning and nursery habitat for Atlantic salmon are known to occur on the upper River Severn (above Shrewsbury) and several larger tributaries, including the River Tanat, River Vyrnwy and the River Rhiw. Historical spawning activity of Alosa spp. appears to have been extensive throughout the main stem River Severn, extending beyond Shrewsbury weir as far upstream as Welshpool, although potentially more so for twaite shad than allis shad. Recent monitoring at the weir as part of the Unlocking the Severn project, however, has demonstrated that significant numbers of twaite shad traverse this structure. Further improvements in passability could, therefore allow shad to migrate further upstream in the catchment. Similarly, river and sea lamprey are also known to spawn in the middle and upper catchment of the River Severn.

Walkover surveys completed in January 2021 of the River Vyrnwy, downstream of Dolanog Falls, found frequent areas of appropriate juvenile salmonid habitat, with suitable depth, velocity and substrate, most notably for parr. Connectivity between areas of juvenile habitat within the watercourse is considered good, with areas of run and glide interspersed with regularity across the full length of the survey reach. The conditions within the reach also provide suitable connectivity for upstream and downstream migrating fish. Walkovers completed in 2022 also identified lamprey spawning habitat in the River Vyrnwy with ammocoete habitat mapping also showing optimal and sub-optimal ammocoete habitat in the River Vyrnwy. Sea lamprey eDNA has also been confirmed in the lower reaches of the River Vyrnwy[52]. Shad spawning habitat has also been identified in the reaches of the River Vyrnwy.

[50] APEM (2020). STT Ecological Literature Review. APEM Scientific Report P00004288. Severn Thames Transfer Partnership, September 2020, v2.0 Final, 480 pp

[51] Natural England and Countryside Council for Wales (2009). Severn Estuary SAC, SPA and Ramsar Site: Regulation 33 Advice. Natural England and Countryside Council for Wales, 1 – 175

[52] Jason Jones, NRW Fisheries Technical Specialist, *Pers Comm.*

5.4.2.2 Changes in flow, velocity and depth

A detailed assessment of the potential changes in flow, velocity and depth is presented in the Physical Environment Assessment Report[53]. Flow, velocity and depth (and subsequently habitat quality and quantity) will not be affected in the supporting Wye and Usk rivers or the River Clun SAC. The potential changes in the waterbodies associated with an unsupported and full STT have been summarised in Table 5-5.

From the results it is evident that the potential changes in flow via a direct release of 25Ml/d into the Vyrnwy, is not considered to be distinct from the baseline pattern or substantial in magnitude and will likely be within the inter annual variations that would be observed under reference conditions. The modelled changes in velocity and depth (as associated with either a supported or unsupported STT) are also not considered to be of a magnitude to result in impacts on habitat availability for the fish community as the velocity and depths that would be observed under a supported or unsupported STT will remain mostly similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community associated with the various waterbodies.

This includes the requirements for juvenile Atlantic salmon and sea trout, river and sea lamprey ammocoetes as well as shad spawning habitat and is further supported by measured data collected under different flow conditions in 2021.

Hydraulic surveys that were completed in June and October 2021 at a site on the River Severn near Montford with two surveys completed under flows of 697Ml/d measured on 15 June 2021 and 948Ml/d measured on 14 October 2021, a difference of 251Ml/d, representing flows that are above those that would be observed during a fully supported STT in the River Severn. The hydraulic data indicates that there is a very limited amount of suitable flow habitat for Atlantic salmon and brown trout (0+ and juvenile), with spawning habitat also very limited (as expected in these flows). The measured hydraulic data also indicates limited habitat suitability for lamprey ammocoetes, but extensive flow habitats available for coarse fish. The measured data shows a slight increase in habitat under higher flows which is likely reflective of the greater hydraulic radius, leading to an increase in slower and deeper flows at inundated margins. There appears to be a slight decrease in habitat suitability for juvenile coarse fish, noting that the measured data was at flows that will exceed the support flows and remain within the preferred tolerances for juvenile coarse fish (i.e., <0.2m/s).

Figure 5.1 shows the River Severn near Atcham (downstream of Shrewsbury and upstream of the confluence with the River Tern) on two separate survey dates. This includes a survey on 15th June 2021 when water levels in the River Severn were at 0.644m (as measured on the River Severn at Montford) and 14th October 2021 when water levels in the River Severn was at 0.644m (as measured on the River Severn at Montford) 0.813m. This represents a level increase of ~17cm and despite the noticeable level increase habitat availability has not changed, as represented in the modelled data.

Hydraulic surveys that were also completed in July and October 2021 at a site on the River Severn near Deerhurst with two surveys completed under flows of 1,926Ml/d measured on 15 and 21 July 2021 and 3,367Ml/d measured on 28 October 2021, a difference of 1,441Ml/d. The results of the analyses are provided in Annex A of the Physical Environment Assessment Report[54]. The extensive difference in flow is over representative of what would be observed under an unsupported STT (decrease in flow) or supported STT (increase in flow). The hydraulic data indicates that there is relatively limited suitable flow habitat for juvenile coarse fish and lamprey in this reach. Any changes in juvenile habitat availability under decreasing flows are likely in response to decreasing hydraulic radius and decreasing marginal inundation. Due to the lowland nature of the River Severn at this point, the impacts on habitat availability will be limited.

Figure 5.2 shows the River Severn downstream of the confluence with the River Teme on two separate dates in July 2021. This includes 14th July when water levels (as measured at Saxon Lode was at 0.482m) and 20th July 2021 (when flows were at 0.420m). This represents a difference in level of ~6cm and there is no perceptible change in habitat availability for fish in at this location.

Figure 5.3 shows the River Severn downstream of the Deerhurst on two separate dates in 2021. This includes 21st July 2021 when water levels (as measured at Deerhurst) was at 0.584m and 13th August 2021 (when flows

[53] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Physical Environment Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

[54] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Physical Environment Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

were at 0.692m). This represents a difference in level of ~10cm and there is no perceptible change in habitat availability for fish in at this location.

The exception appears to be the reaches of the River Avon downstream of Warwick where both modelled and measured data indicates a change in the quantity and/or quality of habitat available for fish (when considering survey data which was collected at a higher flow rate when compared to the proposed 115Ml/d discharge). The change in habitat is mostly related to the increase in velocities, noting that in most areas the velocities will remain within the preference for juvenile coarse fish and brown trout. It is noted that the modelled data shows that the expected change in habitat quality and quantity will be minor and limited to the reaches upstream of Alveston. **This reach provides limited supporting habitat to the majority of the fish community of the Severn Estuary due to multiple impassable barriers along the length of the River Avon.** It should, however, be noted that the European eel population are physiologically capable of traversing sluice and lock gates, and their migration supported via the numerous eel passes present on many of the weirs throughout this reach.

In addition to the changes summarised in Table 5-5, the potential changes in the River Vyrnwy have also been considered.

Initially the modelling considered a release of up to 75Ml/d. In A82, STT solution releases potentially coincide with Severn Regulation releases on 31 dates in July and August, with managed releases (compensation flow, Severn Regulation Release and STT solution release) up to 170Ml/d. In M96, STT solution releases potentially coincide with Severn Regulation releases on 115 dates between mid-June and mid-October, with managed releases (compensation flow, Severn Regulation Release and STT solution release) up to 195Ml/d.

As a result, immediately downstream of the Vyrnwy Reservoir the flow in the River Vyrnwy will generally increase by 167% when the River Vyrnwy is at compensation releases. At times when Severn regulation releases are in place, flows would increase by up to 300%. Downstream of the reservoir this would have resulted in an average daily increase of 1 – 14 % in velocity in the months of June – October in an A82 scenario and an average daily increase in velocity of 5 – 13% increase in velocity in the months of May – November in M96 scenario. The equates to a maximum increase in flow of approximately 0.1m/s. On average, depths would increase by 8 – 86% in the A82 scenario and by 29 – 80% in the M96 scenario. This equates to a maximum increase in depth of approximately 20cm in the A82 scenario and the M96 scenario noting that depths will not exceed 50cm.

The potential impacts on habitat as a result of the proposed 75Ml/d would have been significant. The risk to salmonid habitat has been subject to detailed investigating as part of the monitoring programme to inform physical losses of a supported STT[55]. Analysis of habitat and velocity/depth changes during these investigations indicated an inflection point of 174Ml/d as the upper limit of the tolerances in velocity for the salmonid community. At these flows, habitats become less suitable and continuous releases at this rate would also impact on fine sediment accumulation in riffles, further impacting on habitat quality. As noted above, flows will be at or exceed this critical flow rate on 31 days in an A82 scenario and 115 days in a M96 scenario. It should also be noted that further data are required between compensation flows of 45Ml/d and this 174Ml/d inflection point to support the assessments as the inflection point could be at a lower flow rate.

The findings of the habitat assessments were corroborated by the results of the velocity/depth surveys undertaken prior to and during the trial releases. The data from these surveys identified a significant loss in habitat when flows exceed 175Ml/d for juvenile salmonids. In order to gain a general understanding of the potential impact of the releases across the model period, the 1D modelled data was also processed to extract the flow velocity and flow depth data for each of the model nodes for the A82 and M96 reference and full model runs. This covered the full reach of ~246km between the Vyrnwy Reservoir and the tidal limit of the River Severn. For each of the Atlantic salmon life stages, when compared to the model habitat baseline, the habitat data indicate:

- **0+** – For the A82 and M96 model runs, ~97% of the habitat remains unchanged, with around a 3% loss in habitat and a gain of 0.1-0.2% for A82 and M96 runs respectively.
- **Juvenile** – For the A82 and M96 model runs, ~97% of the habitat remains unchanged, with around a 3% loss in habitat and a gain of 0.1% for M96 run only (there is no gain in habitat for A82).

[55] Ricardo Energy & Environment (2021). Seven to Thames Transfer SRO River Vyrnwy Test Releases – Initial Ecological Findings. Report for United Utilities on behalf of the STT Group. November 2021.

- **Spawning** – For spawning habitat no change in habitat is indicated for the A82 run. For the M96 run there is a 2% loss, 0.3% gain and 97% remains unchanged.

Although this is based on hydraulic habitats only, it was noted that most of the habitat loss will occur in the first 50km of the River Vyrnwy.

The STT solution was, therefore, amended to include a maximum release of 25Ml/d from the Vyrnwy Reservoir. In A82, with managed releases (compensation flow, Severn Regulation Release and STT release) flows are expected to be 120Ml/d and 145Ml/d in the M96 scenario. As such, flows are expected to remain below the 175Ml/d threshold that was identified and modelled data shows only limited reductions in suitable habitat and therefore no significant effects on supporting habits.

In summary, the potential for changes in the quality and quantity of supporting habitats in the River Severn is considered unlikely as the changes in flow, velocity and depth STT will remain mostly similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community associated with the various waterbodies. As such, no risk of adverse effects on site integrity have been identified.

Figure 5.1 Photographs showing the River Severn downstream of Shrewsbury (at Atcham on 15th June 2021 (top) and 14th October 2021 (bottom) when levels were at 0.644m and 0.813m respectively (as measured at Montford)

Figure 5.2 Photographs showing the River Severn downstream of the River Teme confluence on 14th July 2021 (left) and 20th July 2021 (right) when levels were at 0.482m and 0.420m respectively (as measured at Saxons Lode)

Figure 5.3 Photographs showing the River Severn downstream of the Deerhurst on 21st July 2021 (top) and 13th August 2021 (bottom) when levels were at 0.584m and 0.692m respectively (as measured at Deerhurst)

Table 5-5 Summary of the potential changes in flow, velocity and depth as a result of the operation of the STT solution (early phase and full STT) in different modelled scenarios

Reach	Potential change in flow	Potential change in velocity	Potential change in depth
River Vyrnwy	Downstream of the reservoir, the flow is increased by 25Ml/d from 27th June to 9th October in the A82 scenario and from 12th June to 2nd November in the M96 scenario. This is a percentage change in flow of between 25 and 100% depending on the baseline flow. The duration of the STT support changes between Scenario A82 and M96 because of when the transfer of water is required.	The mean change in depth-average velocity is modelled as 0.028 m/s (a 3% increase).	The mean change in water depth is modelled as 0.068 m (a 7% increase).
River Severn from downstream of the confluence with the River Vyrnwy to Bewdley.	After the confluence with the River Vyrnwy the flow from the STT solution is approximately 16% of the total flow.	Downstream of the confluence with the River Vyrnwy the average daily increase of 0.7 – 12% in velocity in June to October in an A82 scenario and an average daily increase in velocity of 0 – 14% increase in velocity in June – November in M96 scenario. The resulting change is an approximate increase of ~0.02m/s	The average daily increase in water depth will be 0.2 – 5% in June to October in an A82 scenario and 0 – 6% increase in velocity in June – November in M96 scenario. The resulting change is an approximate increase of ~0.02m
The River Severn from Bewdley to the confluence with the River Avon	At Bewdley, the percentage of flow from the scheme increases to around 17% of the total flow, due to the flow not abstracted from Shrewsbury. Upstream of the confluence with the River Avon the increase in flow due to the fully supported STT scheme is approximately 14%.	At Bewdley the average daily increase in velocity is expected to be 0.1 – 16% in in June to October in an A82 scenario and of 8 – 17% increase in velocity in June – November in M96 scenario. The resulting change is an approximate increase of ~0.03m/s Upstream of the confluence with the River Avon the average daily increase in velocity is expected to be 0.1 – 13% in in June to October in an A82 scenario and of 6– 16% increase in velocity in June – November in M96 scenario. The resulting change is an approximate increase of ~0.03m/s	At Bewdley the average daily increase in water depth will be 1 – 4% in June to October in an A82 scenario and 8– 17% increase in velocity in June – November in M96 scenario ~0.03m. Upstream of the confluence with the River Avon the daily increase in water depth will not be distinct from the baseline pattern or substantial in magnitude
The River Avon from Stoneleigh to the confluence with the River Severn	Downstream of Warwick the flow will be increased by around 41% in A82 and 50% in M96 compared to the reference conditions. At Evesham the flow is increased by around 25% in A82 and 28% in M96 compared to the reference conditions.	Upstream of Alveston the average daily increase in velocity is expected to be 35 - 42% in the months of July, August and September in an A82 scenario and 19 – 50% increase in the months of June – October in M96 scenario. The resulting change is an approximate increase of ~0.02m/s Downstream of Alveston the average daily increase in velocity is expected to be 20 – 26% in the months of July, August and September in an	Upstream of Alveston the potential changes in depths have been assessed as a maximum increase of 2% (~4cm) in both scenarios Upstream of Alveston the potential changes in depths have been assessed as a maximum increase of 1% (~2cm) in both scenarios

Reach	Potential change in flow	Potential change in velocity	Potential change in depth
	Upstream of the confluence with the River Severn the flow is increased by around 20% in A82 and 23% in M96 compared to the reference conditions.	A82 scenario and 217 – 25% increase in the months of June – October in M96 scenario. The resulting change is an approximate increase of ~0.03m/s Upstream of the confluence with the River Severn the average daily increase in velocity is expected to be 18– 27% in the months of July, August and September in an A82 scenario and 21 – 26% increase in the months of June – October in M96 scenario. The resulting change is an approximate increase of ~0.01m/s.	Upstream of the confluence with the River Severn the resulting change in depth will not be distinct from the baseline pattern or substantial in magnitude
The River Severn from the confluence with the River Avon to Deerhurst	The increase in flow upstream of Deerhurst, due to the fully supported STT scheme is around 15% in the A82 scenario and 17% in the M96 scenario	At the Upper Lode weir/downstream of the confluence with the River Avon the average daily increase in velocity will be 4- 13 % in the months of June - October in an A82 scenario and 3 – 16% increase in velocity in the months of June – November in M96 scenario. The proportionate change in the average velocities is ~ 0.02m/s in both scenarios. Downstream of Upper Lode weir/upstream of Deerhurst average daily velocities are expected to increase by 0.1- 16% in the months of June - October in an A82 scenario and 1 – 19% increase in the months of June – November in M96 scenario. The proportionate change in the average velocities is ~ 0.02m/s in both scenarios.	At the Upper Lode weir/downstream of the confluence with the River Avon the modelled data shows that depth will not change during operation, although a slight decrease in depth is noted in October (~0.5cm). Downstream of Upper Lode weir/upstream of Deerhurst the modelled data shows that depth will not change during operation, although a slight decrease in depth is noted in October (~0.5cm)
The River Severn from Deerhurst to the tidal limit at Gloucester.	In an unsupported scenario, reduction in the flow in the River Severn downstream of Deerhurst will be 5 to 15% depending on the flow in the river. In the fully supported STT scheme, there is a flow reduction of approximately 1.5% during the summer	In an unsupported abstraction the maximum velocity decrease will be 5% in November in an A82 scenario and an average daily increase in velocity of approximately 3% in December in an M96 scenario. As a result, the proportionate change in the average velocities will not be distinct from the baseline pattern or substantial in magnitude. In a supported scenario, average velocities will decrease by 2- 5 % in the months of September - November in an A82 scenario and 0.1 – 5% in the months of October to January in M96 scenario. As a result, the proportionate change in the average	In an unsupported and/or supported abstraction the change in depth in both scenarios is not expected to exceed 2% which equates to approximately 2cm in autumn noting that depths will exceed 3m.

Reach	Potential change in flow	Potential change in velocity	Potential change in depth
		velocities will not be distinct from the baseline pattern or substantial in magnitude.	

5.4.2.3 Changes in water quality

In the 15.1km reach of the River Severn from the confluence with the River Avon to the tidal limit, the water quality change pathway from the Minworth Transfer is lessened due to the large flow increase from the River Severn. Noting the inclusion of an advanced treatment unit at Minworth STW prior to transfer for the STT Solution, both the River Avon and River Severn dilute the influence of the Minworth Transfer. The results of the water quality modelling indicate that water quality changes in the River Severn are expected to be minimal with a slight decrease in some nutrients expected. The temperature and dissolved oxygen (as % saturation) will remain within the range for achieving high ecological status. Within the Severn Estuary, no changes in the physico-chemical characteristics of the water are assessed as to occur from the STT Solution. Decreased soluble reactive phosphate and DIN concentration from the STT Solution would provide a potential benefit through a reduction in algal growth in the Severn Estuary. As the Gate 2 assessment identified no distinct or substantial adverse change in physico-chemical water quality passed forward into the Severn Estuary, there are no associated pathways of impact on any supporting habitats for the designated fish community of the Severn Estuary.

In terms of chemical water quality, Gate 2 assessed a large chemical dataset[56], with review against environmental quality standards (EQS) set out in the WFD Regulations[57] and other operational EQS set by the EA. For WFD chemicals this is summarised in Table 5-6 for the site representing the receiving water quality for a Minworth Transfer for both short term (either maximum values or 95 percentiles) and long term (mean) EQS, where these are applicable. It is noted that this is not a WFD status statement as that is undertaken by the EA using EA sampling and analysis at specified WFD monitoring locations within WFD water bodies.

Monitoring data have been reviewed against EQS set out in the WFD Regulations[58]. This is summarised in Table 5-6 for the site representing the receiving water quality for a Minworth Transfer for both short term (either maximum values or 95 percentiles) and long term (mean) EQS, where these are applicable. It is noted that this is not a WFD status statement as that is undertaken by the EA using EA sampling and analysis at specified WFD monitoring locations within WFD water bodies. This is measured baseline without the STT Solution.

The STT solution monitoring data indicate that the River Avon upstream of Warwick does not achieve EQS for 6 WFD chemicals, with one chemical without suitable data for analysis. For ten chemicals the assessment is incomplete as the laboratory limit of detection is higher than the EQS; however, for all 10 chemicals all reported values were less than the limit of detection used.

Table 5-6 Review of measured baseline for WFD chemicals against EQS at the Avon above Warwick SRO monitoring site (2020/2021, typically 16 samples)

Substance	Substance	Substance
1,2-dichloroethane	cyanide total	mecoprop
2,4-dichlorophenol	cybutryne (Irgarol)	mercury dissolved
2,4-dichlorophenoxyacetic acid (2,4-D)	cypermethrin	methiocarb
3,4-dichloroaniline	DDT total	naphthalene
aclonifen	di(2-ethylhexyl)phthalate (DEHP)	nickel dissolved
alachor	Diazinon	nonylphenols
aldrin	dichloromethane	octylphenols
anthracene	dichlorvos	PBDEs
arsenic total	Dicofol	pendimethalin
atrazine	Dieldrin	pentachlorobenzene
benzene	dimethoate	pentachlorophenol
benzo(a)pyrene	Diuron	perfluorooctane sulfonic acid and its derivatives
benzo(b)fluoranthene	endosulfan	permethrin
benzo(g,h,i)perylene	Endrin	phenol
benzo(k)fluoranthene	fluoranthene	polycyclic aromatic hydrocarbons (PAH) sum
benzyl butyl phthalate	glyphosate	quinoxyfen

[56] The pan SRO monitoring programme commenced in December 2021 and typically has 16 samples for the Gate 2 assessment. The monitoring suite includes all WFD Chemicals, All chemicals used in environmental permitting by the Environment Agency (EQSD Directive) and a suite of olfactory inhibitors agreed with NAU during Gate 2. The locations of monitoring sites have been reviewed with the NAU in Gates 1 and 2 and include all source waters, all discharge locations and other key locations in the River Severn catchment.

[57] Schedule 3 of The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015;

[58] Schedule 3 of The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015;

Substance	Substance	Substance
bifenox	heptachlor and heptachlor epoxide	simazine
C10-13 chloroalkanes (total)	hexabromocyclododecane (HBCDD)	terbutryn
cadmium total	hexachlorobenzene	tetrachloroethane
carbendazim	hexachlorobutadiene	tetrachloroethylene
carbon tetrachloride	hexachlorocyclohexane	toluene
chlorfenvinphos	indeno(1,2,3-cd)pyrene	tributyltin compounds (as tributyltin cation)
chlorine total	iron dissolved	trichlorobenzenes
chlorothalonil	isoproturon	trichloroethylene
chlorpyrifos (chlorpyrifos-ethyl)	lead dissolved	trichloromethane (chloroform)
chromium (III) dissolved	lead dissolved	triclosan
chromium (VI) dissolved	Linuron	trifluralin
copper dissolved	manganese dissolved	zinc dissolved

Legend:

All reported values achieve applicable EQS
Reported values identify short-term EQS not achieved
Reported values identify long-term EQS not achieved
Reported values identify neither short-term or long-term EQS achieved
Limit of detection used does not enable full comparison of reported data with EQS
No data for analysis at Gate 2

Target concentrations of the chemicals listed above were provided to process engineers for the Minworth SRO to ensure no change to existing in-river concentration (no WFD deterioration risk) or EQS (no impediment to WFD target status). The process engineers established where the advanced treatment processes for Minworth SRO, as proposed at Gate 2, may not effectively reduce the chemicals in the source water (Minworth STW final effluent) sufficiently to achieve the target concentrations and identified that there are post advanced treatment risks to proposed targets associated with eight WFD chemicals. These WFD chemicals were reviewed further in based on the STT water quality model).

Table 5-7 Review of post-treatment risk of WFD chemicals associated with the Minworth Transfer

WFD chemical	Summary	Notes
Chromium (III) dissolved	No change	Apart from one high river value, all other reported values achieve long term ES.
Hexabromocyclododecane (HBCDD)	No change	~6% increase in mean value of river, remains achieving EQS
Nonylphenols	Risk to long term EQS	~56% increase in mean value of river, potential change from achieving long term EQS to not. Gate 2 evidence indicates risk of EQS failure low.
Terbutryn	No change	~1% increase in mean value of river, remains achieving EQS
Trichloromethane (chloroform)	No change	~4% increase in mean value of river, remains achieving EQS
Cypermethrin	Risk of worsening non-achievement of long term EQS	~34% increase in mean value of river, remains not achieving EQS
Perfluorooctane sulfonic acid and its derivatives	Risk of worsening non-achievement of long term EQS	~34% increase in mean value of river, remains not achieving EQS
Permethrin	Risk of worsening non-achievement of long term EQS	~32% increase in mean value of river, remains not achieving EQS

Taking into account the treatment efficacy provided by Minworth SRO process engineers at Gate 2, three chemicals (cypermethrin, perfluorooctane sulfonic acid and its derivatives, and permethrin) are considered a risk without further understanding of treatment removal rates or the inclusion of additional treatment processes. All three chemicals would associate with further deterioration in current EQS failures in the River Avon and impede the River Avon reaching targets. SRO monitoring data indicate the lower River Severn fails EQS for cypermethrin and that is the dominant pressure on water quality in the River Severn, not the contribution of the River Avon or Minworth Transfer. Perfluorooctane sulfonic acid and its derivatives has such a large EQS

failure in both rivers that increases from the Minworth Transfer could impede targets being reached, noting that PFOS use is heavily restricted, and this should see concentrations reduce in the future. Permethrin is rarely detected in the lower Avon or lower Severn at present and risks to long-term EQS from Minworth Transfer are considered low.

The effects of increased exposure to pyrethroid insecticides such as permethrin are well understood. This includes behavioural changes (e.g., schooling behaviour, mucus production), reproductive disorders and malformations, histopathological alterations, haemato-biochemical alterations, neurotoxicity, endocrine disruption, oxidative stress and immunotoxicity[59].

In addition to the three chemicals listed above, concentrations of chromium (III), cobalt, selenium and zinc could also increase in the River Avon and potentially downstream.

The River Avon is not considered to provide supporting habitat for other migratory fish species of the Severn Estuary European Marine Site, with the exception of European eel. The potential changes in concentrations are not expected to reduce the quality of supporting habitat for European eel in the River Avon or the River Severn. That said, it is not known whether there may be any long-term implications on eel physiology, anatomy, or behaviour owing to the cumulative impact of additional chemical stressors (e.g., permethrin). For instance, the ability of individuals undertaking their >5000 km spawning migration to the Sargasso Sea may be reduced, thereby impacting reproductive success, and contributing to declines in stocks and associated RAMSAR/SAC designation. Ongoing reviews of the evidence databases will be required as new peer reviewed scientific literature becomes available on this topic.

It is also important to consider the risk of increases in concentration in those chemicals listed above to lamprey ammocoete and shad and note the same uncertainties regarding long-term chronic impacts of chemical stressors mentioned above on other fish species.

The reach of the River Severn that will be affected (from the confluence of the River Avon to the tidal limit) provides a migratory route for Atlantic salmon and sea trout to spawning grounds and does not provide functional habitat for juvenile individuals. The upriver migration of adult Atlantic salmon from above the tidal limit comprises of a rapid upstream movement up to 20km per day[60] to a first holding site, which may be a long-distance upstream and, in some cases, adjacent to their intended spawning site[61]. As such, any exposure to those chemicals listed above will be over several hours and are unlikely to impact the salmonid species during upstream or downstream passage to the upper reaches of the Severn Catchment or the River Teme and River Clun. Similarly, the spawning of lamprey also occurs in the upper catchment and adult lamprey and juvenile lamprey will not be impacted during upstream and downstream migration.

However, it is well documented that the reaches of the River Seven that will be affected by the increase in concentrations of selected chemicals, provide spawning habitat for shad. As such, shad could be exposed to increased concentrations of those chemicals listed above during spawning activities, and eggs would be exposed during incubation. The exposure period for both spawning adults and incubation will be very short as the speed of migration has been estimated at 20 km per day[62]. Hatching occurs within 4-8 days[63] and, although concentrations will increase, the concentrations that would be observed are unlikely to result in impacts on the incubating eggs (such as a delay in hatching). After hatching, the young remain in the slow-flowing reaches of the lower parts of rivers, then move into the estuary and eventually into coastal waters and the open sea,

There is some uncertainty with regards to the potential impacts on juvenile shad and lamprey ammocoete. After hatching juvenile shad will drift to the lower reaches of the River Severn until reaching adult life stages. Similarly, lamprey ammocoete will remain in the nursery habitats in the margins of the River Severn for several years. As such, both lamprey and shad juveniles will be exposed to increased concentrations of selected chemicals for extended period (e.g., up to 3 months).

---

[59] Farag MR, Alagawany M, Bilal RM, Gewida AGA, Dhama K, Abdel-Latif HMR, Amer MS, Rivero-Perez N, Zaragoza-Bastida A, Binnaser YS, El-Saber Batiha G and Mohammed AEN (2021) An Overview on the Potential Hazards of Pyrethroid Insecticides in Fish, with Special Emphasis on Cypermethrin Toxicity. Animals 2021, 11, 1880. https:// doi.org/10.3390/ani11071880

[60] Banks J.W. (1969) A review of the literature on the upstream migration of adult salmonids. Journal of Fish Biology 1, 85–136.

[61] Milner, N.J., Solomon, D.J. & Smith, G.W. (2012). The role of river flow in the migration of adult Atlantic salmon, Salmo salar, through estuaries and rivers. Fisheries Management and Ecology, 2012, 19, 537–547

[62] Aprahamian, M. W., Aprahamian, C. D., Baglinière, J. L., Sabatié, M. R.& Alexandrino, P.(2003). Alosa and Alosa fallax spp. Literature Review and Bibliography. R&D Project W1-014. Environment Agency, Rio House, Waterside Drive, Aztec West, Almondsbury Bristol BS32 4UD

[63] Maitland PS & Hatton-Ellis TW (2003). Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough.

While the effects of increased metal concentrations on fish eggs, hatching success and juveniles are well understood, the available information only provides an indication of the risk of changes in concentrations. The magnitude of the risk to river and sea lamprey is considered low as the potential risk is unlikely to result in a decrease in density and abundances across the catchment of the River Severn, River Wye and River Usk. The magnitude of the impact on shad is also considered low as the Minworth SRO will not be operational in April, but rather constantly running through 1% and 13% of the dates in May and June respectively. As such, egg incubation and hatching will not be affected. Any effects on shad will be in response to limited exposures of juveniles to increased concentrations in August and September, or through to November under a future climate scenario.

In summary, changes in water quality that could affect the supporting habitats for the migratory fish of the Severn Estuary is considered likely. However, the magnitude is considered low (low confidence) and the risk of adverse effects on site integrity is also considered low. This in the context of baseline water quality data and the proposed advanced treatment of the Minworth and Netheridge final effluent.

There remains some uncertainty in the assessment, as summarised in Section 7.3.

Table 5-8 Summary of the potential changes in water quality as a result of the operation of the STT solution (unsupported and full STT) in different modelled scenarios

Reach	Potential change in physical-chemical parameters	Potential change chemical determinands	Potential change in olfactory inhibitors/reproductive disruptors
River Vyrnwy from the Vyrnwy reservoir to the confluence with the River Severn	Temperature of managed releases of water from Vyrnwy Reservoir are cooler than downstream River Vyrnwy temperatures, with distinct seasonal pattern and day-to-day variability. An additional 25Ml/d direct release from Vyrnwy Reservoir for STT Solution would not change water temperature locally downstream of the reservoir but could lead to the extent of influence of the cooler water extending further, for example a 0.25-0.75°C cooling of the River Vyrnwy in the Meifod Valley 25km downstream. Such changes are largely indistinct from the baseline pattern and not substantial in magnitude. As there is no distinct substantial water temperature change associated with the STT Solution, there is no pathway to change in the oxygen carrying capacity, the dissolved oxygen saturation, of the River Vyrnwy. There are no other pathways of general water quality change in this reach.	Review of measured data identifies EQS failure in the managed release water from Vyrnwy Reservoir only for chlorine (total). Chlorine (total) monitored at all other sites in the River Vyrnwy also all identify potential EQS failure. It is not considered that a 25Ml/d direct release from Vyrnwy Reservoir would increase the concentration of chlorine (total) in the River Vyrnwy.	There is no pathway of olfaction change in this reach from STT operation.
River Severn from downstream of the confluence with the River Vyrnwy to Bewdley.	A precautionary approach to assessing the scope of water temperature effects from a Vyrnwy Bypass into the River Severn identified no distinct change in water temperature pattern and substantial changes in magnitude only when the River Severn temperatures are warm (greater than 15°C) and river flows low (c.700Ml/d in late July 2022). A median change of 0.4°C cooling was assessed with changes assisting water temperatures becoming consistent with WFD High status for salmonid waters of 20°C (98-percentile). There is no pathway to adverse change in the oxygen carrying capacity, the dissolved oxygen saturation, of the River Severn. There are no other pathways of general water quality change in this reach.	Review of measured data identifies EQS failure in the River Severn at the Vyrnwy Bypass outfall location only for chlorine (total). River Severn chlorine (total) values in the River Severn only partially associate with EQS failures in the River Vyrnwy and mean values are greater than Vyrnwy Reservoir water. It is not considered that a 155Ml/d Vyrnwy Bypass would increase the concentration of chlorine (total) in the River Severn.	There is no pathway of olfaction change in this reach from STT operation.

Reach	Potential change in physical-chemical parameters	Potential change chemical determinands	Potential change in olfactory inhibitors/reproductive disruptors
The River Severn from Bewdley to the confluence with the River Avon	There is no pathway of general water quality, chemical water quality change or changes in olfaction change in this reach from STT operation. This is because the water that would be discharged in this reach is from the same source (i.e., the Vyrnwy Reservoir) and/or will simply be discharged in the River Severn instead of entering the River Severn via the River Vyrnwy.		
The River Avon from Stoneleigh to the confluence with the River Severn	Temperature is expected to increase by up to 0.5°C at the confluence with River Severn (remaining below 18^0C) Dissolved oxygen (as %saturation) will remain above 75% within the first 20km and remain above 90% for the remainder of the reach, up to the confluence with the River Severn. Ammoniacal nitrogen is expected to increase by up to 0.15mg/l (0.02mg/l at the confluence with the River Severn). Soluble reactive phosphate concentrations are reduced by the scheme throughout the River Avon by up to 0.1mg/l.	Potential increased concentrations of nonylphenols cypermethrin, perfluorooctane sulfonic acid (PFOS) and its derivatives and permethrin	Potential increased load of chromium (III) and total, selenium, zinc, cypermethrin and permethrin
The River Severn from the confluence with the River Avon to Deerhurst	No changes in temperature, dissolved oxygen or ammoniacal nitrogen is expected. • Soluble reactive phosphate concentrations are predicted to be reduced by up to 0.05 mg/l during the operation of the STT		
The River Severn from Deerhurst to the tidal limit at Gloucester.	Downstream of Deerhurst (upstream of the Netheridge discharge) and at the tidal limit, the STT operation is predicted to reduce water temperature by 0.3°C and dissolved oxygen by about 0.1 mg/l (a reduction of less than 1% saturation). Ammoniacal nitrogen concentrations are predicted to be increased by about 0.02 mg/l at both sites and soluble reactive phosphate concentrations are predicted to be reduced by up to 0.02 mg/l.		

5.4.3 Impacts of increased flows on upstream and downstream migration within the River Vyrnwy, River Severn and River Avon

The following section reviews the potential operational impacts of the STT solution. The potential impacts associated with the increased flows on upstream and downstream migration within the River Vyrnwy, River Severn and River Avon are summarised in **Table 5-9**. Overall, no risk of adverse effects on site integrity has been identified as the potential change in flow is not considered to be distinct from the baseline pattern or substantial in magnitude.

Table 5-9 Summary of impact pathway assessment for the impacts of increased flows on upstream and downstream migration within the River Vyrnwy, River Severn and River Avon.

Parameter	Summary
Impact type	Increased flows could have a **direct** impact on migration as well as the passability of weirs and the functionality of fish passes.
Probability	STT SRO would only be operational during low flows. Therefore, the probability of impact will vary on an annual basis.
Magnitude	The magnitude of the impact is considered low (certain).
Extent	Impacts within the River Severn and Severn Estuary.
Duration	Impacts are likely to be continuous when operational but will not occur every year (scheme only operational in 24 of the 47 years, and on 16% of days overall.
Timing	Flow changes in this reach would typically be in the months July to October, peaking in August at 47% of days in August
Frequency	Impacts are likely to be occasional as will not occur every year (scheme only operational in 24 of the 47 years, and on 16% of days overall.
Reversibility	Changes in flow are deemed as a reversible impact as the flows will return to 'natural' regime when the SRO is not operational and the overall viability of the receptors will not be impacted.
Summary	Overall, no risk of adverse effects on site integrity has been identified as the potential change in flow is not considered to be distinct from the baseline pattern or substantial in magnitude.

5.4.3.1 Context

Increased flows within the River Severn and River Avon could have a **direct** impact on the Severn Estuary SAC and Ramsar site as well as the River Clun SAC. As a fully supported scheme is most likely to operate in the months of May-October, all migratory species could be affected.

- **Atlantic salmon**
  - In the Severn catchment, adult will migrate into the river throughout the year, holding in deep pools before moving upstream to spawning grounds during October and November. Downstream migration occurs in March and mid-May and peaks in April (this is *outside* the likely period of operation
- **Sea trout**
  - Upstream migration of sea trout and local migration by brown trout occurs in autumn and winter (October-December). Downstream migration occurs March and April (this is *outside* the likely period of operation)
- **Twaite shad**
  - Adult twaite shad will migrate from coastal waters into the Severn Estuary and the River Severn during mid to late spring (April – June) which would coincide with support releases.
- **Lamprey**
  - Sea lamprey spawning migration usually takes place between April and May and will partly coincide with a full STT operation. Downstream migration occurs from September-March and will also partly coincide with the operation of a full and/or unsupported STT. River lamprey also migrate upstream between October-January which will also partly coincide with the operation of a full and/or unsupported STT.
- **European eel**
  - Mature eel undertake downstream migrations to sea in the autumn (typically September to December) and this would partially coincide with support releases and unsupported

abstraction. Support releases will also coincide with the upstream migration of elver in October – December.

It is evident that the River Severn provides a key migration route into the middle and upper reaches of the catchment, including the tributaries of the River Severn that provide supporting habitat to the Severn estuary European site (and the River Clun SAC). The operation of the STT solution could therefore impact on the upstream migration of Atlantic salmon and sea trout and the upstream and downstream migration of river lamprey, sea lamprey, shad and European eel.

Areas of key spawning and nursery habitat for Atlantic salmon are known to occur on the upper River Severn (above Shrewsbury) and several larger tributaries, including the River Tanat, River Vyrnwy and the River Rhiw. Historical spawning activity of *Alosa spp*. appears to have been extensive throughout the main stem River Severn, extending beyond Shrewsbury weir as far upstream as Welshpool, although potentially more so for twaite shad than allis shad. Recent monitoring at the Shrewsbury Weir as part of the Unlocking the Severn project, however, has demonstrated that significant numbers of twaite shad traverse this structure. Further improvements in passability could, therefore allow shad to migrate further upstream in the catchment. Similarly, river and sea lamprey are also known to spawn in the middle and upper catchment of the River Severn.

Walkovers completed in January 2021 of the River Vyrnwy, downstream of Dolanog Falls, found frequent areas of appropriate juvenile salmonid habitat, with suitable depth, velocity and substrate, most notably for parr. Connectivity between areas of juvenile habitat within the watercourse is considered good, with areas of run and glide interspersed with regularity across the full length of the survey reach. The conditions within the reach also provide suitable connectivity for upstream and downstream migrating fish. Walkovers completed in 2022 also identified lamprey spawning habitat in the River Vyrnwy with ammocoete habitat mapping also showing optimal and sub-optimal ammocoete habitat in the River Vyrnwy. Shad spawning habitat has also been identified in the reaches of the River Vyrnwy.

Significant changes in flow could, therefore, impact on the ability of these species to reach spawning grounds and impact the passability of barriers and the functionality of fish passes.

5.4.3.2 Changes in flow

A detailed assessment of the potential changes in flow is presented in the Physical Environment Assessment Report[64] and are also discussed in detail in section 5.4.2.

In summary, the impact of changes in flow on the migration of the fish of the Severn Estuary into and from the River Severn is considered unlikely and will remain mostly similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community[65] associated with the various waterbodies. As such, no risk of adverse effects on site integrity have been identified.

5.4.3.3 Impacts on fish passes

In addition to the changes in flow along the length of the River Severn, River Vyrnwy and River Avon, the potential changes in level at several barriers and fish passes has been considered. The detailed assessment is included in the Fisheries Assessment Report[66] and the results of the potential changes in level are summarised in Table 5-10.

From the results it is evident that there will be limited change in the level at the various fish passes that are associated with the River Severn and the associated tributaries as a result of the operation of the STT (unsupported and full STT). As such, the passability of the barriers will not be impacted by the operation of the scheme (based on the changes in water levels), noting that further information is required to confirm the critical levels for fish passage).

In summary, the impact of changes in level on the passability of barriers and fish passes is considered unlikely and will remain mostly similar to baseline conditions and within the natural inter-annual variations that would be experienced within the catchment[50]. As such, no risk of adverse effects on site integrity have been identified.

[64] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Physical Environment Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

[65] Cowx IG, Noble RA, Nunn AD, Harvey JP, Welcomme RL, and Halls AS (2004). Flow and Level Criteria for Coarse Fish and Conservation Species. Report for the Environment Agency. Science Report SC020112/SR.

[66] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Fisheries Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

Table 5-10 Potential changes in level under different conditions at four fish passess indentified in this reach

	Fish Pass	A82 Scenario, mean increase in level in metres (showing % increase from baseline)	M96 Scenario, mean increase in level in metres (showing % increase from baseline)
River Vyrnwy from the Vyrnwy reservoir to the confluence with the River Severn	No fish pass details available, noting a fish pass is present at Pont Robert. Available data indicates a potential change in level of ~ 0.01m in the A82 and M96.		
River Severn from downstream of the confluence with the River Vyrnwy to Bewdley	Shrewsbury right bank	0.03(0.06% and 0.07%)	0.04m (0.06% - 0.07%), noting towards the end of November levels decrease towards.
The River Severn from Bewdley to the confluence with the River Avon	Lincomb	0.05m (0.028% - 0.26%)	0.03m (0.19% - 0.28%), noting towards the end of October levels decrease.
	Holt	0.04m (0.21% – 0.27%)	0.03m (0.20% – 0.28%), noting towards the end of October levels decrease.
	Bevere	0.03m (0.04% - 0.52%)	0.03m (0.30% – 0.38%), noting towards the end of October levels.
	Diglis	0.02m(0.02% - 0.26%)	0.03m (0.20% – 0.27%), noting towards the end of October levels decrease.
The River Avon from Stoneleigh to the confluence with the River Severn	Stoneleigh Abbey 2	0.15m (0.16% - 0.32%)	(0.01% - 0.34%)
	Warwick Castle 1	0.04m (0.07% - 0.10%)	(0.02% - 0.10%)
	Barford 2	0.03m (0.05% - 0.08%)	(0.02% - 0.08%)
	Alveston 2	0.04m (0.05% - 0.12%)	(0.03% - 0.12%)
	Stratford Upon Avon	0.03m (0.02% - 0.07%)	(0.02% - 0.08%)
	Marlcliffe Weir	0.03m (0.02% - 0.11%)	(0.02% - 0.11%)
	Harvington	0.13m (0.04% - 0.61%)	(0.02% - 0.63%)
	Anchor Meadow Weir	0.04m (0.12% - 0.20%)	(0.07% - 0.24%)
	Evesham	0.01m (0.04% - 0.05%)	(0.02% - 0.06%)
	Fladbury	0.02m (0.10% - 0.12%)	(0.05% - 0.14%)
	Wyre Piddle	0.08m (0.48% - 0.70%)	(0.30% - 0.67%)
	Pershore	0.11m (0.62% - 0.99%)	(0.03% - 0.90%)
	Narfford	0.04m (0.19% - 0.33%)	(0.08% - 0.30%)
	Strensham	0.04m (0.24% - 0.45%)	(0.08% - 0.46%)
The River Severn from the confluence with the River Avon to Deerhurst	Upper Lode Left Bank	0.03 m (0.05% - 0.44%) noting towards the end of November levels decrease.	0.07m (0.03% - 1.48%), noting towards the end of October levels decrease.
The River Severn from Deerhurst to the tidal limit at Gloucester.	No fish passes have been identified in this reach		

5.4.4 Impacts of the reduction in pass forward flow and changes in water quality on supporting habitats of the Severn Estuary

The following section reviews the potential operational impacts of the STT solution. The potential impacts associated with the reduction in pass forward flow and changes in water quality on supporting habitats of the Severn Estuary are summarised in **Table 5-11**. Overall, **no** risk of adverse effects on site integrity is predicted as changes in pass forward flow and water quality not considered to be distinct from the baseline pattern or substantial in magnitude.

Table 5-11 Summary of impact pathway assessment for the impacts of the reduction in pass forward flow and changes in water quality on supporting habitats of the Severn Estuary.

Parameter	Summary
Impact type	Changes in pass forward flow and water quality could have a **direct** impact on the condition of the habitats within the Severn Estuary which are qualifying features of the SAC and Ramsar site and also provide supporting habitats to the qualifying species of the SAC, SPA and Ramsar site
Probability	STT SRO would only be operational during low flows. Therefore, the probability of impact will vary on an annual basis.
Magnitude	The magnitude of the impact is considered low given .
Extent	Impacts within the River Severn and Severn Estuary.
Duration	Impacts are likely to be intermittent and will not occur every year (scheme only operational on 15% of dates in the modelled 47-year period).
Timing	Impacts are most likely to occur in July to October, peaking in September at 46% of dates in September in the modelled 47-year period.
Frequency	Impacts are likely to be intermittent and will not occur every year (scheme only operational on 15% of dates in the modelled 47-year period).
Reversibility	Changes in flow are deemed as a reversible impact as the flows will return to 'natural' regime when the SRO is not operational and the overall viability of the receptors will not be impacted. However, from the River Avon to the Severn Estuary there is a EQS failure associated with the Minworth discharge for three determinands and therefore, the impact pathway cannot be deemed as reversible at this stage.
Summary	Overall, risk of adverse effects on site integrity is considered to be low. This is in consideration of the minor increase in load of selected determinands following advanced treatment of the Minworth final effluent, the length of river that will be affected, and the structure and function of the River Severn that will be affected. There is low confidence in the assessment due to limited information on the efficacy and operational reliability for the planned treatment processes.

5.4.4.1 Context

While not all estuarine habitats are directly dependent on freshwater inflows, some habitats that support the bird and fish communities of the Severn Estuary will be reliant on freshwater inflows for maintaining the required salinity and sediment regime as well as water quality. For example, the intertidal mudflats and sandflats largely require the salinity which limits the penetration of marine species upstream where freshwater influences are strongest. The Atlantic salt meadows of the estuary also rely on freshwater inputs for maintaining the sediment and nutrient regime.

The available data (in particular Appendix 9 of the Regulation 33 advice)[67] suggests that the upper estuary provides extensive supporting habitat for the qualifying birds of the Severn Estuary SPA and Ramsar site. During low tides, these habitats are of particular importance for feeding. Adverse changes in freshwater inflows could affect the salinity regime and wetted width of available intertidal habitats. This could impact on the overall structure and function of mudflats and sandflats not covered by seawater at low tide and Atlantic salt meadows , with a consequent impact on the ability to support and maintain the qualifying features of the Severn Estuary European sites. It is noted, however, that the potential impact of changes freshwater inflows into the estuarine environment on waterbird populations is not well understood.

Similarly, some of the qualifying species of fish associated with the Severn Estuary SAC and Ramsar site are also dependent on the supporting habitats within the upper reaches of the Severn Estuary. While species such as Atlantic salmon, sea lamprey and adult shad will only use the estuary as a migration route from the marine to the freshwater environment, river lamprey and juvenile shad will occur within the estuary for extended

[67] https://naturalresources.wales/media/673877/Appendix%209%20-%20low%20tide%20bird%20distribution%20maps.pdf

periods (often years). In the Severn Estuary, juvenile twaite shad gorge themselves on the mysids feeding at the salt wedge near the head of the tide and are also known to feed on benthic invertebrates[68]. River lamprey also spend most of their adult lives in estuary and impacts on supporting habitats could impact on prey species, many of which are considered qualifying features of the Severn Estuary Ramsar site.

The habitats in the upper estuary, which are most likely to be affected by significant changes in freshwater inputs consists mostly of intertidal mudflats and sandflats, Atlantic salt meadows, and a few small areas of hard substrate habitats along the margins. The most likely impacts as a result of changes in pass forward flow and water quality would, therefore, be a change in the benthic invertebrate community structure, a change in the structure of the Atlantic salt meadows and an increase in macroalgae which could smother habitats.

With regards to pass forward flow, there are no flow targets for the Severn Estuary. The Regulation 33 advice does, however, indicate that the target for the tidal regime and flows (conservation objective; maintaining the characteristic physical form and flow) is for riverine flows (Rivers Wye, Usk and Severn) and estuarine flows to be sufficient to ensure Water Framework Directive target of Good Ecological Status (GES) is met.

Research in 1992 recommended maintaining a Mean Residual Flow of 1,200-1,500Ml/d during neap tides and 1,800-2,400Ml/d during spring tides[69]. These regulation 'freshet' releases were tested but terminated in 2006 due to the assessments that concluded that this was as an inefficient use of resources with no reported benefits.

To attain favourable condition, water quality within the Severn estuary and supporting habitats needs to be sufficient to support migratory passage. Levels (for temperature, salinity, turbidity, pH, and dissolved oxygen) should comply with targets established under the Water Framework Directive. Toxic contaminants in the water column and sediment should also be below levels which would pose a risk to the ecological objectives of the site.

NE have noted that[70], for the estuaries, mudflats and sandflats not covered by seawater at low tide, and Atlantic salt meadows features, the two factors contributing to unfavourable condition were: (i) coastal squeeze impacts; and (ii) water quality impacts (based upon Water Framework Directive reporting for the relevant Welsh waterbodies). The assessment for sea lamprey, river lamprey and Twaite shad was based on data from the inflowing rivers (Rivers Usk and Wye) as relevant marine data on the populations had not been collected. Sea lamprey and river lamprey were deemed to be in unfavourable condition due to water quality issues. Twaite shad was deemed to be in unfavourable condition due to water quality issues and artificial barriers to migration.

The conservation advice for the Severn Estuary European Marine Site also highlights the vulnerability of habitat to changes in water quality. Changes in any of the physico-chemical parameters in the water column can impact on the quality of the estuary habitat and hence could lead to changes in the presence and distribution of species (along with recruitment processes and spawning behaviour) and those at the edge of their geographic ranges and non-natives. In particular this relates to:

- Toxic contamination through the introduction of synthetic and/or non-synthetic compounds
- Changes in nutrient loading
- Changes in the thermal regime
- Changes in salinity
- Changes in oxygenation

Changes in any of the physico-chemical parameters in the water column can impact on the quality of the estuary habitat and hence could lead to changes in the presence and distribution of species (along with recruitment processes and spawning behaviour) and those at the edge of their geographic ranges and non-natives.

Of particular concern is significant increases in Dissolved Absorbable Inorganic Nitrogen (DAIN) which can change the species composition of the plants on the saltmarsh and thus the structure of the sward. Increases in nutrients can cause excessive algal growth on the mudflats, denying the birds access to their invertebrate prey and changing the invertebrate species composition in the sediment. However, high nutrient loads can

[68] Maitland PS & Hatton-Ellis TW (2003). Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough.

[69] Environment Agency (2013). River Severn Drought Order Environmental Report.

[70] Natural England (2022). Position Statement: Indicative Condition Assessment of the Severn Estuary/Môr Hafren Special Area of Conservation (SAC). May 2022

also be beneficial to some species of birds by increasing the density and size of prey items. Though the water quality has been improved in recent years there are still local areas of concern.

5.4.4.2 Changes in pass forward flow

Downstream of the normal tidal limit of the main River Severn at Maisemore Weir and the Eastern Channel at Llanthony Weir, the channel sees normal tidal estuarine hydrodynamics, with a pattern of twice-daily high-low-high tides. The main freshwater flow contribution from the River Severn to the Severn Estuary is over Maisemore Weir, with the Eastern Channel providing further freshwater input at the Lower Parting, approximately 2 km seawards. The tidal volume of the Severn estuary on a spring tide at high water (around 15m) is circa 5 x 109 m^3. Tidal volume of the Severn estuary on a neap tide at high water (around 7m) drops to about 3 x 109 m^3. The Severn is a fully mixed estuary and, given the tidal range, the estuary is 'tide dominated'. The outer estuary is polyhaline and when freshwater flows start to influence the salinity regime the estuary becomes mesohaline until freshwater input become dominant i.e., oligohaline.

A detailed assessment of the potential changes in pass forward flow is presented in the Physical Environment Assessment Report[71] with the main outcomes summarised below.

The pass-forward flow to the Severn Estuary from the freshwater River Severn would be amended by unsupported STT abstraction. The daily pattern of unsupported STT solution abstraction rates – either early phase STT or full STT are illustrated as the purple periods of the 47 water resources years in **Figure 1.4**. Overall, this describes a pattern of unsupported STT solution abstraction only in 24 of the 47 years, and on 11% of days overall.

In environmental terms, unsupported STT abstraction would specifically be protected by licence HoF conditions as set out in **Table 1-2.** Following these conditions, the greatest impact on pass forward flows would either be at the lowest remaining flow conditions, or highest abstraction rate. The greatest STT solution impact under lowest remaining flow conditions would be abstraction of 172 Ml/d at river flows at Deerhurst of 2,740 Ml/d, reducing flow at Deerhurst to 2,568 Ml/d. The greatest STT solution impact under highest abstraction rates would be abstraction of 500 Ml/d at river flows at Deerhurst of 3,661 Ml/d, reducing flow at Deerhurst to 3,161 Ml/d.

As shown on **Figure 5.4**, pass forward flow changes would typically be in the months October to December, peaking in November at 35% of days in November. Outside this period, there would be less regular flow changes in August, September and January, with changes very rare in June, July and February and not anticipated in March, April or May.

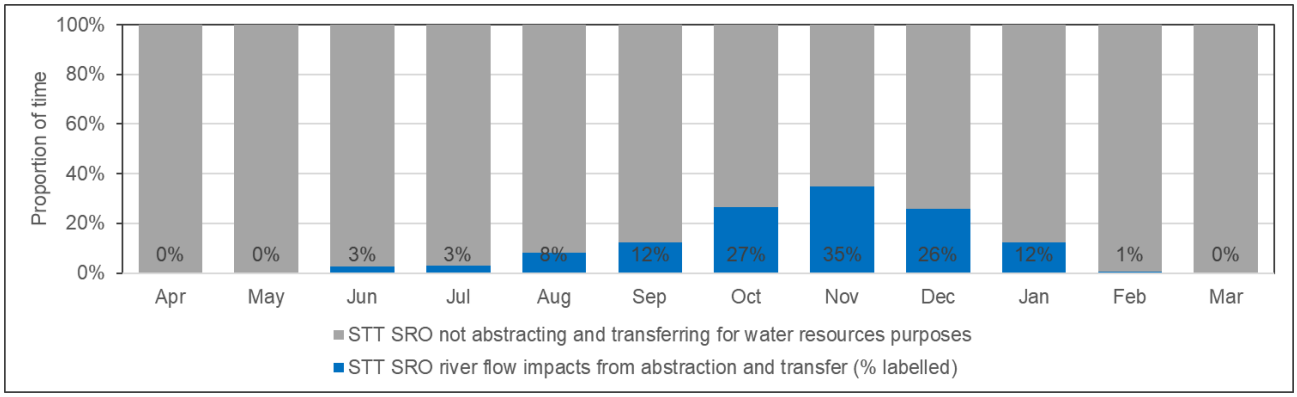

Figure 5.4 Representation of seasonality of unsupported STT solution abstraction for water resources transfer amending River Severn flows to the Severn Estuary

The A82 scenario would include a period of unsupported abstraction for 60 days from late September to late November, including 25,400 Ml abstracted, at peak rate of 500 Ml/d for 53, non-continuous days. The M96 scenario would include a period of unsupported abstraction for 70 days from late September to early January, including 32,900 Ml abstracted, at peak rate of 500 Ml/d for 64, non-continuous days.

[71] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Physical Environment Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

There are other minor reductions in pass-forward flow to the Severn Estuary associated with the STT solution. These are the periods when abstraction at Deerhurst to provide the 20 Ml/d interconnector pipeline maintenance flow is unsupported. These are outside the times that the STT solution would be in use for water resources transfer purposes, at times when river flows at Deerhurst are above HoF conditions. The gold periods on Figure 5.5 shows that these circumstances are routine and represent the most common effect of the STT solution.

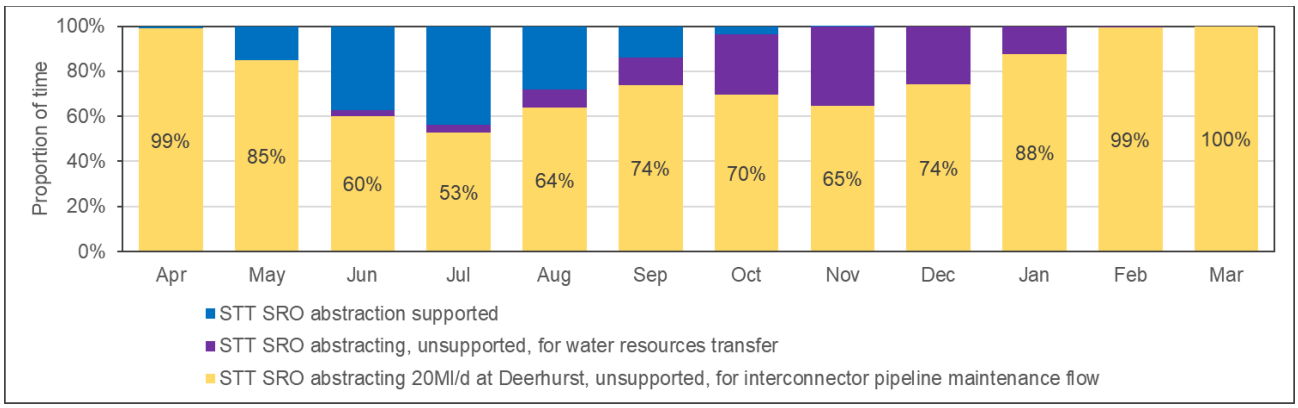

Figure 5.5 Representation of seasonality of unsupported STT solution abstraction for interconnector maintenance flow amending River Severn flows to the Severn Estuary

In addition, the Mythe temporary licence transfer is considered likely to reduce flows into the Severn Estuary. STW's Mythe licence is accounted for within the HoF conditions and as such the full licence abstraction rate can be abstracted without constraint from the HoF conditions. In the modelling it is noted that the abstraction rate attributed to the Mythe intake in the reference conditions for A82 and M96 affords for 15 Ml/d additional abstraction at Deerhurst in the full STT model scenarios, without the need to reduce the abstraction rate at Mythe. As such there is 15 Ml/d additional abstraction modelled at Deerhurst at times of supported STT abstraction. At these times the pass-forward flow modelled to the Severn Estuary reduces by 15 Ml/d.

The potential changes in flow are summarised in **Figure 5.6** which shows the most substantial change in flow occurring in autumn for a few days when flows could decrease by ~10%, noting that flows in this period will still exceed 5,000Ml/d.

These changes from the STT solution are set against a dynamic flow regime in the River Severn. Flows in the River Severn at this part of the flow regime are not stable day-on-day flows, those stable conditions only exist under very low flow conditions, which are less than the HoF condition and unsupported abstraction does not take place. Thus, dates with significant flow change are on higher flow days.

It is also noted that the two different HoF conditions are considerably higher when compared to the naturalised flows into the estuary, especially during low flow periods in summer when average modelled naturalised flow are ~1,672Ml/d in July and ~2,104Ml/d in August. It is also noted that the HoF of 2,568Ml/d which is well above the flow required to prevent saline intrusion above Maisemore Weir of 1,800 and 1,200Ml/d on spring and neap tides respectively. This is mostly because flows from around Q96 onwards are elevated towards what would naturally have occurred[72]. However, the flow regime met the EA's Environmental Flow Indicator (EFI) requirements at all times, at the time of writing the Severn Drought Order[73].

Overall, the effect on pass-forward flows to the Severn Estuary from the STT solution is show on the flow duration curve for the full 47 year representative period on **Figure 5.7**. In terms of the overall pattern of changes to pass-forward flow of freshwater from the River Severn to the Severn Estuary, the effects of the STT solution are not distinct from the baseline pattern or substantial.

[72] Environment Agency (2013). River Severn Drought Order Environmental Report. Appendix H.
[73] Environment Agency (2013). River Severn Drought Order Environmental Report.

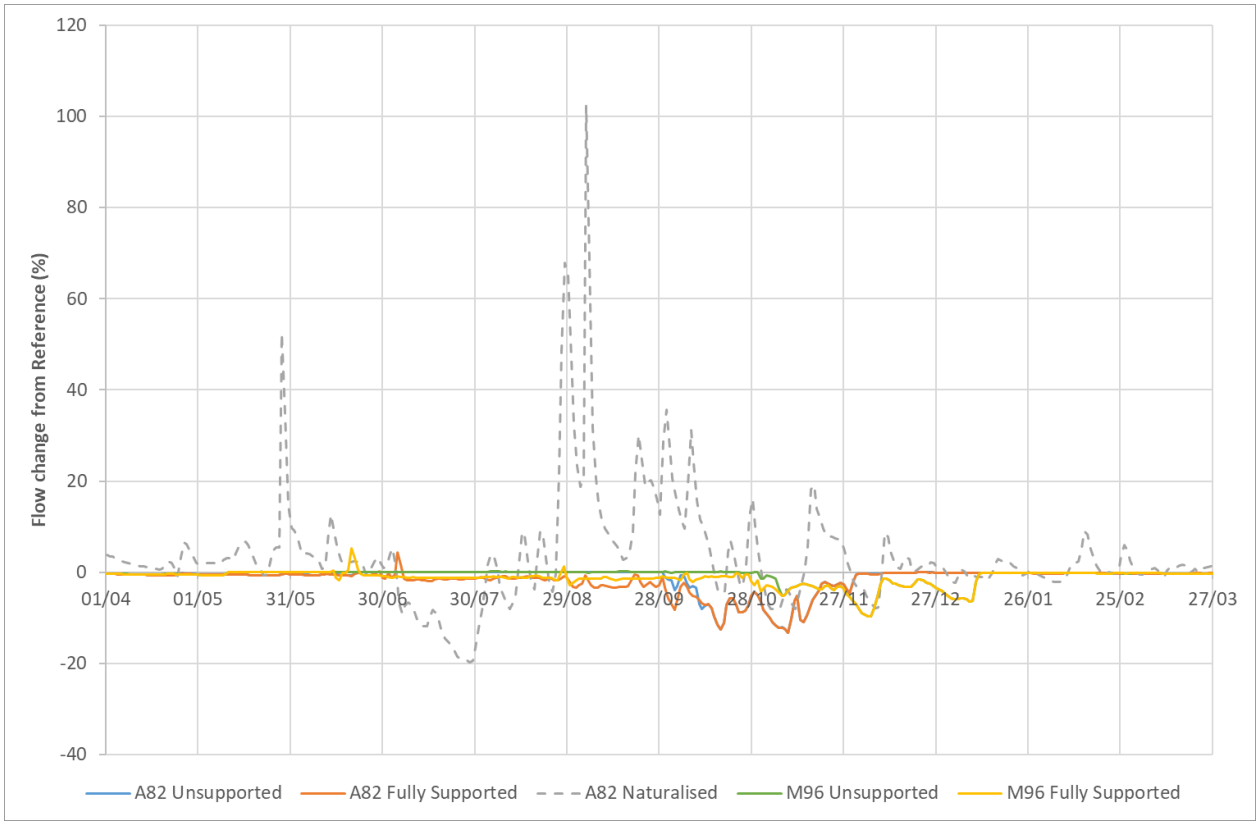

Figure 5.6 Summary of potential proportionate change in flow under different modelled scenarios

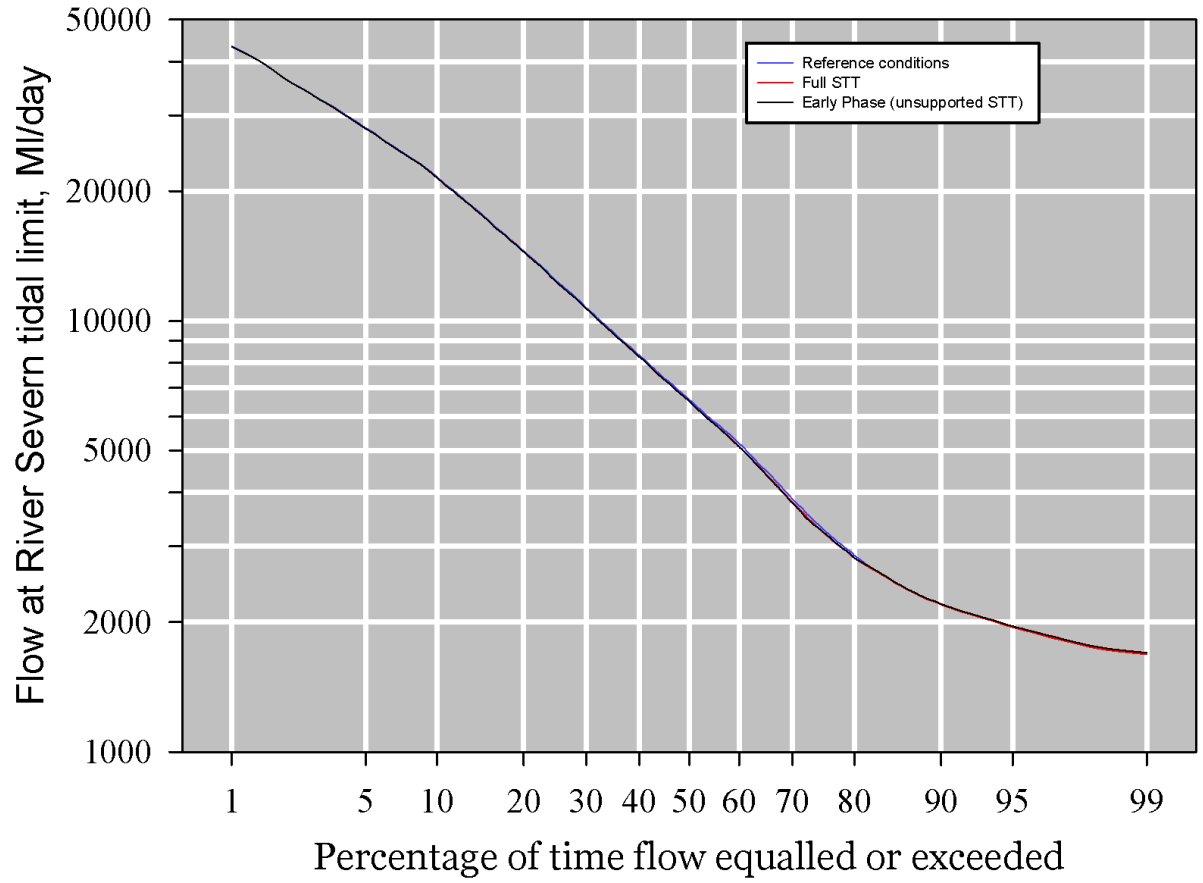

Figure 5.7 Flow duration curve representing 47-year pattern of flow change into the Severn Estuary from either early phase STT or full STT

From the assessment of impacts on freshwater forward flow, it is evident that the proportionate reduction in flow is not of a magnitude to result in changes in salinity with the associated habitats continued to be influenced by the large tidal regime and the associated estuarine processes.

In summary, the impact of changes in pass forward flow is considered likely. However, the magnitude is considered low as freshwater inflows will still be sufficient to support any habitat processes and will remain above the residual flow requirements. Particularly in summer, flow will generally be higher when compared to naturalised flow conditions and the changes will be within the natural annual variations that would be observed under baseline conditions. As such, the risk of adverse effects on site integrity is considered low.

5.4.4.3 Changes in water quality

A detailed assessment of the potential changes in water quality are presented in the Water Quality Assessment Report[74] with the main outcomes summarised below.

At the tidal limit, the residual effects on flow and water quality of the River Severn from flow augmentation and abstraction from the STT solution would be passed forward to the Severn Estuary. The patterns of abstraction described in Section 1 1.3 and illustrated as the blue and purple periods of the 47 water resources years in Figure 1.4, there would be flow augmentation releases from advanced treated wastewater transfer from Netheridge WwTW to the River Severn upstream Haw Bridge.

Of the flow augmentation releases, only the Minworth Transfer (indirectly) and the Netheridge Transfer (directly) have the potential for amending water quality in the pass forward flow. Changes to the quantity of pass forward flow have the potential for interacting with tidal processes which drive salinity patterns within the Severn Estuary. As discussed, the sections above, the potential changes in pass forward flow is not considered to be distinct from the baseline pattern or substantial in magnitude and changes in salinity is therefore not expected.

The resulting changes in physical-chemical parameters are as follows:

- In the River Severn at the tidal limit, the scheme is predicted to reduce water temperature by 0.2°C (A82) and 0.3°C (M96)
- Dissolved oxygen concentrations are predicted to be reduced by about 0.1 mg/l for both scenarios
- Ammoniacal nitrogen concentrations are predicted to be increased by about 0.02 mg/l for both scenarios
- Oxidised nitrogen is increased by about 0.8 mg/l during the scheme (~10% increase on baseline). Dissolved Inorganic Nitrogen (DIN) concentrations are increased by a similar amount

Specific additional analysis has been undertaken in relation to DIN using the EA long term water quality monitoring point at Haw Bridge[75] for the 10 year period 2013-2022. DIN is considered as part of the Water Framework Directive status for transitional waters and is one of the main limiting nutrients in the estuarine environment.

The 117 data points identify DIN concentration as 5.65 mg-N/l with a standard deviation of 1.14 mg-N/l. Allowing for the expected removal rates of the Minworth SRO's advanced treatment processes for the Minworth Transfer, discharged concentration to the Avon could be around 17mg-N/l. Allowing for the expected removal rates of the Severn Trent Sources SRO's advanced treatment processes for the Netheridge Transfer, discharged concentration to the Severn at Haw Bridge could be approximately 16 mg-N/l. Modelled assessment identifies:

- For the full year of the A82 moderate-low flow year scenario, and including abstraction rates for full STT, this could lead to a decrease in annual DIN contribution from the freshwater River Severn to the Severn Estuary of 96 tonnes from a baseline of 15,369 tonnes – a reduction of approximately 0.6%. This includes 192 tonnes/year load addition from Minworth Transfer and 67 tonnes/year addition from Netheridge Transfer; together with a 356 tonnes/year load reduction from STT abstraction. It is noted

[74] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Water Quality Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

[75] https://environment.data.gov.uk/water-quality/view/sampling-point/MD-00025085

that under these circumstances at least a further 67 tonnes/year less DIN would be input into the Severn Estuary from Netheridge WwTW at the current outfall.

- For the full year of the M96 very low flow year scenario, and including abstraction rates for full STT, this could lead to a decrease in annual DIN contribution from the freshwater River Severn to the Severn Estuary of 112 tonnes from a baseline of 14,804 tonnes – a reduction of around 0.8%. This includes 268 tonnes/year load addition from Minworth Transfer and 90 tonnes/year addition from Netheridge Transfer; together with a 470 tonnes/year load reduction from STT abstraction. It is noted that under these circumstances at least a further 90 tonnes/year less DIN would be input into the Severn Estuary from Netheridge WwTW at the current outfall.

As such there would be an overall reduction in DIN input from the freshwater River Severn and Netheridge WwTW combined into the Severn Estuary as result of STT solution.

In addition to the physico-chemical parameters, a detailed assessment has also been undertaken for the various WFD chemicals.

With regards to the Netheridge Transfer and the planned advanced treatment processes included in the Severn Trent Sources SRO Gate 2 scheme, for those chemicals with an EQS, there would be no change in concentration that changes from EQS pass to EQS fail; no reduction in quality where there is EQS pass; no further reduction in quality where there is currently EQS fail; and for chemicals with current EQS fail, no impediments to achieving EQS pass. The review has been undertaken using River Severn at Deerhurst chemical concentrations and post-removal treatment efficacy from Severn Trent Sources SRO engineers and is without recourse to the minimum 1:37 dilution rate of the River Severn at the Netheridge Transfer outfall.

With regards the Minworth Transfer, four WFD chemicals were identified as at risk of quality deterioration in the River Severn downstream of the River Avon. The carry-forward of that risk into the tidal reach was assessed utilising the modelled conservative tracer analysis presented for each of these chemicals for the Severn at Deerhurst monitoring point and the data collected via a targeted pan-SRO water quality monitoring programme:

- Nonylphenols: EQS for transitional waters match those for freshwaters[76]. Mean values calculated from the reported concentrations indicate EQS pass at Deerhurst, with nonylphenols not detected at the Severn at Deerhurst monitoring site. A concentration increase could be associated with the Minworth Transfer during the 15% of time that transfer would be in operation, but that would not lead to EQS failure at Deerhurst or in the pass-forward flow to the estuary. An initial review of load change passed forward to the Severn Estuary, based on the mean reported concentrations for Minworth final effluent and accounting for partial re-abstraction at Deerhurst for STT solution, indicates an additional 3 - 5 kg/y for the moderate low flow (A82) and very low flow years respectively (A82). As nonylphenols were not detected at the Severn Deerhurst monitoring site this cannot be expressed as a proportion change.

- Cypermethrin: EQS for transitional waters match those for freshwaters[77]. Mean values calculated from the reported concentrations indicate EQS fail at the Severn Deerhurst monitoring site, with four of the 15 reported values greater than the limit of detection which mirrors the EQS. A concentration increase could be associated with the Minworth Transfer but during the 15% of time that transfer would be in operation, this is considered with medium confidence to not lead to long-term deterioration in quality or impeding achievement of targets as the main pressures to the reach lie with the upstream River Severn, not the River Avon. An initial review of load change passed forward to the Severn Estuary, based on the mean reported concentrations for Minworth final effluent and accounting for partial re-abstraction at Deerhurst for the STT solution, indicates an additional 2 – 4 g/y for the moderate low flow and very low flow years respectively. As cypermethrin was not regularly detected at the Severn Deerhurst monitoring site this cannot be expressed as a proportion change.

- Perfluorooctane sulfonic acid and its derivatives: EQS for transitional waters are at 0.00014 µg/l (long term average) tighter than for freshwaters. Mean values calculated from the reported concentrations indicate routine EQS fail at the Severn Deerhurst monitoring site. A concentration increase could be associated with the Minworth Transfer, and it is considered with medium confidence to potentially

[76] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

[77] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

impede achievement of targets in the lower River Severn where the River Avon is a significant pressures to PFOS concentration in the downstream River Severn. An initial review of load change passed forward to the Severn Estuary, based on the mean reported concentrations for Minworth final effluent and accounting for partial re-abstraction at Deerhurst for the STT solution, indicates an additional 0.21 – 0.29 kg/y for the moderate low flow and very low flow years respectively. Based on the mean reported concentrations for the Severn Deerhurst monitoring site this represents a 3-5% increase during years when the STT solution would be in operation.

- Permethrin: Mean values calculated from the reported concentrations indicate EQS fail at the Severn Deerhurst monitoring site, with one of the 15 reported values greater than the limit of detection which mirrors the EQS. A concentration increase could be associated with the Minworth Transfer but during the 15% of time that transfer would be in operation, this is considered with medium confidence to not lead to long-term deterioration in quality or impeding achievement of targets, noting the very low detection rate at the assessment point. An initial review of load change passed forward to the Severn Estuary, based on the mean reported concentrations for Minworth final effluent and accounting for partial re-abstraction at Deerhurst for the STT solution, indicates an additional 33 - 46 g/y for the moderate low flow and very low flow years respectively. As permethrin was not regularly detected at the Severn Deerhurst monitoring site this cannot be expressed as a proportion change.

As such, there is potential for a minor load increase into the Severn Estuary for each of the banned chemicals nonylphenols and cypermethrin, and the heavily restricted perfluorooctane sulfonic acid and its derivatives, as well as the widely used permethrin. The Regulation 33 advice for the Severn Estuary European Marine Site indicates that the target for the toxic contaminants in water column and sediment should be below levels which would pose a risk to the ecology of the estuary habitats and species.

None of nonylphenols, cypermethrin or permethrin have been regularly detected in the SRO chemical monitoring in the lower Severn and concentration changes are difficult to reliably predict. However, given the minor increase in load for these WFD chemicals, lethal and sub-lethal impacts on the species that depend on the supporting habitats are not predicted (low confidence).

It should be considered that nonylphenols are a priority hazardous substance under the WFD Regulations and have been prohibited from production and use in UK since 2005[78] and in the EU; and has consequently in 2021 been banned in imported clothing and textiles[79]. Perfluorooctane sulfonate and related substances are a priority hazardous substance under the Priority Substances Directive (2013/39/EU) and most uses are phased out, banned or restricted in the UK[80]. Similarly, the use of chemical such as permethrin and cypermethrin is now heavily restricted in the UK. As such, the concentrations of these chemicals in the long-term is expected to decrease at the source.

In summary, the impact of changes in water quality is considered likely. However, the magnitude is considered low as the overall load change is not considered significant (low confidence). This is in view of the proposed advanced treatment process that have been suggested for the Minworth and Netheridge final effluent.

There remains some uncertainty in the assessment, as summarised in Section 7.3.

5.4.5 Impacts of the reduction in pass forward flow and changes in water quality on migration and reproduction.

The following section reviews the potential operational impacts of the STT solution. The potential impacts associated with the reduction in pass forward flow and changes in water quality on migration and reproduction of the fish community of the Severn Estuary and tributaries are summarised in **Table 5-12**. Overall, the risk of adverse effects on site integrity is considered to be low. This is in consideration of the minor increase in load of selected determinands following advanced treatment of the Minworth and Netheridge final effluent. There is low confidence in the assessment due to limited data on the proportionate change in load and performance efficacy and operational reliability for the planned treatment processes.

[78] Controls on Nonylphenol and Nonylphenol Ethoxylate Regulations 2004 SI (2004) No. 1816

[79] Environment Agency: REACH update, February 2021. REACH Annex 17, entry 46a: Nonylphenol Ethoxylates within the textile sector. https://brc.org.uk/media/677248/21_03_15_pdf-reach-anx-17-46a-textile-update-uk-ea.pdf

[80] Environment Agency (2021) Perfluorooctane sulfonate (PFOS) and related substances: challenges for the environment https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1027501/PFOS-challenges-for-the-water-environment.odt

Table 5-12 Summary of impact pathway assessment for the impacts of a reduction in pass forward flow and changes in water quality on migration and reproduction.

Parameter	Summary
Impact type	Changes in pass forward flow and water quality could have a **direct** impact on the migration of anadromous and catadromous fish into the rivers associated with the Severn Estuary (including the River Severn and tributaries, the River Usk and tributaries and the River Wye and tributaries)
Probability	The impact is likely during operation of the scheme as changes in olfactory cues (water quality) have been identified. Impacts on migratory cues (hydrological) are not considered likely as discussed below. It is noted that STT SRO would only be operational during low flows. Therefore, the probability of impact will vary on an annual basis.
Magnitude	The magnitude of any impacts cannot be determined at this time, however, based on the potential increase in load of selected determinands the risk is considered low.
Extent	The extent of the impact includes the River Avon (Warwickshire) from Stoneleigh to the confluence with the River Severn, The River Severn form the confluence with the River Avon to the tidal limit and the Severn Estuary
Duration	Impacts are considered to occur in the long-term, but not permanent as scheme will not be operational every year
Timing	Impacts are most likely to occur in July to October, peaking in September at 46% of dates in September in the modelled 47-year period.
Frequency	Impacts are likely to be intermittent and will not occur every year (scheme only operational on 15% of dates in the modelled 47-year period)
Reversibility	Impacts are considered reversible as the overall viability of the receptors will not be impacted
Summary	Overall, risk of adverse effects on site integrity is considered to be low. This is in consideration of the minor increase in load of selected determinands following advanced treatment of the Minworth and Netheridge final effluent. There is low confidence in the assessment due to limited data on the proportionate change in load and performance efficacy and operational reliability for the planned treatment processes.

5.4.5.1 Context

Migratory fish species have complex life cycles often with multiple stages including freshwater and seaward migrations along with juvenile imprinting phases. Migratory species such as Atlantic salmon, sea trout, river lamprey, sea lamprey, allis shad, twaite shad and European eel use a range of cues including olfaction (smell)[81], water temperature[82], dissolved oxygen[83], river flow[6], tidal state[84], and lunar phase[6] to trigger and navigate migrations (see additional information below).

- **Atlantic salmon and sea trout**
  - The migratory behaviours and the role of olfaction in Atlantic salmon are well understood. Olfaction plays an important role at several stages of the Atlantic salmon life history and numerous studies suggest that spawning migrations are initiated by a range of environmental cues including, flow[6], temperature[6], tidal[8] and dial phases[6] as well as chemical olfactory[5] cues. The 'alevins' of salmonids may undergo a period of imprinting shortly after hatching, during which the chemical nature of the natal watercourse is learned using olfactory senses allowing individuals to return accurately. Smolt migrations are believed to be triggered by river flow and temperatures, though at this stage there is evidence to suggest that individuals learn the migratory route during the outward migration using olfaction[85].
- **Twaite shad**
  - The role and mechanisms of olfaction in twaite and allis shad has not been subject to extensive research. Previous work using otolith chemistry has shown that elemental signatures in juvenile American shad from three large rivers along the northeast Atlantic coast of the United

[81] Hara T. J. (1975). Olfaction in fish. Progress in Neurobiology. 5 (4), Pp 271-335.

[82] Jonsson, N. (1991). Influence of water flow, water temperature and light on fish migrations in rivers. Nord J Freshw Res. 66. 20-35.

[83] Maes J, Stevens M, & Breine J. (2007). Modelling the migration opportunities of diadromous fish species along a gradient of dissolved oxygen concentration in a European tidal watershed. Estuarine Coastal and Shelf Science, 75, 151-162.

[84] Solomon D J, Sambrook H T, Broad K J. (1999). Salmon Migration and River Flow - Results of tracking radio tagged salmon in six rivers in South West England. Environment Agency and South West Water. R&D Publication 4.

[85] Stabell, O.B., 1984. Homing and olfaction in salmonids: a critical review with special reference to the Atlantic salmon. Biological Reviews, 59(3), pp.333-388.

States were highly distinct[86]. Strontium (Sr) isotopes in otoliths provided a particularly powerful addition to the suite of variables used to determine the natal origins of juvenile American shad. The composition of rocks within a watershed determines the ratio of different isotopes of dissolved inorganic Sr in river water. Otolith Sr is, in turn, isotopically equilibrated with the ambient water[87]. Adult shad will migrate from coastal waters into the Severn Estuary during mid to late spring (April – June) which would coincide with the operation of the ST Sources SRO. The total flow change in the impacted reach during this period is expected to be <1% in either a moderate-low or a very low flow year (A82 and M96 scenario). The ST Sources SRO will not impact on the passability of any barriers to shad migration and the proportionate change will not impact on migratory cues (physical or chemical

- **Lamprey**
  - Olfaction may play an important role at several stages of the lamprey life history and studies suggest that spawning migrations are initiated by a range of environmental cues including, flow, temperature, tidal and dial phases as well as chemical olfactory cues. However, unlike the 'alevins' of salmonid species which undergo a period of imprinting shortly after hatching, lampreys use conspecific odours to identify suitable spawning habitat, search for mates, and avoid risk[88]. Larvae excrete lamprey-specific bile acids[89] into the water at rates sufficient to create a detectable concentration in a river (~10 ng/h)[90]. Three bile acids, petromyzonol sulphate (PZS), petromyzonamine disulfate (PADS), and petromyzosterol disulfate (PSDS) are released into the water[28] and elicit strong electrophysiological responses from the olfactory epithelium and influence the behaviour of migratory lamprey in laboratory mazes[91].
- **European eel**
  - During their migration into freshwater habitats from October to December the glass eels/elvers respond to a range of environmental cues allowing them to identify and navigate towards freshwater sources. Glass eels utilise cues that include temperature, salinity, flow, dial and tidal phases as well as olfactory stimulants[92]. Following maturation within the freshwater environment, downstream migration towards the estuary is triggered by lunar activity, temperature, rainfall and increased river flow though olfaction may play an important role in predator avoidance[93]. In contrast to salmonids, the marine to freshwater migration of European eel occurs during the juvenile (glass eel/elver) phase, as such, their migration into freshwater is not influenced by natal homing.

The presence of chemical inhibitors (which disrupt olfaction), and changes in water quality, physical habitat modifications and changes in flow have been shown to impact the success of migratory species by limiting their ability to access watercourses as a result of their influence on migratory cues, natal stream imprinting, habitat availability and navigation. As such, there is a risk that an unsupported and/or full STT could impact on migration into the River Severn and tributaries of the River Severn and Severn Estuary.

5.4.5.2 Changes in pass forward flow

As discussed in Section 5.4.4.2, changes in pass forward flow as a result of an unsupported and full STT will not be distinct from the baseline pattern or substantial in magnitude. As such, no impacts on hydrological cues for migration are predicted.

---

[86] Thorrold, S. R., C. M. Jones, S. E. Campana, J. W. McLaren, and J. W. H. Lam. 1998. Trace element signatures in otoliths record natal river of juvenile American shad (*Alosa sapidissima*). Limnology and Oceanography 43:1826–1835

[87] Kennedy, B. P., J. D. Blum, C. L. Folt, and K. H. Nislow. 2000. Using natural strontium isotopic signatures as fish markers: methodology and application. Canadian Journal of Fisheries and Aquatic Sciences 57:2280–2292.

[88] Wagner CM, Stroud EM, Meckley TD, Kraft C. (2011). A deathly odour suggests a new sustainable tool for controlling a costly invasive species. Can J Fish Aquat Sci.; 68: 1157–60

[89] Haslewood GAD, Tökés L. (1969). Comparative studies of bile salts. Bile salts of the lamprey Petromyzon marinus L. Biochem J. 114:179.

[90] Fine JM, Sorensen PW. (2010). Production and fate of the sea lamprey migratory pheromone. Fish Physiol Biochem. 36:1013–20

[91] Sorensen PW, Fine JM, Dvornikovs V, Jeffrey CS, Shao F, Wang J, *et al*. (2005). Mixture of new sulfated steroids functions as a migratory pheromone in the sea lamprey. Nat Chem Biol. 1:324–8.

[92] 15 Cresci, A., (2020). A comprehensive hypothesis on the migration of European glass eels (Anguilla anguilla). Biological Reviews, 95(5), pp.1273-1286.

[93] Power D, Guerreiro P, Hubbard P, Huertas M, Morgado I, Fuentes J. (2010). Endocrinology applied to aquaculture of finfish. 10.13140/RG.2.2.20935.50084.

5.4.5.3 Changes in water quality

A detailed assessment of the potential changes in water quality are presented in the Water Quality Assessment Report[94], with the main outcomes summarised in Section 5.4.2. From the results it is evident that the operation of the unsupported and full STT will not result in distinct or substantial changes in the physical water quality parameters that are important in terms of migratory cues (e.g., temperature, salinity, flow, tidal regime, etc.).

In the 15.1km reach of the River Severn from the confluence with the River Avon to the tidal limit the water quality change pathway from the Minworth Transfer is weaker, due to the large flow increase from the River Severn, including additional augmented flows from the STT solution at times coincident with the Minworth Transfer. The change in water quality relates mainly to an increase in selected chemicals with a pass forward risk to the Severn Estuary.

Significant changes in the concentrations of selected determinands could result in the bioaccumulation of olfactory inhibitors which could impact on migration into the River Severn, River Wye and the River Usk. Significant increases in chemicals could also impact on reproduction due to their ability to act as endocrine disrupters, this includes species that are considered estuarine residents..

A detailed review of the impacts of various determinands on olfaction and reproduction of fish associated with the Severn Estuary was completed in 2021[95]. This review identified several potential chemicals of concern which subsequently informed the update of the pan-SRO chemical monitoring programme. Olfactory inhibitors have been included in the analysis of the for a monitoring site on the River Avon at Twyford as an indicator of the current influence of the River Avon on the Severn Estuary.

As discussed in Section 5.4.2, for any of the chemicals of interest listed as detected in the final effluent at Minworth, principally metals, diazinon, isoproturon, nonylphenols, perfluorooctane, cypermethrin, permethrin, triclosan, there would likely be a load increase in the pass forward flow to the Severn Estuary at times STT operation includes the Minworth Transfer. However, the Gate 2 proposed treatment units would have good removal efficiency for mercury, nickel, isoproturon and triclosan; and limited efficacy for chromium (III), cobalt, cypermethrin and permethrin.

Therefore, for those chemicals of interest which are included in the monitoring programme reported at Gate 2, water passed forward to the Severn Estuary is considered likely to be higher in concentration for:

- Chromium (III) and total
- Selenium
- Zinc
- Cypermethrin
- Permethrin

Chromium, selenium and zinc are known to be fish olfactory inhibitors and can also act as endocrine disruptors, though the information is limited. Only a few studies have assessed the toxicity of mixtures of metals, such as those associated with surface waters contaminated with industrial discharges, or stormwater runoff. Investigation into the toxicity of metal mixtures has shown that the presence of several metals can protect against the effect of individual metals. For example, the presence of nickel, zinc, calcium (Ca), sodium (Na), and magnesium (Mg) have been shown to protect against the effects of cadmium in rainbow trout[96].

Exposure to pyrethroid pesticides such as cypermethrin and permethrin can significantly reduce the olfactory response in fish. This could be really low concentrations such as in the case of Atlantic salmon where concentrations of <0.004 µg/L[97] have shown to impact on olfaction. Although the effect of individual pesticides has been assessed, a more realistic, yet understudied, scenario likely to occur is the presence of several

[94] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Water Quality Assessment Report. Report for United Utilities on Behalf of the STT Group. May 2022.

[95] Ricardo Energy & Environment (2021). Technical Note. Severn Thames Transfer SRO – Impact of determinands on olfaction and fish populations in the Severn Estuary. United Utilities on behalf of the Severn Thames Transfer Programme. December 2021

[96] Dew, W.A., Veldhoen, N., Carew, A.C., Helbing, C.C. and Pyle, G.G., (2016). Cadmium-induced olfactory dysfunction in rainbow trout: Effects of binary and quaternary metal mixtures. *Aquatic Toxicology*, *172*, pp.86-94.

[97] Moore, A. and Waring, C.P., (2001). The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (*Salmo salar* L.). *Aquatic toxicology*, *52*(1), pp.1-12.

pesticides at one time and their interactive effects (i.e., additive, antagonistic, or synergistic)[98]. Exposure to several pesticides at one time may have the potential to ultimately lower the threshold concentration required to cause an effect on olfactory response[99]. Many chemicals that have been identified as endocrine disruptors are pesticides and McKinlay (2008)[100] lists the endocrine disrupting effects of approximately 105 pesticides. An assessment of the current state-of-the-science has demonstrated that endocrine-disrupting compounds are present in the aquatic environment in sufficient concentrations to elicit responses normally under the control of endocrine hormones[101]. Overall, the data available supports the hypothesis that some pesticides may alter the glucuronidation of testosterone and estradiol, and this interference may account for significant in vivo alterations.

It is noted that the concentration at which individual or groups of chemicals may be disruptive to individual relevant migratory fish species and impact on reproduction are poorly understood, as is the potential role of bioaccumulation. This is of particular importance in relation to the STT solution as most of the available data on the effect concentrations (as applicable to toxic units) are based on short-term laboratory exposure studies with limited data on effects in the freshwater, estuarine and marine environment. Despite a gap in current understanding, many of the determinands that could inhibit olfactory cues are now heavily restricted. This includes cypermethrin which is banned and perfluorooctane sulfonic acid and its derivatives which is heavily restricted. As such the future concentrations of these chemicals at Minworth WwTW should reduce such that the risk recedes.

The risk to the freshwater life stages of the various migratory species have been discussed in **Section 5.4.2**. With regards to the Severn Estuary, it is also important to consider the risks to the adult life stages of migratory species and all life stages of the estuarine fish community, as they may be exposed to the increase in load of the determinands noted above.

Overall, the changes in water quality will be intermittent and will only be experienced on 15% of the dates in the modelled 47 year period. In addition, the total increase in load has to be considered in the context of baseline estuarine processes. Laboratory limits of detection are not a guide to absence of influence of a chemical, and nor is detected presence of chemical a reliable guide to presence of influence. Due to their hydrophobicity[102], pyrethroids (such as cypermethrin and permethrin), for example, associate with soils and sediments. This makes them subject to metabolic breakdown by mixtures of bacteria inhabiting sediments of fresh, estuarine, and marine waters. It is also important to consider the potential change in concentration/load in the context of the Severn Estuary and further dilution from other tributaries and the significant influence of the tidal regime of the Severn Estuary.

In summary, the impact is considered likely due to the change in water quality. The magnitude of the impact is considered low due to the minimal increase in load in the context of the Severn Estuary. The risk of adverse effects on the Severn Estuary European site, River Clun SAC, River Wye SAC and the River Usk SAC is considered low (low confidence).

There remains some uncertainty in the assessment, as summarised in **Section 7.3**.

5.5 SUMMARY OF ADVERSE EFFECTS OF THE STT SOLUTION ALONE

The informal appropriate assessment of the associated European sites is summarised in Table 5-13 and the accompanying Excel Workbook (***STT HRA Conservation Objective Summary.xlsx***).

For construction related impacts, no suitable functionally linked habitat was identified for violet click beetle within the footprint of the interconnector and due to the distance from the construction works to the European site no adverse effects are anticipated from increased air pollution. Potential changes to the hydrological

[98] Thoré, E.S.J., Van Hooreweghe, F., Philippe, C., Brendonck, L., and Pinceel, T. (2021). Generation-specific and interactive effects of pesticide and antidepressant exposure in a fish model call for multi-stressor and multigenerational testing. Aquatic Toxicology. 232, pp.105743.

[99] Moore, A., and Lower, N. (2001). The impact of two pesticides on olfactory-mediated endocrine function in mature male Atlantic salmon (Salmo salar L.) parr. Comp. Biochem. Phys. B. 129 (2-3), pp.269-276.

[100] 65. McKinlay R, Plant JA, Bell JNB and Voulvoulis N (2008). Endocrine disrupting pesticides, Implications for risk assessment. Environ. Int;34:168–183.

[101] Arcand-Hoy LD and Benson WH (2009). Fish reproduction: An ecologically relevant indicator of endocrine disruption. Environmental Toxicology and Chemistry, Vol. 17, No. 1, pp. 49–57

[102] Hydrophobicity is the association of nonpolar groups or molecules in an aqueous environment which arises from the tendency of water to exclude nonpolar molecules.

regime/ groundwater supply in Midland Meres and Mosses Phase 2 Ramsar site was identified however, based on the localised impacts anticipated from the Vyrnwy Bypass installation, no adverse effects on site integrity were identified. With the implementation of appropriate mitigation measures, no adverse effects on site integrity from the construction of the outfall associated with Vyrnwy Bypass and intake associated with the interconnector were identified for the Severn Estuary European sites.

With regards to impacts during operation, the available data (modelled and measured), indicates that changes in flow, velocity and depth will not be distinct or substantial and will not result in a change in the quality or quantity of supporting habitat within the River Severn (and tributaries) or within the Severn Estuary. As such, no risk of adverse effects on site integrity have been identified. This is because the changes in flow including pass forward flow into the estuary and the resulting changes in velocity, depth and water level will be within the interannual variations that would be observed under baseline conditions.

The available data also indicate that changes in water quality will be minimal. The available data (modelled) suggest that changes in physical-chemical characteristics within the River Severn and the Severn Estuary will not be distinct from the baseline pattern or substantial in magnitude with a likely decrease in selected nutrients during operation of the STT. There is a risk of an increase in the load (and concentration) of some chemical determinands..

There remains some uncertainty in the assessment of the potential adverse effects as a result of water quality changes. The pan-SRO water quality monitoring programme is still on-going and limited data are available for a number of determinands that are known to result in olfactory inhibition. Furthermore, the risks associated with many of these determinands was based on short-term laboratory exposure studies, with limited data of effects in the freshwater, estuarine and marine environment. The assessment was also completed in view of the proposed advanced treatment process at the Minworth and Netheridge WwTWs and there are no cases to date in the UK of reduced performance efficacy and operational reliability for the planned treatment processes.

Table 5-13 Summary of the results of the informal appropriate assessment

European European site	Associated components	Risk of adverse effect
Berwyn and South Clywd Mountains SAC	Vyrnwy Bypass	N/A
Berwyn SPA	Vyrnwy Bypass	N/A
Bredon Hill SAC	Deerhurst to Culham Interconnector Mythe abstraction licence transfer	N/A
Chilterns Beechwoods SAC	Deerhurst to Culham Interconnector	N/A
Cothill Fen SAC	Deerhurst to Culham Interconnector	N/A
Cotswold Beechwoods SAC	Netheridge Transfer	N/A
Dixton Wood SAC	Deerhurst to Culham Interconnector Mythe abstraction licence transfer	No
Hartslock Wood SAC	Deerhurst to Culham Interconnector	N/A
Little Wittenham SAC	Deerhurst to Culham Interconnector	N/A
Montgomery Canal SAC	Vyrnwy Bypass	N/A
Midland Meres and Mosses Phase 1 Ramsar	Vyrnwy Bypass Shrewsbury redeployment	No
Midland Meres and Mosses Phase 2 Ramsar	Vyrnwy Bypass	No
River Clun SAC	All components (including unsupported)	No (uncertain)
River Dee and Bala Lake SAC	Vyrnwy Bypass	N/A
River Usk SAC	All components (including unsupported)	No (uncertain)
River Wye SAC	All components (including unsupported)	No (uncertain)
Severn Estuary SAC	All components (including unsupported)	No (uncertain)
Severn Estuary SPA	All components (including unsupported)	No (uncertain)
Severn Estuary Ramsar	All components (including unsupported)	No (uncertain)
Tanat and Vyrnwy Bat sites SAC	Vyrnwy Bypass	No
Walmore Common SPA	Netheridge Transfer	N/A
Walmore Common Ramsar	Netheridge Transfer	N/A

6. IN-COMBINATION ASSESSMENT

The in-combination assessment draws on the proposed approach outlined in Section 3.6. As described, this HRA report considers the schemes associated with the STT solution only and separate assessments are being undertaken to inform the HRA of the other sources that enable the operation of the STT solution (e.g., Minworth SRO, STS SRO, etc.). In-combination assessments of the various SROs that form the STT System is not subject to this report and will be considered in the relevant regional plan.

As such this HRA only considers in-combination effects in terms of local and site-specific information including large development allocations within Local Plans and larger planning applications.

The list of other developments and plans within the ZoI of the STT solution are shown below.

6.1.1 Shropshire Council planning applications

There are currently no planning applications (pending or granted) within the ZoI of the relevant STT solution components.

6.1.2 Gloucester City Council Website - Planning applications

Great Western Yard is a proposed residential development scheme of up to 330 dwellings with associated landscaping, parking, and ancillary works on land at Great Western Yard, Great Western Road, Gloucester. Planning permission is not yet confirmed, but the construction activities will occur within an existing build up areas and no supporting habitat will be impacts. As such, no in-combination impacts are expected.

6.1.3 Gloucester City 2019 Plan

Screening found that both Cotswolds Beechwoods SAC and Walmore Common SPA were identified as being the closest sites to the plan Area. The Cotswolds Beechwoods SAC site is located only 2.4km from the Plan area and the Walmore Common SPA is 4km from the plan area. Screening determined that the policies in the plan should prevent significant impacts occurring. These policies include the creation of open spaces in the plan boundary for recreational use and the protection of playing fields from any potential loss. The policies also ensure noise and light pollution is restricted especially when near sensitive zones such as a European designation. As such, no in-combination impacts are expected.

6.1.4 Planning Inspectorate's Programme of Projects

The M5 Junction 10 improvements involves upgrading the existing junction with a grade separated roundabout centred on the existing junction. The improvements will not result in a direct loss of supporting habitats and will involve the upgrade of an existing road and major junction. As such, impacts on the bird communities are unlikely. The HRA for the M5 Junction 10 improvement concluded that in the absence of mitigation, pollution impacts to the River Chelt during construction and operation, and disturbance impacts to qualifying European eel and river lamprey using the River Chelt during construction may have an LSE on these qualifying species of the Severn Estuary SAC and Ramsar site. An appropriate assessment however concluded that, with mitigation measures in place, no adverse effects on site integrity will be expected.

While planning permission has not yet been granted, it is possible that the construction activities associated with the STS solution and the M5 Junction 10 improvements could coincide. The potential in-combination impacts (in the absence of mitigation measures) could result in adverse effects on European eel and river lamprey that will use the River Chelt as functionally lined habitat.

No in-combination impacts are, however, expected (noting the early stage of the STT design and feasibility) should the mitigation measures listed in this report and the HRA for the M5 Junction 10[103] improvements be implemented.

[103] Gloucestershire County Council (2021). M5 Junction 10 improvements scheme. Preliminary Environmental Information Report (PEIR) Biodiversity chapter. November 2021. Prepared by Atkins.

6.1.5 Tewkesbury Borough Council Website - Planning application advanced search (Major dwellings, mineral, Major retail)

Two projects have been identified from the Tewkesbury Borough Council Website. This includes the following:

- Twigworth Strategic Allocation: A mixed use development comprising demolition of existing buildings; up to 725 dwellings and a local centre of approximately 0.3ha; primary school, open space, landscaping, parking, and supporting infrastructure and utilities; and the creation of a new vehicular access from the A38 Tewkesbury Road.
- Innsworth Strategic Allocation: A mixed use development comprising demolition of existing buildings, up to 1,300 dwellings and approximately 8 hectares of land for employment generating uses comprising a neighbourhood centre of around 4ha, office park of around 1ha and business park of approximately 3ha, primary school, open space, landscaping, parking, and supporting infrastructure and utilities, and the creation of new vehicular accesses from the A40 Gloucester Northern Bypass, Innsworth Lane and Frogfurlong Lane.

The development is located >7km from the interconnector. The available information indicates that the proposed development area will mostly impact arable fields and impacts on supporting habitats will not be significant. The development on both projects have commenced and the construction timelines are unlikely to overlap. No low level residual effects that could have an in-combination effect with STT SRO have been identified with currently available information.

6.1.6 Joint Core Strategy (JCS) which includes Cheltenham, Gloucester, and Tewkesbury.

In addition to the Innsworth and Twigworth Strategic Allocation, the Joint Core Strategy (JCS) which includes Cheltenham, Gloucester and Tewkesbury also includes the potential development of the Churchdown strategic allocation. The available information indicates that the proposed development area will mostly impact arable fields and impacts on supporting habitats will not be significant. No low level residual effects that could have an in-combination effect with STT SRO have been identified with currently available information.

6.1.7 Transport and Works Act (TWA) applications and decisions

There are currently no transport and Works Act (TWA) applications and decisions associated with the Zol, hence no-combination impacts are expected.

6.1.8 Gloucester County Council Website – Planning application advanced search

Tewkesbury Major Mineral Application, Tewkesbury Major Waste Application, Gloucester Major Mineral Application and Gloucester Major Waste Application. All applications are either sufficiently distanced (> 1 km) from STT SRO to avoid in-combination effects or are dated 2015 or older (i.e., will not be in-combination with the STT SRO). As such, no low level residual effects that could have an in-combination effect with STT SRO have been identified with currently available information.

7. CONCLUSIONS

7.1 SUMMARY OF THE EFFECT UNDER CURRENT CONDITIONS

The *informal* Stage 1 Screening identified the risk of LSE associated with the construction of the Deerhurst to Culham interconnector on qualifying features of Dixton Wood SAC and the Severn Estuary European sites (SAC, SPA and Ramsar). The risk of LSE has also been identified for the Midland Meres and Mosses Phase 2 Ramsar site and the Severn Estuary SAC and Ramsar as a result of Vyrnwy Bypass construction works.

The risk of LSE has also been identified for the Severn Estuary European sites during the operation of the STT (unsupported and full STT), with a risk of LSE also identified for tributaries of the River Severn and the Severn Estuary (i.e., the River Clun SAC, River Usk SAC and River Wye SAC).

The following conclusions were made regarding the potential adverse effects during construction of STT SRO:

- For Dixton Wood SAC, no suitable functionally linked habitat was identified for violet click beetle within the footprint of the interconnector and due to the distance from the construction works to the European site, no adverse effects are anticipated from increased air and dust emissions.
- For the Midland Meres and Mosses Phase 2 Ramsar, potential changes to the hydrological regime/ groundwater supply for the site were identified but no adverse effects on site integrity were anticipated, as changes in hydrological regime/ groundwater supply are likely to be localised to the Vyrnwy Bypass installation.
- For the Severn Estuary European sites, no adverse effects on site integrity from the construction of the outfall associated with the Vyrnwy Bypass or the intake associated with the Deerhurst to Culham interconnector were identified, assuming the implementation of appropriate mitigation measures.

The following conclusions were made regarding potential adverse effects during operation of STT SRO:

- The available data (modelled and measured), indicates that changes in flow, velocity and depth will not be distinct from the baseline pattern or substantial in magnitude and will not result in a change in the quality or quantity of supporting habitat within the River Severn (and tributaries) or within the Severn Estuary. As such, no risk of adverse effects on site integrity have been identified. This is because the changes in flow including pass forward flow into the estuary and the resulting changes in velocity, depth and water level will be within the interannual variations that would be observed under baseline conditions.
- The available data also indicates that changes in water quality will be minimal. The available data (modelled) suggests that changes in physical-chemical characteristics within the River Severn and the Severn Estuary will not be distinct from the baseline pattern or substantial in magnitude with a likely decrease in selected nutrients during operation of the STT. There is a risk of an increase in the load (and concentration) of a handful of chemical determinands, but the potential increase is not considered to be of a magnitude that would result in a risk of adverse effects on site integrity. Furthermore, the assessment has considered the restrictions on the use of selected determinands.

There remains some uncertainty with regards to the assessment of the operational effects on water quality. The pan-SRO water quality monitoring programme is still on-going and limited data are available for a number of determinands that are known to result in olfactory inhibition. The risks associated with many of these determinands is based on short-term laboratory exposure studies with limited data of effects in the freshwater, estuarine and marine environment. The was also completed in view of the proposed advanced treatment process at the Minworth and Netheridge WwTWs and there are no cases to date in the UK of reduced performance efficacy and operational reliability for the planned treatment processes.

7.2 SUMMARY OF THE EFFECTS UNDER FUTURE CONDITIONS

Downstream of the reservoir, the flow is increased by 25Ml/d which is a percentage change in flow of between 10 and 100% depending on the baseline flow.

Downstream of the confluence with the River Banwy, the absolute increase in flow with the fully supported condition is slightly reduced to ~22 Ml/d compared to immediately downstream of the reservoir due to losses. The percentage of flow due to the supported release from the reservoir increases to between 5% and 35% of the flow downstream of the River Banwy, because the River Banwy increases the reference flow in the river.

With the A82 Future flow scenario, the flow is increased by approximately 22 Ml/d from the reservoir release (less the losses between the reservoir and Llanymynech) at Llanymynech. The flow increase with the scheme is around 15% of the total flow in the river under future conditions.

Comparison of the baseline habitat at (45 Ml/d) compensation flow only and habitat under the 25 Ml/d Vyrnwy Reservoir flow augmentation release for STT shows only limited reductions in suitable habitat under the A82 Future scenario run, but thus is likely to exacerbate the effects of prolonged, large Severn Regulation releases included in the reference scenario.

7.3 UNCERTAINTY AND CONFIDENCE DATA GAPS

There remains some uncertainty in the assessment and further monitoring, modelling and assessment is required in Gate 3, as summarised below:

- All models rely on the quality of the data available to specify inputs, and the representation of incoming water quality is based on approximate monthly spot observations. This means that some relatively short-term events may not be represented. Equally, the effect of some short-term events may be exaggerated in duration. More data will be required to further calibrate and validate the Gate 2 model.
- For the River Severn and Avon environmental water quality model, there are significant missing data, which means that for some sources (rivers and WwTWs), there are no data for certain parameters at all or there are periods of missing data. Further monitoring will be required to reduce the uncertainty in the assessment.
- The main limitation with the chemical data in the Gate 2 assessment is that the treatment plant for the Minworth Transfer and Netheridge Transfer, designed by SRO process engineers, is unique and there are no previous examples of such treatment in UK. There is uncertainty regarding evidence of efficacy and operational reliability for the planned treatment processes.
- Lack of wintering bird survey data at the WeBS site River Severn – Hawk Bridge to Tewkesbury which is within the footprint of the interconnector intake and pipeline. Survey data only publicly available for 2019/20.

7.4 RECOMMENDATIONS FOR GATE 3

The ecological data and information used to undertake the informal HRA at Gate 2 is considered sufficient, however, there is some uncertainty with regards to the current condition of some of the features of the Severn Estuary SAC.

Sufficient physical environment and water quality evidence is available for the Gate 2 assessment. However, there remain gaps in understanding the possible scheme operation: this can be assessed through further scenario modelling using the 1D hydraulic models as the gated process progresses. For example, further model scenarios can be developed to assess alternative STT operating regimes, and cumulative assessments with other water resources options selected by both WRW and WRSE in their respective Regional Plans.

For the River Severn and Avon environmental water quality model, there are significant missing data, which means that for some sources (rivers and WwTWs), there are no data for certain parameters at all or there are periods of missing data. This includes many of the determinands that are known to be olfactory inhibitors and/or act as endocrine disruptors. Monitoring of these determinands needs to continue at the current monitoring locations to ensure that sufficient data are available to complete further modelling and assessment in Gate 3. In addition, the likely presence of several pesticides at one time and their interactive effects (i.e., additive, antagonistic, or synergistic)[104] requires further investigation at Gate 3.

It is recommended that the in-channel habitat analysis that has been undertaken for the River Vyrnwy should be undertaken for other locations and reaches. This would generate detailed information on changes in water level, flow and velocities providing greater understanding of the potential effects of the scheme on ecological receptors, allowing more robust conclusions to be reached in terms of changes to habitat availability.

[104] Thoré, E.S.J., Van Hooreweghe, F., Philippe, C., Brendonck, L., and Pinceel, T. (2021). Generation-specific and interactive effects of pesticide and antidepressant exposure in a fish model call for multi-stressor and multigenerational testing. Aquatic Toxicology. 232, pp.105743.

Further information is also required regarding the proposed advanced treatment processes at the Minworth and Netheridge WwTWs to fully understand the efficacy of the proposed treatment process and the overall risk to the ecological features of the Severn Estuary European site and associated tributaries.

As potential functionally linked habitat is present (coastal and floodplain grazing marsh priority habitat) for qualifying birds of the Severn Estuary SPA and Ramsar site at the intake and pipeline route, additional wintering surveys are recommended to determine species presence and movement from feeding and roosting grounds. This will determine if qualifying bird populations present are associated with the Severn Estuary SPA and Ramsar site.

Fish habitat surveys are also recommended at the outfall location of Vyrnwy Bypass (option 27) to determine if suitable silt beds are present for lamprey ammocoetes.

Fish habitat surveying (for all the notified migratory species of the SAC) should also be undertaken, along the downstream reach where flows will be significantly elevated, to understand the ecological impact.

ANNEXES

Annex 1 Detailed Screening Tables

European site name:	**Berwyn and South Clwyd Mountains (UK0012926)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	**4030 European dry heaths** **7130 Blanket bogs (* if active bog)** 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites) 7140 Transition mires and quaking bogs 8120 Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*) 8210 Calcareous rocky slopes with chasmophytic vegetation	**Water Dependency** Habitats identified as water dependent[105]: • **4030 European dry heaths** • **7130 Blanket bogs** • 7140 Transition mires and quaking bogs • 8120 Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*) • 8210 Calcareous rocky slopes with chasmophytic vegetation
Current conservation status:	**4030 European dry heaths: Bad and deteriorating** (range: favourable, area: favourable, structure and function: bad and deteriorating, future prospects: bad but improving). Main pressures: grazing, abandonment of pastoral systems, burning, urbanised areas, human habitation, continuous urbanisation, discontinuous urbanisation, communication networks, energy transport, other forms of transportation and communication, air pollution, invasion by a species. Main threats: grazing, abandonment of pastoral systems, burning, discontinuous urbanisation, other pollution or human impacts/activities and invasion by a species. **7130 Blanket bogs (* if active bog): Bad but improving** (range: favourable, area: inadequate and deteriorating, structure and function: bad but improving, future prospects: bad but improving. Main pressures: problematic native species, grazing; drainage for agriculture, air pollution, conversion to other land uses, modification of hydrological conditions, renewable energy infrastructure and human disturbance. Main threats: problematic native species, grazing, drainage for agriculture and air pollution. **6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia): Bad but improving** (range: favourable, area: inadequate and deteriorating, structure and function: bad but improving, future prospects: favourable. Main pressures: grazing, air pollution, air-borne pollutants, modification of cultivation practices, livestock farming and animal breeding (without grazing), fertilisation, forest planting on open ground, mining and quarrying, urbanised areas, human habitation, deer grazing/ browsing/ trampling, outdoor sports and leisure activities, recreational activities, other human intrusions and disturbances, soil pollution and solid waste (excluding discharges), invasive non-native species, problematic native species, fire and fire suppression, other ecosystem modifications, biocenotic evolution, succession, changes in abiotic conditions and changes in biotic conditions. Main threats: As stated in pressures. **7140 Transition mires and quaking bogs; Very wet mires often identified by an unstable `quaking` surface: Bad and deteriorating –** Main pressures: water abstraction, grazing, fragmentation, absence of or inappropriate management, pollution, air pollution – Main threats: water abstraction, grazing, fragmentation, absence of or inappropriate management, pollution, air pollution and climate change. **8120 Calcareous and calcshist screes of the montane to alpine levels: Bad but improving** (range: favourable, area: favourable, structure and function: bad but improving, future prospects: favourable). Main pressures: grazing, air pollution, sports, tourism and leisure activities, problematic native species and natural succession. Main threat: invasive species, climate change, grazing, air pollution, sports, tourism and leisure activities, problematic native species and natural succession. **8210 Calcareous rocky slopes with chasmophytic vegetation: Bad but improving** (range: favourable, area: favourable, structure and function: bad but improving, future prospects: bad but improving. Main pressures: grazing, air pollution, sports, tourism and leisure activities and problematic native species. Main threats: grazing, air pollution, sports, tourism and leisure activities, invasive species, natural succession and climate change.	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of the habitats of qualifying species. • The structure and function of the habitats of qualifying species. • The supporting processes on which the habitats of qualifying species rely. • The populations of qualifying species. • The distribution of qualifying species within the site.	
SSSI Condition assessment:	Information not currently available	
Site Improvement Plan:	Information not currently available	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Vyrnwy Reservoir release (25 Ml/d)	This element is located approximately 2 km to the east of Berwyn and South Clwyd Mountains SAC. Relevant threats and pressures of the qualifying features that could be affected include modification of hydrological conditions and water abstraction (listed in current conservation status). No construction activity is required at Vyrnwy Reservoir. Although all of the qualifying features have been identified as water dependant, the SAC is not hydrologically connected downstream of the proposed regulation release. UU currently abstracts water from Vyrnwy Reservoir for treatment at the Oswestry WTWs. The abstraction volume is limited by an abstraction licence. In addition, regulation releases and flood drawdown releases are often made from the Vyrnwy Reservoir. At times of operation of this element, the Oswestry WTWs will be (part) supplied by the UU Sources SRO and regulation and flood drawdown releases will remain unchanged or potentially reduced). As such, baseline water levels will remain unchanged. No additional impact pathways during the operation of this element have been identified on qualifying features of the SAC. Therefore, no likely significant effects (LSE) are anticipated from this element.	**No**
Vyrnwy Bypass	This element is located approximately 2 km (at its closest point) to the east of Berwyn and South Clwyd Mountains SAC. Relevant threats and pressures of the qualifying features to this element include air pollution, air borne-pollutants, modification of hydrological conditions, human disturbance, soil pollution and solid waste, water abstraction and other ecosystem modifications. No construction activity is required at Vyrnwy Reservoir and construction works on the proposed bypass are a sufficient distance away (around 12km), eliminating soil pollution and solid waste, human disturbance and other ecosystem modifications from further consideration. Although all of the qualifying features have been identified as water dependant, the SAC is not hydrologically connected downstream of the proposed regulation releases. UU currently abstracts water from Vyrnwy Reservoir for treatment at the Oswestry WTWs. The abstraction volume is limited by an abstraction licence. In addition, regulation releases and flood drawdown releases are often made from the Vyrnwy Reservoir. At times of operation of this element, the Oswestry WTWs will be (part) supplied by the UU Sources SRO and regulation and flood drawdown releases will remain unchanged or potentially reduced). As such, baseline water levels will remain unchanged. Therefore, no LSE are anticipated from this element.	**No**

[105] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Berwyn (UK9013111)**	
Designation type: (SAC, SPA, Ramsar):	**SPA**	
Qualifying features:	082 *Circus cyaneus;* Hen harrier 098 *Falco columbarius;* Merlin 103 *Falco peregrinus;* Peregrine falcon 074 *Milvus;* Red kite	**Water Dependency** Species identified as water dependent[106]: • 082 *Circus cyaneus;* Hen harrier (breeding and wintering). • 098 *Falco columbarius;* Merlin (breeding and wintering). • 103 *Falco peregrinus;* Peregrine falcon (breeding). • 074 *Milvus;* Red kite (breeding).
Current conservation status:	**082 *Circus cyaneus;* Hen harrier: Unfavourable** (type: reproducing, size: minimum 14; maximum 14 (approximately 2% of the British breeding population 5-year mean, 1991 – 1995), unit: pairs, data quality: good, population: 2 – 15%, isolation: population not isolated, but on margins of area of distribution). **098 *Falco columbarius;* Merlin: Unfavourable** (type: reproducing, size: minimum 14; maximum 14 (approximately 1% of the British breeding population 5-year mean, 1991 – 1995) unit: pairs, data quality: good, population: <2%, isolation: population not isolated within extended distribution range) **103 *Falco peregrinus;* Peregrine falcon: Unfavourable** (type: reproducing, size: minimum 18, maximum 18 (approximately 2% of the British breeding population 5-year mean, 1991 – 1995), unit: pairs, data quality: good, population: <2%, isolation: population not isolated within extended distribution range) **074 *Milvus;* Red kite: Unknown** (type: reproducing, size: minimum 2; maximum 3 (approximately 1% of the British breeding population 5-year mean, 1991 – 1995), unit: pairs, data quality: good, population: <2%, isolation: Population not isolated, but on margins of area of distribution) Main threats and pressures: High – fire and fire suppression; problematic native species; outdoor sports and leisure activities, recreational activities; invasive non-native species; grazing. Medium – hunting and collection of wild animals; biocenotic evolution, succession.	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of the habitats of qualifying species • The structure and function of the habitats of qualifying species • The supporting processes on which the habitats of qualifying species rely • The populations of qualifying species, and, The distribution of qualifying species within the site.	
SSSI Condition assessment:	Information not currently available.	
Site Improvement Plan:	Information not currently available.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Vyrnwy Reservoir release (25Ml/d)	This element is located approximately 525 m south-west of Berwyn SPA. None of the main threats and pressures are relevant to this element (listed in current conservation status) and no construction works will be required. Although all the qualifying species of the SPA have been identified as water dependent, the operation of regulation releases from Vyrnwy Reservoir will not lead to any changes to the baseline water environment in the vicinity of the SPA. UU currently abstracts water from Vyrnwy Reservoir for treatment at the Oswestry WTWs. The abstraction volume is limited by an abstraction licence. In addition, regulation releases and flood drawdown releases are often made from the Vyrnwy Reservoir. At times of operation of this element, the Oswestry WTWs will be (part) supplied by the UU Sources SRO and regulation and flood drawdown releases will remain unchanged or potentially reduced). As such, baseline water levels will remain unchanged. No additional impact pathways have been identified for the proposed element; therefore, no LSE are anticipated.	**No**
Vyrnwy Bypass	This element is located approximately 12.25 km north-east of Berwyn SPA (at closest point). None of the main threats and pressures are relevant to this element (listed in current conservation status). Due to distance between the proposed bypass and Berwyn SPA, the impact of noise, vibration and light disturbance plus the potential for air pollution during construction is considered negligible on qualifying features of the SPA. Although all the qualifying species of the SPA have been identified as water dependent, the operation of regulation releases from Vyrnwy Reservoir, the bypass (option 27) and Shrewsbury redeployment will not lead to any changes to the baseline water environment in the vicinity of the SPA. UU currently abstracts water from Vyrnwy Reservoir for treatment at the Oswestry WTWs. The abstraction volume is limited by an abstraction licence. In addition, regulation releases and flood drawdown releases are often made from the Vyrnwy Reservoir. At times of operation of this element, the Oswestry WTWs will be (part) supplied by the UU Sources SRO and regulation and flood drawdown releases will remain unchanged or potentially reduced). As such, baseline water levels will remain unchanged. No additional impact pathways have been identified for the proposed element; therefore, no LSE are anticipated.	**No**

[106] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Bredon Hill (UK0012587)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1079. *Limoniscus violaceus*; Violet click beetle	**Water Dependency** Species not identified as water dependent[107].
Current conservation status:	**1079 *Limoniscus violaceus*; Violet click beetle: Bad and deteriorating** (range: favourable, population: bad and deteriorating, habitat: inadequate and deteriorating, future prospects: bad).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of the habitats of qualifying species • The structure and function of the habitats of qualifying species • The supporting processes on which the habitats of qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site.	
SSSI Condition assessment:	Bredon Hill SSSI: 95% Favourable and 5% Unfavourable recovering.	
Site Improvement Plan:	1. Forestry and woodland management – Pressure/Threat - 1079 Violet click beetle - Formulate and implement a wood mould continuity strategy for the Violet click beetle population. 2. Feature location/ extent/ condition unknown – Pressure/Threat - 1079 Violet click beetle - Survey of Violet click beetle, to identify site distribution. 3. Disease – Threat - S1079 Violet click beetle - Monitor for the impact of Ash dieback and investigate the effect of tree death on the wood mould persistence and continuity. 4. Air Pollution: impact of atmospheric nitrogen deposition – Pressure - 1079 Violet click beetle - Reduce the impact of atmospheric nitrogen deposition. 5. Climate Change – Threat - 1079 Violet click beetle - Monitor and plan for the effect of increased losses due to storms and changed environment.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 Ml/d)	This element is located approximately 8.5 km south-east of Bredon Hill SAC. The only SIP pressure of potential relevance to this element is (4) air pollution, that could occur during construction. Given the distance of the element to the SAC, significant air quality impacts on qualifying features can be excluded. The operation of water abstraction and transfer from Deerhurst to Culham is not anticipated to have a LSE on the violet click beetle, as it has not been identified as water dependent and the Bredon Hill SAC is not hydrologically connected downstream of the proposed intake site.	**No**
Mythe abstraction reduction (15 Ml/d)	This element is located approximately 6.8 km south of Bredon Hill SAC. The only SIP pressure of potential relevance to this proposed element is (4) air pollution, that could occur during construction. Given the distance of the element to the SAC, significant air quality impacts on qualifying features can be excluded. The operation of abstraction reductions at the Mythe intake is not anticipated to have a LSE on the violet click beetle, as it has not been identified as water dependent and the Bredon Hill SAC is not hydrologically connected downstream of the proposed abstraction site.	**No**

[107] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Chilterns Beechwoods (UK0012724)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1083 *Lucanus cervus;* Stag beetle 6210 Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) 9130 *Asperulo-Fagetum* Beech forests	**Water Dependency** Habitat and species not identified as water dependent, but it will be important to protect the rooting structure of the beech tree features[107].
Current conservation status:	**6210 Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*): Bad but improving** (range: favourable area: inadequate but improving, structure and function: Bad but improving, Future prospects: favourable). **9130 *Asperulo-Fagetum* Beech forests: Bad but improving** (range: favourable area: inadequate but improving, structure and function: Bad but improving, Future prospects: favourable) **1083 *Lucanus cervus;* Stag beetle: Favourable** (range: favourable, population: favourable, habitat: unknown, future prospects: favourable)	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of qualifying natural habitats and habitats of qualifying • species • The structure and function (including typical species) of qualifying natural habitats • The structure and function of the habitats of qualifying species • The supporting processes on which qualifying natural habitats and the habitats of • qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site.	
SSSI Condition assessment:	Naphill Common SSSI: 100% Favourable; Bisham Woods SSSI: around 97% Favourable and 3% Unfavourable recovering; Windsor Hill SSSI: around 27% Favourable and 73% Unfavourable recovering; Tring Woodlands SSSI: 100% Unfavourable recovering; Hollowhill & Pullingshill Woods SSSI: 100% Favourable; Ellesborough & Kimble Warrens SSSI: around 11% Favourable and 89% Unfavourable recovering; Bradenham Woods, Park Wood & The Coppice SSSI: around 95% Favourable and 5% Unfavourable recovering; Ashridge Commons & Woods SSSI: around 86% Favourable and 14% Unfavourable recovering; and Aston Rowant Woods SSSI: 100% Favourable.	
Site Improvement Plan:	1. Forestry and woodland management – Pressure/Threat – 9130 Beech forests - Secure appropriate woodland management. 2. Deer – Pressure/Threat - 9130 Beech forests - Improve deer management. 3. Changes in species distributions – Threat - 1083 Stag beetle - Monitor stag beetle population. 4. Invasive species – Pressure/Threat - 9130 Beech forests - Investigate the impacts of grey squirrel. 5. Disease – Threat – 9130 Beech forests - Address box blight and other diseases. 6. Public Access/disturbance – Threat – 1083 Stag beetle - Reduce visitor impact on dead wood. 7. Air Pollution: impact of atmospheric nitrogen deposition – Pressure - 6210 Semi-natural dry grasslands and scrubland facies, 9130 Beech forests, 1083 Stag beetle - Establish a Site Nitrogen Action Plan.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 Ml/d)	Chilterns Beechwoods SAC is approximately 0.1 km east of the River Thames (Reading to Cookham). Downstream of the proposed outfall in Culham, the River Thames will experience higher discharge volumes and water dependent habitats within the immediate vicinity of the River Thames may be impacted. The only SIP pressure of potential relevance to this element is (7) air pollution, that could occur during construction. However, given the distance between the proposed outfall in Culham and Chiltern Beechwoods SAC (37 km), significant air quality impacts can be excluded. In addition, none of the SACs qualifying features have been identified as water dependent and therefore, LSE from higher discharge volumes down the River Thames are not anticipated.	**No**

European site name:	**Cothill Fen (UK0012889)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	7230 Alkaline fens 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	**Water Dependency** Habitat identified as water dependent[108]: • 7230 Alkaline fens. • 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*).
Current conservation status:	**7230 Alkaline Fens: Bad** (range: favourable, area: unknown, structure and function: bad, future prospects: bad but improving) **91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*: Bad but improving** (range: favourable, area: inadequate, structure and function: bad but improving, future prospects: inadequate but improving).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of qualifying natural habitats • The structure and function (including typical species) of qualifying natural habitats, and • The supporting processes on which qualifying natural habitats rely	
SSSI Condition assessment:	Cothill Fen SSSI: around 65% Favourable and 35% Unfavourable recovering	
Site Improvement Plan:	1. Water Pollution – Pressure - 7230 Alkaline fens - Investigate the impact, pathways and sources of water pollution. Draw up and implement a Diffuse Water Pollution Plan (DWPP). 2. Hydrological Changes – Pressure/Threat - 7230 Alkaline fens - Investigate the hydrology of the site. 3. Air Pollution: impact of atmospheric nitrogen deposition – Pressure - 7230 Alkaline fens - Reduce the impacts of atmospheric nitrogen.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 Ml/d)	The element is located approximately 3.2 km south-west of Cothill Fen SAC. All of the SIP threats and pressures for this SAC are considered potentially relevant to this element: (1) water pollution, (2) hydrological changes and (3) air pollution. Construction of the pipeline is unlikely to affect groundwater levels in the unconfined Corallian aquifer in the vicinity of the SAC, as the pipeline is on different geological strata and no water or air pollution impacts are anticipated, due to the distance between the proposed works and European site. In addition, no impact pathways including hydrological changes have been identified during operation of this element, as the Cothill Fen SAC is not located downstream of the intake or outfall sites and therefore, no LSE are anticipated.	**No**

[108] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Cotswold Beechwoods (UK0013658)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	9130 *Asperulo-Fagetum* Beech forests 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)	**Water Dependency** Habitat and species not identified as water dependent, but it will be important to protect the rooting structure of the beech tree features[109].
Current conservation status:	**9130 *Asperulo-Fagetum* Beech forests: Unfavourable recovering.** (range: favourable, area: unfavourable - inadequate, structure and function: unfavourable – bad, future prospects: unfavourable - bad). **6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites): Favourable.** (range: favourable, area: favourable, structure and function: unfavourable – bad, future prospects: unfavourable - bad).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of qualifying natural habitats • The structure and function (including typical species) of qualifying natural habitats, and • The supporting processes on which qualifying natural habitats rely	
SSSI Condition assessment:	Cotswold Commons and Beechwoods SSSI: around 56% Unfavourable – recovering and 44% Favourable.	
Site Improvement Plan:	1. Invasive species – Threat – 9130 Beech forests - Reduce invasive sycamore especially in the canopy; Reduce squirrel damage to trees. 2. Deer – Threat – 9130 Beech forests - Reduce deer browsing pressure. 3. Disease – Threat – 9130 Beech forests - Produce a strategy to deal with potential ash dieback. 4. Public access/disturbance – Threat – 9130 Beech forests - Minimise impact of recreational use, especially mountain biking, horse riding and dog walking. 5. Changes in species distributions – Threat – 9130 Beech forests - Monitor the effects of drought on beech trees. 6. Air pollution: impact of atmospheric nitrogen deposition – Pressure – 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates – Control, reduce and ameliorate atmospheric nitrogen impacts.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Netheridge WwTW discharge diversion, Deerhurst pipeline (35 Ml/d)	This element is located approximately 7 km north-west of Cotswold Beechwoods SAC. No impact pathways during the operation of this element have been identified as Cotswold Beechwoods SAC is not hydrologically connected downstream of the Netheridge discharge location. Beech forests are also not classified as water dependent species. Therefore, no LSE are anticipated on the qualifying features of the SAC.	**No**

[109] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Dixton Wood (UK0030135)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1079. *Limoniscus violaceus*; Violet click beetle	**Water Dependency**: Species not identified as water dependent[110].
Current conservation status:	**1079 *Limoniscus violaceus*; Violet click beetle: Bad and deteriorating** (range: favourable, population: bad and deteriorating, habitat: inadequate and deteriorating, future prospects: bad).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of the habitats of qualifying species • The structure and function of the habitats of qualifying species • The supporting processes on which the habitats of qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site	
SSSI Condition assessment:	Dixton Wood SSSI: 100% Unfavourable recovering	
Site Improvement Plan:	1. Changes in species distributions – Threat - 1079 Violet click beetle - Carry out survey and monitoring work to inform advice to landowner. 2. Forestry and woodland management – Pressure/Threat - 1079 Violet click beetle - Formulate and implement a wood mould continuity strategy for the Violet click beetle population. 3. Disease – Threat - 1079 Violet click beetle - Monitor for Chalara and take appropriate action.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 Ml/d)	The element is located approximately 1 km south of Dixton Wood SAC, based on a 40 m working width during construction. Changes in species distribution is a relevant SIP threat of the violet click beetle due to noise and vibration disturbance and potential presence within the footprint of the works. Due to limited information on the dispersal dynamics of violet click beetle, radio-telemetric monitoring of stag beetles *Lucanus cervus* has been used to inform this assessment. The study concluded that the colonisation of new nest sites depended on the dispersal ability of female stag beetles, as male dispersal was directed by reproductive females. The maximum dispersal distance recorded for female stag beetles was 727 m[111]. Adopting a precautionary approach, a 1 km buffer of Dixton Wood SAC was used to identify potential functionally linked habitat affected by the Deerhurst to Culham Interconnector. There is potential for the temporary loss of 2,747 m²/ 0.27 ha of functionally linked habitat for violet click beetle, where open cut installation is proposed in deciduous woodland. In addition to temporary habitat loss, there is potential for violet click beetles to be present during construction works and direct mortality to occur during removal of trees, grassland and soil. Short term air quality impacts (dust and vehicle emissions) on supporting habitat of violet click beetle (broadleaved deciduous woodland) could potentially occur during construction, given the close proximity of the European site. Therefore, the risk of LSE on violet click beetles as a result of the construction activities cannot be ruled out at this stage.	**Yes**
Mythe abstraction reduction (15 Ml/d)	The element is located approximately 9 km north-west of Dixton Wood SAC. None of the SIP threats and pressures for this SAC are considered relevant to an abstraction reduction at the Mythe intake. The proposed element will not require land take from within the SAC boundaries and construction activities are at a sufficient distance from the SAC, that no LSE are anticipated. As the violet click beetle is not water dependent and Dixton Wood is not hydrologically connected downstream of the Mythe intake, LSE on the qualifying feature of the SAC is not anticipated.	**No**

[110] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.
[111] Rink, M. and Sinsch, U. (2007) Radio-telemetric monitoring of dispersing stag beetles: implications for conservation. *Journal of Zoology*, 272 (3), pp. 235-243

European site name:	**Hartslock Wood (UK0030164)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	91J0 *Taxus baccata* woods of the British Isles 6210 Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*)	**Water Dependency** Habitats not identified as water dependent, but it will be important to protect the rooting structure of the qualifying features[112].
Current conservation status:	**6210 Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*): Bad but improving** (range: favourable area: inadequate but improving, structure and function: bad but improving, future prospects: favourable). **91J0 *Taxus baccata* woods of the British Isles: Bad but improving** (range: favourable area: favourable, structure and function: bad but improving, future prospects: inadequate but improving).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying features, by maintaining or restoring: • The extent and distribution of the qualifying natural habitats • The structure and function (including typical species) of the qualifying natural habitats; and • The supporting processes on which the qualifying natural habitats rely	
SSSI Condition assessment:	Hartslock SSSI: around 88% Favourable and 12% Unfavourable recovering.	
Site Improvement Plan:	1. Air Pollution: risk of atmospheric nitrogen deposition – Threat - 6210 Semi-natural dry grasslands and scrubland facies, 91J0 *Taxus baccata* woods of the British Isles - Further investigate impacts of atmospheric nitrogen deposition.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 Ml/d)	Hartslock Wood SAC is immediately adjacent to the River Thames on the eastern bank between Wallingford to Caversham. Downstream of the proposed outfall in Culham, the River Thames will experience higher discharge volumes and habitats within the immediate vicinity of the River Thames may be impacted. The threat of (1) air pollution is of potential relevance to this element during construction, however, given the distance between the proposed outfall in Culham and Hartslock Wood SAC (approximately 19 km), significant air quality impacts can be excluded. In addition, as none of the qualifying features have been identified as water dependent, no LSE are anticipated from operation of this element.	**No**

[112] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Little Wittenham (UK0030184)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1166 *Triturus cristatus*; Great crested newt	**Water Dependency** Species identified as water dependent: • 1166 *Triturus cristatus*; Great crested newt[112].
Current conservation status:	**1166 *Triturus cristatus*, Great crested newt: Inadequate** (range: Favourable, population: Inadequate and deteriorating, Habitat: unknown, future prospects: favourable).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of habitats of qualifying species • The structure and function of the habitats of qualifying species • The supporting processes on which the habitats of qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site.	
SSSI Condition assessment:	Little Wittenham SSSI: 100% Favourable.	
Site Improvement Plan:	1. Invasive Species – Pressures/Threat - 1166 Great crested newt - Remove fish from breeding ponds; Construct further ponds in the SAC to provide additional fish-free breeding habitat. 2. Public Access/Disturbance – Threat - 1166 Great crested newt - Conduct audits to determine the best locations for signed access routes and construct new access routes.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 Ml/d)	Little Wittenham SAC is immediately adjacent to the River Thames on the eastern bank between Evenlode to Thame and 7 km west of the proposed outfall located at Culham. The proposed scheme will not require land take from within the SAC boundaries and construction activities are at a sufficient distance that no significant impacts on the qualifying features are anticipated. The pressure/threat of introducing invasive and non-native species from the River Severn to the River Thames has been identified as an impact pathway associated with this element, however, as the breeding ponds of the Little Wittenham SAC are not hydrologically connected to the River Thames. Therefore, LSE on the qualifying feature of the SAC are anticipated.	**No**

European site name:	**Midland Meres and Mosses Phase 1 (UK11043)**	
Designation type: (SAC, SPA, Ramsar):	**Ramsar**	
Qualifying features:	The Meres & Mosses form a geographically discrete series of lowland open water and peatland sites in the north-west Midlands of England. These have developed in natural depressions in the glacial drift left by receding ice sheets which formerly covered the Cheshire/Shropshire Plain. The 16 element sites include open water bodies (meres), the majority of which are nutrient-rich with associated fringing habitats; reed swamps, fen, carr & damp pasture. Peat accumulation has resulted in nutrient poor peat bogs (mosses) forming in some sites in the fringes of meres or completely infilling basins. In a few cases the result is a floating quaking bog or schwingmoor. The wide range of resulting habitats support nationally important flora & fauna. **Ramsar Criterion 1:** The site comprises a diverse range of habitats from open water to raised bog. **Ramsar Criterion 2:** Supports a number of rare species of plants associated with wetlands, including five nationally scarce species six stamened water wort *Elatine hexandra*, least spike rush *Eleocharis acicularis*, cowbane *Cicuta virosa*, marsh fern *Thelypteris palustris*, and elongated sedge *Carex elongate.* It also supports an assemblage of rare wetland invertebrates including three endangered insects and five other British Red Data Book species of invertebrates).	**Water Dependency:** The Ramsar Site and its various qualifying criteria (by definition) are all water dependent.
Current conservation status:	N/A	
Conservation objectives:	Not available	
SSSI Condition assessment:	Bomere, Shomere and Betton Pools SSSI: 100% Unfavourable – recovering	
Site Improvement Plan:	Information not currently available	
Potential Effects		
		Risk of Likely Significant Effects?
Vyrnwy Bypass	The Bomere, Shomere and Betton Pools SSSI is the only element of the Midland Meres and Mosses phase 1 Ramsar site within 10 km of the option. It is located approximately 6 km south east of Shrewsbury intake and approximately 4 km south of the River Severn at the closest section (downstream of the Shrewsbury intake). The Ramsar site is located over 10 km from the proposed bypass pipeline route and is therefore highly unlikely to be adversely affected by the construction of these elements. The SSSI citation identifies that this constituent SSSI of the Ramsar site is of interest due to water chemistry, aquatic and wetland vegetation and invertebrate communities. The site also includes a small basin mire, a more extensive area of peat around Shomere and an area of woodland. Given the distance of the elements that require construction (>10 km) to the Ramsar site the risk of construction related impacts such as, dust, habitat loss, pollution or biosecurity are highly unlikely. The Bomere Pool, Shomere Pool, and Betton Pool located over 3 km from the River Severn and are not hydrologically dependent on the river for maintenance of the water level in the meres or the condition of adjacent wetland habitats. Therefore, the site would not be affected by changes in water level or flow within the waterbodies receiving the discharge (River Vyrnwy) or reduction in abstraction (River Severn). No significant air quality impacts are anticipated as the option element is sufficiently distant from the European sites. Therefore, no LSE on the qualifying feature is anticipated.	**No**
Vyrnwy Mitigation – Shrewsbury redeployment (25 Ml/d)	This element includes the enhancement of infrastructure at Shelton wastewater treatment works (WwTW), which is located approximately 6 km south-east of Midland Meres and Mosses Phase 1 (Bomere, Shomere and Betton Pools SSSI) at its closest point and 4 km south of the River Severn at the closest section; downstream of the Shrewsbury intake. The proposed process enhancements consist of hypochlorite dosing, rapid gravity filters, hypochlorite dosing pre-contact tank, BH pumps M&E and a contact tank. In addition, the Ford PS upgrade is proposed approximately 9 km north-west of the Ramsar site. The Fenemere SSSI (an element of Midland Meres and Mosses Phase 1 Ramsar site) is also approximately 9 km north of Shelton WTW and around 9 km east of a proposed pumping station for Ruyton PSR. Potential impact pathways from construction works at Shelton WTW, Ford PS upgrade and pumping station include air pollution, pollution incidents and introduction/ spread of invasive and non-native species while using construction vehicles. Due to the distance between this element and the Ramsar site, impacts from pollution incidents and invasive species are considered unlikely. No significant air quality impacts are anticipated as the option element is sufficiently distant from the European sites. Hydrological changes during operation of this element must also be considered. However, the habitats at Bomere, Shomere and Betton Pools and Fenemere are not hydrologically dependent on the River Vyrnwy or River Severn for maintenance of the water level or condition of adjacent wetland habitats. Therefore, no LSE on the qualifying feature is anticipated.	**No**

European site name:	**Midland Meres and Mosses Phase 2 (UK11080)**	
Designation type: (SAC, SPA, Ramsar):	**Ramsar**	
Qualifying features:	The Meres and Mosses form a geographically diverse series of lowland open water and peatland sites in the north-west Midlands of England and north-east Wales. These have developed in natural depressions in the glacial drift left by receding ice sheets which formerly covered the Cheshire/ Shropshire Plain. The 18 element sites include open water bodies (meres), the majority of which are nutrient-rich with associated fringing habitats, reed swamp, fen, carr and damp pasture. Peat accumulation has resulted in the nutrient-poor peat bogs (mosses) forming in some sites on the fringes of the meres or completely infilling basins. In a few cases the result is a floating quaking bog or schwingmoor. The wide range of resulting habitats support nationally important flora and fauna. Nationally important species occurring on the site. Higher Plants. *Calamagrostis stricta, Carex elongata, Cicuta virosa, Thelypteris palustris* Lower Plants. *Sphagnum pulchrum, Dicranum undulatum* **Ramsar Criterion 1:** The site comprises a diverse range of habitats from open water to raised bog. **Ramsar Criterion 2:** Supports a number of rare species of plants associated with wetlands, including the nationally scarce cowbane *Cicuta virosa* and, elongated sedge *Carex elongata*. Also present are the nationally scarce bryophytes *Dicranum affine* and *Sphagnum pulchrum*. Also supports an assemblage of invertebrates including several rare species. There are 16 species of British Red Data Book insect listed for this site including the following endangered species: the moth *Glyphipteryx lathamella*, the caddisfly *Hagenella clathrata* and the sawfly *Trichiosoma vitellinae*. **Species currently occurring at levels of national importance:** Species with peak counts in spring/autumn: Northern shoveler, *Anas clypeata*, NW & C Europe 171 individuals, representing an average of 1.1% of the GB population (5-year peak mean 1998/92002/3) Species with peak counts in winter: Great cormorant, *Phalacrocorax carbo carbo*, - NW Europe 323 individuals, representing an average of 1.4% of the GB population (5-year peak mean 1998/92002/3) Great bittern, *Botaurus stellaris stellaris*, - W Europe, NW Africa 1 individuals, representing an average of 1% of the GB population (5 year peak mean 1998/92002/3) Water rail, *Rallus aquaticus*, - Europe 7 individuals, representing an average of 1.5% of the GB population (5-year peak mean 1998/92002/3)	**Water Dependency:** The Ramsar Site and its various qualifying criteria (by definition) are all water dependent.
Current conservation status:	N/A	
Conservation objectives:	Not available	
SSSI Condition assessment:	Morton Pool and Pasture SSSI: 100% Favourable Hencott pools SSSI: around 60% unfavourable recovering, 40% unfavourable – No change.	
Site Improvement Plan:	Information not currently available	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Vyrnwy Bypass	Midland Meres and Mosses Phase 2 Ramsar site and the underpinning SSSI, Morton Pool and Pasture, is approximately 1 km west of the proposed Vyrnwy Bypass (option 27). The SSSI citation for Morton Pool identifies that this site is of interest for the mere, Morton Pool, the surrounding fen and carr vegetation, and the damp peaty pasture to the west of Morton Pool; which is identified as being one of the best examples of damp grassland in Shropshire. Morton Pool is not identified as supporting the populations of waterfowl of national importance, for which other units of the Midland Meres and Mosses Ramsar site are designated. Due to the distance between the proposed construction works and the European site and short-term nature of construction works, no impact pathways that could lead to exceedance of NOx critical loads via exposure to increased air pollution have been identified. However, there is a risk of changes to the hydrological regime/ groundwater supply to the Ramsar site and exposure to pollution incidents if the pipeline is installed at a depth where groundwater is present and hydrologically connected to Morton Pool and Pasture SSSI. Therefore, the risk of likely significant effects cannot be ruled out at this stage. As the Midland Meres and Mosses Phase 2 at Morton Pool are not hydrologically dependent on the River Vyrnwy or River Severn for maintenance of the water level or condition of adjacent wetland habitats, no impact pathways have been identified during operation of STT SRO.	**Yes**
Vyrnwy Mitigation – Shrewsbury redeployment (25Ml/d)	There are multiple construction sites proposed as part of delivering this element within 10km of the Midland Meres and Mosses Phase 2. The proposed pumping station for Pant DSR is located approximately 2 km west of Midland Meres and Mosses Phase 2 (Morton Pool and Pasture SSSI). Other elements of the Shrewsbury redeployment within 10km of Midland Meres and Mosses Phase 2 (Morton Pool and Pasture SSSI) include the booster station to Shelton (approximately 4 km south-east) and pumping station for Ruyton DSR (approximately 6 km south-east). Infrastructure enhancements at Shelton wastewater treatment works (WwTW) are located 3.3 km south-west of Midland Meres and Mosses Phase 2 (Hencott Pool SSSI) and 2.35 km north-east of the River Severn at the closest section; downstream of the Shrewsbury intake. The proposed process enhancements consist of hypochlorite dosing, rapid gravity filters, hypochlorite dosing pre-contact tank, BH pumps M&E and a contact tank. In addition, the Ford PS upgrade is proposed around 7 km south-west of the Ramsar site. Potential impact pathways from these construction works include air pollution, pollution incidents and introduction/ spread of invasive and non-native species while using construction vehicles. Due to the distance between this element and the Ramsar site, impacts from pollution incidents and invasive species are considered unlikely. No significant air quality impacts are anticipated as the option element is sufficiently distant from the European sites. Hydrological changes during operation of this element must also be considered. However, the habitats at Morton Pool and Pasture and Hencott Pool are not hydrologically dependent on the River Vyrnwy or River Severn for maintenance of the water level or condition of adjacent wetland habitats. Therefore, no LSE on the qualifying feature is anticipated.	**No**

European site name:	**Montgomery Canal (UK0030213)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1831 Floating water-plantain *Luronium natans*	**Water Dependency:** Habitat and species identified as water dependent: • 1831 Floating water-plantain *Luronium natans.*
Current conservation status:	**1831 Floating water-plantain *Luronium* natans: Deteriorating** (range: unfavourable - inadequate, population: unfavourable – inadequate, habitat for the species: unknown, future prospects: unfavourable – inadequate). Main pressures: agricultural activities point source water pollution, agricultural diffuse water pollution, invasive alien species, problematic native species, development and operation of dams, modification of hydrological flow and natural succession. Main threats: agricultural diffuse water pollution, air pollution, management of fishing stocks and game, invasive alien species, problematic native species (I04), mixed source water pollution, flow modification and natural succession.	
Conservation objectives:	Maintain the extent and distribution of floating water-plantain *Luronium natans* within the Montgomery Canal at favourable conservation status, where all of the following conditions are satisfied: • The *L. natans* population in favourable condition will reflect the natural carrying capacity of the canal habitat and will be limited principally by species ability to spread or be relocated (vegetative or otherwise), the suitability of the rooting medium and competition between species as part of habitat succession. • Recreation pressure, principally through boat movements and fisheries management, will not significantly affect the maintenance of the species, or its ability to disperse throughout the canal network and any associated off-line reserves. • The ecological status of the water environment, including elements of water quality and physical habitat quality, will be sufficient to support the population of *L. natans* in favourable condition. • All factors affecting the achievement of the above conditions are under control. Maintain the extent, distribution and quality of the floating, submerged, emergent and marginal vegetation that constitutes the canal vegetation habitat feature within the Montgomery Canal at favourable conservation status, where all of the following conditions are satisfied: • The canal vegetation in favourable condition will reflect the natural carrying capacity of the canal habitat and will be limited principally by species ability to spread or be relocated (vegetative or otherwise), the suitability of the rooting medium and competition between species as part of habitat succession. • The ecological status of the water environment, including elements of water quality, depth and clarity, will be sufficient to support species-rich canal vegetation with a variety of submerged, floating and marginal species and the populations of locally rare or uncommon species in favourable condition. • Recreation pressure, principally through boat movements and fisheries management, will not significantly affect the maintenance of the canal vegetation, or its ability to disperse throughout the canal network and any associated off-line reserves. • All factors affecting the achievement of the above conditions are under control.	
SSSI Condition assessment:	Montgomery Canal, Aston Locks - Keeper's Bridge SSSI: 100% Unfavourable – no change.	
Site Improvement Plan:	Information not currently available.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Vyrnwy Bypass	The closest part of the Montgomery Canal SAC to the bypass is approximately 3 km south-west the proposed bypass pipeline route. The Montgomery Canal crosses the affected reach of the River Vyrnwy via an aqueduct but is not hydrologically dependent on the river flow for maintenance of the aquatic habitats within the SAC. The SAC is designated for populations of floating water plantain; this species requires slow flowing or still aquatic habitats and the maintenance of the SAC population is not dependent on habitats located outside of the SAC boundary. There is no direct hydrological connectivity between the proposed bypass pipeline route or from the reservoir release and the Montgomery Canal. Therefore, due to the distance to the SAC boundary and absence of hydrological connectivity between the pipeline route, no likely significant effects on habitat availability as a result of construction or operation of the Vyrnwy bypass have been identified. Construction activity adjacent to the canal has potential to reduce habitat suitability for floating water plantain, due to introduction of dust/ sediments which could reduce water clarity or increase nutrient content of the water. However, this is unlikely to be significant due the distance from the proposed route (2 km at closest point to Montgomery canal SAC boundary around 3 km). Increased traffic emissions or construction access routes adjacent to the canal have potential to affect nutrient and sediment loads through deposition of emissions, dust or road run off if access routes cross or are adjacent to the canal. No significant air quality impacts are anticipated as the option element is sufficiently distant from the European sites. Due to the absence of hydrological connectivity with the canal, there is no potential to change the water depth or extent through operation of the Bypass pipeline. Therefore, no likely significant effects on the qualifying features of the SAC during operation of Vyrnwy Bypass have been identified.	**No**

European site name:	**River Clun SAC (UK0030250)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1029 Freshwater pearl mussel *Margaritifera margaritifera*	**Water Dependency** Habitat and species identified as water dependent: 1029 Freshwater pearl mussel *Margaritifera margaritifera*
Current conservation status:	1029 Freshwater pearl mussel *Margaritifera margaritifera***: Deteriorating** (range: unfavourable - bad, population: unfavourable – bad, habitat for the species: unfavourable - bad, future prospects: unfavourable – bad). Main pressures: Agricultural activities generating diffuse pollution to surface or ground waters, forestry activities generating pollution to surface or ground waters, physical alteration of water bodies, illegal harvesting, collecting and taking. Main threats: Agricultural activities generating diffuse pollution to surface or ground waters, forestry activities generating pollution to surface or ground waters, Illegal harvesting, collecting and taking	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of the habitats of qualifying species. • The structure and function of the habitats of qualifying species. • The supporting processes on which the habitats of qualifying species rely. • The populations of qualifying species. • The distribution of qualifying species within the site.	
SSSI Condition assessment:	River Teme SSSI (Unit 6) – Unfavourable - declining	
Site Improvement Plan:	3 Low breeding success/ Pressure poor recruitment- Pressure/threat -1029 Freshwater pearl mussel *Margaritifera margaritifera*- Intensive programme to safeguard and increase through breeding the vulnerable mussel population	
Potential Effects		
Element:		Risk of Likely Significant Effects?
All components	The River Clun is a tributary of the River Teme, which is the second largest tributary of the River Severn. The site includes only the lower reaches of the river and extends upstream from the confluence with the Teme to Broadward Bridge near Marlow. This section of the river holds a population of the freshwater pearl mussel, one of the few lowland populations left in the UK. The freshwater pearl mussel larvae attach to the gills of salmon and trout before eventually detaching and settling in the riverbed gravels where they grow to adulthood. The operation of the Minworth WwTW discharge diversion will result in the transfer of water which is currently discharged into the River Tame to the River Avon. The Environment Agency and Natural England have identified that there is uncertainty regarding the potential impact on migratory cues (chemical) for Atlantic salmon which may impact on the number of juveniles salmonids in the watercourse which contribute to the lifecycle of the species.	**Yes**

European site name:	**River Dee and Bala Lake (UK0030252)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation.1106 Atlantic salmon *Salmo salar* 1831 Floating water-plantain *Luronium natans* 1095 Sea lamprey *Petromyzon marinus* 1096 Brook lamprey *Lampetra planeri* 1099 River lamprey *Lampetra fluviatilis* 1163 Bullhead *Cottus gobio* 1355 Otter *Lutra lutra*	**Water Dependency:** Habitats and species identified as water dependent[113]: • 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. • 1106 Atlantic salmon *Salmo salar.* • 1831 Floating water-plantain *Luronium natans.* • 1095 Sea lamprey *Petromyzon marinus.* • 1096 Brook lamprey *Lampetra planeri.* • 1099 River lamprey *Lampetra fluviatilis.* • 1163 Bullhead *Cottus gobio.* 1355 Otter *Lutra lutra.*
Current conservation status:	**3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation: Bad and deteriorating** – (range: favourable, area: inadequate, structure and function: bad and deteriorating, future prospects: bad and deteriorating). Main pressures: pollution, hydrological interventions, physical interventions and biological interventions. Main threats: pollution, hydrological interventions, physical interventions, biological interventions and climate change. **1106 Atlantic salmon *Salmo salar:* Unfavourable - inadequate (**Range: favourable, Population: unfavourable – inadequate, habitat for the species: favourable, Future prospects: unfavourable – inadequate). Main pressures: modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial) and mixed source marine water pollution (marine and coastal). Main threats: use of plant protection chemicals in agriculture, modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal), and abstraction from groundwater and surface water or mixed water. **1831 Floating water-plantain *Luronium* natans: Deteriorating (**Range: unfavourable - inadequate, Population: unfavourable – inadequate, habitat for the species: unknown, Future prospects: unfavourable – inadequate). Main pressures: agricultural activities point source water pollution, agricultural diffuse water pollution, invasive alien species, problematic native species, development and operation of dams, modification of hydrological flow and natural succession. Main threats: agricultural diffuse water pollution, air pollution, management of fishing stocks and game, invasive alien species, problematic native species (I04), mixed source water pollution, flow modification and natural succession. **1095 Sea lamprey *Petromyzon marinus*: Unknown** (Range: unknown, Population: unknown, habitat for the species: unknown, Future prospects: unknown). Main pressures: agricultural activities generating point source pollution to surface or ground waters, agricultural activities generating diffuse pollution to surface or ground waters, forestry activities generating pollution to surface or ground waters, hydropower (dams, weirs, run-off-the-river), including infrastructure and discharge of urban waste water (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water. Main threats: same as main pressures. **S1096 Brook lamprey *Lampetra planeri*: Inadequate but improving** – (range: favourable, population: unknown, habitat: inadequate but improving, future prospects: favourable). Main pressures: bait digging, sand and gravel extraction, water pollution, management of aquatic and bank vegetation for drainage purposes, removal of sediments, canalisation, modification of hydrographic functioning, general, modifying structures of inland water courses, management of water levels, drying out / accumulation of organic material, eutrophication, acidification, invasion by a species, competition; introduction of disease. Main threats: bait digging, sand and gravel extraction, water pollution, management of aquatic and bank vegetation for drainage purposes, Removal of sediments, canalisation, modification of hydrographic functioning, general, modifying structures of inland water courses, management of water levels, drying out / accumulation of organic material, eutrophication, acidification, invasion by a species, competition and introduction of disease. **1099 River lamprey *Lampetra fluviatilis*: Favourable** – (range: favourable, population: favourable, habitat: unknown, future prospects: favourable). Main pressures: Agricultural activities generating point source pollution to surface or ground waters, Agricultural activities generating diffuse pollution to surface or ground waters, Hydropower (dams, weirs, run-off-the-river), including infrastructure, Discharge of urban waste water (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water, Mixed source pollution to surface and ground waters (limnic and terrestrial) , Drainage, Development and operation of dams, Modification of hydrological flow, Physical alteration of water bodies, and Change of habitat location, size, and / or quality due to climate change. Main threats: same as main pressures. **S1163 Bullhead *Cottus gobio*: Unknown** – (range: favourable, population: unknown, habitat: unknown, future prospects: unknown) - main pressures: Fish and Shellfish Aquaculture; Sand and gravel extraction; water pollution; management of aquatic and bank vegetation for drainage purposes; Canalisation; Modification of hydrographic functioning, general; modifying structures of inland water courses; management of water levels; Erosion; Silting up; predation; competition. Main threats: same as pressures. **1355 Otter *Lutra lutra*: Stable** – (range: favourable, population: favourable, habitat: favourable, future prospects: favourable). Main Pressures: modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal). Main threats: use of plant protection chemicals in agriculture, modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure, illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal), and abstraction from groundwater, surface water or mixed water.	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of qualifying natural habitats and habitats of qualifying species • The structure and function (including typical species) of qualifying natural habitats • The structure and function of the habitats of qualifying species • The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site.	
SSSI Condition assessment:	River Dee (England) SSSI: around 60% Favourable and 40% Unfavourable – no change.	
Site Improvement Plan:	Information not currently available	
Potential Effects		
Element:		Risk of Likely Significant Effects?

[113] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final].* UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**River Dee and Bala Lake (UK0030252)**	
Vyrnwy bypass	The River Dee and Bala Lake SAC boundary is located 7.4 km north of the closest element; the proposed Bypass pipeline route. The proposed route is located outside of the River Dee catchment with no identified hydrological connectivity or potential impact pathways identified for construction of the bypass pipeline route or operation of the pipeline, reservoir release, or reduction in abstraction of the Shrewsbury intake on the River Severn. This is due to the distance between the European site and element, which limits disturbance, water quality, habitat availability and quality, habitat connectivity, or air quality impacts on qualifying features of the SAC. Operation of this element is unlikely to affect the qualifying features of the SAC, due to absence of hydrological connectivity between the River Vyrnwy and River Severn and the River Dee SAC. Therefore, no LSE are anticipated.	**No**

<table>
<tr><td>European site name:</td><td colspan="2">River Usk (UK0013007)</td></tr>
<tr><td>Designation type:
(SAC, SPA, Ramsar):</td><td colspan="2">SAC</td></tr>
<tr><td>Qualifying features:</td><td>3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation.1106 Atlantic salmon Salmo salar
1095 Sea lamprey Petromyzon marinus
1096 Brook lamprey Lampetra planeri
1099 River lamprey Lampetra fluviatilis
1103 Twaite shad Alosa fallax
1102 Allis shad Alosa alosa
1106 Atlantic salmon Salmo salar
1163 Bullhead Cottus gobio
1355 Otter Lutra lutra</td><td>Water Dependency:
Habitats and species identified as water dependent[114]:
3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation.
1106 Atlantic salmon Salmo salar.
1095 Sea lamprey Petromyzon marinus.
1096 Brook lamprey Lampetra planeri.
1099 River lamprey Lampetra fluviatilis.
1163 Bullhead Cottus gobio.
1355 Otter Lutra lutra.
1103 Twaite shad Alosa fallax
1102 Allis shad Alosa alosa</td></tr>
<tr><td>Current conservation status:</td><td colspan="2">3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation: Bad and deteriorating – (range: favourable, area: inadequate, structure and function: bad and deteriorating, future prospects: bad and deteriorating). Main pressures: pollution, hydrological interventions, physical interventions and biological interventions. Main threats: pollution, hydrological interventions, physical interventions, biological interventions and climate change.
1106 Atlantic salmon Salmo salar: Unfavourable - inadequate (Range: favourable, Population: unfavourable – inadequate, habitat for the species: favourable, Future prospects: unfavourable – inadequate). Main pressures: modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial) and mixed source marine water pollution (marine and coastal). Main threats: use of plant protection chemicals in agriculture, modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal), and abstraction from groundwater and surface water or mixed water.
diffuse water pollution, air pollution, management of fishing stocks and game, invasive alien species, problematic native species (I04), mixed source water pollution, flow modification and natural succession.
1103 Alosa fallax; Twaite shad: Unfavourable – inadequate (range: unfavourable - inadequate, population: unfavourable - inadequate, habitats for the species: unfavourable - inadequate, future prospects: unfavourable – inadequate). Main Pressures: mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow, physical alteration of water bodies. Threats: wind, wave and tidal power, including infrastructure, hydropower (dams, weirs, run-off-the-river), including infrastructure, mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow (K04), physical alteration of water bodies.
1103 Alosa alosa; Allis shad: Unfavourable – inadequate (range: unfavourable - inadequate, population: unfavourable - inadequate, habitats for the species: unfavourable - inadequate, future prospects: unfavourable – inadequate). Main Pressures: mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow, physical alteration of water bodies. Threats: wind, wave and tidal power, including infrastructure, hydropower (dams, weirs, run-off-the-river), including infrastructure, mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow (K04), physical alteration of water bodies.
1095 Sea lamprey Petromyzon marinus: Unknown (Range: unknown, Population: unknown, habitat for the species: unknown, Future prospects: unknown). Main pressures: agricultural activities generating point source pollution to surface or ground waters, agricultural activities generating diffuse pollution to surface or ground waters, forestry activities generating pollution to surface or ground waters, hydropower (dams, weirs, run-off-the-river), including infrastructure and discharge of urban wastewater (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water. Main threats: same as main pressures.
S1096 Brook lamprey Lampetra planeri: Inadequate but improving – (range: favourable, population: unknown, habitat: inadequate but improving, future prospects: favourable). Main pressures: bait digging, sand and gravel extraction, water pollution, management of aquatic and bank vegetation for drainage purposes, removal of sediments, canalisation, modification of hydrographic functioning, general, modifying structures of inland water courses, management of water levels, drying out / accumulation of organic material, eutrophication, acidification, invasion by a species, competition; introduction of disease. Main threats: bait digging, sand and gravel extraction, water pollution, management of aquatic and bank vegetation for drainage purposes, Removal of sediments, canalisation, modification of hydrographic functioning, general, modifying structures of inland water courses, management of water levels, drying out / accumulation of organic material, eutrophication, acidification, invasion by a species, competition and introduction of disease.
1099 River lamprey Lampetra fluviatilis: Favourable – (range: favourable, population: favourable, habitat: unknown, future prospects: favourable). Main pressures: Agricultural activities generating point source pollution to surface or ground waters, Agricultural activities generating diffuse pollution to surface or ground waters, Hydropower (dams, weirs, run-off-the-river), including infrastructure, Discharge of urban waste water (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water, Mixed source pollution to surface and ground waters (limnic and terrestrial) , Drainage, Development and operation of dams, Modification of hydrological flow, Physical alteration of water bodies, and Change of habitat location, size, and / or quality due to climate change. Main threats: same as main pressures.
S1163 Bullhead Cottus gobio: Unknown – (range: favourable, population: unknown, habitat: unknown, future prospects: unknown) - main pressures: Fish and Shellfish Aquaculture; Sand and gravel extraction; water pollution; management of aquatic and bank vegetation for drainage purposes; Canalisation; Modification of hydrographic functioning, general; modifying structures of inland water courses; management of water levels; Erosion; Silting up; predation; competition. Main threats: same as pressures.
1355 Otter Lutra lutra: Stable – (range: favourable, population: favourable, habitat: favourable, future prospects: favourable). Main Pressures: modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal).
Main threats: use of plant protection chemicals in agriculture, modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure, illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal), and abstraction from groundwater, surface water or mixed water.</td></tr>
<tr><td>Conservation objectives:</td><td colspan="2">Conservation Objective for the water course
The capacity of the habitats in the SAC to support each feature at near-natural population levels, as determined by predominantly unmodified ecological and hydromorphological processes and characteristics, should be maintained as far as possible, or restored where necessary.
The ecological status of the water environment should be sufficient to maintain a stable or increasing population of each feature. This will include elements of water quantity and quality, physical habitat and community composition and structure. It is anticipated that these limits will concur with the relevant standards used by the Review of Consents process
Flow regime, water quality and physical habitat should be maintained in, or restored as far as possible to, a near-natural state, in order to support the coherence of ecosystem structure and function across the whole area of the SAC.
All known breeding, spawning and nursery sites of species features should be maintained as suitable habitat as far as possible, except where natural processes cause them to change.</td></tr>
</table>

[114] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**River Usk (UK0013007)**	
	• Flows, water quality, substrate quality and quantity at fish spawning sites and nursery areas will not be depleted by abstraction, discharges, engineering or gravel extraction activities or other impacts to the extent that these sites are damaged or destroyed. • The river planform and profile should be predominantly unmodified. Physical modifications having an adverse effect on the integrity of the SAC, including, but not limited to, revetments on active alluvial river banks using stone, concrete or waste materials, unsustainable extraction of gravel, addition or release of excessive quantities of fine sediment, will be avoided. • River habitat SSSI features should be in favourable condition. In the case of the Usk Tributaries SSSI, the SAC habitat is not underpinned by a river habitat SSSI feature. In this case, the target is to maintain the characteristic physical features of the river channel, banks and riparian zone. • Artificial factors impacting on the capability of each species feature to occupy the full extent of its natural range should be modified where necessary to allow passage, e.g. weirs, bridge sills, acoustic barriers. • Natural factors such as waterfalls, which may limit the natural range of a species feature or dispersal between naturally isolated populations, should not be modified • Flows during the normal migration periods of each migratory fish species feature will not be depleted by abstraction to the extent that passage upstream to spawning sites is hindered. • Flow objectives for assessment points in the Usk Catchment Abstraction Management Strategy will be agreed between EA and CCW as necessary. It is anticipated that these limits will concur with the standards used by the Review of Consents process given in Annex 1 of this document. • Levels of nutrients, in particular phosphate, will be agreed between EA and CCW for each Water Framework Directive water body in the Usk SAC, and measures taken to maintain nutrients below these levels. It is anticipated that these limits will concur with the standards used by the Review of Consents process. • Levels of water quality parameters that are known to affect the distribution and abundance of SAC features will be agreed between EA and CCW for each Water Framework Directive water body in the Usk SAC, and measures taken to maintain pollution below these levels. It is anticipated that these limits will concur with the • For all other features the conservation objectives are: • The conservation objective for the water course as defined above must be met • The population of the feature in the SAC is stable or increasing over the long term. • The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. Suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions eg. Food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration, will be assessed in view the population of the feature in the SAC is stable or increasing over the long term. There is, and will probably continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.	
SSSI Condition assessment:	Information not currently available	
Site Improvement Plan:	Information not currently available	
Potential Effects		
Element:		Risk of Likely Significant Effects?
All components	The River Usk SAC rises in the Black Mountain range in the west of the Brecon Beacons National Park and flows east and then south, to enter the Severn Estuary at Newport. The River Usk will not be in hydrological connectivity with the STT as such that unsupported abstraction or support flows would impact on the watercourse. The operation of the Minworth WwTW discharge diversion will result in the transfer of water that is currently discharged into the River Tame to the River Avon. The Environment Agency and Natural England have identified that there is uncertainty regarding the potential impact on migratory cues (chemical) for migratory species that could result in LSE on the SAC.	**Yes**

<table>
<tr><td>European site name:</td><td colspan="2">River Wye (UK0012642)</td></tr>
<tr><td>Designation type:
(SAC, SPA, Ramsar):</td><td colspan="2">SAC</td></tr>
<tr><td>Qualifying features:</td><td>1095 Sea lamprey Petromyzon marinus
1096 Brook lamprey Lampetra planeri
1099 River lamprey Lampetra fluviatilis
1103 Twaite shad Alosa fallax
1102 Allis shad Alosa alosa
1106 Atlantic salmon Salmo salar
1163 Bullhead Cottus gobio
1355 Otter Lutra lutra
1092 White-clawed (or Atlantic stream) crayfish Austropotamobius pallipes</td><td>Water Dependency:
Habitats and species identified as water dependent[115]:
1106 Atlantic salmon Salmo salar.
1095 Sea lamprey Petromyzon marinus.
1096 Brook lamprey Lampetra planeri.
1099 River lamprey Lampetra fluviatilis.
1163 Bullhead Cottus gobio.
1355 Otter Lutra lutra.
1103 Twaite shad Alosa fallax
1102 Allis shad Alosa alosa
1092 White-clawed (or Atlantic stream) crayfish Austropotamobius pallipes</td></tr>
<tr><td>Current conservation status:</td><td colspan="2">1106 Atlantic salmon Salmo salar: Unfavourable - inadequate (Range: favourable, Population: unfavourable – inadequate, habitat for the species: favourable, Future prospects: unfavourable – inadequate). Main pressures: modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial) and mixed source marine water pollution (marine and coastal). Main threats: use of plant protection chemicals in agriculture, modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal), and abstraction from groundwater and surface water or mixed water.
diffuse water pollution, air pollution, management of fishing stocks and game, invasive alien species, problematic native species (I04), mixed source water pollution, flow modification and natural succession.
1103 Alosa fallax; Twaite shad: Unfavourable – inadequate (range: unfavourable - inadequate, population: unfavourable - inadequate, habitats for the species: unfavourable - inadequate, future prospects: unfavourable – inadequate). Main Pressures: mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow, physical alteration of water bodies. Threats: wind, wave and tidal power, including infrastructure, hydropower (dams, weirs, run-off-the-river), including infrastructure, mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow (K04), physical alteration of water bodies.
1103 Alosa alosa; Allis shad: Unfavourable – inadequate (range: unfavourable - inadequate, population: unfavourable - inadequate, habitats for the species: unfavourable - inadequate, future prospects: unfavourable – inadequate). Main Pressures: mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow, physical alteration of water bodies. Threats: wind, wave and tidal power, including infrastructure, hydropower (dams, weirs, run-off-the-river), including infrastructure, mixed source pollution to surface and ground waters (limnic and terrestrial), modification of hydrological flow (K04), physical alteration of water bodies.
1095 Sea lamprey Petromyzon marinus: Unknown (Range: unknown, Population: unknown, habitat for the species: unknown, Future prospects: unknown). Main pressures: agricultural activities generating point source pollution to surface or ground waters, agricultural activities generating diffuse pollution to surface or ground waters, forestry activities generating pollution to surface or ground waters, hydropower (dams, weirs, run-off-the-river), including infrastructure and discharge of urban waste water (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water. Main threats: same as main pressures.
S1096 Brook lamprey Lampetra planeri: Inadequate but improving – (range: favourable, population: unknown, habitat: inadequate but improving, future prospects: favourable). Main pressures: bait digging, sand and gravel extraction, water pollution, management of aquatic and bank vegetation for drainage purposes, removal of sediments, canalisation, modification of hydrographic functioning, general, modifying structures of inland water courses, management of water levels, drying out / accumulation of organic material, eutrophication, acidification, invasion by a species, competition; introduction of disease. Main threats: bait digging, sand and gravel extraction, water pollution, management of aquatic and bank vegetation for drainage purposes, Removal of sediments, canalisation, modification of hydrographic functioning, general, modifying structures of inland water courses, management of water levels, drying out / accumulation of organic material, eutrophication, acidification, invasion by a species, competition and introduction of disease.
1099 River lamprey Lampetra fluviatilis: Favourable – (range: favourable, population: favourable, habitat: unknown, future prospects: favourable). Main pressures: Agricultural activities generating point source pollution to surface or ground waters, Agricultural activities generating diffuse pollution to surface or ground waters, Hydropower (dams, weirs, run-off-the-river), including infrastructure, Discharge of urban waste water (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water, Mixed source pollution to surface and ground waters (limnic and terrestrial) , Drainage, Development and operation of dams, Modification of hydrological flow, Physical alteration of water bodies, and Change of habitat location, size, and / or quality due to climate change. Main threats: same as main pressures.
S1163 Bullhead Cottus gobio: Unknown – (range: favourable, population: unknown, habitat: unknown, future prospects: unknown) - main pressures: Fish and Shellfish Aquaculture; Sand and gravel extraction; water pollution; management of aquatic and bank vegetation for drainage purposes; Canalisation; Modification of hydrographic functioning, general; modifying structures of inland water courses; management of water levels; Erosion; Silting up; predation; competition. Main threats: same as pressures.
1355 Otter Lutra lutra: Stable – (range: favourable, population: favourable, habitat: favourable, future prospects: favourable). Main Pressures: modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure (e.g. bridges, viaducts, tunnels), illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal).
Main threats: use of plant protection chemicals in agriculture, modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams), roads, paths, railroads and related infrastructure, illegal shooting/killing, bycatch and incidental killing (due to fishing and hunting activities), mixed source pollution to surface and ground waters (limnic and terrestrial), mixed source marine water pollution (marine and coastal), and abstraction from groundwater, surface water or mixed water.
1092 White-clawed (or Atlantic stream) crayfish Austropotamobius pallipes: Deteriorating - Stable – (range: unfavourable - bad, population: unfavourable - bad, habitat: favourable, future prospects: unfavourable - bad). Main Pressures: Invasive alien species of Union concern, interspecific relations (competition, predation, parasitism, pathogens). Threats: Invasive alien species of Union concern, interspecific relations (competition, predation, parasitism, pathogens).</td></tr>
<tr><td>Conservation objectives:</td><td colspan="2">Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by
maintaining or restoring:
The extent and distribution of qualifying natural habitats and habitats of qualifying species
The structure and function (including typical species) of qualifying natural habitats
The structure and function of the habitats of qualifying species
The supporting processes on which qualifying natural habitats and habitats of qualifying species rely
The populations of qualifying species, and,
The distribution of qualifying species within the site</td></tr>
</table>

[115] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**River Wye (UK0012642)**	
SSSI Condition assessment:	River Wye SSSI: around 13% Favourable and 87% Unfavourable – declining.	
Site Improvement Plan:	Information not currently available	
Potential Effects		
Element:		Risk of Likely Significant Effects?
All components	The Wye, on the border of England and Wales, is a large river with a geologically mixed catchment, including shales and sandstones. There is a clear transition between the upland reaches, with characteristic bryophyte-dominated vegetation, and the lower reaches, with extensive water crow-foot *Ranunculus* beds. The River Wye will not be in hydrological connectivity with the STT as such that unsupported abstraction or support flows would impact on the watercourse. The operation of the Minworth WwTW discharge diversion will result in the transfer of water, that is currently discharged into the River Tame, to the River Avon. The Environment Agency and Natural England have identified that there is uncertainty regarding the potential impact on migratory cues (chemical) for migratory species that could result in LSE on the SAC.	**Yes**

European site name:	**Severn Estuary SAC (UK0013030)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1130 Estuaries 1140 Mudflats and sandflats not covered by seawater at low tide 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) 1110 Sandbanks which are slightly covered by sea water all the time 1170 Reefs 1095 *Petromyzon marinus*; Sea lamprey 1099 *Lampetra fluviatilis;* River lamprey 1103 *Alosa fallax*; Twaite shad	**Water Dependency:** Habitat and species identified as water dependent: • 1130 Estuaries • 1140 Mudflats and sandflats not covered by seawater at low tide • 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • 1110 Sandbanks which are slightly covered by sea water all the time • 1170 Reefs • 1095 *Petromyzon marinus*; Sea lamprey • 1099 *Lampetra fluviatilis;* River lamprey • 1103 *Alosa fallax*; Twaite shad
Current conservation status:	**1130 Estuaries: Unfavourable – Bad** (range: favourable area: unknown, structure and function: unfavourable - bad, future prospects: unfavourable - bad). **1140 Mudflats and sandflats not covered by seawater at low tide: Unfavourable – Bad** (range: favourable, area: unknown, structure and function: unfavourable – bad, future prospects: unfavourable – bad). **1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*):** **1110 Sandbanks which are slightly covered by sea water all the time: Deteriorating** (range: favourable area: unfavourable - inadequate, structure and function: unfavourable - bad, future prospects: unfavourable - bad). **1170 Reefs: Unknown** (range: unknown, area: unknown, structure and function: unfavourable - inadequate, future prospects: unfavourable - inadequate). **1095 *Petromyzon marinus*; Sea lamprey: Unknown** (range: favourable, population: unknown, habitats for the species: unknown, future prospects: unknown). **1099 *Lampetra fluviatilis;* River lamprey: Favourable** (range: favourable, population: favourable, habitats for the species: unknown, future prospects: favourable). **1103 *Alosa fallax*; Twaite shad: Unfavourable – inadequate** (range: unfavourable - inadequate, population: unfavourable - inadequate, habitats for the species: unfavourable - inadequate, future prospects: unfavourable – inadequate).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of qualifying natural habitats and habitats of qualifying species • The structure and function (including typical species) of qualifying natural habitats • The structure and function of the habitats of qualifying species • The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site.	
SSSI Condition assessment:	Severn Estuary SSSI: around 95.80% Favourable, 0.08% Unfavourable - recovering and 3.4% Unfavourable - no change. Bridgwater Bay SSSI: around 88% Favourable, 11% Unfavourable – Recovering and 1% Unfavourable – No change. Upper Severn Estuary SSSI: 85.85% Favourable and 4.14% Unfavourable – Recovering.	
Site Improvement Plan:	1. Public access/disturbance – Pressure/Threat - 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows – Identify/reduce impacts of disturbance to birds and damage to habitats. 2. Physical modification – Threat - 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad – Reduce, remove (where possible) and prevent barriers to migratory species. 3. Impacts of development – Pressure/Threat - 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows, 1140 Intertidal mudflats and sandflats, 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad – Inform strategic planning decisions to minimise impact of development. 4. Coastal squeeze – Pressure/Threat - 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows, 1140 Intertidal mudflats and sandflats – Limit coastal squeeze, provide sustainable coastal defences, improve existing structures, deliver compensatory habitat. 5. Change in land management – Pressure/Threat - 1130 Estuaries, 1330 Atlantic salt meadows – Maintain appropriate levels and timing of grazing and management of intertidal saltmarsh habitat. 6. Changes in species distributions – Threat – 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad – Understand/prepare for changes in species distribution (caused by climate change/other events). 7. Water pollution – Pressure/Threat - 1110 Subtidal sandbanks, 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows, 1140 Intertidal mudflats and sandflats, 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad – Identify any existing issues and prevent/reduce decline in water and sediment quality (applying relevant measures to all relevant tributaries in England and Wales). 8. Air Pollution: impact of atmospheric nitrogen deposition – Pressure - 1130 Estuaries, 1330 Atlantic salt meadows, 1095 Sea lamprey, 1099 River lamprey, 1103 Twaite shad and waterbird assemblage – Develop a Site Nitrogen Action Plan. 9. Marine consents and permits minerals and waste – Pressure/Threat - 1110 Subtidal sandbanks, 1140 Intertidal mudflats and sandflats, 1170 Reefs, 1330 Atlantic salt meadows, 1095 Sea lamprey, 1099 River lamprey, 1103 Twaite shad – Ensure in-combination/cumulative impacts from aggregate extraction, maintenance dredging and disposal are fully considered. 10. Fisheries: recreational marine and estuarine – Pressure – 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad, 1140 Intertidal mudflats and sandflats, 1170 Reefs and 1330 Atlantic salt meadows – Establish levels and location 11. Fisheries: commercial marine and estuarine – Threat - 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad, 1140 Intertidal mudflats and sandflats, 1170 Reefs and 1330 Atlantic salt meadows - Identify any threats to site features and habitats from commercial fisheries activity and establish and ensure compliance with any necessary management measures. 12. Invasive species – Threat - 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows, 1140 Intertidal mudflats and sandflats – Assess the risks from and control the spread of invasive non-native species. 13. Marine litter – Pressure/Threat - 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows, 1140 Intertidal mudflats and sandflats, 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad – Investigate sources of marine litter and implement actions for removal/shoreline clean up. 14. Marine pollution incidents – Threat - 1110 Subtidal sandbanks, 1130 Estuaries, 1170 Reefs, 1330 Atlantic salt meadows, 1140 Intertidal mudflats and sandflats, 1095 Sea lamprey, 1099 River lamprey and 1103 Twaite shad – Minimise impact from marine pollution incidents and clean up response.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
All components	The nearest component is located 10.3km from the boundary of the site with the furthest (Vyrnwy Reservoir) located approximately 132 km north-west of the Severn Estuary SAC and 227 km north-west via hydrological connectivity. The SIP threats and pressures of potential relevance to this proposed element are (2) physical modification, (6) changes in species distribution, (7) water pollution and (12) invasive species.	**Yes**

European site name:	**Severn Estuary SAC (UK0013030)**	
	River lamprey, sea lamprey and twaite shad There are potential impact pathways of this element on functional spawning and nursery habitats, not within the boundary of the SAC during operation. Elevated volumes of water transported down the River Vyrnwy and the River Severn and the subsequent rise in water flow could cause an increase in suspended sediment, disturbance/ displacement of river and sea lamprey ammocoetes present in silt beds (nursery habitat) upstream and increased velocities over nursery habitats. Increased flows could also impact on migration cues and the passability of barriers. Furthermore, the changes in water quality as a result of the transfer of treated effluent could also impact on migration cues and juvenile individuals. Therefore, LSE on river lamprey and sea lamprey cannot be discounted at this stage. Adult twaite shad migrate upstream to spawn from mid-May – mid July. Twaite shad spawning activity on the lower main stem River Severn is well documented in the scientific literature, although the spatial extent of spawning activity appears to be quite restricted compared to historical accounts. On the River Severn, twaite shad spawning activity has been observed in the lower catchment, downstream of Upper Lode weir. It was previously believed that a lack of observed spawning activity upstream of the weir may have been attributable to the weir posing a physical barrier to upstream migration. It is, therefore, considered unlikely that increased releases in the River Vyrnwy will result in impacts on spawning of twaite shad. However, NRW and the EA have identified that Unlocking the Severn scheme may potentially result in an increase in the extent of spawning habitat of twaite shad and increased flows in the reaches of the River Severn as a result of support releases from the Vyrnwy Reservoir could impact on twaite shad in the future. Therefore, LSE on twaite shad cannot be discounted at this stage. Further assessment will consider the following conservation objectives - **River lamprey, sea lamprey and twaite shad**: the migratory passage of both adult and juvenile river lamprey, sea lamprey and twaite shad through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality; and the size of the river lamprey, sea lamprey and twaite shad populations in the Severn Estuary and the rivers which drain into it, is at least maintained and is at a level that is sustainable in the long term[116].	
	Estuaries, mudflats and sandflats, Atlantic salt meadows, sandbanks and reefs During construction potential impact pathways on the estuary include siltation and deposition, impedance of movement, entrapment and impingement, noise and vibration disturbance, salinity regime changes and temperature changes. During operation, abstraction from the River Severn will reduce the volume of water transported downstream to the Severn Estuary, in addition to potential changes in water quality. The reduced flow could also expose a greater area of peripheral habitats in the Severn Estuary including mudflats and sandflats and Atlantic salt meadows during times of operation (summer).	**Yes**

[116] Natural England and Countryside Council for Wales (2009). *Severn Estuary SAC, SPA and Ramsar Site: Regulation 33 Advice*. Natural England and Countryside Council for Wales, 1 - 175

European site name:	**Severn Estuary SPA (UK9015022)**	
Designation type: (SAC, SPA, Ramsar):	**SPA**	
Qualifying features:	Severn Estuary SPA 051 *Anas strepera;* Gadwall 394 *Anser albifrons albifrons;* Greater white-fronted geese 672 *Calidris alpina;* Dunlin 037 *Cygnus columbianus bewickii;* Bewick's swan 048 *Tadorna tadorna;* Common shelduck 162 *Tringa tetanus;* Common redshank WATR Internationally important assemblage of waterfowl (wildfowl and waders)	**Water Dependency:** Species identified as water dependent[117]. • 051 *Anas strepera;* Gadwall. • 394 *Anser albifrons albifrons;* Greater white-fronted geese. • 672 *Calidris alpina;* Dunlin. • 037 *Cygnus columbianus bewickii;* Bewick's swan. • 048 *Tadorna tadorna;* Common shelduck. • 162 *Tringa tetanus;* Common redshank. • WATR Internationally important assemblage of waterfowl (wildfowl and waders).
Current conservation status:	**051 *Anas strepera;* Gadwall:** (type: wintering, size: minimum 282; maximum 282 (approximately 1% of the population 5 year peak mean 1991/92 – 1995/96), unit: individuals, data quality: good, population: 2 – 15%, isolation: population not isolated within extended distribution range). **394 *Anser albifrons albifrons;* Greater white-fronted geese** (type: wintering, size: minimum 2664; maximum 2664 (approximately 0.4% of the population 5 year peak mean 1991/92 – 1995/96), unit: individuals, data quality: good, population: 15 - 100%, isolation: population not isolated, but on margins of area of distribution). **672 *Calidris alpina alpina;* Dunlin** (type: wintering, size: minimum 44624; maximum 44624 (approximately 3% of the population 5 year peak mean 1991/92 – 1995/96), unit: individuals, data quality: good, population: 2 - 15%, isolation: population not isolated within extended distribution range). **037 *Cygnus columbianus bewickii;* Bewick's swan** (type: wintering, size: minimum 280; maximum 280 (approximately 4% of the population 5 year peak mean 1991/92 – 1995/96), unit: individuals, data quality: good, population: 2 - 15%, isolation: population not isolated within extended distribution range). **048 *Tadorna tadorna;* Common shelduck** (type: wintering, size: minimum 3330; maximum 3330 (approximately 1% of the population 5 year peak mean 1991/92 – 1995/96), unit: individuals, data quality: good, population: 2 - 15%, isolation: population not isolated within extended distribution range). **162 *Tringa tetanus;* Common redshank** (type: wintering, size: minimum 2330; maximum 2330 (approximately 1% of the population 5 year peak mean 1991/92 – 1995/96), unit: individuals, data quality: good, population: 2 - 15%, isolation: population not isolated within extended distribution range). **WATR Waterfowl assemblage** (size: minimum 84317; maximum 84317. Unit: individuals; motivation: International conventions).	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring; • The extent and distribution of the habitats of the qualifying features • The structure and function of the habitats of the qualifying features • The supporting processes on which the habitats of the qualifying features rely • The population of each of the qualifying features, and, • The distribution of the qualifying features within the site.	
SSSI Condition assessment:	Severn Estuary SSSI: around 96% Favourable, 0.1% Unfavourable - recovering and 3% Unfavourable - no change. Aust Cliff SSSI: 100% Favourable. Blue Anchor to Lilstock Coast SSSI: 100% Favourable. Bridgewater Bay SSSI: around 88% Favourable, 11% Unfavourable – Recovering and 0.3% Unfavourable – no change. Clevedon Shore SSSI: 100% Favourable. Lydney Cliff SSSI: 100% Favourable. Middle Hope SSSI: around 80% Favourable and 20% Unfavourable – Recovering. Portishead Pier to Black Nore SSSI: 100% Favourable. Purton Passage SSSI: 100% Favourable. Spring Cove Cliffs SSSI: 100% Favourable. Steep Holm SSSI: 100% Favourable. Upper Severn Estuary SSSI: around 86% Favourable, 11% Unfavourable – Declining and 3% Unfavourable – Recovering.	
Site Improvement Plan:	1. Public access/disturbance – Pressure/Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Identify/reduce impacts of disturbance to birds and damage to habitats. 2. Impacts of development – Pressure/Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage - Inform strategic planning decisions to minimise impact of development. 3. Coastal squeeze – Pressure/Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Limit coastal squeeze, provide sustainable coastal defences, improve existing structures, deliver compensatory habitat. 4. Change in land management – Pressure/Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Maintain appropriate levels and timing of grazing and management of intertidal saltmarsh habitat. 5. Changes in species distributions – Threat – 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose, waterbird assemblage - Understand/prepare for changes in species distribution (caused by climate change/other events). 6. Water pollution – Pressure/Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Identify any existing issues and prevent/reduce decline in water and sediment quality (applying relevant measures to all relevant tributaries in England and Wales). 7. Air Pollution: impact of atmospheric nitrogen deposition – Pressure - 051 Gadwall and waterbird assemblage – Develop a Site Nitrogen Action Plan. 8. Fisheries: recreational marine and estuarine – Pressure – 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Establish levels and location 9. Fisheries: commercial marine and estuarine – Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage - Identify any threats to site features and habitats from commercial fisheries activity and establish and ensure compliance with any necessary management measures. 10. Marine litter – Pressure/Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Investigate sources of marine litter and implement actions for removal/shoreline clean up. 11. Marine pollution incidents – Threat - 037(NB) Bewick's swan, 048(NB) Common shelduck, 051(NB) Gadwall, 149(NB) Dunlin, 162(NB) Common shelduck, 394(NB) Greater white-fronted goose and waterbird assemblage – Minimise impact from marine pollution incidents and clean up response.	
Potential Effects		
Element:		Risk of Likely Significant Effects?

[117]UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Severn Estuary SPA (UK9015022)**	
All elements	The nearest element is located approximately 10 km north-east of the Severn Estuary SPA and is approximately 45 km north-east via hydrological connectivity. The SIP threats and pressures of potential relevance to this element during construction are (2) impacts of development, (5) changes in species distributions, (6) water pollution and (7) air pollution. The footprint of the STT is outside of the boundary of the SPA, however, supporting habitats could be affected during construction. The most relevant SIP threat and pressure to this element during operation are (2) impacts of development and (5) changes in species distributions. Changes in pass forward flow and water quality as a result of the operation of the STT could impact on the supporting habitats within the Severn Estuary.	**Yes**

European site name:	**Severn Estuary Ramsar (UK11081)**	
Designation type: (SAC, SPA, Ramsar):	**Ramsar site**	
Qualifying features:	**Ramsar criterion 1** Due to immense tidal range (second-largest in world), this affects both the physical environment and biological communities. **Ramsar criterion 3** Due to unusual estuarine communities, reduced diversity and high productivity. **Ramsar criterion 4** This site is important for the run of migratory fish between sea and river via estuary. Species include Atlantic salmon (*Salmo salar*), sea trout (*S. trutta*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), allis shad (*Alosa alosa*), twaite shad (*A. fallax*) and European eel (*Anguilla anguilla*). It is also of particular importance for migratory birds during spring and autumn. **Ramsar criterion 5** Assemblages of international importance: Species with peak counts in winter: 70919 waterfowl (5 year peak mean 1998/99-2002/2003). **Ramsar criterion 6** Species/populations occurring at levels of international importance. Qualifying species/populations (as identified at designation): *Calidris alpina;* Dunlin – Passage/Wintering *Anas strepera;* Gadwall – Wintering *Tringa tetanus;* Common redshank – Passage/Wintering *Tadorna tadorna;* Common shelduck – Wintering *Anser albifrons albifrons;* Greater white-fronted geese – Wintering *Charadrius hiaticula;* Ringed plover – Passage *Numenius phaeopus*; Whimbrel – Passage Waterbird assemblage – Wintering Estuary with immense tidal range Unusual estuarine communities Run of migratory fish Possible future consideration under criterion 6: lesser black-backed gull (*Larus fuscus graellsii*), Eurasion teal (*Anas crecca*) and Northern pintail (*Anas acuta*) **Ramsar criterion 8** The fish of the whole estuarine and river system is one of the most diverse in Britain, with over 110 species recorded. Atlantic salmon, sea trout, sea lamprey, river lamprey, allis shad, twaite shad and European eel use the Severn Estuary as a key migration route to their spawning grounds in the many tributaries that flow into the estuary. The site is important as a feeding and nursery ground for many fish species particularly allis shad and twaite shad which feed on mysid shrimps in the salt wedge.	**Water Dependency:** The Ramsar Site and its qualifying criteria (by definition) are all water dependent.
Current conservation status:	N/A	
Conservation objectives:	Not available.	
SSSI Condition assessment:	Severn Estuary SSSI: around 96% Favourable, 0.1% Unfavourable - recovering and 3% Unfavourable - no change. Aust Cliff SSSI: 100% Favourable. Blue Anchor to Lilstock Coast SSSI: 100% Favourable. Clevedon Shore SSSI: 100% Favourable. Lydney Cliff SSSI: 100% Favourable. Middle Hope SSSI: around 80% Favourable and 20% Unfavourable – Recovering. Portishead Pier to Black Nore SSSI: 100% Favourable. Purton Passage SSSI: 100% Favourable. Spring Cove Cliffs SSSI: 100% Favourable. Steep Holm SSSI: 100% Favourable. Upper Severn Estuary SSSI: around 86% Favourable, 11% Unfavourable – Declining and 3% Unfavourable – Recovering.	
Site Improvement Plan:	See threats and pressures listed in Severn Estuary SAC and SPA screening table.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
	Ramsar Criterion 4 and 8 Off-site functional habitat could potentially be affected during construction works as a result of localised increases in suspended sediment (siltation and deposition), potential invasive and non-native species introduction/ spread from construction vehicles and unclean PPE, noise and vibration disturbance, entrapment and impingement and potential water pollution incidents. There are potential impact pathways on functional spawning and nursery habitats, not within the boundary of the site during operation. Elevated volumes of water transported down the River Vyrnwy and the River Severn and the subsequent rise in water flow could cause an increase in suspended sediment, disturbance/ displacement of river and sea lamprey ammocoetes present in silt beds (nursery habitat) upstream and increased velocities over nursery habitats. Increased flows could also impact on migration cues and the passability of barriers. Furthermore, the changes in water quality as a result of the transfer of treated effluent could also impact on migration cues and juvenile individuals.	**Yes**
	Ramsar Criterion 5 and 6 The footprint of this element is outside of the boundary of the Ramsar site, however, off site functional habitats could be impacted during the construction works. Furthermore, changes in pass forward flow and water quality could also impact on supporting habitats within the estuary during operation.	
	Ramsar Criterion 1 and 3 During construction potential impact pathways on the estuary include siltation and deposition, impedance of movement, entrapment and impingement, noise and vibration disturbance, salinity regime changes and temperature changes. During operation, abstraction from the River Severn will reduce the volume of water transported downstream to the Severn Estuary, in addition to potential changes in water quality. The reduced flow could also expose a greater area of peripheral habitats in the Severn Estuary including mudflats and sandflats and Atlantic salt meadows during times of operation (summer).	

Designated site name:	**South West London Waterbodies (UK9012171)**

Designation type: (SAC, SPA, Ramsar):	**SPA**	
Qualifying features:	056 *Anas clypeata;* Northern shoveler (wintering). 051 *Anas strepera*; Gadwall (wintering).	**Water Dependency** Species identified as water dependent: • 056 *Anas clypeata;* Northern shoveler • 051 *Anas strepera*; Gadwall
Current conservation status:	**056 *Anas clypeata;* Northern shoveler** (status: short term – increasing, long term – increasing; type: non-breeding, size: minimum – 853, maximum 853, represented approximately 2% of the North West European population (5 year peak mean 1993/94 – 1997/98 based on WeBS data supplied by BTO); unit: individual, data quality: good, population: 2 – 15%, isolation: population not-isolated within extended distribution range) **051 *Anas strepera*; Gadwall** (status: short term – increasing, long term – increasing; type: non-breeding, size: minimum – 710, maximum 710, represented approximately 2% of the North West European population (5 year peak mean 1993/94 – 1997/98 based on WeBS data supplied by BTO); unit: individual, data quality: good, population: 2 – 15%, isolation: population not-isolated within extended distribution range)	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring; • The extent and distribution of the habitats of the qualifying features • The structure and function of the habitats of the qualifying features • The supporting processes on which the habitats of the qualifying features rely • The population of each of the qualifying features, and • The distribution of the qualifying features within the site.	
SSSI Condition assessment:	Kempton Park Reservoirs SSSI: 100% Unfavourable - Recovering; Knight and Bessborough Reservoirs SSSI: 100% Favourable; Staines Moor SSSI: around 96% Favourable, 4% Unfavourable - Recovering; Thorpe Park No.1 Gravel Pit SSSI: 100% Favourable; Wraysbury and Hythe End Gravel Pits SSSI: 100% Favourable; Wraysbury No. 1 Gravel Pit SSSI: 100% Favourable; and Wraysbury Reservoir SSSI: 100% Favourable.	
Site Improvement Plan:	1. Public access/ disturbance – Pressure/Threat – 051 Gadwall, 056 Shoveler – Produce written agreement with landowners and recreational users to reduce recreational disturbance. 2. Changes in species distributions – Pressure/Threat - 051 Gadwall, 056 Shoveler – In partnership with bird recorders/watchers, review existing data and secure fit-for-purpose recording practices across the SPA and its surroundings. 3. Invasive species – Pressure/Threat - 051 Gadwall, 056 Shoveler – Manage *Crassula helmsii* and equip recreational users and landowners to monitor for the plant. 4. Natural changes to site conditions – Pressure/Threat - 051 Gadwall, 056 Shoveler – Carry out strategic habitat management, including management of bankside vegetation. 5. Fisheries: fish stocking – Pressure - 051 Gadwall, 056 Shoveler – Secure appropriate fish stocking levels. 6. Inappropriate weed control – Threat - 051 Gadwall, 056 Shoveler – Clarify appropriate weed control with owners and tenants through consents and carry out enforcement action where necessary. 7. Invasive species – Threat - 051 Gadwall, 056 Shoveler – Research Egyptian geese and control if necessary.	
Potential Effects		
Element	Screening assessment	Risk of likely significant effects?
	The European site is located approximately 160 m at its closest point to potentially impacted reaches of the River Thames and approximately 54 km from proposed construction works. Therefore, no impact pathways have been identified during construction works on qualifying features of the South West London Waterbodies SPA. During operation of the scheme, there is potential for changes in flow, water level and velocity in the River Thames to impact on the availability of suitable supporting habitat via changes in wetted width of the channel and potential changes in macrophyte extent and community assemblage. This is relevant to the SIP pressure/ threat of changes in species distribution. In winter, Northern shoveler are distributed across the SPA, using the shallow waterbodies present in the marshes, flooded pastures, lakes and reservoirs. Northern shoveler use inland eutrophic waterbodies with a mixture of rich vegetation and sufficient open water with shallow margins where they are able to feed on aquatic invertebrates and zooplankton[118]. The European site support an estimated 2% of the north-west/ central European population of northern shoveler (based on 5-year peak mean 1993/94 – 1997/98)[119]. As Northern shoveler are more likely to reside in enclosed waterbodies and due to a lack of species records in the River Thames (no records of Northern shoveler found from publicly available information on Wetland Bird Survey (WeBS) from 2010- 2020), no LSEs are anticipated on Northern shoveler populations associated with the South West London Waterbodies SPA. Gadwall use both inland eutrophic waterbodies and coastal bays with shallow margins and a mixture of rich vegetation (reedbeds and wooded inlets) and a sufficient area of open water[120]. Their diet is primarily aquatic vegetation including macrophytes and filamentous algae. The European site supports an estimated 2 % of the north-west European population of gadwall (based on 5-year peak mean 1993/94 – 1997/98)[121], although distributional changes and use of other waterbodies in the wider Thames Valley area have been noted previously[122]. As gadwall are more likely to reside in enclosed waterbodies and coastal bays and due to limited species records in the River Thames (WeBS recorded one gadwall at River Thames: Moulsford to Streatley survey site in 2012/13 and 2018/19 and two individuals at Cherstsey Bridge to Laleham in 2011/12) no LSEs are anticipated on gadwall populations associated with the South West London Waterbodies SPA.	No

[118] Svensson, L (2009). Collins Bird Guide, 2nd edition. Harper Collins Publishers Ltd. 1 – 429.
[119] English Nature (2000). EC Directive 79/409 on the Conservation of Wild Birds: Special Protection Areas (SPA). South West London Waterbodies, Classification citation, pg 1.
[120] Svensson, L (2009). Collins Bird Guide, 2nd edition. Harper Collins Publishers Ltd. 1 – 429.
[121] English Nature (2000). EC Directive 79/409 on the Conservation of Wild Birds: Special Protection Areas (SPA). South West London Waterbodies, Classification citation, pg 1.
[122] Banks, A. N., Austin. G. E. and Rehfisch, M. M (2004). South West London Waterbodies SPA – Wildfowl Population Analysis. BTO Research Report 361.

Designated site name:	South West London Waterbodies (UK11065)	
Designation type: (SAC, SPA, Ramsar):	Ramsar	
Qualifying features:	**<u>Ramsar criterion 6</u>** Species/populations occurring at levels of international importance. Species peak count in spring/autumn: *Anas clypeata;* Northern shoveler (wintering) - 397 individuals, representing an average of 2.6% of the British populations (5 year peak mean 1998/9 – 2002/3). Species peak count in winter: *Anas strepera*; Gadwall (wintering) - 487 individuals, representing an average of 2.8% of the British population (5 year peak mean 1998/9 – 2002/3). <u>Species currently occurring at levels of national importance:</u> *Podiceps cristatus*; Great crested grebe *Phalacrocorax carbo*; Great cormorant *Aythya fuligula*; Tufted duck *Podiceps nigricollis*; Black-necked grebe *Mergellus albellus*; Smew	**<u>Ramsar criterion 6</u>** Species/populations occurring at levels of international importance. Species peak count in spring/autumn: *Anas clypeata;* Northern shoveler (wintering) - 397 individuals, representing an average of 2.6% of the British populations (5 year peak mean 1998/9 – 2002/3). Species peak count in winter: *Anas strepera*; Gadwall (wintering) - 487 individuals, representing an average of 2.8% of the British population (5 year peak mean 1998/9 – 2002/3). <u>Species currently occurring at levels of national importance:</u> *Podiceps cristatus*; Great crested grebe *Phalacrocorax carbo*; Great cormorant *Aythya fuligula*; Tufted duck *Podiceps nigricollis nigricollis*; Black-necked grebe *Mergellus albellus*; Smew
Current conservation status:	N/A	
Conservation objectives:	Information not currently available.	
SSSI Condition assessment:	Kempton Park Reservoirs SSSI: 100% Unfavourable - Recovering; Knight and Bessborough Reservoirs SSSI: 100% Favourable; Staines Moor SSSI: around 96% Favourable, 4% Unfavourable - Recovering; Thorpe Park No.1 Gravel Pit SSSI: 100% Favourable; Wraysbury and Hythe End Gravel Pits SSSI: 100% Favourable; Wraysbury No. 1 Gravel Pit SSSI: 100% Favourable; and Wraysbury Reservoir SSSI: 100% Favourable.	
Site Improvement Plan:	Information not currently available.	
Potential Effects		
Element	Screening assessment	Risk of likely significant effects?
	The European site is located approximately 160 m at its closest point to potentially impacted reaches of the River Thames and approximately 54 km from proposed construction works. Therefore, no impact pathways have been identified during construction works on qualifying features of the South West London Waterbodies Ramsar. During operation of the scheme, there is potential for changes in flow, water level and velocity in the River Thames to impact on the availability of suitable supporting habitat via changes in wetted width of the channel and potential changes in macrophyte extent and community assemblage. In winter, Northern shoveler are distributed across the SPA, using the shallow waterbodies present in the marshes, flooded pastures, lakes and reservoirs. Northern shoveler use inland eutrophic waterbodies with a mixture of rich vegetation and sufficient open water with shallow margins where they are able to feed on aquatic invertebrates and	No

	zooplankton[123]. The European site support an estimated 2% of the north-west/ central European population of northern shoveler (based on 5-year peak mean 1993/94 – 1997/98)[124]. As Northern shoveler are more likely to reside in enclosed waterbodies and due to a lack of species records in the River Thames (no records of Northern shoveler found from publicly available information on Wetland Bird Survey (WeBS) from 2010- 2020), no LSEs are anticipated on Northern shoveler populations associated with the South West London Waterbodies Ramsar. Gadwall use both inland eutrophic waterbodies and coastal bays with shallow margins and a mixture of rich vegetation (reedbeds and wooded inlets) and a sufficient area of open water[125]. Their diet is primarily aquatic vegetation including macrophytes and filamentous algae. The European site supports an estimated 2 % of the north-west European population of gadwall (based on 5-year peak mean 1993/94 – 1997/98)[126], although distributional changes and use of other waterbodies in the wider Thames Valley area have been noted previously[127]. As gadwall are more likely to reside in enclosed waterbodies and coastal bays and due to limited species records in the River Thames (WeBS recorded one gadwall at River Thames: Moulsford to Streatley survey site in 2012/13 and 2018/19 and two individuals at Cherstsey Bridge to Laleham in 2011/12) no LSEs are anticipated on gadwall populations associated with the South West London Waterbodies Ramsar.	

[123] Svensson, L (2009). Collins Bird Guide, 2nd edition. Harper Collins Publishers Ltd. 1 – 429.
[124] English Nature (2000). EC Directive 79/409 on the Conservation of Wild Birds: Special Protection Areas (SPA). South West London Waterbodies, Classification citation, pg 1.
[125] Svensson, L (2009). Collins Bird Guide, 2nd edition. Harper Collins Publishers Ltd. 1 – 429.
[126] English Nature (2000). EC Directive 79/409 on the Conservation of Wild Birds: Special Protection Areas (SPA). South West London Waterbodies, Classification citation, pg 1.
[127] Banks, A. N., Austin. G. E. and Rehfisch, M. M (2004). South West London Waterbodies SPA – Wildfowl Population Analysis. BTO Research Report 361.

European site name:	**Tanat and Vyrnwy Bat sites (UK0014783)**	
Designation type: (SAC, SPA, Ramsar):	**SAC**	
Qualifying features:	1303 *Rhinolophus hipposideros;* Lesser horseshoe bat	**Water Dependency:** Species not identified as water dependent[128] however, lesser horseshoe bats utilise riparian habitats.
Current conservation status:	**1303 Lesser horseshoe bat *Rhinolophus hipposideros*: Improving** (range: favourable, population: favourable, habitat for the species: favourable, future prospects: favourable). Main pressures: removal of small landscape features for agricultural land consolidation, abandonment of grassland management, livestock farming (without grazing), conversion to other types of forests including monocultures, logging without replanting or natural regrowth, extraction of minerals, roads, paths, railroads and related infrastructure, construction or modification in existing urban or recreational areas, sports, tourism and leisure activities. Main threats: as identified above for main pressures in addition to other natural catastrophes.	
Conservation objectives:	The conservation objective is for the feature be in a favourable conservation status, where all of Performance Indicator conditions are satisfied, and all factors affecting the achievement of these conditions are under control. Performance indicators include performance indicators for feature condition: • Pre-parturition population(s) in maternity roosts • Population(s) in hibernation roosts. Performance indicators for factors affecting the feature: Site Security, Roost entrance(s), external disturbance, stability of roost, external condition of building, internal condition of the roost area, and the quality and quantity of woodland/scrub/hedgerow	
SSSI Condition assessment:	Hendre, Llangedwyn SSSI: 100% Favourable Allt-y-Main Main SSSI: 100% Favourable	
Site Improvement Plan:	Information not currently available	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Vyrnwy Bypass	Management Unit 7 and 8 which form the Hendre Llangedwyn SSSI are located approximately 10 km west of Bypass pipeline route to the Lower Vyrnwy. Management Unit 7 is designated for a maternity roost of lesser horseshoe bats with Unit 8 designated for the presence of hedgerows that provide the only connectivity to adjacent woodland habitats that are used for foraging. There is no hydrological connectivity between the proposed bypass option and the Tanat and Vyrnwy Bat sites SAC Units 7 and 8. Preferred foraging habitats include broadleaved woodland well connected by commuting routes such as hedges, woodland edge and riparian trees (Bontadina *et al.*, 2002; Schofield *et al.*, 2002). CSZs are the area surrounding a communal bat roost within which habitat availability and quality will have a significant influence on the resilience and conservation status of the colony using the roost. The CSZ for lesser horseshoe bats is identified as 2 km by Collins, 2016. Therefore, the temporary habitat loss required during construction of the Vyrnwy bypass pipeline route is unlikely to significantly affect the lesser horseshoe roost at Hendre Llangedwyn. The Vyrnwy release and alteration of the abstraction at Shrewsbury will occur over 10 km from the SAC boundary and do not require construction. Therefore, there will be no potential for construction related impacts from these elements. Construction of the pipeline could result in temporary disturbance and fragmentation of foraging habitats however as the proposed route is predominantly over 10km from the Hendre roost site and are outside of the core sustenance zone for lesser horseshoe bats (2 km from roost) no significant effects are anticipated during construction element. The reach of the River Vyrnwy that will receive the reservoir release is located approximately 5km south of Units 7 and 8 at Hendre and 1 km south of Unit 9 Allt-y-main, which is a disused mine that supports hibernating lesser horseshoe bats. The reach of the River Vyrnwy is over 10km upstream of the bypass pipeline discharge to the River Severn or Shrewsbury intake on the River Severn downstream of the Vyrnwy confluence. Although lesser horseshoe bats utilise riparian habitats for foraging and commuting, they are not considered to be a water dependent species and are not considered to be sensitive to changes in flow velocity or water level in foraging habitats. Therefore, no LSE are anticipated during operation of the reservoir release, bypass pipeline or Shrewsbury intake.	**No**
Vyrnwy Mitigation – Shrewsbury redeployment (25 Ml/d)	This element comprises of multiple elements with the pumping station for Pant DSR located approximately 9 km east of the Tanat and Vyrnwy Bat sites SAC. Potential impact pathways during construction of the pumping station include temporary noise, light and vibration disturbance, fragmentation of foraging habitat, air pollution and pollution incidents from construction vehicles. Due to the location of the pumping station close to the A483 and lack of linear vegetation, no significant impacts on foraging habitat are anticipated. In addition, due to the distance between the proposed pumping station and the SAC, noise, light and vibration disturbance and pollution incidents from construction works are considered unlikely to impact on qualifying species of the SAC. No significant air quality impacts are anticipated as the option element is sufficiently distant from the European sites. Hydrological changes during operation of this element must also be considered. Lesser horseshoe bats are not considered to be a water dependent species and are not considered to be sensitive to changes in flow velocity or water level in foraging habitats. Therefore, no LSE are anticipated during operation of Shrewsbury redeployment	**No**

[128] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Walmore Common SPA (UK9007051)**	
Designation type: (SAC, SPA, Ramsar):	**SPA**	
Qualifying features:	A037 *Cygnus columbianus bewickii*, Bewick's swan	**Water Dependency** Species identified as water dependent[129]: • *Cygnus columbianus bewickii*, Bewick's swan.
Current conservation status:	**A037 *Cygnus columbianus bewickii*, Bewick's swan: Unknown.** Type: Wintering. Size: minimum 104, maximum 104. Unit: Individuals. Data quality: Good. Population: <2%. Isolation: Population not-isolated within extended distribution range.	
Conservation objectives:	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; • The extent and distribution of habitats of qualifying species • The structure and function of the habitats of qualifying species • The supporting processes on which the habitats of qualifying species rely • The populations of qualifying species, and, The distribution of qualifying species within the site.	
SSSI Condition assessment:	Walmore Common SSSI: 100% Unfavourable – no change.	
Site Improvement Plan:	1. Hydrological changes – Threat – 037(NB) Bewick's swan - Water level management plan. 2. Changes in species distributions – Threat – 037(NB) Bewick's swan - Research into Bewick's swan distribution. 3. Change in land management – Threat – 037(NB) Bewick's swan - Improve habitat connectivity. 4. Offsite habitat availability/management – Pressure/Threat – 037(NB) Bewick's swan - Review designation boundaries to include critical grazing areas. 5. Public access/disturbance – Threat – 037(NB) Bewick's swan - Access strategy 6. Energy production – Threat – 037(NB) Bewick's swan - Appropriate ecological information available to inform development control.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Netheridge WwTW discharge diversion, Deerhurst pipeline (35 Ml/d)	This element is located 6 km south-east of Walmore Common SPA. The SIP threats and pressures of potential relevance to this element are (1) hydrological changes, (2) changes in species distribution and (4) offsite habitat availability/management. Due to the distance between the European site and the proposed works, no disturbance or air pollution impacts during construction are anticipated, that could cause changes in specie distribution. As Bewick's swans overwinter at Walmore Common from October – March, hydrological changes in the Severn Estuary during operation of the element will not directly impact on the population. Negligible impacts on hydrological regime are anticipated within the Severn Estuary and therefore, no impacts on supporting saltmarsh habitat are expected. In conclusion, no LSE are anticipated.	**No**

[129] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.

European site name:	**Walmore Common Ramsar (UK11076)**	
Designation type: (SAC, SPA, Ramsar):	**Ramsar**	
Qualifying features:	**Ramsar Criterion 6** Species/populations occurring at levels of international importance. Qualifying species/populations (as identified at designation): *Cygnus columbianus bewickii*, Bewick's swan – Wintering, NW Europe 43 individuals, representing an average of 0.5% of the GB population (5 year peak mean 1998/9-2002/3).	**Water Dependency** Species identified as water dependent[130]: • *Cygnus columbianus bewickii*, Bewick's swan
Current conservation status:	N/A	
Conservation objectives:	Information not available.	
SSSI Condition assessment:	Walmore Common SSSI: 100% Unfavourable – no change.	
Site Improvement Plan:	1. Hydrological changes – Threat – Bewick's swan - Water level management plan. 2. Changes in species distributions – Threat – Bewick's swan - Research into Bewick's swan distribution. 3. Change in land management – Threat – Bewick's swan - Improve habitat connectivity. 4. Offsite habitat availability/management – Pressure/Threat – Bewick's swan - Review designation boundaries to include critical grazing areas. 5. Public access/disturbance – Threat – Bewick's swan - Access strategy 6. Energy production – Threat – Bewick's swan - Appropriate ecological information available to inform development control.	
Potential Effects		
Element:		Risk of Likely Significant Effects?
Netheridge WwTW discharge diversion, Deerhurst pipeline (35 Ml/d)	This element is located 6 km south-east of Walmore Common Ramsar site. Due to the distance between the European site and the proposed works, no disturbance or air pollution impacts during construction are anticipated, that could cause changes in specie distribution. As Bewick's swans overwinter at Walmore Common from October – March, hydrological changes in the Severn Estuary during operation of the element will not directly impact on the population. Negligible impacts on hydrological regime are anticipated within the Severn Estuary and therefore, no impacts on supporting saltmarsh habitat are expected. In conclusion, no LSE are anticipated.	**No**

[130] UKTAG (2003). *Guidance on the Identification of Natura Protected Areas [Final]*. UK Technical Advisory Group on the Water Framework Directive. TAG Work Programme Task 4.a, 1 – 20.