Strategic Regional Water Resource Solutions: Annex B4.1: Initial Environmental Appraisal Report

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

Date: November 2022

Severn to Thames Transfer

Initial environmental appraisal report

STT-G2-S3-120

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

Initial Environmental Appraisal (IEA) Report

Ricardo ref. ED15323 Issue: 005 13/10/2022

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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.

Glossary and Abbreviations	
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 SOLUTION

1.1.1 The River Severn to River Thames Transfer (STT) Description

The aim of the Severn Thames Transfer (STT) 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 Resources in the South East (WRSE) group's emerging regional plan. 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 this 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 Severn Trent Water licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst;
- **Minworth**: The transfer of 115Ml/d of treated wastewater discharge from Severn Trent Water'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 Severn Trent Water'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 standard 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 2

The guidance stated the environmental assessment methodologies should be consistent with any relevant legislation and guidance and follow best practice. This includes, where relevant, EA Water Resource Planning Guidelines (WRPG[2]), All Company Working Group (ACWG) guidance[3], and the EA Invasive Non-native Species (INNS) risk assessment tool.

Figure 1.1 (which is colour-coded to aid understanding of the different types of investigations) 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 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.

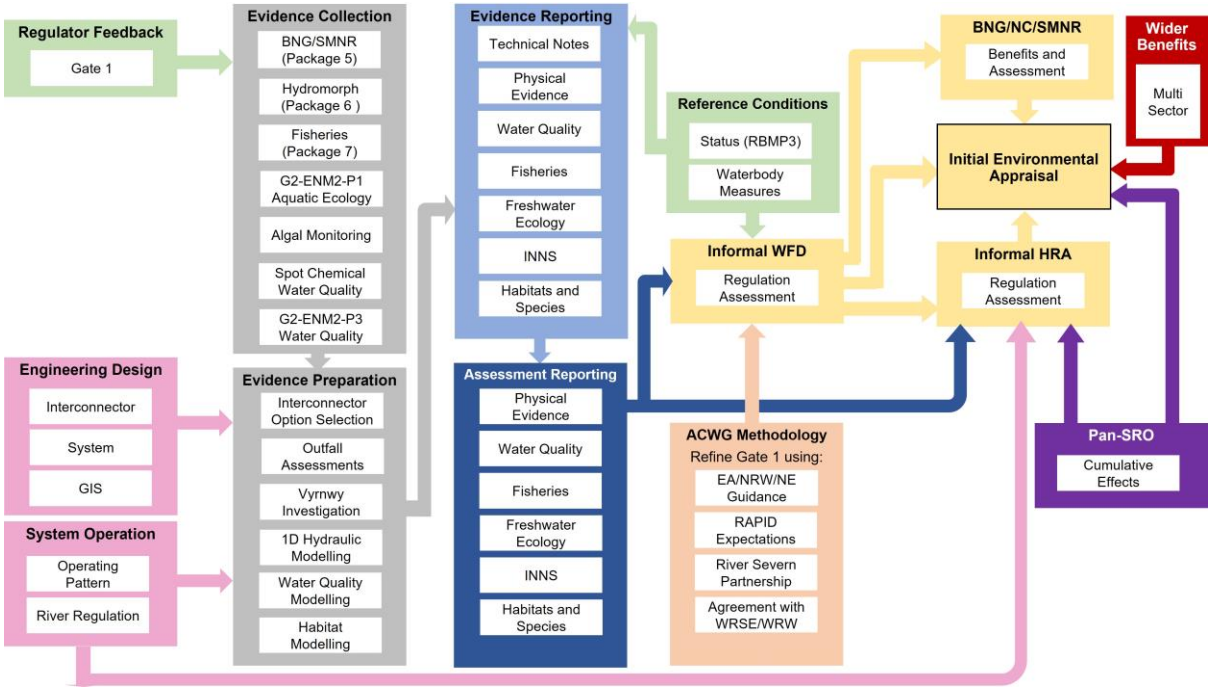

Figure 1.1 Flow chart showing the scope of investigations for STT Gate 2 and their interactions

1.2 STUDY AREA

The study area for the STT solution for Gate 2 assessment is limited to 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

[2] Environment Agency (2021) Water resources planning guideline, July 2021. Available at Water resources planning guideline - GOV.UK (www.gov.uk)

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

4. The River Thames catchment (River Thames from Culham to Teddington Weir)

It should be noted that the consideration of impacts in the River Tame and Trent, from the transfer of treated discharge from Minworth Wastewater Treatment Works (WwTW) to the River Avon, is included in Severn Trent Water's Minworth Strategic Resource Option (SRO) and is 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 (United Utilities and Severn Trent Water Sources). It therefore includes an assessment of the potential effects of the water arising from the outfalls from the transfers (Minworth and Netheridge). It does not cover the impact of infrastructure construction of the latter solutions, as they are covered by Severn Trent Water's Minworth and Sources SRO assessments.

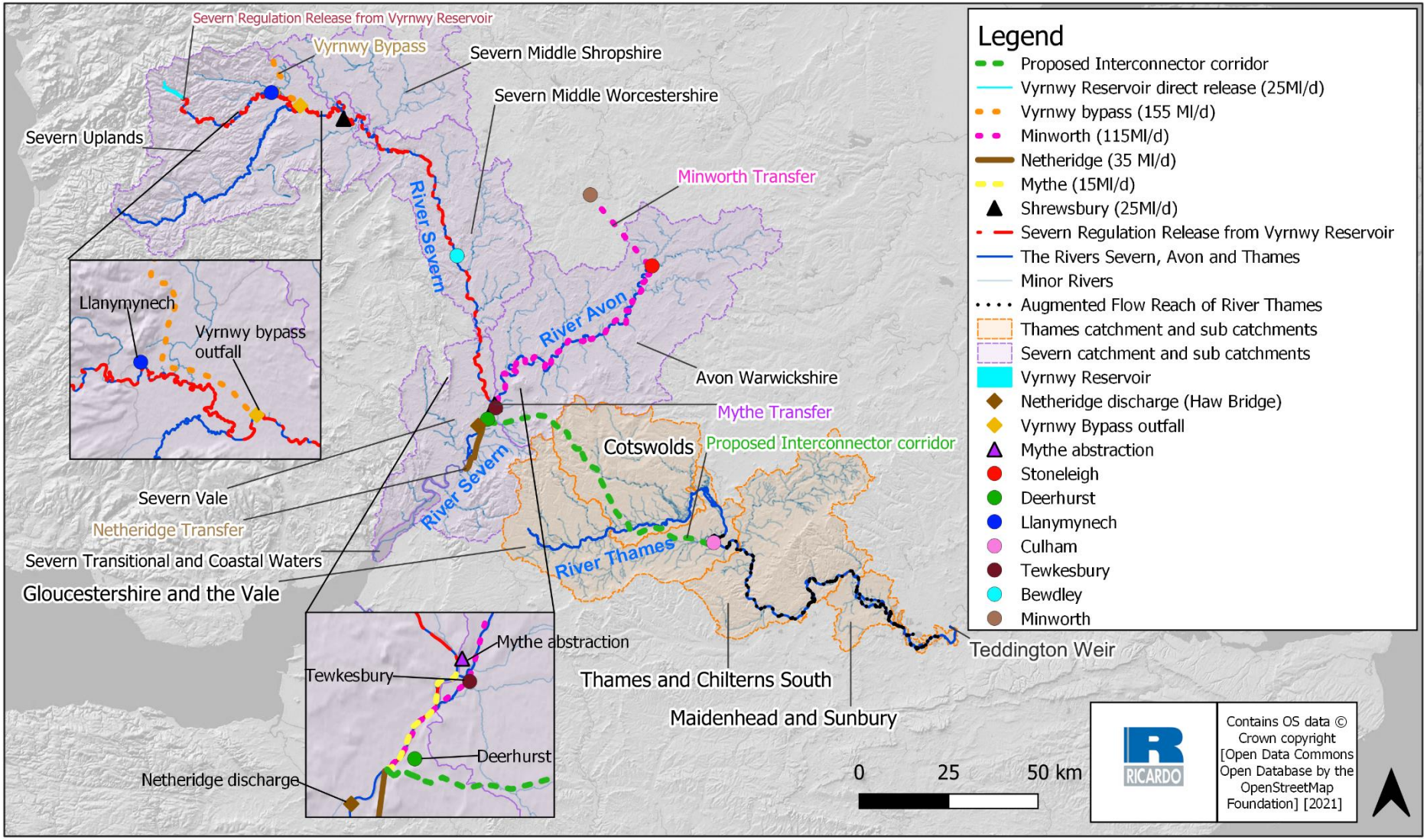

Figure 1.2 Map showing the study area and associated catchments

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 (see Section 1.1.1), 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 1-2.

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 2,568 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 355 Ml/d can be abstracted, in addition to the available 172 Ml/d unsupported[4]. This is summarised in Table 1-1.

Table 1-1 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

The EA has advised the STT Group of appropriate values of "in-river losses" to include in the hydraulic modelling[5] and subsequent environmental assessments. The advised values 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 supporting flows 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 1-2 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 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 the 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. The early phase STT solution does not include the full range of support options and as such supported abstraction is limited to the value of the Netheridge Transfer, 35 Ml/d.	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 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;

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

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

Early Phase STT	Full STT
	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 licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst; 5. **Minworth**: The transfer of 115Ml/d of treated wastewater discharge from Severn Trent Water's Minworth Wastewater Treatment Works (WwTW) via a pipeline, to the River Severn via the River Avon at Stoneleigh; and 6. **Netheridge**: 35Ml/d of the Severn Trent Water licensed abstraction piped to 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 hands-off flow 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 hands-off flow conditions; or • Supported abstraction by flow volume matching from Netheridge Transfer

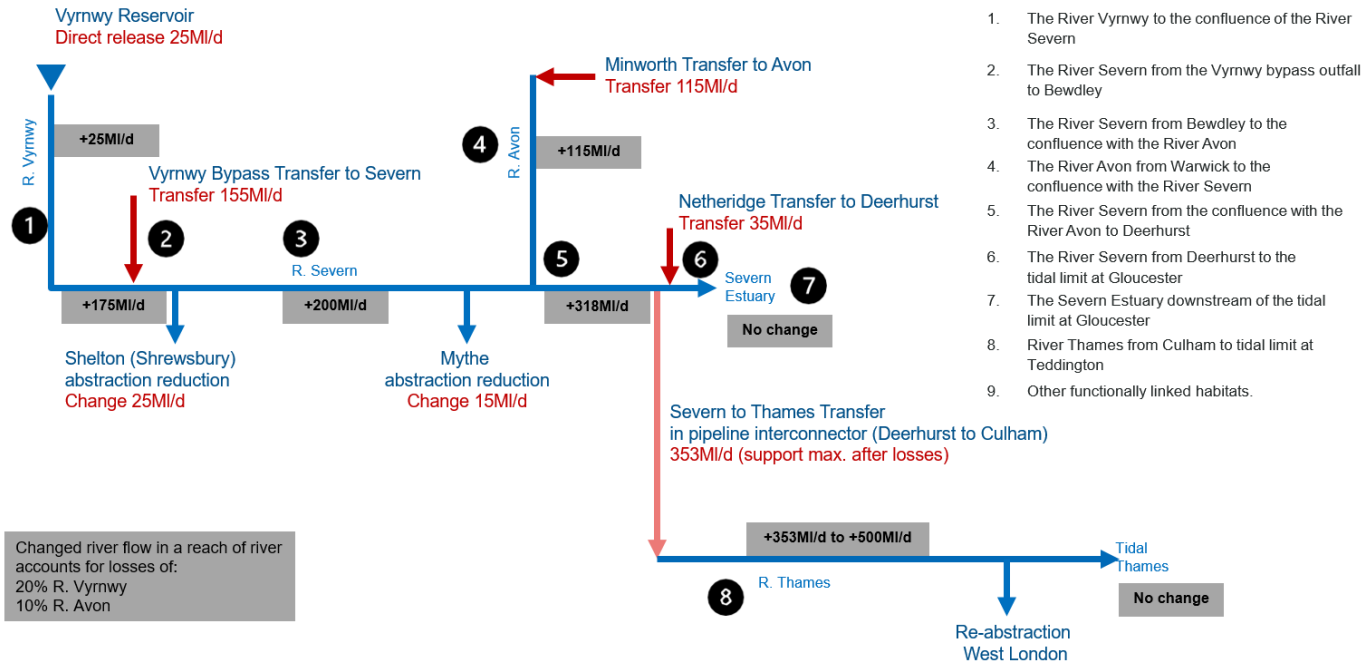

Figure 1.3 Schematic representing flow changes (accounting for losses) of STT Solution

There are several configurations for how the Interconnector source elements could combine. The source elements can be introduced in a phased manner in response to an increasing deficit. To further enhance adaptability, the Vyrnwy and Minworth sources can be broken down into six steps and two steps respectively. This reflects the work required to replace their respective flows but also highlights the adaptability of the sources to meet varying needs.

Optimisation modelling by Jacobs has revealed the optimum phasing of the sources. This indicates how the sources will be brought into operation sequentially to provide the required flows. When not required, the

sources will be taken out of operation and will be drained down. A notice period of 20 days will be required to bring source support online. The phasing proposal submitted to WRSE for inclusion in their regional modelling is given in Table 1-3.

Table 1-3 Optimised phasing of source support

Phase	Source	Incremental Volume	Cumulative Volume	Notes
1	Netheridge	35		Sweetening flow
2	Unsupported	Varies		
3	Vyrnwy phase1	50	50	Vyrnwy cumulative
4	Vyrnwy phase2	25	75	
5	Vyrnwy phase3	25	100	
6	Vyrnwy phase4	35	135	
7	Vyrnwy phase5	15	150	
8	Vyrnwy phase6	30	180	
9	Minworth phase1	58	58	Minworth cumulative
10	Minworth phase2	57	115	
11	Mythe	15		
12	Shrewsbury	25		

To support the environmental assessments at Gate 2, an indicative operating pattern has been developed. The approach uses the 19,200year 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 represents contemporary climate conditions and provides 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] 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 the report *STT-G2-S3-112-Modelling / Physical Environment Evidence Assessment*, 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 Thames Water, without conjunctive use with other Thames Water SROs (such as the Southeast Strategic Resource Option (SESRO)). It also uses the controlling triggers developed by Thames Water for SESRO based on lower River Thames flows and Thames Water's total London reservoir storage.

[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,

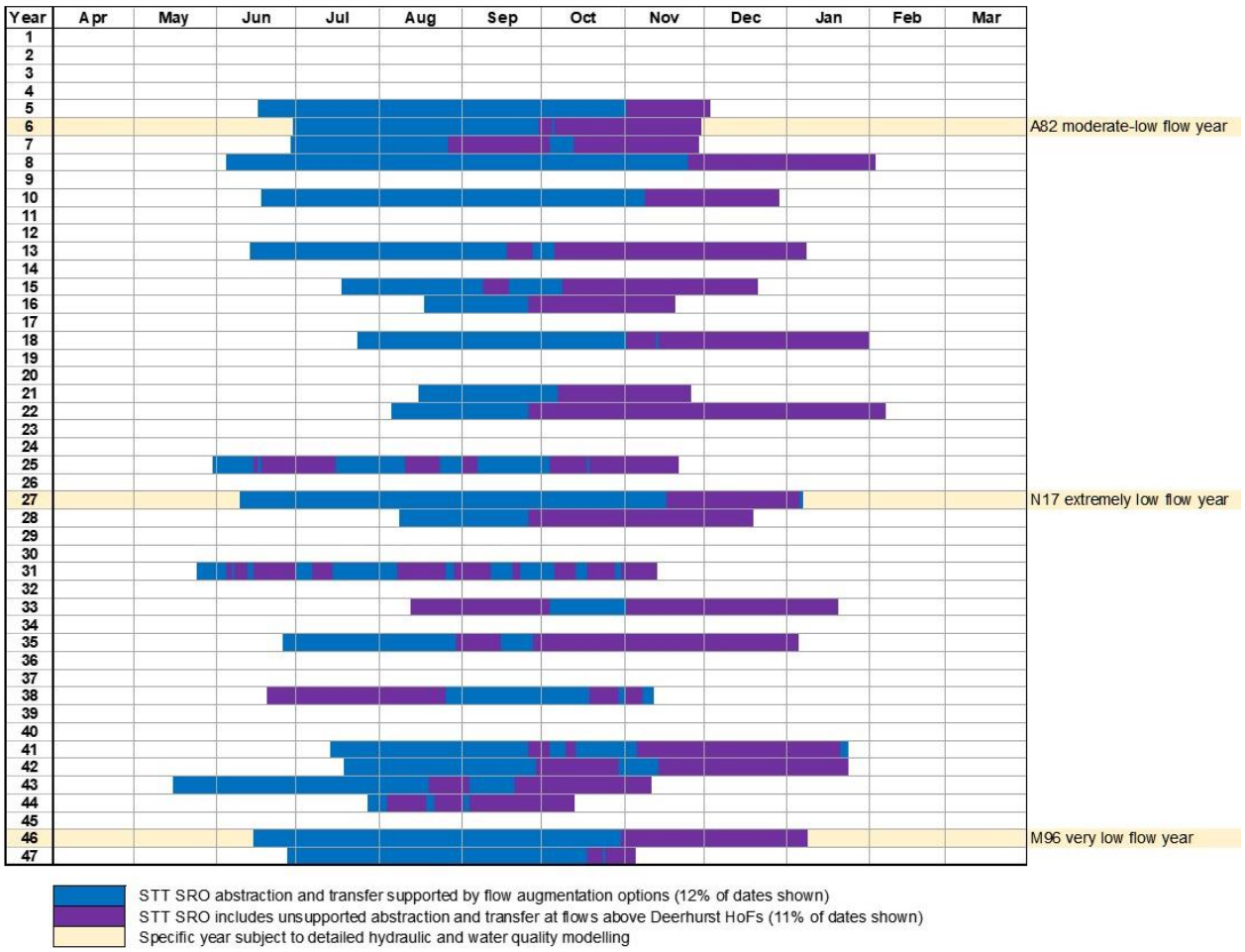

Figure 1.4 Representation of dates full STT solution would be on (for water resources purposes) as used in the environmental assessment

The general description in Figure 1.4 identifies periods in purple when the early phase STT pattern would be in operation (unsupported abstraction) and the combined purple and blue periods show the periods when the full STT operation pattern is being deployed (supported abstraction). The review of river flows and operating patterns for the environmental assessments 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. Having identified these patterns, return frequencies have been selected for the detailed assessment for Gate 2, which has included hydraulic modelling of different scenarios. The scenarios modelled 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); and
- 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 scenarios capture a suitable range of circumstances and have been discussed and reviewed with the regulators during Gate 2.

It should be noted that, in addition to the above, 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 the consideration of scheme resilience. Such a low return frequency is outside the regularity of occurrence included in Water Framework Directive (WFD) assessments and is thus not described further in this report. For further information see the EA's position statement LIT 14339 01/2021[7].

[7] EA (2021) Supporting implementation of river basin management plans position. LIT 14339. 01/2021.

The Gate 2 assessment also incorporates climate change scenarios into 1D hydraulic models for the assessment of river flows and Severn Estuary pass-forward flows. The A82 Future and M96 Future years are illustrative of the potential types of changes to river flows and operating patterns in the future. At this stage, as the full 19,200 stochastic years have not been reworked as 2070s RCM8.5 futures, it is not possible to derive a suitable 48-year period that is representative of the return frequencies for the environmental assessments.

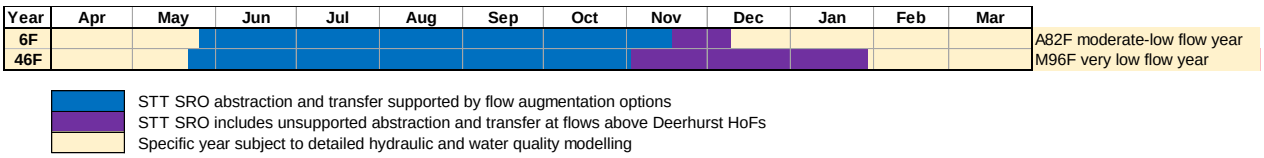

Figure 1.5 Representation of dates full STT solution would be on (for water resources purposes) for selected future scenarios as used in the environmental assessment

Where: purple indicates periods of unsupported abstraction and blue indicates periods of supported abstraction

1.4 CONSTRUCTION TECHNIQUES

Infrastructure associated with the STT solution includes the installation of two pipeline routes (Vyrnwy Bypass option 27 and the Deerhurst to Culham Interconnector) with associated intakes and outfalls, pumping stations and a new water treatment works (WTW).

Mitigation measures listed in the *STT-G2-S3-303- Interconnector Deerhurst to Culham pipeline conceptual design* report[8] include:

- 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 the perimeter at permanent sites will be provided at the start of construction (which can provide noise barrier benefits).

Mitigation measures listed in the *STT-G2-S3-331-River Vyrnwy bypass pipeline conceptual design report* [9] include:

- 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 and 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

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

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

migration and spawning for twaite shad, river lamprey and sea lamprey.

Conceptual Design Reports for all elements of the STT solution are provided as additional appendices including:

- *STT-G2-S3-303- Interconnector Deerhurst to Culham pipeline conceptual design report*
- *STT-G2-S3-308- Interconnector Cotswold Canal conceptual design report*
- *STT-G2-S3-331-River Vyrnwy bypass pipeline conceptual design report*

1.5 SRO ENVIRONMENTAL ASSESSMENTS AND THEIR RELATIONSHIP WITH REGIONAL PLANS AND WRMPS

The focus of Gate 2 in RAPID's gated process is to ensure that funding for continued investigation and development of solutions is aligned to water resources planning[10]. Decisions about whether or not a solution goes ahead will be made through water resources planning and subsequently applications for planning and environmental consents.

The EA has also set out a National Framework[11] for water resources that requires water companies to work together to produce regional plans. STT and the other SROs are included in the current round of water resource management plans (WRMP24) and regional and company plans, and these plans will determine whether and when the options will be needed. The emerging regional WRSE plan, published on 20th January 2022, identified a need for up to 500Ml/d of water from the STT solution under the 'High Scenario' from 2040-2060.

Appendix 2 of the National Framework 'Regional Planning' sets out the actions that 'must, should and could' feature in regional plans. Amongst the requirements are that it:

- must include enhanced environmental improvements;
- must comply with Strategic Environmental Assessment[12] (SEA) and Habitats Regulations Assessment[13] (HRA) legislation;
- should look to use the natural capital approach in their decision making where appropriate; and
- must include environmental net gain in their decision making, to achieve measurable improvements for the environment on a regional and local level.

The decision-making process for determining regional plan solutions to regional and national needs will be developed following the EA Water Resource Planning Guidelines (WRPG[14]) and supplementary guidance[15] which contain a number of requirements and recommendations regarding the scope of WRMP environmental assessment, in particular, in relation to SEA, Biodiversity Net Gain (BNG) and Natural Capital Assessment (NCA). The Regional Plans will need to be reflected in the WRMPs and the assessments and, therefore, need to be consistent with the requirements of the WRPG.

As part of the assessment of water companies' PR19 business plans, Ofwat introduced proposals in their December 2019 Final Determination[16] to support the delivery of SROs over the next 5 to 15 years with solutions required to be 'construction ready' for the 2025-2030 period. Ofwat set out a RAPID gateway process[17], for development of SROs for the co-ordination and development of a consistent set of SROs.

[10] Environment Agency (2021) Water resources planning guideline, July 2021. Available at Water resources planning guideline - GOV.UK (www.gov.uk)

[11] https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources

[12] Strategic Environmental Assessment Directive, European Directive 2001/42/EC.

[13] Habitats Regulation Assessment, Conservation of Habitats and Species Regulations 2017.

[14] Environment Agency (2021) Water resources planning guideline, July 2021. Available at Water resources planning guideline - GOV.UK (www.gov.uk)

[15] Environment Agency (2021) Water resources planning guideline supplementary guidance – Environment and society in decision-making, External guidance: 18643. November 2021.

[16] Ofwat (2019) PR19 Final Determinations, Strategic regional water resource solutions appendix

[17] Regulatory Alliance for Progressing Infrastructure Development (RAPID) Gated planning process https://www.ofwat.gov.uk/regulated-companies/rapid/

In October 2020, the group of Water Companies involved in developing SROs in the RAPID gateway process (known as the All Company Working Group - ACWG), published guidance[18] for environmental assessment methods for SROs which is aligned to the WRPG for WRMP 2024[19], to increase the consistency of environmental assessment. These guidelines specified that SEA should be considered as standard in the early stages of WRMP and SRO development, including Gates 1 and 2.

It is recognised that the SEA approach can assist in the identification of likely significant environmental effects (positive and negative) of water resource options, both individually and in-combination, and that knowledge of these effects can help to identify preferred options, programmes of options and mitigation requirements.

The ACWG methodology[20] sets out the requirements and approaches to achieve this consistency and alignment at each stage of the RAPID gated process. The four RAPID gates are as follows:

- Gate 1: Initial concept design and decision making
- Gate 2: Detailed feasibility, concept design and multi-solution decision making
- Gate 3: Developed design, finalised feasibility, pre-planning investigations and planning applications
- Gate 4: Planning applications, procurement and land purchase

It was confirmed in the RAPID letter dated April 2020[21], that a full statutory SEA was not required for Gate 1. Statutory SEAs, required by the Environmental Assessment of Plans and Programmes Regulations 2004 are, however, being undertaken through the WRMP process, and for the Regional Plans, with the SROs forming options within these.

In consequence, a formal statutory SEA for submission of the STT solution at Gate 1 was not undertaken. Instead, the environmental assessment of the STT solution was undertaken in Gate 1 in the context of the ACWG guidance. The approach was adopted to assess the various components of the STT system, thus determining the environmental risk of the STT solution in a manner consistent with the assessments undertaken for the regional plans and individual water company WRMPs.

The STT solution remains broadly similar to that proposed in Gate 1 but has been refined during the course of Gate 2. Updates on the scheme solution have been provided to the WRSE Regional Plan team and draft output from WRSE suggests that the scheme remains on course to be a solution proposed within the draft Regional Plan.

The recommendations and actions received from RAPID and feedback from Stakeholders from the Gate 1 process have been reflected in the scheme development.

The STT SRO has been included in the regional plan modelling and is on the preferred and alternative pathways in the draft regional plans. The Water Resources South East (WRSE) emerging draft regional plan has selected a 500Ml/d interconnector option in 2050 as the preferred transfer capacity. The support elements of the STT come online in a phased manner thereafter. Following a thorough and robust options analysis process, for the STT solution, a pipeline interconnector has been selected as the preferred option to transfer water from the River Severn to the River Thames. This will form the basis of the scheme development. The options appraisal process was based on information and assessment of a wide range of factors, including those relating to the environment, appropriate to the early scheme development options stage. The preferred option and alternatives will be consulted upon in Gate 3.

Multiple users have been identified by WRSE Investment Modelling: Thames Water and Affinity by abstraction from the River Thames and via the Thames to Affinity Transfer (T2AT); and Southern Water and South East Water via the Thames to Southern Transfer T2ST. The final output from the regional modelling is needed to better define and quantify how much each company could benefit from the STT solution. The prioritisation and commercial models will be negotiated in Gate 3 once the final regional and company plans are adopted.

1.6 GATE 1 OUTPUTS

The outputs from the SEA assessment in Gate 1 (SEA output tables) followed the same format as the SEA assessment undertaken by WRSE in the development of its Regional Plan. This approach facilitated the

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

[19] Ofwat (2020) draft Water Resources Planning Guideline (WRPG): Working Version for Water Resource Management Plan 2024

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

[21] Ofwat 3 April 2020. Strategic Regional Water Resource Solutions: Gate one assessment. Letter issued via email to Regulatory Directors of companies with strategic regional water resource solutions. [note incorrect date of April 2019 is stated on the front page of this letter)

adoption of the environmental assessment information from the STT solution into the Regional Plan, especially since WRSE used the SEA output tables to generate the environmental metrics for the Regional Plan.

With elements of the STT solution having been refined from those considered in Gate 1, a re-assessment of these amended elements has been undertaken for the WRSE Regional Plan, including the development of updated environmental metrics. The updating of the SEA output tables produced in Gate 1 will help to satisfy this requirement and can also be incorporated into the water company WRMPs being developed along similar timescales.

In particular, as SROs moves through the RAPID gated process and the level of design and environmental understanding increases, the environmental assessment process develops from strategic through to a more project specific assessment. In this context, at Gate 2, SROs are at a conceptual design stage meaning that more detailed assessment is possible than for Gate 1; however, the level of design information will still be much less detailed than that available at the consenting/Environmental Impact Assessment (EIA) stage.

1.7 PURPOSE AND SCOPE OF THE IEA

The purpose of Gate 2 is to refine the Gate 1 activities to improve the detail and breadth of feasibility studies and to develop concept solution designs with reduced uncertainty in costs and benefits. With respect to environmental assessment, SRO schemes are to be developed to a standard suitable for submitting into final Regional Plans and / or final WRMPs.

The Initial Environmental Appraisal (IEA) of the STT solution at Gate 2 (this report) is an overarching document, pulling together various workstreams and providing an overview of key results and findings. The IEA draws upon the separate regulatory reports being produced (as well as the supporting Environmental Evidence and Assessment reports):

- *STT-G2-S3-122-Water Framework Directive (WFD) Assessment;*
- *STT-G2-S3-121-Informal Habitats Regulation Assessment (HRA);*
- *STT-G2-S3-116-INNS Assessment;*
- *STT-G2-S3-118-Natural Capital & Biodiversity Net Gain (England) Assessment*; and
- *STT-G2-S3-119-Ecosystem resilience, wellbeing & Sustainable Management of Natural Resources (SMNR) (Wales) Assessment).*

The IEA provides a summary of other relevant workstreams, signposting to where further information can be found if published at Gate 2, such that the report acts as a standalone document that can be read to understand the environmental risks and opportunities of the solution proposed at Gate 2.

As the Gate 2 submission does not form a statutory plan or project, there is no statutory SEA required to be undertaken for Gate 2; however, the Gate 2 guidance[22] does states that "*some SROs may require an SEA, in particular where they are forming a plan or programme of works. Legal advice should be sought by the water company to determine the need for a statutory SEA*." This report is prepared on the basis that there is no requirement for a formal SEA for the STT solution at Gate 2.

Having regard to the maturity of the design of the SRO, which is still at feasibility and concept design stage in Gate 2, the environment assessment undertaken in Gate 2 comprises an initial high-level appraisal, although this appraisal is cognisant of the likely EIA requirements at Gate 3.

Some aspects of the SEA and EIA are common to both requirements, including consideration of similar environmental topics as set out in Schedule 2 of the SEA Regulations[23] and Schedule 4 of the EIA Regulations[24]. The structure of the IEA report has regard to these common topic areas.

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

[23]Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment ("SEA Directive")

[24]Directive 97/11/EC amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment ("EIA Directive")

2. APPROACH TO THE IEA

2.1 OVERVIEW AND CONTENT OF THE IEA

2.1.1 Background to the IEA

In April 2022, RAPID produced final guidance as to the expectations of the regulators for solution submission at Gate 2[25]. This guidance indicates a change in approach from the original Gate 2 guidance and the ACWG methodology, which both envisaged a SEA approach, to an IEA report. As a result, a proposed scope of the STT solution IEA was developed in early 2022 (referred to as the IEA Methodology[26]) which had regard to the Gate 2 guidance. The STT IEA has also reflected on comments made by the regulators on the STT Gate 1 submission, plus RAPID's recommendations and actions contained in its Gate 1 final decision on the STT solution[27].

As mentioned, the IEA is intended as a summary of the STT workstreams and environmental assessments undertaken. Section 2.1.2 signposts where the various requirements of the Gate 2 guidance are covered in this IEA.

The Gate 2 submission does not form a statutory plan or programme and therefore there is no statutory requirement for SEA. However, as with Gate 1, it is recognised that the SEA approach can assist in the identification of potential environmental effects (positive and negative) as well as mitigation and enhancement measures and aid option refinement and selection. These outputs help identify potential environmental risks and opportunities, mitigation measures as well as data gaps and uncertainties.

The structure and scope of the IEA has regard to the environmental topic areas as identified in both the SEA and EIA regime and Gate 2 RAPID guidance. The topics included are Biodiversity, Soil and Land Cover, Water, Air, Climate, Landscape and Visual Amenity, Historic Environment, Population and Human Health and Material Assets. Additional topics (Noise, Transport) are considered through impacts on sensitive biodiversity and human receptors. In line with the IEA Methodology, the IEA undertaken in Gate 2 comprises an initial high-level appraisal, but is cognisant of the likely EIA requirements at Gate 3.

A summary of the baseline environment is provided in Section 5 with reference to relevant work completed during Gate 2 and the additional evidence base available across the STT solution. The key sensitive receptors across each SEA/EIA topic are defined in Section 5.2 following the baseline review.

For Gate 2, the Interconnector Options Appraisal[28] and the Vyrnwy Bypass Options Appraisal[29] are considered within this report to help inform and determine the key environmental positive and negative effects. The Netheridge discharge diversion and Mythe licence transfer are covered separately in the ST Sources SRO IEA Report[30]. Within Section 6, the effects identified from the Gate 1 SEA output tables have been reviewed, alongside an update of activities and pathways for impact, to help determine areas where design refinements and optimisation at Gate 2 are to be considered further, and to help develop further mitigation and enhancement measures to be embedded within the detailed design. Where additional work is required to further develop these mitigation measures, the necessary investigations and studies have also been identified. Following the review of potential effects and existing uncertainty around the proposed additional mitigation measures, an overall risk rating has been applied to each effect. The risk assessment uses a "traffic light" red / amber / green (RAG) system to display the findings of the assessment. The risk scoring used is provided in Table 2-1.

[25] RAPID, April 2022, Strategic regional water resource solutions guidance for gate two

[26] Ricardo Energy and Environment, March 2022, Severn Thames Transfer SRO Gate 2 Methodology Report: Initial Environmental Appraisal

[27] Regulators' Alliance for Progressing Infrastructure Development, 21 December 2021, Strategic regional water resource solutions: Standard gate one final decision for River Severn to River Thames Transfer

[28] Mott Macdonald (2022) STT-G2-S3-301-Interconnector Route Options Appraisal

[29] Jacobs (2022) STT-G2-S3-333-River Vyrnwy bypass pipeline - Options Appraisal

Table 2-1 Risk RAG Scores

Risk Score	Description
Red	Effect is a major/moderate environmental constraint and is likely to be challenging to overcome; significant additional mitigation required; there is significant current uncertainty surrounding understanding of effect and/or scope/effectiveness of additional mitigation measures, will require extensive further investigations to improve understanding.
Amber	Effect is a major/moderate environmental constraint, but with known or commonly applied mitigation measures effect will be overcome; mitigation will potentially be extensive; likely to require further studies and investigations to improve understanding of effect and refine mitigation measures.
Green	Effect is a negligible or minor constraint or is easily mitigatable with best practice measures and currently defined mitigation or minor additional mitigation requirements.

Enhancements and opportunities are considered within Section 4.5.

Section 8.1 provides a summary of the proposed plan of work for Gate 3 required to address remaining data gaps and uncertainties. The proposed scope has been developed to address the likely requirements for planning consent.

To facilitate the environmental appraisal of the STT solution being developed to a level suitable for submitting into final regional plans or final WRMPs, the SEA output tables produced in Gate 1 have been updated for the Gate 2 design using the same methodology, objectives and presentational format. The SEA tables are provided in **Annex A**.

2.1.2 Information informing the IEA

The Gate 1 STT SEA assessment recognised that there were still a number of uncertainties and risks that need to be managed, and that further iterations of the assessment are required as more detailed information and assessment work becomes available during the gated process. The Gate 1 SEA assessment recommended that the Gate 2 work should include the consideration of the recommended *further* mitigation measures as well as confirming the effectiveness of the embedded mitigation measures identified within the Gate 1 matrices.

In this context, the environmental appraisals have been updated in Gate 2 as more detailed design and mitigation information is now available. These appraisals cover the physical environment, water quality, fish, invasive species, protected species, protected habitats, macroinvertebrates and other ecology. In addition, updated HRA, WFD, NCA, BNG and SMNR assessments have been undertaken and have fed into this IEA.

Table 2-2 illustrates how the further survey work, studies and assessments help inform the development of the concept designs, mitigation measures and the IEA.

The assessment uses qualitative and/or quantitative information where this is available (such as identified by the HRA or WFD assessment process, conceptual design information, and/or public domain datasets including GIS datasets). The appraisal is at a strategic level and makes use of spatial analysis, professional judgement and applicable assessment guidelines relating to that topic/objective.

2.1.3 Specific requirements of the Gate 2 Guidance

The Gate 2 guidance states that the submission should be supported by an annexed IEA report that addresses the following:

- An update of the Gate 1 work where relevant
- The environmental appraisal work undertaken to date – likely to be at a strategic scale.
- Baseline and analysis – this might include results of monitoring, modelling, environmental surveys, etc.
- Options assessment, with sufficient detail to allow comparison of options within the solution and identify potential effects (positive and negative) and opportunities.
- Assessment of the effects of the solution, an evaluation of their significance and any cumulative or in-combination effects.

- Clear justification as to options within the solution discounted, those taken forward, and the preferred option selected. Where the preferred option is identified, potential environmental effects and opportunities should be discussed.
- The appraisal work should include consideration of resilience (e.g., climate change,)
- A description of the connection to other assessments (e.g., biodiversity net gain, WFD, natural capital, carbon) and demonstrate how they have been considered within this initial appraisal work.
- Development of mitigation and enhancement opportunities.
- Any future monitoring requirements of the identified environmental effects and efficacy of any included mitigation measures.
- A plan to address uncertainties and data gaps.

As stated in the guidance, and at the request of the regulators, these items are summarised within the IEA as shown in Table 2-2. A number of elements identified in the Gate 2 guidance document are assessed in detail through other STT workstreams outside the environmental assessment work and Table 2-2 signposts where in this IEA report these items are covered.

Table 2-2: Gate 2 IEA Requirements

Gate 2 Guidance Requirements	Compliance Check List
An update of the Gate 1 work	Detailed throughout e.g., within Section 3: Options Appraisal
The environmental appraisal work undertaken to date	Section 3: Options Appraisal and Section 4: Regulatory Reports
Baseline and analysis	Section 5: Environmental Baseline
Options assessment	Section 3: Options Appraisal and Section 6: Assessment The IEA includes a summary of options appraisals and signposting to specific options appraisal reports produced by Jacobs and Mott MacDonald. A summary of reasons for phasing decisions/optimisation is included in Section 1.3, and the environmental appraisal approach used during options appraisal is provided in Section 3.
Assessment of the effects of the solution	Section 6: Assessment
Preferred options selection	Section 3: Options Appraisal and Section 6: Assessment The IEA includes a summary of environmental input and appraisal approach to the options appraisal for Vyrnwy Bypass, Shrewsbury, Deerhurst to Culham interconnector and signposting to specific options appraisal reports produced by Jacobs/Mott MacDonald. The IEA also includes a summary of environmental effects and opportunities of preferred routes selection signposting to specific options appraisal reports produced by Jacobs/Mott MacDonald.
Consideration of resilience	Section 5: Baseline and Section 6: Assessment Section 4.2 of the main STT Gate 2 report summarises the results of the Pywr system model which showed that the deployable output for the unsupported elements of the STT solution account for climate change impacts and are therefore considered to be resilient to climate change. The availability of the supported elements has been tested for Lake Vyrnwy for climate change and the Minworth and Netheridge options are not impacted by climate change due to the nature of the source. The licence characteristics of the Mythe source means it is unaffected by climate change. Droughts in the Severn catchment and the Thames catchment will not always be coincident and therefore there is some resilience against droughts through this option.

Gate 2 Guidance Requirements	Compliance Check List
Description of the connection to other assessments	See relevant sections of Section 2: Approach to the IEA and Section 4: Regulatory reports
Development of mitigation and enhancement opportunities	Section 6.3: additional mitigation measures are identified in risk assessment process. Enhancement opportunities are described in Section 4.5.
Future monitoring requirements	Section 8.1: Next steps at Gate 3
Plan to address uncertainties and gaps	Section 8.1: Next steps at Gate 3

2.1.4 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 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.

2.2 CUMULATIVE EFFECTS AND IN-COMBINATION ASSESSMENT

Whilst the Gate 2 environmental appraisal is not a regulatory assessment, the requirement to assess cumulative effects is set out in the Rapid Gate 2 guidance[31]. The cumulative effects and in-combination assessment draws on the proposed approach outlined in the Gate 2 Environmental Appraisal - Cumulative effects methodology (December 2021) (referred to as the Cumulative effects methodology)[32], originally presented to the NAU for comment by the Thames Water SRO team in February 2022[33]. **Figure 2.1** presents a high-level overview of the approach taken.

[31] Rapid (Feb 2022) Strategic regional water resource solutions guidance

[32] Mott Macdonald (April 2022), Gate 2 Environmental Appraisal, Cumulative effects methodology

[33]The latest version of the note was circulated on 5 April 2022, with a subsequent meeting with the NAU Leads to formally agree its adoption for the SRO process.

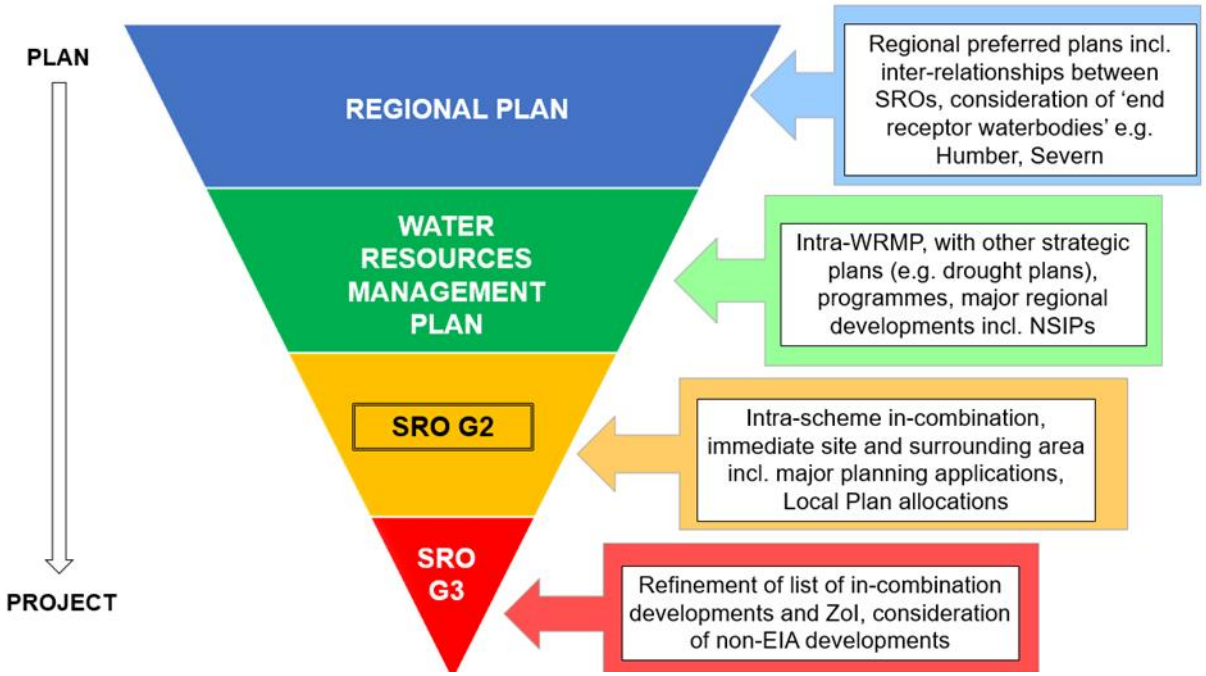

Figure 2.1 The proposed responsibility for completion of cumulative effects assessment: Regional Plans, WRMPs and SROs

In terms of SROs, the Cumulative effects methodology states that these will report the outcomes of the regional plan and WRMP24 in-combination and cumulative effects assessments (relevant to their SRO), where timing permits, and will not undertake any further assessment of the in-combination and cumulative effects of the SRO with the other SROs, plans or programmes identified in these assessments. It will be assumed that the Regional Plan and WRMP24 assessments have concluded no significant in-combination and cumulative effects at a plan level, enabling the SRO to progress. The SRO specific cumulative effects assessment will then look in further detail at the site and surrounding area in terms of local and site-specific information including large development allocations within Local Plans and larger applications such as Development Consent Orders (DCO), Transport and Works Act and Hybrid Bills.

At Gate 2, the SROs are at a conceptual design stage and, therefore, the level of design information is much less detailed than that available at the EIA stage. Furthermore, the appraisal that is presented in the IEA does not report on likely significant effects but rather potential environmental effects in terms of risks and opportunities and likely required mitigation. Therefore, a full cumulative effects assessment, as would be reported in an EIA, is not appropriate for Gate 2, but rather the focus is on identification of risks due to potential cumulative effects of SROs with other plans and projects that will need to be addressed at future gates and for which additional mitigation may be required.

As per the hierarchy shown in **Figure 2.1**, the SRO cumulative effects assessment at Gate 2 focuses on the larger and longer-term developments that could combine with the SRO to cause an additional or different effects on receptors and will be undertaken for the whole of an SRO scheme regardless of consenting route.

The first step is to identify the other plans and developments to be considered by establishing a zone of influence (ZOI) for each topic, using GIS, to determine the maximum area within which other developments and plans will need to be identified. **Table 2-3** provides indicative ZOIs per topic[34].

Table 2-3 Environmental topics and Zone of Influence

Environmental topic	Zone of influence explanation
Air quality	**Construction:** 350m ZoI from anticipated construction activities for effects relating to construction dust and emissions. **Operation:** 1km ZoI for construction and operational traffic effects.

[34] Mott Macdonald (April 2022), Gate 2 Environmental Appraisal, Cumulative effects methodology

Environmental topic	Zone of influence explanation
Biodiversity, flora and fauna	2km ZoI for both construction and operational effects on national statutory designated sites which will be extended where impacts extend beyond this e.g. where there is a SSSI impact risk zone. 1km ZoI for both construction and operational effects on habitat and non-statutory designated sites which will be extended where impacts extend beyond this. Habitats Regulations Assessment to define ZoI for internationally designated sites.
Historic environment	500m ZoI for both construction and operational effects on the significance of designated heritage assets. 200m ZoI for both construction and operational effects on the significance of non-statutory heritage assets.
Landscape	**Construction and operation:** 1km ZoI for both construction and operational effects on landscape.
Material assets	**Construction and operation:** 200m ZoI for both construction and operational effects.
Noise	**Construction and operation:** 600m ZoI from anticipated construction activities as a worst case.
Population and human health	**Construction and operation:** 500m ZoI for assessing impacts on community assets with considering to effects outside of the 500m area where these are likely to occur.
Soils	**Construction and operation:** A 200m ZoI for both construction and operational effects.
Transport and access	**Construction and operation:** A 1km ZoI for both construction and operational effects which will be extended where impacts extend beyond this.
Water	**Construction and operation:** 1km ZoI for flood risk which will be extended where impacts extend beyond this. Water Framework Directive Assessment to define ZoI for water resource (flow and quality) for construction and operational effect.

2.2.1 Cumulative effects assessment with other plans and developments

As per the Cumulative effects methodology, it is assumed that the Regional Plan will have been subject to an in-combination effects assessment with SROs, and that the WRMPs will be subject to a cumulative effects assessment with adopted and emerging Development Plans, therefore, these have been excluded from the SRO-specific cumulative effects assessment at Gate 2 with the exception of large existing and emerging site allocations. Other confirmed investments by water companies at sites that form part of the SRO options are also considered.

Therefore, the list of other developments and plans considered for this IEA are:

- Large existing and emerging Local Plan allocations e.g., 500 or more dwellings.
- Projects on the Planning Inspectorate's Programme of Projects.
- Hybrid Bills e.g., HS2 Phase One.
- Transport and Works Act Orders for large-scale transport infrastructure.
- Minerals and waste applications, including for landfill and energy from waste.
- Large Town and Country Planning applications where an EIA is required.

Initially, the list of other plans and developments, and a schedule has been developed providing information for each development including location information, planning status, and programme for construction / operation to determine if there is an overlap in temporal scope and which receptors have potential to experience effects from both the SRO and the other development. This allows the potential for cumulative effects of two or more developments to be identified by virtue of overlaps in temporal or geographical scope or due to the scale and nature of the 'other development' / receiving environment, and whether these could require additional mitigation. The intention is to identify interactions of construction and/ or operational effects between developments. This information has not been collected to inform route and/or site selection decisions. Therefore, developments that are likely to be completed prior to construction commencing on the SRO will be excluded from a cumulative effects assessment, as they will instead become part of local, environmental baselines against which broader environmental assessment will be undertaken.

Potential SRO-specific cumulative effects are reported within this IEA together with any proposed mitigation measures (including how the mitigation could be secured and delivered).

It is noted that as the RAPID process progresses and the scheme is refined at Gates 3 and 4, the topic ZOIs will need to be reviewed and updated as necessary. As the ZOIs change, data collection on 'other developments' will therefore also be reviewed and updated ahead of a future EIA Scoping Opinion request.

The list of developments for the EIA-stage cumulative effects assessment will also need to be reviewed and updated, for example, consideration given to applications for National Significant Infrastructure Projects (NSIPs) under the Planning Act (2008) and for major developments under The Town and Country Planning Act (TCPA) (1990).

2.2.2 Inter-relationships between effects

There is no standard approach to the assessment of interrelationships between effects. Effects are very rarely additive, but rather a collection of impacts on a receptor that need to be drawn together. Consideration also needs to be given to the potential for 'synergistic' effects whereby different types of impact affecting a receptor may interact together and increase their effect.

A receptor-based approach to the assessment of interrelationships between effects is set out below.

- Step 1: Identify receptor types (e.g., community, ecological habitat or species, a heritage asset, landscape feature or natural feature, waterbody, or watercourse) and geographical locations.
- Step 2: Identify receptors and their geographical location.
- Step 3: Screen out receptors where there is no potential for interrelationships between effects or temporal overlap of impacts, or where impacts are anticipated to be negligible.
- Step 4: Assess interrelationships between effects at remaining receptors and report on a receptor basis (within geographical areas) appropriate to the effects identified.

It is considered that climate change can be scoped out of the assessment of interrelationships between effects as topic-specific climate change effects will be considered through topic assessments (and be carried through to the cumulative assessment if appropriate), with no separate input to the cumulative assessment required for the climate change topic. Carbon effects are not location specific within the anticipated ZOI for the SROs and do not interact with other environmental effects. Climate change effects will be appropriately considered in scoping of the future EIA.

3. OPTIONS APPRAISAL

3.1 APPRAISALS COMPLETED

This section provides an overview of the work undertaken thus far on the elements comprising the STT solution. Please note that the appraisal of the ST Sources SRO covering the Netheridge WwTW discharge diversion, Haw Bridge pipeline scheme and the Mythe abstraction licence transfer scheme are documented in the ST Sources IEA.

3.1.1 Interconnector

The STT Interconnector Options Appraisal is summarised below[35]. For further information refer to the *STT-G2-S3-301-Interconnector Route Options Appraisal* report [36].

3.1.1.1 Option Appraisal Overview

The overarching objective for the STT Interconnector Gate 2 Options Appraisal is to identify a preferred STT Interconnector solution that would provide a resilient water supply to the Southeast of England. The preferred option is to be technically feasible and deliver best value to water company customers, where best value is considered to balance:

- Environmental and social impact
- Resilience
- Cost (including engineering risk and procurement / delivery complexity)
- Potential to deliver biodiversity net gain
- Other social and environmental benefits that would be delivered by the scheme

This Options Appraisal also seeks to consider whether synergies with other schemes, particularly restoration of the Cotswold Canals, could deliver additional benefits or cost savings through an integrated multi-sector approach.

The approach to option appraisal and best value is aligned with National Framework and WRPG requirements for water resource planning. STT solution options were put forward to the WRSE plan based on Gate 1 information - these included representative pipeline options of 300, 400 and 500 Ml/d capacity and a representative option that utilised the Cotswold Canals corridor with a capacity of 300 Ml/d. The Options Appraisal states that the WRSE plan will evaluate all water resources options in the region, determine a best value plan and set out the options that will be needed to solve the predicted water resources needs to the year 2100.

This STT interconnector option appraisal study focused initially on 300 Ml/d interconnector options; however, the impact of a long term need for a higher capacity transfer should also be considered and has therefore been included at the validation stage in the potential future scenarios.

To summarise the above, the objectives of this study were as follows:

● Identify a preferred STT Interconnector solution for the Gate 2 submission that would increase water supply to the Southeast of England

● Appraise the options to identify the best value solutions, taking account of wider benefits

● Consider potential synergies with other schemes that could deliver additional benefits or cost savings through an integrated multi-sector approach

● Consider a range of transfer capacities in line with those being considered by WRSE The Options Appraisal aligned with best practice as shown in Figure 3.1.

[35] Schematics from Mott Macdonald (2022), PowerPoint Presentation - STT Options Appraisal v0.1_EA Methodology Meeting 240322
[36] Mott MacDonald (2022), STT Interconnector Gate 2 Options Appraisal Report Rev F

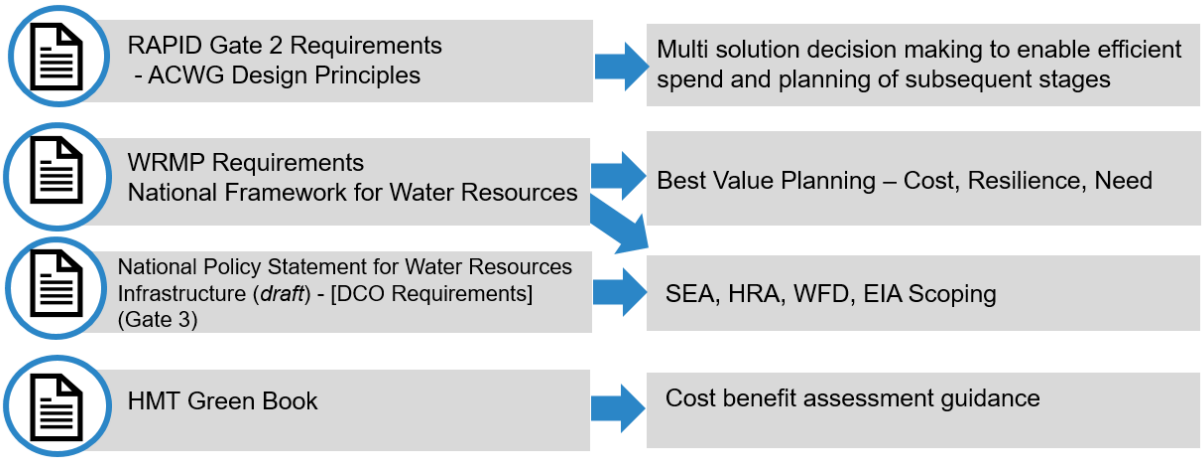

Figure 3.1 Schematic showing the Options Appraisal alignment with best practice

The Gate 2 interconnector option appraisal methodology consisted of three stages:

- Longlist - At the long list stage the study area was defined, and the components of potential options (such as pipelines or treatment facilities) were identified for appraisal.
- Shortlist - At the short list stage, the components were combined into full transfer options and appraised in greater detail.
- Validation - Following the short list appraisal, a validation stage considered a range of potential future scenarios and allowed further consideration of potential benefits to be assessed.

The longlist and shortlist stages focused on a 300Ml/d capacity transfer for water supply, whereas the validation stage considered a range of potential futures that included consideration of larger capacity transfers and integration of the water supply scheme with restoration of the disused Cotswold Canals for boat navigation.

Longlist appraisal was undertaken against qualitative environmental impact and engineering criteria. Shortlist appraisal considered both costs and benefits, in a monetised and non-monetised assessment.

Rejection reasoning was developed for all options that were not taken forward to the next stage of the assessment. This multi-phased approach allowed for a staged review of the options with an increasing level of detail and assessment at each stage.

3.1.1.2 The high-level summary of the option appraisal process.

The study area is primarily defined by the reaches of the River Severn that can be used for abstraction, acceptable locations for the discharge into the River Thames and the topography of the Cotswold Hills.

The development of the options from longlist to shortlist to Preferred Option is shown in Figure 3.2. Longlist appraisal was undertaken against qualitative environmental impact and engineering criteria. Shortlist appraisal considered both costs and benefits, in a monetised and non-monetised assessment.

Long-List Option Identification involved defining the search area considering topography, urban areas and environmental constraints as shown in the schematic below. The constraints defined the study area shown in Figure 3.3.

Multiple components that comprise a single interconnector option were identified as shown in Figure 3.4.

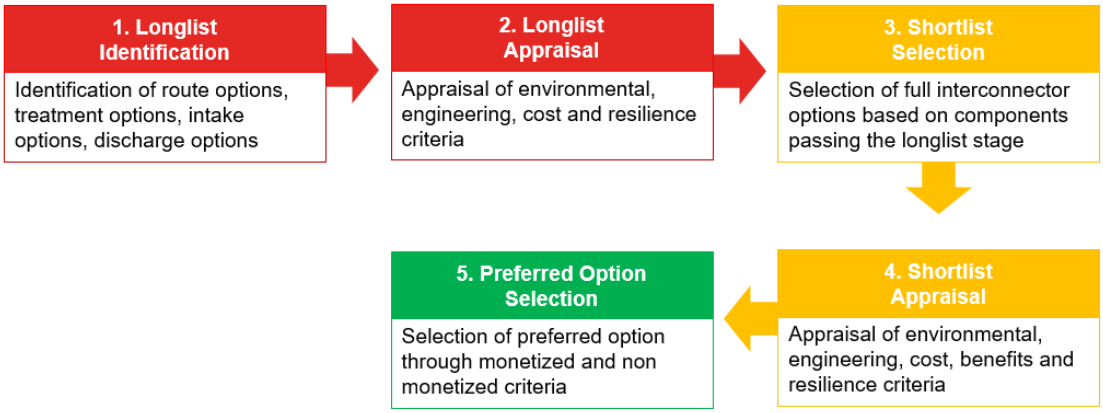

Figure 3.2 Schematic showing the development of the options from longlist to shortlist to Preferred Option

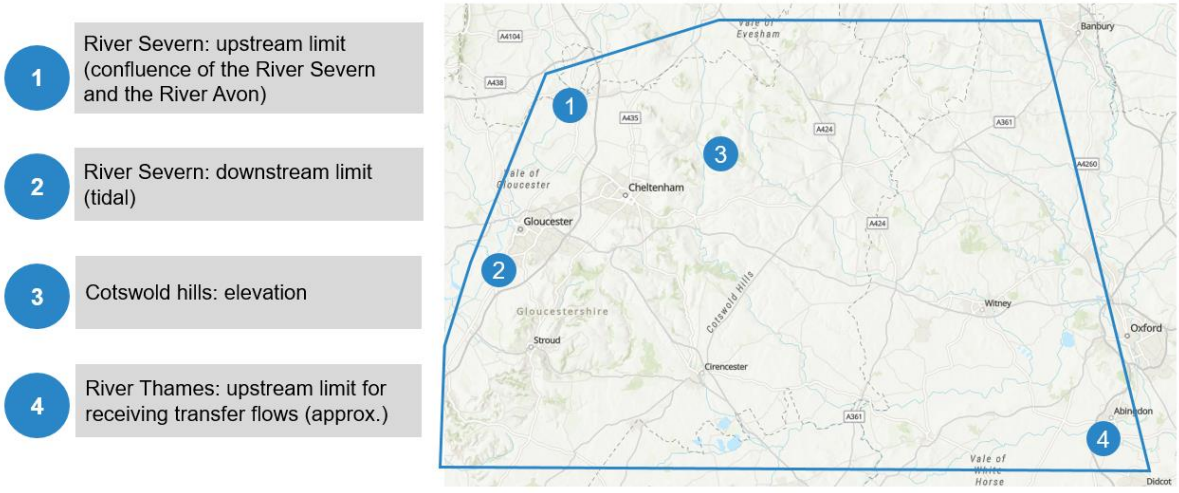

Figure 3.3 Schematic showing the Options Appraisal alignment with best practice

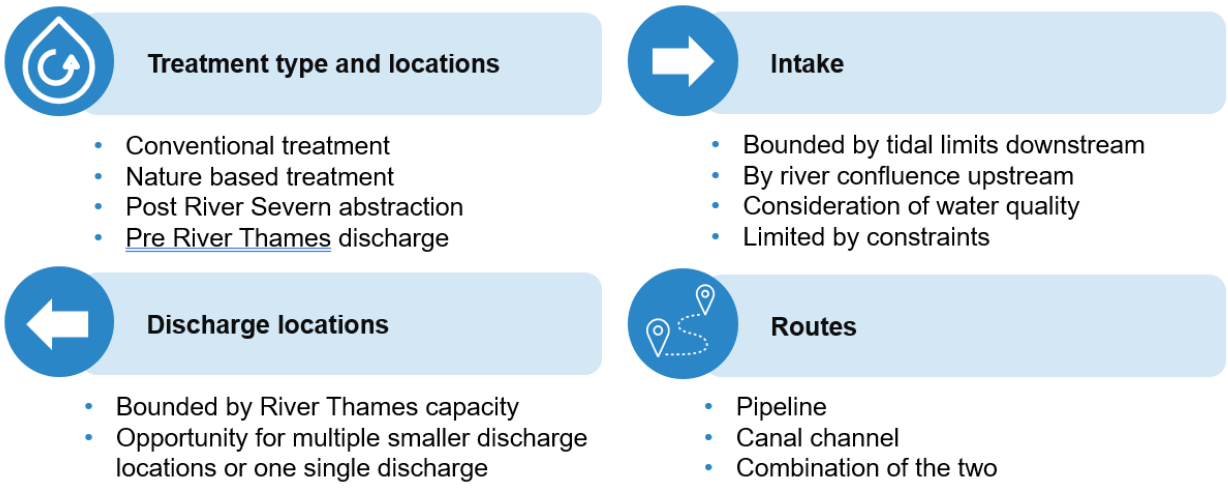

Figure 3.4 Schematic showing the multiple components that comprise a single interconnector option

3.1.1.3 Identification of Long list options – Routes.

Various longlist route options comprising the pipeline, canal and combinations of the two were reviewed and refined as shown in **Figure 3.5.**

The option components, Abstraction and discharge locations, Treatment, Break pressure tanks and Route (i.e. pipeline, canal or combined), were considered at the long list stage and brought together to form full options at the short list stage. The components are summarised in Figure 3.6.

All options discharge to the River Thames at Culham. Options were developed and assessed against qualitative criteria; those that passed were considered for shortlist selection.

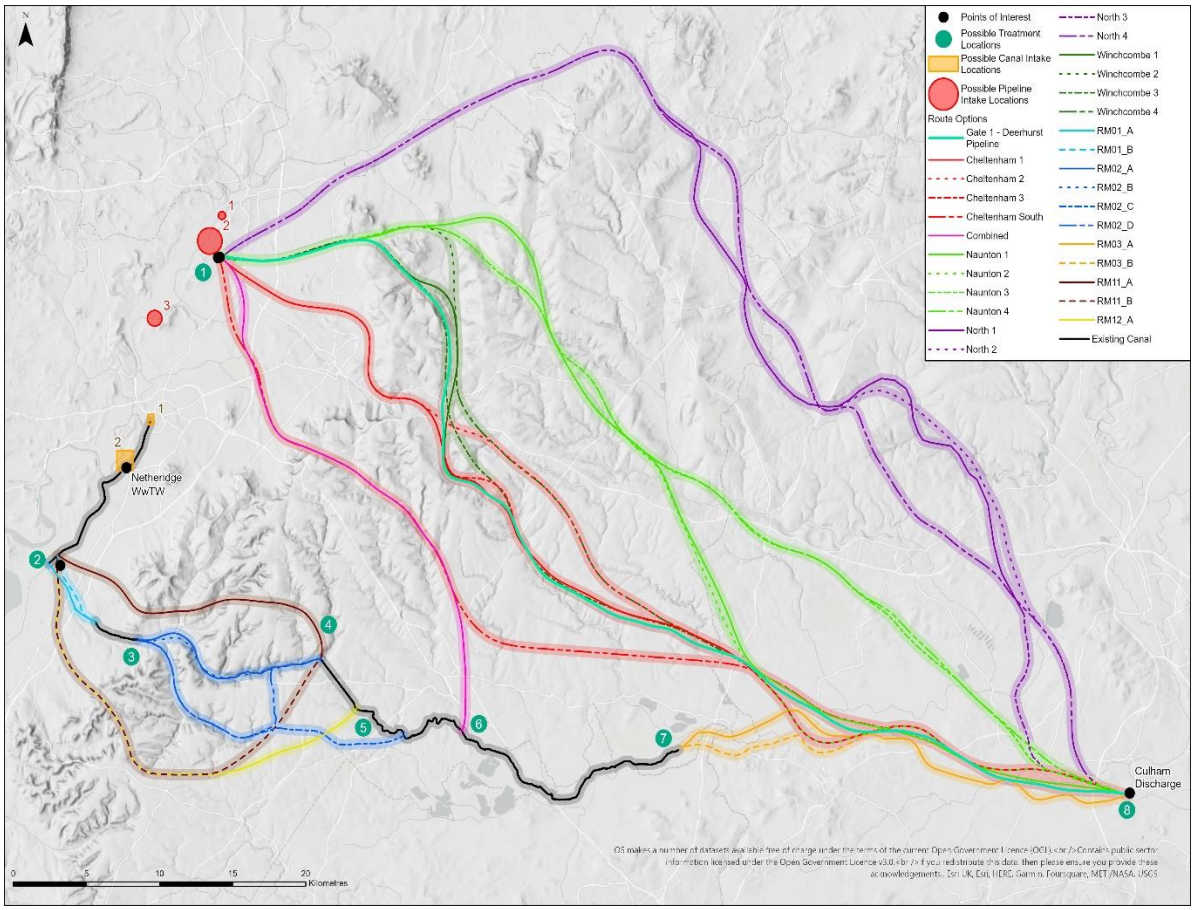

Figure 3.5 Indicative map of all long list options – Deerhurst to Culham Pipeline routes and Gloucester Docks to Culham with the Gloucester and Sharpness Canal

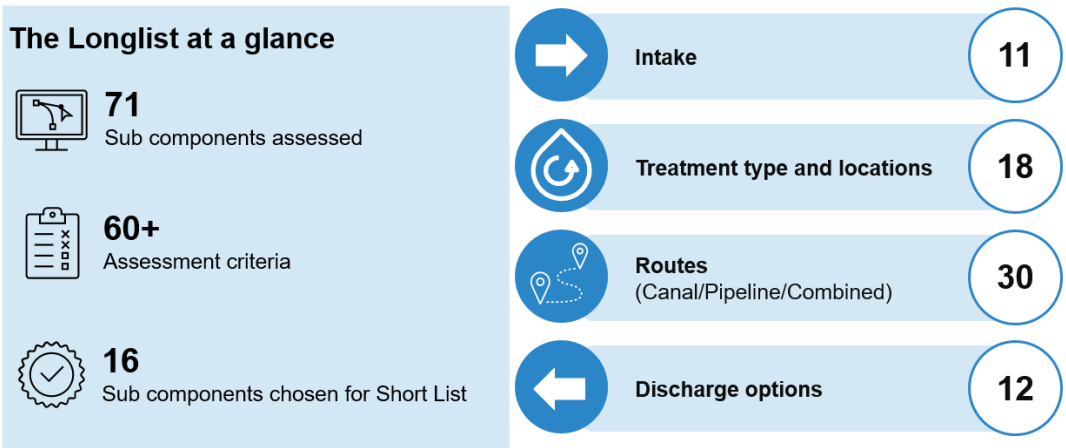

Figure 3.6 Summary of the options components

3.1.1.4 Longlist appraisal: Developing preferred transfer components

Generic routes, treatment and location options were assessed against critical success factors. A Red Amber Green (RAG) assessment was carried out on these subcomponents which were assessed against environmental, social, engineering, cost and resilience criteria. The preferred subcomponents were then identified with detailed rejection reasoning. The Green Book guidance on assessing options against high level success factors was used.

Table 3-2-3.5 from the Options Appraisal report summarise the Engineering, Socio-economic and Cost RAG scoring as well as the Environmental RAG assessment for the pipeline and canal routes. Further details and assessment tables are available in the Options Appraisal report.

Options that were not selected were recorded in a rejection register and a shortlist of options was identified using a matrix of preferred components that had passed the longlist stage.

Four direct pipeline options passed the longlist appraisal and could have been included on the shortlist. They were technically similar and, therefore, one of the four options was selected to represent this option type in the shortlist assessment. This approach ensured that the Stage 2 shortlist assessment was focussed on the fundamental differences between options such as different intake locations or use of pipelines vs open water transfer rather than comparing options that are generically similar.

Three shortlist options were identified that would reconstruct sections of the Cotswold Canals for open water transfer. The canal route cannot be used for the whole transfer as the two rivers are separated by the Cotswold hills and the canal corridor drops away from the summit pound towards each river. Therefore, the canal-based options include pumped pipelines to transfer water uphill as appropriate. The four shortlisted options are shown in **Figure 3.7**.

3.1.1.5 Shortlist appraisal: Identifying the preferred transfer option

A range of full interconnector options was selected based on feasibility, cost and appraisal. These options were reviewed against Critical Success Factors. Monetised costs of each option were assessed for capital expenditure (CAPEX) and operational expenditure (OPEX) and Carbon and Monetised benefits were assessed for Recreation (Angling, Canal and Land value) and Environment (Carbon Sequestration, Agriculture Value and Flood risk reduction). A qualitative RAG assessment was carried out against environmental and resilience criteria to inform identification of the preferred full option.

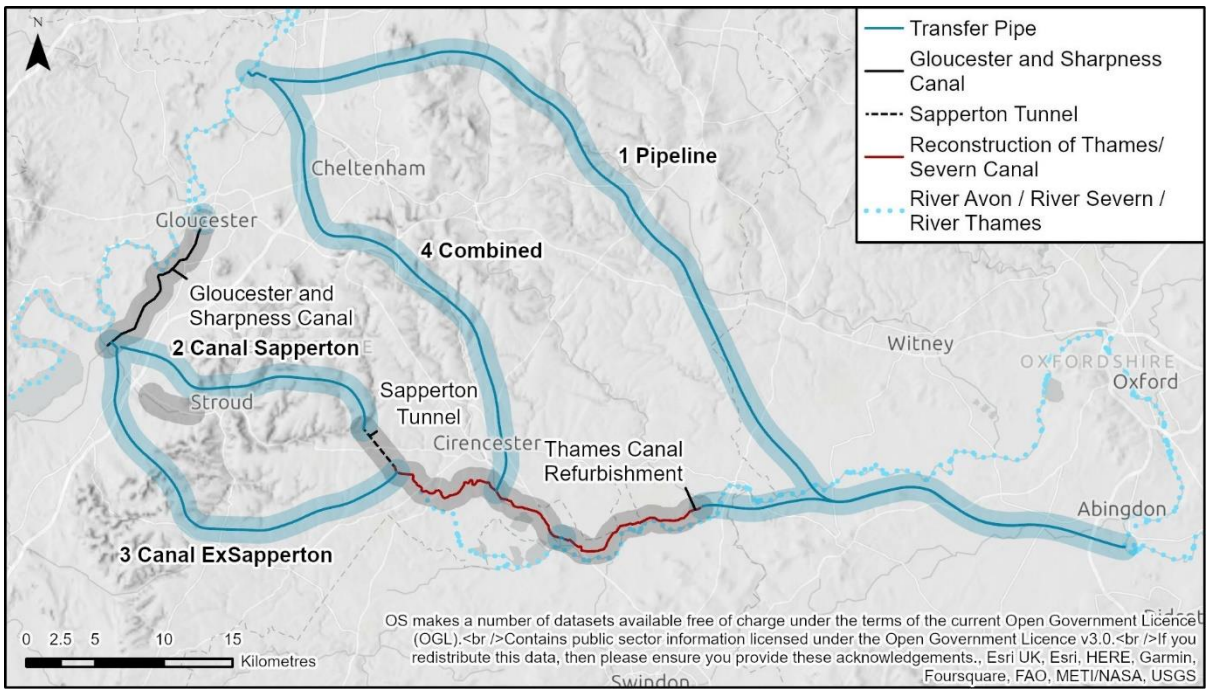

Figure 3.7 Map showing indicative shortlist options

Table 3-1: Summary of shortlist options

Option	Inlet Location	Treatment Location & Approach
Option 1 Pipeline	Deerhurst	Deerhurst (conventional treatment)
Option 2 Canal Sapperton	Gloucester Docks	Gloucester Sharpness (conventional treatment) + Active monitoring of INNS in the Thames & Severn Canal section
Option 3 Canal Excl. Sapperton	Gloucester Docks	Gloucester Sharpness (conventional treatment) + Active monitoring of INNS in the Thames & Severn Canal section
Option 4 Combined	Deerhurst	Deerhurst (conventional treatment)

3.1.1.6 Preferred option selection

The selection of the best value option was carried out by a qualitative assessment. The net present cost was identified by comparing total present costs and total present benefits (monetised benefits) which allowed comparison between option types. The comparison between options was then based on qualitative assessment status and resilience scores. This allowed a holistic appraisal of best value options based on cost and wider environmental and societal impacts.

The qualitative environmental screening of the shortlist options for the conveyance of water from the River Severn to the River Thames adopted a RAG system to display the findings of the assessment and to demonstrate how each option performs against the assessment criteria. The supporting shortlist qualitative Environmental RAG table is included in **Table 3-6**.

Based on the assessment results, Option 1 Pipeline, which would transfer water from the River Severn to the River Thames through a direct pipeline from Deerhurst to Culham, was chosen as the preferred option to deliver a 300Ml/d water supply transfer.

The option was selected for the following reasons:

- Option 1 has the lowest Net Present Cost (including monetisation of benefits) of the four shortlisted options and there is a 26% difference between this option and Options 2 or 3, the next lowest net present cost options. The option also has the lowest capital and operating costs, although it does not deliver any recreational benefits unlike the canal based alternative options.
- Option 1 also performed better overall in the qualitative assessment:
  - The option was assessed to have the highest water supply resilience with fewer assets in series, a single operator and minimal public access to the transfer infrastructure.
  - The option had no major environmental constraints and scored more favourably in criteria relating to the impact of INNS from construction and operation of the option, and the amount of flood zones 2 and 3 impacted by the option.
  - In contrast with options that reconstruct canal pounds for open water transfer, the direct pipeline option did not provide opportunities for enhancement of tourism and recreation, however, it is noted that the shortlisted canal options would only deliver the canal restoration needed for transfer and therefore the opportunities associated with these options are also limited.

Table 3-2: Engineering and Socio-Economic RAG scoring for Deerhurst to Culham Pipeline Route Options

		Engineering Construction		Engineering Cost						Engineering Operation	Resilience		Cost		
No.	Name	Access during construction	Buildability	Length (km)	No. of major crossings	Length with narrow working width (<50m) (km)	Length of trenchless excluding crossings (m)	Static lift (m)	Power (MW)	Access during operation	Resilience- vulnerability to other failure modes	Operational Complexity	CAPEX	OPEX	CAPEX+ OPEX
1	Deerhurst	R	A	86	34	9	590	211	12.3	G	A	G	100%	100%	100%
2	Cheltenham 1	A	A	85	27	7	1070	188	11.6	G	A	G	90%	94%	91%
3	Cheltenham 2	A	G	82	24	4	700	227	13.1	G	A	G	87%	106%	93%
4	Cheltenham 3	A	A	85	24	5	1070	223	13.1	G	A	G	93%	106%	97%
6	Naunton 2	A	G	85	23	5	130	229	12.9	G	A	G	87%	105%	92%
7	Naunton 3	A	G	80	29	5	130	229	12.9	G	A	G	84%	105%	90%
9	Winchcombe 1	A	G	89	28	8	960	225	12.9	G	A	G	97%	104%	99%
10	Winchcombe 2	R	G	92	28	8	750	224	13.0	G	A	G	98%	104%	100%
12	Winchcombe 4	A	G	84	22	6	350	225	12.7	G	A	G	93%	103%	96%
14	North 2	A	G	102	40	3	500	146	9.8	G	A	G	139%	80%	121%
16	North 4	A	G	100	35	1	310	171	11.4	G	A	G	128%	92%	117%
18	Combined Pipeline	A	G	41	24	1	120	250	17.5	G	G	G	N/A	N/A	N/A

Table 3-3: Environmental RAG assessment for Deerhurst to Culham Pipeline Route Options

		Environmental - Impact										
No.	Name	Biodiversity- Flora and Fauna	Biodiversity Net Gain	Soil	Water- flood risk	Water resources	Air	Historic Environment	Landscape	Human Health	Population- recreation	Population- economy
1	Deerhurst	R	R	A	A	A	G	A	A	A	A	A
2	Cheltenham 1	R	A	A	A	A	R	A	A	A	A	A
3	Cheltenham 2	A	A	A	G	G	R	A	A	A	A	A
4	Cheltenham 3	A	A	A	G	G	R	A	A	A	A	A
6	Naunton 2	A	A	A	G	G	A	A	A	A	A	A
7	Naunton 3	A	A	A	G	G	A	A	A	A	A	A
9	Winchcombe 1	R	A	A	A	A	A	A	A	A	A	A
10	Winchcombe 2	R	A	A	A	A	A	A	A	A	A	A
12	Winchcombe 4	A	A	A	G	G	A	A	A	A	A	A
14	North 2	R	R	A	G	G	A	A	A	A	A	A
16	North 4	R	R	A	G	G	A	A	A	A	A	A
18	Combined Pipeline	A	A	A	G	A	A	A	A	A	A	G

Table 3-4: RAG Engineering, Socio-Economic and Cost Assessment for Canal Pipeline options

		Engineering Construction		Engineering Cost						Engineering Operation	Resilience		Cost		
No.	Name	Access during construction	Buildability	Length (km)	No. of major crossings	Length with narrow working width (<50m) (km)	Length of trenchless excluding crossings (m)	Static lift (m)	Pumping Head (m)	Access during operation	Resilience- vulnerability to other failure modes	Operational complexity	CAPEX	OPEX	CAPEX+ OPEX
1	RM01_A	A	G	5	4	0.17	0	23	32	G	A	G	100%	100%	100%
2	RM01_B	R	G	5	5	0.17	0	26	35	G	A	A	91%	110%	100%
3	RM02_A	R	R	15	26	7.56	1508	108	134	G	A	A	100%	100%	100%
4	RM02_B	R	R	24	10	17	3298	136	163	G	A	A	105%	100%	102%
5	RM02_C	A	A	24	7	*	*	253	272	G	R	A	142%	123%	132%
6	RM11_A	A	A	34	13	*	*	230	245	G	A	A	81%	165%	123%
7	RM11_B	A	A	34	11	*	*	230	245	G	A	A	99%	151%	125%
8	RM12_A	A	R	34	17	1.90	0	19	37	G	A	G	95%	151%	123%
9	RM03_A	A	A	34	11			230	245	G	A	A	100%	100%	100%
10	RM03_B	A	G	33	9	1.17	0	13	31.5	G	A	G	93%	82%	91%

* Not assessed at Gate 2: Longlist stage

Table 3-5: Environment RAG Assessment for Canal options

		Environmental - Impact										
No.	Name	Biodiversity- Flora and Fauna	Biodiversity Net Gain	Soil	Water- flood risk	Water resources	Air	Historic Environment	Landscape	Human Health	Population- recreation	Population- economy
1	RM01_A	G	A	A	R	G	G	A	G	G	G	G
2	RM01_B	G	A	A	G	G	G	A	G	G	G	G
3	RM02_A	A	R	A	A	A	G	A	R	A	A	G
4	RM02_B	A	R	A	A	A	G	A	R	A	A	G
5	RM02_C	R	R	A	G	A	G	R	R	A	A	G
6	RM11_A	A	G	A	G	G	G	A	R	A	A	G
7	RM11_B	A	A	A	G	G	G	R	R	A	A	G
8	RM12_A	A	A	A	G	G	G	A	R	A	A	G
9	RM03_A	A	A	A	A	G	A	A	A	G	A	A
10	RM03_B	A	A	G	G	G	A	A	A	G	A	A

Table 3-6: Shortlist Qualitative Environmental RAG Rating

		RAG Rating			
SEA Topic Area	**Criteria Considered**	Option 1 Pipeline	Option 2 Canal inc Sapperton	Option 3 Canal Ex Sapperton	Option 4 Combined
Nature Conservation and Biodiversity	Extent of construction and operational effects on European designated sites and their qualifying features (SPA, SAC, Ramsar)				
Nature Conservation and Biodiversity	Extent of construction and operational effects on nationally designated sites and their qualifying features (SSSI)				
Nature Conservation and Biodiversity	Extent of construction and operational effects on non-statutory designated sites (Ancient woodland, NNR) and priority habitats				
Nature Conservation and Biodiversity	Extent of construction and operational effects on invasive and non-native species (INNS)				
Land use and Soil	Extent of construction and operational effects on nationally designated sites and their qualifying features (SSSI (geodiversity))				
Land use and Soil	Extent of construction and operational effects on agricultural land (Agriculture land classification)				
Land use and Soil	Extent of construction and operational effects on landfill sites (historic and permitted landfill sites)				
Land use and Soil	Extent of construction and operational effects on nationally significant infrastructure including mineral sites (NSIP land and mineral safeguarded land)				
Water	Extent of construction and operational effects on the floodplain				
Water	Extent of construction and operational effects on water features – flows and geomorphology				
Water	Extent of construction and operational effects on water quality				
Air Quality	Extent of construction and operational effects on Air quality management areas (AQMAs)				
Landscape	Extent of construction and operational effects on national landscape designations (National Parks / AONB)				
Landscape	Extent of construction and operational effects on greenbelt designated land (Greenbelt)				
Historic Environment	Extent of construction and operational effects on statutory designated heritage assets, including overall setting (LB's, Scheduled Monuments, Conservation Areas)				
Historic Environment	Extent of construction and operational effects on non-statutory designated heritage assets, including overall setting (Registered Parks and Gardens and Battlefields)				
Population and Human Health	Extent of construction and operational effects on the health, amenity and wellbeing of local communities (Built up areas)				
Tourism and Recreation	Extent of construction and operational effects on recreational activities and / or tourism (National trails, country parks, open access land, PRoW)				
Material Assets	Extent of construction and operational effects on built assets and infrastructure				

3.1.1.7 Validation – Potential Futures Appraisal

The STT interconnector options appraisal focussed on the selection of a preferred option for the transfer of water from the River Severn to the River Thames, to meet water supply needs in the Southeast. The work on the Interconnector to the end of 2021 demonstrated that the pipeline was the most viable option for the purposes of the water transfer.

However, it was recognised that the canal options have the potential to deliver a dual-purpose multi-sector scheme that would provide water transfer and support restoration of the Cotswold Canals for navigation. What remains unclear is the balance of cost and benefits (to wider society) that would be achieved by a combined

scheme and how this compares with delivering water transfer and canal restoration separately, i.e., whether the joint objectives of navigation and transfer would best be served by an STT canal transfer, or through a separate STT pipeline and restored canal.

The Cotswold Canal Trust has advanced plans to restore the canal and there is the possibility that external (e.g., lottery funding) could be secured to deliver the navigational components that have not yet been restored. There may also be cost benefits arising from dual use such as combining the need for water for navigation with the sweetening flow requirements for the canal options developed for water transfer.

The Potential Futures Options Appraisal considered whether it would be a better outcome for society and the environment if there was:

- no new connection between the Thames and Severn
- two connections between the Thames and Severn – a pipeline for water transfer and a canal for navigation: one connection for both navigation and water transfer
- one connection for water transfer only
- one connection for navigation only

The key differences between this assessment and that undertaken in the main interconnector options appraisal were:

- Consideration of higher flows up to 500Ml/d for some scenarios.
- Assessment of costs and benefits associated with restoring the canal for full navigation (the main options assessment has only considered restoration of the canal to enable water transfer).
- Inclusion of costs for full navigation (the main options assessment has only considered costs for channel restoration).

A number of potential future scenarios (**Table 3-7**) were identified which encompassed a range of transfer options, from a pipeline only to a combination of transfer and navigation through to a navigation only option, as follows:

- Options that either delivered a transfer or navigation
- Options that delivered both a transfer and navigation for 300Ml/d
- Options that delivered both a transfer and navigation for 500Ml/d

The assessment included collation and review of monetised costs and benefits for canal restoration (recreational, tourism, volunteering, and land value benefits), carbon, updated/pro-rated sizing for different transfer volumes, BNG/NCA quantitative and qualitative assessments for additional scenarios as well as non-monetised costs and benefits such as consideration of environmental and resilience factors. Updated costs to account for all scenarios were also considered.

The scenarios were assessed through reviewing the costs and benefits for each scenario. The benefits assessment included specific benefits resulting from enabling navigation of the canal.

Despite the increased monetisable benefits attributable to scenarios where navigation is enabled, these did not significantly reduce the cost difference between a pipeline and a canal transfer. When qualitative factors such as resilience and environmental impacts were included in the assessment, the pipeline was also shown to be the preferred option.

The results indicated that Scenario C demonstrates lower net present costs for development of a separate pipeline for water transfer, in comparison to the canal restored for navigation. The outcomes of this assessment therefore confirmed the findings of the main options appraisal report, that the pipeline route remains the preferred option for an STT interconnector route.

For further information refer to the Potential Futures Report appended to the STT-G2-S3-301- Interconnector Options Appraisal Main Report.

Table 3-7: Summary of potential future scenarios

Scenario	Potential future scenario	Navigation Between Thames & Severn	Water Transfer
A	Do nothing	The Cotswold canals are not fully restored for navigation	There is no STT water transfer
B	STT piped connection only	No restoration of canal components take place, and no navigation is enabled.	There is a pipeline water transfer between the River Severn and River Thames (300, 400 or 500 Ml/d)
C	Two connections: STT piped connection and canal connection is restored (but only for navigation)	The Cotswold canals are fully restored for navigation only (not water transfer)	There is a pipeline water transfer between the River Severn and River Thames (300, 400 or 500 Ml/d)
D	STT canal connection (do max)	The SRO fully restores the Cotswold canals both for navigation and also for a water transfer of 300 Ml/d (with pipeline bypasses to the canal as necessary for transfer)	Raw water transfer (300Ml/d) is achieved through a series of canal pounds and pipelines
E	STT canal connection (do min)	Individual canal pounds are restored for the purposes of water transfer only, no navigation is enabled.	The Cotswold Canals are restored only for a water transfer of 300 Ml/d, but not facilitating navigation. Raw water transfer is achieved through a series of canal pounds and pipelines.
F	STT canal connection (do min+)	The Cotswold canals are fully restored for navigation (SRO restores sections required for transfer, CCT restores other sections required for navigation)	The Cotswold Canals are restored for a water transfer of 300 Ml/d. Raw water transfer is achieved through a series of canal pounds and pipelines.
G	Canal restoration for navigation only	The Cotswold canals are fully restored for navigation only (not water transfer)	There is no STT water transfer
H	Two connections: STT piped connection and canal connection is restored	The Cotswold canals are fully restored for navigation (SRO restores sections required for transfer, CCT restores other sections required for navigation) -300 Ml/d	There is a pipeline water transfer between the River Severn and River Thames (200 M/d)

3.1.1.8 Conclusions

The Options Appraisal process recommended that Option 1 Pipeline is taken forward for inclusion in the Gate 2 submission to RAPID. This option was developed from the longlist pipeline solutions to characterise a direct pipeline option for comparison against materially different options that utilised the Cotswold Canal corridor.

The Potential Futures supplementary study considered a number of potential future scenarios for delivery of a water supply transfer from the River Severn to the River Thames and restoration of the historic Cotswold Canals. The scenarios also include water supply transfers greater than 300 Ml/d capacity to validate the findings of Stages 1 and 2 of the STT interconnector options appraisal. The scenarios were evaluated in a similar exercise to the shortlist assessment.

The conclusions indicated that any benefits gained by integrating canal restoration with a water supply transfer are outweighed by the impacts and costs. Furthermore, a direct pipeline is likely to be the only cost-effective solution for transfers larger than 300 Ml/d. These conclusions validate the selection of the preferred water supply solution identified at the shortlist stage, of a direct pipeline from the River Severn to the River Thames.

3.1.2 River Vyrnwy Pipeline Route

This section summarises key findings from the *STT-G2-S3-333-River Vyrnwy bypass pipeline - Options Appraisal*.

A proposed mitigation option to the Vyrnwy Reservoir source option has been identified for the STT. This comprises the development of a raw water pipeline from a branch off from the Vyrnwy raw water mains between Oswestry Water Treatment Works (WTW) to the west of Oswestry to the lower reaches of the River Vyrnwy or the River Severn (downstream of the confluence with the River Vyrnwy).

The purpose of the mitigation option is to reduce and / or avoid the further release of water from the Vyrnwy Reservoir into the upper reaches of the River Vyrnwy due to concerns raised by Natural Resources Wales (NRW) over potential ecological impacts. In particular, NRW have raised concern with regards to the potential impacts of additional releases on the fish community, protected higher plants as well as protected terrestrial invertebrates of the River Vyrnwy downstream of the reservoir and upstream of the confluence with the River Banwy.

Seven longlisted conveyance options running from the Vyrnwy raw water mains between Oswestry WTW to the lower reaches of the River Vyrnwy and the River Severn (downstream of the confluence with the River Vyrnwy) were proposed for appraisal. **Table 3-8** lists the longlist of route options also shown in **Figure 3.8**.

Table 3-8: List of raw water pipeline route options

Option Reference	Option Name	Option Description
21	Vyrnwy Mitigation - Middle Vyrnwy release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, 12km of pipeline. Outfall to the Middle Vyrnwy just upstream of the confluence with the River Tanat
22	Vyrnwy Mitigation - Lower Vyrnwy release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, approximately 10km of pipeline. Outfall to the Lower Vyrnwy to the southeast of Llanymynech
23	Vyrnwy Mitigation - Lower Vyrnwy release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, approximately 11km of pipeline. Outfall to the Lower Vyrnwy just downstream of the confluence with the River Morda
24	Vyrnwy Mitigation - – Vyrnwy Bypass release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, around 15km of pipeline. Outfall to the River Severn approximately 600m southeast of Ponthen
25	Vyrnwy Mitigation - Lower Vyrnwy release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, around 10km of pipeline. Outfall to the Lower Vyrnwy approximately 2km southeast of Llanymynech
26	Vyrnwy Mitigation - Lower Vyrnwy release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, around 14km of pipeline. Outfall to the Lower Vyrnwy approximately 1km northwest of Crosslanes
27	Vyrnwy Mitigation – Vyrnwy Bypass release	Branch off from the Vyrnwy raw water mains between Llanforda open reservoir and Oswestry WTW to the west of Oswestry, around 17km of pipeline. Outfall to the River Severn approximately 800m east of Ponthen

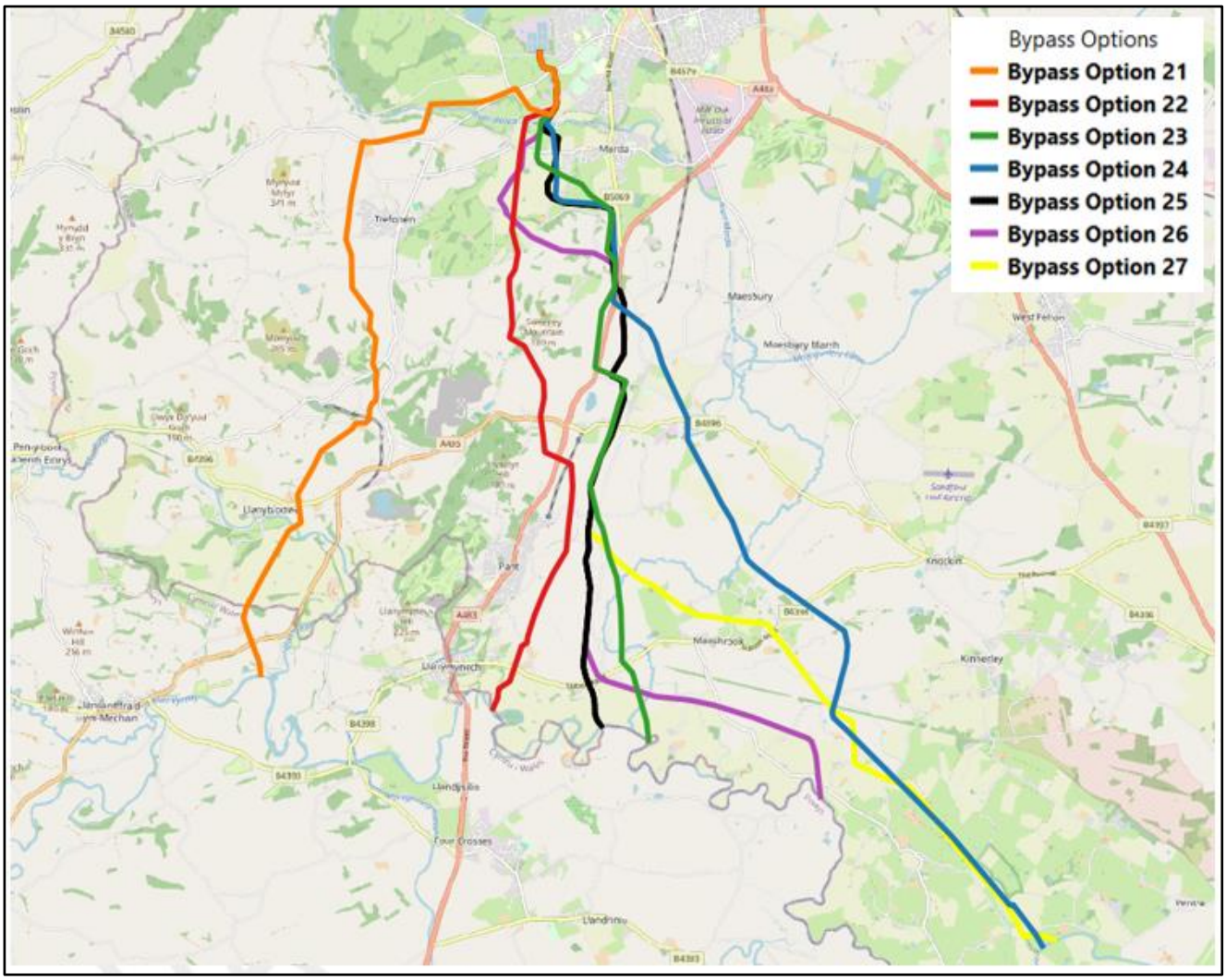

Figure 3.8 Longlisted Route Options 21-27

3.1.2.1 Methodology

The methodology of the options appraisal takes a staged approach as outlined in Figure 3.9.

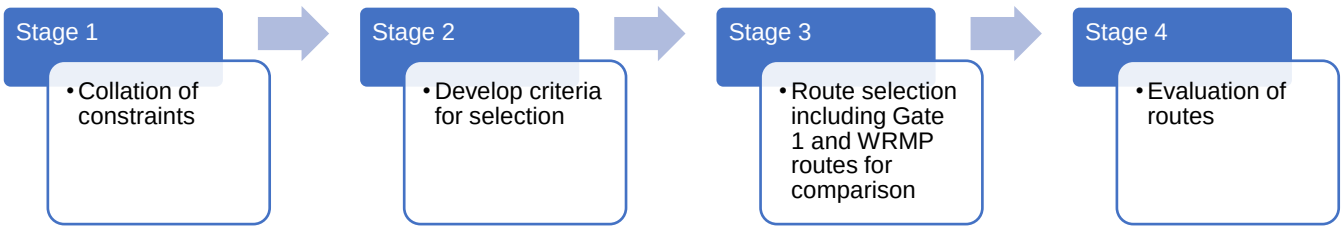

Figure 3.9 Staged methodology

Stage 1: Opensource datasets have been compiled for the area of interest including Environmental, Geotechnical, Major services, and Ground level data. The output of stage 1 is a list of GIS datasets used and a series of Environmental Constraints Plans. The plans identify environmental features and designations of national and some of local importance which the options may have a potential impact on or define the route and design choices.

Stage 2: To allow comparison of the routes, to identify the preferred option, comparative costs have been developed for both CAPEX and OPEX. In addition to cost comparison, a Multi-Objective Decision Analysis (MODA) has been developed to allow the inclusion of non-monetary factors important in option selection.

Stage 3: A preliminary steady state hydraulic analysis has been undertaken in this stage and the output was the identification of long list of potential routes for the pipeline. The general approach in defining the

routes/corridors is based on achieving a balance between achieving the shortest distance from the Oswestry Water Treatment Works (WTW) to the outfall location (River Vyrnwy or Severn), and ensuring the route is functional in terms of pipeline hydraulics, as well as avoiding environmentally sensitive areas such as ancient woodland, SSSI etc.

Stage 4: The routes were assessed against the criteria developed at Stage 2 for inclusion in the multi objective decision analysis tool MODA. To aid transparency of assessment, items included were digitised.

Part of this process was the Carbon impact assessment which has been carried out using Severn Trent Water's internal carbon tool. The main criteria for developing this assessment are carbon emission ratios per meter of pipeline built, average depth and type of work area (field or highway). Full commentary can be found in the Options Appraisal report.

The initial review in Gate 1 consisted of seven routes. Four routes were identified in a study named 'Oswestry Piped Transfers' in 2017 (Route Options 1-4) and three additional routes were identified as part of Gate 1 (Route Options 5-7). Design flows are shown in Table 3.9.

Table 3-9: Design flows

SRO Receptor	Peak flow (Ml/d)
River Vyrnwy	105 or 180Ml/d
River Severn	180 or 205Ml/d

In Gate 2, following modification of Options 1-7, these were re-assessed (as Options 21-27) based on the Gate 1 assessments and updated information with the flows shown in **Table 3-7**. In particular, environmental factors were considered, and the hydraulics were reviewed to provide for a solution that minimised pumping or tunnelling.

The potential option routes were developed from Gate 1 to avoid environmental constraints. The route alignments from Gate 1 have resulted in significant improvements in the environmental constraints associated with each route. The rerouting of the proposed pipeline for Option 24 has also resulted in avoidance of direct encroachment to a European designated site and for Option 22 avoidance of direct encroachment to a nationally designated site. The rerouting of all routes has also avoided the direct encroachment on several areas of ancient woodland, priority habitat and scheduled monuments.

As part of the screening of potential pipeline options, a RAG scoring system was used adopting the principles of statutory SEA. In addition, regard was given to HRA and WFD considerations. A Stage 1 HRA (screening) assessment of each pipeline route and associated discharges and a high-level WFD compliance assessment were undertaken and the results informed the RAG assessment. Further detail and assessment tables for each option are provided in the Environmental Appendices of the Options Appraisal Report.

Table 3-10 summarises the high-level screening assessment results. The high-level environmental RAG assessment screening of the seven longlisted routes for the raw water pipeline between Oswestry WTW, to the west of Oswestry to the lower reaches of the River Vyrnwy or the River Severn (downstream of the confluence with the River Vyrnwy) identified three potential options that did not include any red rated criteria.

Two of the options (Options 25 and 26) required proposed discharges into the River Vyrnwy whilst Option 27 proposed a direct discharge into the River Severn. Having regard to concerns previously expressed by NRW with regards to the potential impacts of additional releases on the fish community, protected higher plants as well as protected terrestrial invertebrates of the River Vyrnwy, in particular lamprey, more detailed assessment of Option 27 was proposed since this route option included releases direct into the River Severn.

The high-level screening assessment results with respect to Options 25 and 26 were the same. Having regard to the additional level of flood zone that is traversed with route Option 26 and the longer conveyance length of this option, it was considered that Option 25 is a better performing option against environmental criteria. Options 25 and 27 were therefore shortlisted for further detailed assessment. Whilst a series of discharge rates were reviewed, it was clarified that for any options that discharge into the River Vyrnwy, the following flows scenarios were used: 105 and 180 M//d and for the River Severn, 180 and 205 M//d.

Table 3-10: Summary of High Level Screening Assessment Results

	RAG Rating per SEA Topic Area							
Option Reference	Biodiversity – Flora and Fauna	Soil	Water	Air	Historic Environment	Landscape	Material Assets	Population and Human Health
21								
22								
23								
24								
25								
26								
27								

The final versions of the Route Options (Options 21-27) were examined from a hydraulic and environmental perspective, and it was concluded that Options 25, and 27 ranked favourably in the qualitative assessment of environmental constraints, with no major constraints identified for these options. This was also true of Option 26. However, it has no advantages over Option 25, yet is longer and passes through a longer length of flood plain. Therefore Options 25 and 27 were recommended for shortlisting and hence further study. A qualitative environmental RAG assessment was then made of each of the shortlisted options.

A separate assessment was made of each of the two shortlisted pipeline routes and two possible discharge volumes for each option:

- Option 25 – with 105Ml/d discharge volume;
- Option 25 – with 180Ml/d discharge volume;
- Option 27 – with 180Ml/d discharge volume; and
- Option 27 – with 205Ml/d discharge volume.

Table 3-11 provides a summary of the assessment of the shortlisted options. A summary of the key differentiators between the shortlisted options is provided with regard being given to each of the environmental constraint criteria considered. Information on the RAG criteria and definitions as well as more detailed assessment tables are provided in the environmental assessment appendices of the options appraisal report.

Option 27 (180 Ml/d and 205 Ml/d) are shown to have the least environmental constraints when considering nature conservation and biodiversity. With respect to effects on European designated sites, Option 25 (180 Ml/d and 105 Ml/d) were assessed as having potential major and moderate environmental constraints respectively in relation to potential impacts on the Severn Estuary SAC and Ramsar.

All shortlisted options are assessed as having potential moderate environmental constraints arising from working in close proximity to priority habitats and from crossing the Shropshire Mineral Safeguarding Zone.

Option 25 (180 Ml/d) was assessed as having a major constraint in relation to river flows and geomorphology, in contrast to the remaining three short listed options which are assessed as having a minor constraint in relation to this criterion. This option was also assessed as having a major constraint with regard to water quality issues, associated with potential impacts related to water temperature. All other options were assessed as having a moderate constraint in relation to this issue.

All options were assessed to have a neutral or minor constraint regarding all other criteria. Option 27 (180 Ml/d and 205 Ml/d) was therefore considered the preferred option from an environmental perspective. Based on the output of the engineering assessment of comparative cost and the non-monetary multi objective decision analysis undertaken in the options appraisal[37], of the options that feed into the River Severn (24 and 27), with their greater flow capacity, 27 is ranked above 24.

[37] *STT-G2-S3-333-River Vyrnwy bypass pipeline - Options Appraisal*

Subsequently Option 27 has been selected as the preferred route for the Gate 2 solution with a discharge volume of 155Ml/d as required by WRSE pending regional reconciliations.

Table 3-11: Summary of short list assessment results

SEA Topic Area	Criteria Considered	RAG Rating			
		Option 25 – 105 Ml/d	Option 25 – 180 Ml/d	Option 27 – 180 Ml/d	Option 27 – 205 Ml/d
Nature Conservation and Biodiversity	Extent of construction and operational effects on European designated sites and their qualifying features (SPA, SAC, Ramsar)				
Nature Conservation and Biodiversity	Extent of construction and operational effects on nationally designated sites and their qualifying features (SSSI)				
Nature Conservation and Biodiversity	Extent of construction and operational effects on non-statutory designated sites (Ancient woodland, NNR) and priority habitats				
Nature Conservation and Biodiversity	Extent of construction and operational effects on invasive and non-native species (INNS)				
Land use and Soil	Extent of construction and operational effects on nationally designated sites and their qualifying features (SSSI (geodiversity))				
Land use and Soil	Extent of construction and operational effects on agricultural land (Agriculture land classification)				
Land use and Soil	Extent of construction and operational effects on landfill sites (historic and permitted landfill sites)				
Land use and Soil	Extent of construction and operational effects on nationally significant infrastructure including mineral sites, allocated major development, major planning applications (NSIP land, mineral safeguarded land, allocated local plan major development, EIA development planning applications				
Water	Extent of construction and operational effects on the floodplain				
Water	Extent of construction and operational effects on water features – flows and geomorphology				
Water	Extent of construction and operational effects on water quality				
Air Quality	Extent of construction and operational effects on Air quality management areas (AQMAs)				
Landscape	Extent of construction and operational effects on national landscape designations (National Parks / AONB)				
Landscape	Extent of construction and operational effects on greenbelt designated land (Greenbelt)				
Historic Environment	Extent of construction and operational effects on statutory designated heritage assets, including overall setting (LB's, Scheduled Monuments, Conservation Areas)				
Historic Environment	Extent of construction and operational effects on non-statutory designated heritage assets, including overall setting (Registered Parks and Gardens and Battlefields)				
Population and Human Health	Extent of construction and operational effects on the health, amenity and wellbeing of local communities (Built up areas)				
Tourism and Recreation	Extent of construction and operational effects on recreational activities and / or tourism (National trails, country parks, open access land, PRoW)				
Material Assets	Extent of construction and operational effects on built assets and infrastructure				

3.1.3 Shrewsbury Redeployment Scheme

The Shrewsbury redeployment options appraisal reviewed the activities undertaken to identify and evaluate options to divert up to 25 Ml/d treated water from UU Oswestry Water Treatment Works (WTW) to supply STW customers within the Shrewsbury area via an existing emergency import, the Llanforda connection, whilst maintaining supply resilience. The methodology of this appraisal took a staged approach as outlined in **Figure 3.10**.

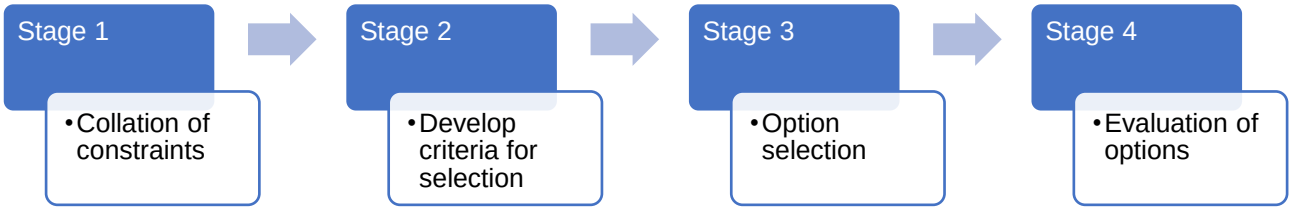

Figure 3.10 Staged methodology

Stage 1: Collation of information on the constraints for the area of interest. These include environmental, system resilience, process, distribution, and wastewater discharge constraints. The output of this stage is a series of tables to be used by the Engineering Team to help with the development and appraisal of the STT options.

Stage 2: To allow comparison of the options and identify the preferred option, comparative costs have been developed for both CAPEX and OPEX. In addition to cost comparison, a multi objective decision analysis tool (MODA) has been developed to allow the inclusion of non-monetary factors important in option selection.

Stage 3: A preliminary mass balance has been undertaken to assess the capability of each of the options to maintain supply in the area under normal operation and during the failure of the Llanforda import, both for average and peak demand conditions. The operational conditions for each of the options has been defined to maximise the import from Oswestry WTW and minimise Shelton River abstraction as much as possible in each of the scenarios assessed. This analysis has ensured that each of the options to be taken forward are functional in terms of supply/demand balance and do not exceed any of the production, import or export limits.

Stage 4: The options have been assessed against the criteria developed at Stage 2 for inclusion in the MODA. To aid transparency of assessment, items included were digitised: either by a point denoting crossing location or a polyline indicating the length of pipeline estimated to be affected. These are included in the GIS data package issued alongside this appraisal.

The Shrewsbury Redeployment scheme was identified as a proposed new mitigation option to the Vyrnwy Reservoir source option for the STT system. Sustained releases from the Vyrnwy Reservoir into the River Vyrnwy in support of the STT solution were identified as being of particular concern by NRW. These concerns relate to potential unacceptable environmental impacts which may need to be mitigated. The Shrewsbury Redeployment scheme represents a mitigation option to the Vyrnwy Reservoir source, as it would have a commensurate reduction of up to 25Ml/d in supply from Vyrnwy Reservoir via a middle River Vyrnwy Bypass.

The scheme comprises redeployment of the existing River Severn abstraction at Shrewsbury via diversion of 25 Ml/d treated water from UU Oswestry WTW to Shrewsbury to supply STW customers normally supplied from STW's Shelton WTW thus reducing abstraction from the River Severn and temporary transfer of licence to the STT Interconnector transfer point of abstraction. The abstraction at Shrewsbury currently serves STW customers in Shrewsbury and Oswestry. The scheme would reduce abstraction from the upper River Severn by 25Ml/d at Shrewsbury and leave water in the river for abstraction at Deerhurst while avoiding supply from Vyrnwy Reservoir of 25Ml/d.

The scheme requires upgrading Shelton WTW and increasing network capacity to import up to 25 Ml/d from UU via the existing emergency import, the Llanforda connection. The schematic of the area supplied by Shelton WTW is shown in **Figure 3.11.**

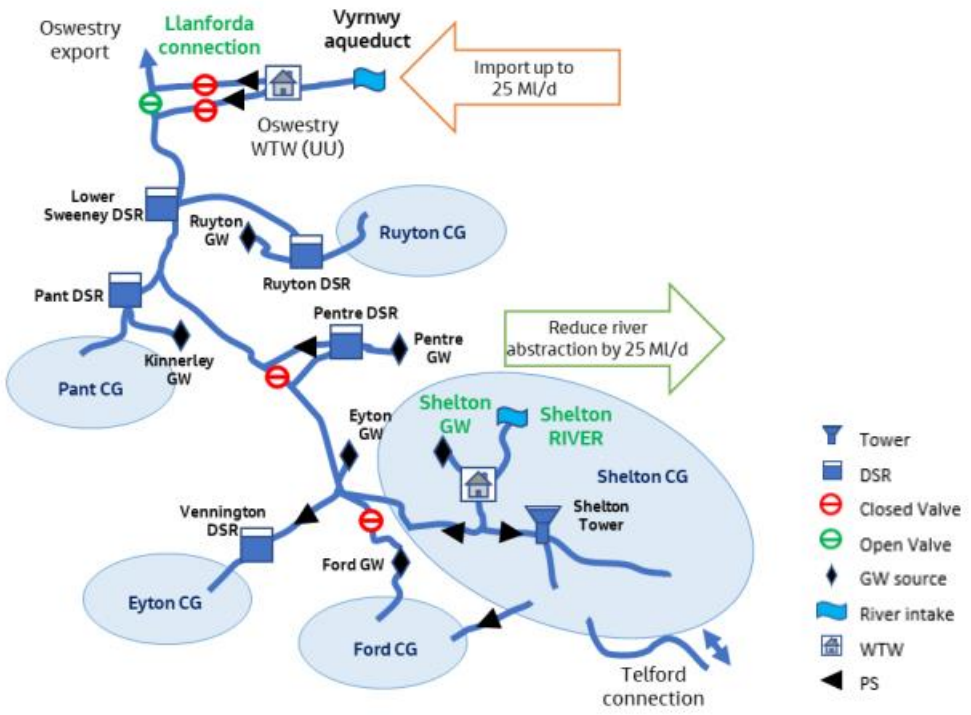

Figure 3.11 Schematic of the area supplied from Shelton WTW

Eight process options were developed at Gate 1 and a review was undertaken to assess the capacity of each of these options to meet local demand requirements and provide system resilience. Further work at Gate 2, including a mass balance study, identified four options to progress for further analysis (Options D, E, I and J, with further details on these options provided in Table 3.12.

Table 3-12: Gate 2 shortlisted options

Option Ref.	Configuration	Treatment streams decoupled	Network upgrades needed	UUI via Llanforda MAX import (Ml/d)	Shelton River MAX output (Ml/d)	Shelton River MIN output (Ml/d)	Shelton BH MAX output (Ml/d)
D	Maximum UU import (25 Ml/d) Network enhancements implemented Shelton River minimum output reduced (13Ml/d) Borehole (BH) output upgrade (18Ml/d) No reverse osmosis (RO) plant	No	Yes	25	28	13	18
E	Maximum UU import (25 Ml/d) Network enhancements implemented Shelton River minimum output reduced (13 Ml/d) BH output upgrade (18 Ml/d) Shelton streams decoupled	Yes	Yes	25	28	13	18

Option Ref.	Configuration	Treatment streams decoupled	Network upgrades needed	UUl via Llanforda MAX import (Ml/d)	Shelton River MAX output (Ml/d)	Shelton River MIN output (Ml/d)	Shelton BH MAX output (Ml/d)
I	Maximum UU import (25 Ml/d) Network reinforcements implemented Shelton River minimum output reduced (13 Ml/d) Shelton River maximised (approx. 39 Ml/d) BH output upgrade (18 Ml/d) Shelton streams decoupled	Yes	Yes	25	39	13	18
J	Maximum UU import (25 Ml/d) Network reinforcements implemented Shelton River minimum output reduced (13 Ml/d) Shelton River maximised (approx.. 39 Ml/d) BH output upgrade (18 Ml/d)	No	Yes	25	39	13	18

The scheme changes from Gate 1 to Gate 2 has led to a reduction in the environmental constraints associated with the scheme, through removal of the Booster 2 station to Shelton WTW, which was situated on grade 2 agricultural land. The changes also resulted in a reduction in the number of new pumping stations and booster stations required, with an associated reduction in resource use.

As part of the option appraisal at Gate 2, a high-level review of the environmental constraints associated with each of the options was undertaken. It should be noted that the Shrewsbury Redeployment scheme involves network enhancements to facilitate 25Ml/d transfer using an existing transfer route from UU to STW. Therefore, location of the new assets required to enhance the network are restricted by system distribution and process constraints. The environmental appraisal considered the potential effects of new infrastructure associated with each option:

- Enhancements at Shelton water treatment works (WTW) [All options]
- Modifications to Shelton WTW river inlet pumps [Options I and J only]
- Upgrade of the Ford pumping station (PS) within the existing site boundary [All options]
- A new PS for Pant distribution service reservoir (DSR), to be located at Llynclys [All options]
- A new booster station to Shelton WTW, to be located to the west of Kinnerley [Options E and I only]

It is acknowledged there are additional network enhancements required (e.g., new flow control structures) across all options, however, as these are which are very small scale in nature with limited potential for environmental effects and are required for all options, they are not considered further the environmental review.

The operational impacts were considered in the Gate 1 environmental assessments. In operation there would be a 25Ml/d reduction in abstraction from the River Severn at Shrewsbury for intermittent periods, in the order of ~15% of dates at times of low flows in the lower River Severn. The flow changes would continue along the River Severn to the re-abstraction location with no overall change in flows to the Severn Estuary. In consequence, of the small abstraction reduction proposed in comparison to the natural flows present in the estuary, there were no significant environmental effects associated with the Shrewsbury Redeployment scheme in isolation and the current environmental appraisal considers the construction effects only.

The high-level environmental RAG assessment screening of the four potential options for the Shrewsbury Redeployment scheme did not identify any red rated criteria. The RAG criteria, definitions, and assessment results for each of the four options are provided in the Options Appraisal with a summary provided in Table 3-13 and in the bullet points below.

Table 3-13: Summary of High Level Screening Assessment Results

	RAG Rating per SEA Topic Area						
Option Reference	**Biodiversity – Flora and Fauna**	**Soil**	**Water**	**Air**	**Historic Environment**	**Landscape**	**Population and Human Health**
E							
D							
I							
J							

The limited and small-scale works associated with the Shrewsbury Redeployment scheme options are not associated with any significant environmental constraints. The environmental assessment carried out during Gate 1 considered the operational effects of the scheme and no significant environmental impacts were identified.

- Assessing Option D: applying the RAG assessment methodology set out limited potential adverse environmental constraints associated with this option. Mitigation measures will be required during construction to avoid impacts on priority habitats and listed buildings in proximity to the scheme.
- Assessing Option E: applying the RAG assessment methodology set out limited potential adverse environmental constraints associated with this option. Mitigation measures will be required during construction to avoid impacts on priority habitats and listed buildings in proximity to the scheme.
- Assessing Option I: applying the RAG assessment methodology set out limited potential adverse environmental constraints associated with this option. Mitigation measures will be required during construction to avoid impacts on priority habitats and listed buildings in proximity to the scheme. Some small scale and temporary works will be required within EA Flood Zone 2.
- Assessing Option J: applying the RAG assessment methodology set out limited potential adverse environmental constraints associated with this option. Mitigation measures will be required during construction to avoid impacts on priority habitats and listed buildings in proximity to the scheme. Some small scale and temporary works will be required within EA Flood Zone 2.

3.1.3.1 Conclusions

- All options assessed meet the main project driver of reducing abstraction from the River Severn at Shelton WTW, allowing for a temporary transfer of the abstraction licence of up to 25 Mld to the STT Interconnector transfer point of abstraction further downstream.
- Options E and I allow for importing greater volumes from UU to supply STW's customers via the Llanforda connection; however, implementing these options would require a greater investment on new network infrastructure and would put the network under greater stress when compared to Options D and J.
- In Options E and I, a RO plant is proposed. This would reduce the chloride levels in the borehole water and allow the borehole and river WTW to run independently, increasing operational flexibility, while maintaining final treated water quality to supply. The installation of an RO plant would increase substantially the process complexity and therefore the training requirements for operatives. The RO plant would drive the total costs of the project up substantially.
- Options D and J do not provide additional treatment for the borehole water meaning the borehole WTW cannot be decoupled from the river WTW and water must be blended in the 60:40 ratio to maintain treated water quality. However, these two schemes are likely to require a much lower capital investment and offer a more economically sensible option than options E and I. Options D and J eliminate any issues related to managing the RO reject flows.
- Options I and J showed greater negative impact than Options D and E with regards to the environment, carbon and constructability and have significant disadvantages over the other options due to the greater number of treatment upgrades required.
- Option D required the lowest capex investment, estimated at £3,786,904 followed by Option J (£8,986,231), Option E (£22,227,604) and Option I (£27,327,115).

It is recommended to select Option D as the preferred option.

3.2 DESIGN EVOLUTION AND DEVELOPMENT OF PREFERRED SOLUTION

3.2.1 Further work carried out since Gate 1 and the influence it has had on the solution

This section highlights key areas of work carried out since Gate 1 and where these environmental assessments have contributed to further refinement of the scheme.

- Flow and water quality changes from STT operation have been subject to extensive assessment in Gate 2. In-channel habitat modelling has been undertaken using modelled and measured data to determine the risk of compliance of the scheme with WFD and HRA objectives, with key emphasis on: the River Vyrnwy as impacted by direct reservoir releases; River Severn as impacted by supplementary by-pass releases and Netheridge discharge; River Avon as impacted by Minworth discharge; and River Thames as impacted by STT interconnector transfer.

- Protected species in the STT catchments have been subject to extensive surveys following Gate 1. This includes surveys for protected higher plants, lichens, bryophytes, Exposed Riverine Sediment (ERS) invertebrates and water vole covering the River Vyrnwy, River Avon and River Severn catchments. These data have reduced the uncertainty from desk based assessments identified in Gate 1.

- Protected habitats have also been subject to extensive surveys. These surveys considered SSSIs, and priority habitats associated with the construction and operation of the STT and considered habitat conditions and connectivity with the waterbodies that will be subject to flow augmentation and abstraction, covering habitats exceeding 1800ha in total.

- Following the Gate 1 assessment, the ecological monitoring programme was updated to provide further evidence to inform the Gate 2 assessments. The monitoring programme was amended to include macroinvertebrate, diatom, INNS, fish and macrophyte sampling at additional locations and frequencies. Targeted surveys were also undertaken to provide data on the extent of offsite supporting functional habitat for the Severn Estuary European site. These data included habitat walkovers, targeted surveys and fish barrier assessment that have been incorporated into the HRA.

- The role of olfaction/olfactory cues in migration and the identification of determinands associated with the operation of the STT solution that could impact on the migration and reproduction of fish species in the Severn Estuary was completed in Gate 2. Further work on olfactory inhibitors is still required throughout Gate 3 to provide sufficient evidence for regulators to engage in discussion of option suitability.

- The conditions status of the Severn Estuary European site has been subject to review by the relevant regulators (NRW and NE). These data have been considered in the Gate 2 HRA to inform the risk of adverse effect on site integrity. The modelled changes in freshwater inflows as a result of the operation of the STT indicates that changes will not be discernible and are within the natural variations observed in the lower River Severn.

- The development corridor of the interconnector would be mainly within rural areas, with 20km of the route passing through the Cotswolds AONB. The most significant impact of the scheme would be during construction with the majority of the pipeline being installed using open-cut construction techniques, with typically a circa 40m to 50m wide construction width along the length of the route.

- The potential option routes of the interconnector were further developed from Gate 1 to avoid environmental constraints. The route alignments from Gate 1 resulted in significant improvements in the proposed routing to avoid sensitive areas and key ecological receptors associated with each route. The rerouting of the proposed Vyrnwy bypass pipeline for Option 24 has also resulted in avoidance of direct encroachment to a European designated site and for Option 22 avoidance of direct encroachment to a nationally designated site. The rerouting of all routes has also avoided the direct encroachment of several areas of ancient woodland, priority habitat and scheduled monuments.

- Some disruption along the pipeline and canal corridor is likely during construction, however the routing corridor has been optimised through Gate 2 to avoid direct impact. The pipeline and canal corridor would pass in close proximity to a number of SSSI, SACs, ancient woodlands and ancient monuments, however, it is expected that any effect on these sensitive areas can be managed and mitigated during construction.

- The Vyrnwy bypass option routes have been re-examined during Gate 2 to avoid environmental constraints identified in Gate 1. Seven routes were examined from a hydraulic and environmental perspective and were shortlisted to two routes which ranked favourably in the qualitative assessment of environmental topics, with no major constraints identified for these options.

- The potential impacts on habitat as a result of the proposed 75Ml/d release from the Vyrnwy reservoir were assessed as being significant. The risk to salmonid habitat was subject to detailed investigations as part of the monitoring programme to inform physical losses of a supported STT38. The findings of the habitat assessments were corroborated by the results of the velocity/depth surveys undertaken prior to and during the trial releases, and modelling of flow and water quality for representative scenarios. The data from these surveys and model outputs identified a significant loss in habitat when flows exceed 175Ml/d for juvenile salmonids. Therefore, in combination with the Severn Regulation releases, and engineering requirements, the STT solution was amended to include a maximum release of 25Ml/d from the Vyrnwy Reservoir. As such, flows are expected to remain below the 175Ml/d, even when Severn Regulation releases are operating, therefore protecting fish habitat and functionally linked habitat of the Severn Estuary.

- A bespoke benefits assessment approach has been developed to consider the wider benefit opportunities in the STT catchments using both the Sustainable Management of Natural Resources (SMNR)[39] and associated Wellbeing Goals approach for Wales and the six capitals approach which is accepted for use in England[40]. Outputs include opportunity mapping and a stakeholder engagement plan.

3.3 EMBEDDED MITIGATION

The scheme design includes a range of best practice mitigation and mitigation informed by the assessments undertaken to date. These measures are captured in the Conceptual Design Reports (see Section 1.4). 'Designed in' features of the solution that have been included early in the process to avoid or reduce impacts comprise some of the following measures (depending on the relevant receptors):

Ecology

- Avoidance of any habitat loss/damage by keeping the working area to the minimum required for construction (informed by UK Habitat and site condition surveys along route).
- Best practice dust and pollution prevention measures to avoid damage to habitats/species.
- Trees protected in line with BS 5837:2012 - Trees in relation to design, demolition, and construction.
- Habitats, trees, shrubs, grassland reinstated (planted, seeded, relevant aftercare).
- Species specific mitigation to be informed by protected and notable species surveys along the route. European protected species (e.g., great crested newt, white clawed crayfish, dormouse, otter and bats) and other protected and/or notable species (e.g., badgers, breeding birds, fish, water vole, common reptiles and invertebrates) to be managed as agreed with Natural England.

Water

- Tunnel or directional drilling under main rivers where possible.
- Minimise removal of riparian vegetation (avoid damage to bank stability, minimise habitat loss). If necessary to remove, reinstate riparian vegetation.
- Minimise duration of any necessary in-channel working to avoid compaction, disruption of flow processes, bank erosion.
- Minimise impacts on water quality through temporary fluming watercourses, buffer strips, straw bales to stop sediment from the site compounds running off-site untreated. Construction mitigation relating to fine sediment runoff and spills and leaks management to be included as defined as part of any environmental permit applications and may require some route re-alignment.
- Timing of in river works and high noise/vibration works to avoid lamprey migration and salmon upstream migration and spawning periods, to be completed within the period June to September where possible.

[38] 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.

[39] Introducing Sustainable Management of Natural Resources

[40] 13-12-08-THE-INTERNATIONAL-IR-FRAMEWORK-2-1.pdf (integratedreporting.org)

Flooding

- Flood compensation ponds will be constructed as part of the enabling works. Earthworks sequencing will include cofferdam formation to avoid flooding of borrow areas during construction.

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. Site temporary construction compounds will be away from residential areas. Any landscaping bunds around perimeter at permanent sites will be provided at the start of construction (which can provide noise barrier benefits).

Transport

- New access roads will be provided at start of construction. Wheel washes for truck deliveries to site will be provided. Approved traffic routes for construction traffic will be applied to minimise impacts on local roads. Haul routes from existing roads to compounds and working areas will be minimised and land reinstated following completion of the construction works.

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.

Landscape and Visual Amenity

- Existing hard landscape features will be retained, protected and stored for future reinstatement, where they form part of a distinctive setting or relate to the character of an area, for example stone walls.
- Existing views or key viewpoints will be maintained where possible to minimise disturbance to visual amenity through appropriate siting of compounds and temporary access routes.
- Disturbance to or removal of key landscape features or amenity features that are distinctive, rare and/or are characteristic of the area will be avoided (e.g. landscape around Deerhurst Priory and Village Greens such as those North and South of Calcot), by appropriate siting and routing of temporary and permanent works.
- Land take for construction will be minimised to reduce landscape and visual impact and subsequent extent of area to be reinstated.
- Where appropriate, new plant and equipment, including chambers and valves will be provided at boundaries to avoid visual intrusion and minimise disturbance to current land use.
- Stockpiling of materials, or delivery of materials to be used in construction in areas of high landscape value or sensitivity, such as public parks, visitor attractions, residential areas, where visual amenity may be affected will be minimised.
- Traffic will be controlled, and deliveries and construction will be organised to minimise visual impact and disturbance to visual amenity during construction; for example, weekend working will be avoided.
- Temporary lighting will be strategically located for safe construction requirements and where possible, will be directional to minimise increase in light levels.

Heritage

- Desk based study of cultural heritage assets within and adjacent to construction works (confirmation of locations, descriptions of assets).
- Agreement of programme of archaeological and heritage investigation with Historic England and the local authority.
- Monitoring by qualified staff prior and during construction as agreed in investigation programme, including recording and intervention as appropriate.

Recreation

- All closures to be agreed with the relevant regulators and stakeholders.
- Alternative routes identified if possible, using existing public rights of way or public highways, with appropriate signage.
- Any public rights of way affected during construction to be reinstated following completion of works.
- Screening to be used where required in construction locations which are in proximity to public rights of way.

4. INFORMAL STATUTORY AND REGULATORY REPORTS

4.1 INTRODUCTION

The IEA draws upon the separate regulatory reports that have been produced and key reports are summarised in this section. The regulatory reports have also been informed by a number of assessment and evidence reports. Findings feed into Section 5: Environmental Baseline as well as the Risk Assessment itself in Section 6.

4.2 SEA

The outputs from the SEA assessment in Gate 1 (SEA output tables) followed the same format as the SEA assessment undertaken by WRSE in the development of its Regional Plan. This approach facilitated the adoption of the environmental assessment information from the STT solution into the Regional Plan, especially since WRSE used the SEA output tables to generate the environmental metrics for the Regional Plan.

The purpose of Gate 2 is to refine the Gate 1 activities to improve the detail and breadth of feasibility studies and to develop concept solution designs with reduced uncertainty in costs and benefits. With respect to environmental assessment, SRO schemes are to be developed to a standard suitable for submitting into final Regional Plans and / or final WRMPs.

With elements of the STT solution scheme having been refined from those considered in Gate 1, a re-assessment of these amended elements has been undertaken for the WRSE Regional Plan, including the development of updated environmental metrics. The updating of the SEA output tables produced in Gate 1 will help to satisfy this requirement and can also be incorporated into the water company WRMPs being developed along similar timescales. The updated SEA tables are available in **Annex A** of this report.

It should be noted, however, that there will be a difference in the point at which the WRMPs and the *STT-G2-S1-001-Severn to Thames Transfer - Gate 2 submission* are submitted and, therefore, the SEA output tables will likely not be identical. This is because of possible further scheme development between the two submission points. As a result, any differences will need to be made clear to relevant stakeholders so that any potential difference is understood.

4.3 HRA

The informal HRA[41] is presented in a separate report[42]: a summary of the key points is presented here.

The informal screening identified the risk of likely significant effects (LSE) associated with the construction of the interconnector for the Dixton Wood SAC as well as the Severn Estuary European site (SAC, SPA and Ramsar site). The risk of LSE has also been identified for the Midland Meres and Mosses Phase 2 Ramsar site as associated with the construction of the Vyrnwy Bypass to the River Severn.

The risk of LSE has also been identified for the Severn Estuary European site during the operation of the STT solution (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.

With regards to 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 regime/ groundwater supply in Midland Meres ad 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 discernible 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 to adverse effects on site integrity have been identified. This is because the changes in flow including pass

[41] STT-G2-S3-121-Informal Habitats Regulation Assessment (HRA)

[42] STT-G2-S3-122-Water Framework Directive (WFD) Assessment

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 discernible with a likely decrease in selected nutrients during operation of the STT solution. 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 effects on water quality. The pan-SRO water quality monitoring programme is still on-going and limited data is available for a number of determinands that are known to result in olfactory inhibition. Furthermore, the risks associated with many of these determinands is based on 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 UK of reduction performance efficacy and operational reliability for the planned treatment processes.

4.4 WFD

The WFD compliance assessment is presented in a separate report[43]: a summary of the key points is presented here.

There is potential for introducing impediments to target status in four waterbodies, and deterioration of status in two waterbodies, in the River Avon from Stoneleigh to the confluence with the River Severn reach. The risk of non-compliance is associated with the 115Ml/d advanced treated effluent transfer from Minworth WwTW during the Full STT scenario where the Minworth Transfer is part of the support system. The waterbodies in this reach at risk of status deterioration and impediments are:

- Avon (Warks) - conf R Sowe to conf R Leam - GB109054043840
- Avon (Wark) conf R Leam to Tramway Br, Stratford - GB109054044402
- Avon- Tramway Br Stratford to Workman Br Evesham - GB109054044401
- Avon conf Workman Br, Evesham to conf R Severn - GB109054044403.

There is potential for introducing impediments to target status in the one waterbody in the River Severn from the confluence with the River Avon to Deerhurst reach. The risk of non-compliance is associated with pass-forward effects of the Minworth Transfer during the Full STT scenario.

- Severn - conf R Avon to conf Upper Parting - GB109054044404

The effects associated with the 115Ml/d advanced treated effluent transfer may be mitigated to compliant through further development of operating rules.

There is potential for introducing impediments to target status in the one waterbody in the Severn Estuary downstream of the tidal limit at Gloucester. The risk of non-compliance is associated with an overall reduction in DIN input from the freshwater River Severn and Netheridge WwTW combined into the Severn Estuary as result of early phase and full STT solution.

- Severn Upper (TRaC) - GB530905415403

There is potential for introducing impediments to target status in five waterbodies in the Thames downstream of Culham to tidal limit reach. The risk of non-compliance is associated with a potential increase in phosphate concentrations during the early phase and full STT solution.

- Thames (Evenlode to Thame) - GB106039030334
- Thames Wallingford to Caversham - GB106039030331
- Thames (Reading to Cookham) - GB106039023233
- Thames (Cookham to Egham) - GB106039023231
- Thames (Egham to Teddington) - GB106039023232

The effects on the River Severn reaches upstream of the River Avon confluence (River Severn from the Vyrnwy Bypass Outfall to Bewdley, and the River Severn from Bewdley to the confluence with the River Avon), along with the Vyrnwy itself, are deemed to be WFD compliant. In these reaches, there is no pathway of

[43] STT-G2-S3-122-Water Framework Directive (WFD) Assessment

environmental water quality change, and potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on aquatic ecology or morphology.

In the c.140 km of the River Thames from Culham to the tidal limit at Teddington, modelled water quality predicts a benefit to a small benefit to dissolved oxygen saturation, and a small benefit to PFOS and the polyaromatic hydrocarbon benzo(g,h,i)perylene. Although, any betterment from STT Solution would not lead to Environmental Quality Standards (EQS) being achieved in the River Thames for these chemicals.

The progressive WFD Assessment Objectives have also been reviewed. Whilst some improvements to physio-chemical water quality and chemical water quality have been established, any betterment from the STT Solution is unlikely to lead to overall improvement in status class and assist the attainment of the WFD Objectives of a waterbody. Whilst it is not clear that the progressive objectives have been assisted at this time, it should be noted that the progressive objectives are not tests of constraint and do not lead to WFD non-compliance of STT Solution if not achieved.

4.5 BNG/NCA/SMNR

The assessment of Natural Capital and SMNR are covered in two separate reports[44]: a summary of the key points is presented here.

A bespoke model was created to collate together over 20 datasets to identify Biodiversity Opportunity Areas (BOAs), assign scores to them so they could be prioritised and identify the most suitable BOAs for habitat restoration or creation. The scoring system was based on Lawton principals and Biodiversity Net Gain Metric questions.

To ensure no net loss and at least 10 % net gain of riverine habitat, enhancements were considered. Rivers that could potentially be enhanced to offset net losses and achieve at least 10 % net gain were identified using outputs from a wider benefits study[45]. The study considered opportunities within the STT solution which encompassed the six capitals[46] approach for use in England, and the SMNR and Wellbeing goals relating to Wales. A key focus area of this study was 'river biodiversity' which was applied to this assessment to determine river BOAs. This identified all rivers within the catchment boundary of the STT solution which had either bad or poor WFD ecological status, bad or poor WFD fish status, and bad or poor WFD overall status due to either 1) invasive species, 2) changes to natural water flow / water levels or 3) physical modifications. These rivers were then the basis of where to identify potential enhancement rivers with the STT solution. Rivers where potential enhancement could be achieved were identified within 1 km of infrastructure that could cause temporary (pipeline) or permanent (abstraction or discharge locations) riverine habitat loss, or within 1 km of reaches potentially impacted via the operation of the STT solution.

The overall environmental benefits in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £1,237,091. The Natural Capital methodology does not take into account the monetary cost of land acquisition and management for the required mitigation. The larger schemes will require more land and associated management costs.

The current ZoI for the assessed components extends to just the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be necessary following stakeholder engagement and agreed engineering specification, etc. as part of further scheme development.

[44] STT-G2-S3-118-Natural Capital & Biodiversity Net Gain (England) Assessment and STT-G2-S3-119-Ecosystem resilience, wellbeing & SMNR (Wales) Assessment

[45] Ricardo (2022). *Severn Thames Transfer SRO. Wider Benefits Study.* Ricardo ref: ED16053.

[46] 13-12-08-THE-INTERNATIONAL-IR-FRAMEWORK-2-1.pdf (integratedreporting.org)

5. ENVIRONMENTAL BASELINE

5.1 INTRODUCTION

This section provides a summary of the baseline environment within the study area with reference to relevant work completed during Gate 2 and the additional evidence base available across the STT solution. The key sensitive receptors across each SEA/EIA topic are defined in Section 5.2 following the baseline review using a 10km buffer around the elements of the scheme (for construction) and around the water courses (for operation and changes in flow) with individual evidence reports detailing any specific buffers used. Section 6 provides the RAG assessment of risks associated with the STT solution across each SEA/EIA topic and Section 8.1 sets out the key additional work required in Gate 3 to address uncertainties and information gaps.

5.1.1 Biodiversity

The STT solution study area contains a number of sites that are designated at a European, national or local level as important for biodiversity, flora and fauna. These are outlined below in **Table 5-1** and shown on **Figure 5.1**,

Figure 5.2 and **Figure 5.3** for the north, central and southern segments of the scheme.

Several areas of habitat protected under Section 41 of the Natural Environment and Rural Communities Act 2006 (NERC Act) and Environment (Wales) Act (2016), Section 7 are also found within the study area, such as coastal and floodplain grazing marsh, traditional orchard, lowland Fens, lowland dry acid grassland and deciduous woodland (see **Figure 5.4**, **Figure 5.5**, **Figure 5.6** and **5.7**).

Further details of the relevant European sites (SAC, SPA and Ramsar) can be found in the *STT-G2-S3-121-Informal Habitats Regulation Assessment (HRA)* report. Other protected sites and habitats (including SSSIs) have also been considered and a number of surveys were carried out during Gate 2 (such as habitat mapping and hydrological connectivity walkovers) to better understand water dependant habitats within the study area. Further details can be found in the *STT-G2-S3-109-Protected Habitats Evidence* report and *STT-G2-S3-117-Protected Habitats Assessment* report. The STT solution assessment reports have provided a key source of information and have informed the risk assessment presented in this IEA.

Table 5-1 Designated sites in the STT solution assessment area

Site	Designation	Associated Schemes
Berwyn	SPA, SAC	Severn Regulation Release (Vyrnwy Reservoir)
Berwyn and South Clwyd Mountains	SAC	Vyrnwy Bypass
Bredon Hill	SAC	Deerhurst to Culham Interconnector
Chilterns Beechwoods	SAC	Deerhurst to Culham Interconnector
Cothill Fen	SAC	Deerhurst to Culham Interconnector
Dixton Wood	SAC	Deerhurst to Culham Interconnector
Hartslock Wood	SAC	Deerhurst to Culham Interconnector
Little Wittenham	SAC	Deerhurst to Culham Interconnector
Montgomery Canal	SAC	Vyrnwy Bypass
Midland Meres & Mosses Phase 1	SPA, Ramsar	Severn Regulation Release
Midland Meres & Mosses Phase 1	SPA, Ramsar	Severn Regulation Release
River Clun	SAC	All components (including unsupported)
River Dee and Bala Lake	SAC	Vyrnwy Bypass
River Usk	SAC	All components (including unsupported)
River Wye	SAC	All components (including unsupported)
Severn Estuary	SSSI, SAC, SPA, Ramsar	All components (including unsupported)
Tanat and Vyrnwy Bat sites	SAC	Vyrnwy Bypass
Walmore Common	SPA, Ramsar	Netheridge Transfer
Garden Cliff	SSSI	All components (including unsupported)
Lydney Cliff	SSSI	All components (including unsupported)
Purton Passage	SSSI	All components (including unsupported)

Site	Designation	Associated Schemes
Old River Severn, Upper Lode	SSSI	Deerhurst to Culham Interconnector
Rectory farm Meadows	SSSI	Deerhurst to Culham Interconnector
Severn Ham, Tewkesbury	SSSI	Severn Regulation Release (Vyrnwy Reservoir)
Upham Meadow & Summer Leasow	SSSI	Severn Regulation Release (Vyrnwy Reservoir)
Upper Seven Estuary	SSSI	All components (including unsupported)
Wainlode Cliff	SSSI	Deerhurst to Culham Interconnector

In addition to the above, there are several areas of ancient woodland in the study area; these are shown on **Figure 5.1,**

Figure 5.2 and **Figure 5.3**.

A description of fisheries within the study area is provided in the *STT-G2-S3-114-Fisheries Assessment* report. In the Severn, several fish species dominate the fish community in different parts of the river depending on the differing habitats. The Severn Estuary has a slightly different population of fish, including sprat, herring, whiting, poor cod and bass. The concerned reaches of the River Avon and the River Thames predominantly contain fish species that are tolerant of pressure, such as perch and minnow.

Several species protected under the NERC Act and Environment (Wales) Act are also found within the study area. These include both water dependant species in proximity to the River Severn which may be impacted by potential habitat changes as a result of the STT solution, and terrestrial species which require consideration in relation to possible pipeline construction impacts. A detailed description can be found in the *STT-G2-S3-124-Protected Species Assessment* report. Protected species found within the study area (not including those already described in the fisheries report summary) include (but are not limited to) depressed river mussel, large garden bumblebee, European otter, house sparrow and floating water plantain. The *STT-G2-S3-115-Macroinvertebrates / Other Freshwater Ecology Assessment* report also notes that several species of mayfly and caddis fly that are present within the reach are listed as priority species among other macroinvertebrates.

There are a number of protected habitats that are, or may be, hydrologically connected to the impacted river reaches, and these are described in the *STT-G2-S3-117-Protected Habitats Assessment* report. These include coastal and floodplain grazing marsh, lowland fens, mudflats, saltmarsh and wet woodland. These habitats are not evenly distributed throughout the assessment area and some reaches do not contain any protected habitats. The Protected Habitats Assessment report also identified a number of SSSIs that may be subject to impacts from the STT solution. These were Garden Cliff SSSI, Lydney Cliff SSSI, Purton Passage SSSI, Old River Severn, Upper Lode SSSI, Rectory farm Meadows SSSI, Severn Estuary SSSI, Severn Ham, Tewkesbury SSSI, Upham Meadow & Summer Leasow SSSI, Upper Seven Estuary SSSI and Wainlode Cliff SSSI. There are also a number of Local Nature Reserves (LNRs) within the STT study area, but it is not anticipated that any would experience adverse impacts.

The *STT-G2-S3-116-INNS Assessment* Report details that within the River Severn, a total of 72 INNS have been recorded within 500m of the watercourse upstream of Deerhurst which may present a risk during a raw water transfer (RWT). Of these, the most prevalent INNS was Himalayan Balsam which was recorded 1043 times. Other prevalent and notable INNS recorded that may be transferred by a RWT include zebra mussel (*Dreissena polymorpha*), New Zealand mud snail, Japanese knotweed, Asian clam and Nuttall's waterweed. A higher concentration of INNS was recorded close to urban areas such as Shrewsbury, Bridgenorth, Kidderminster and Worcester.

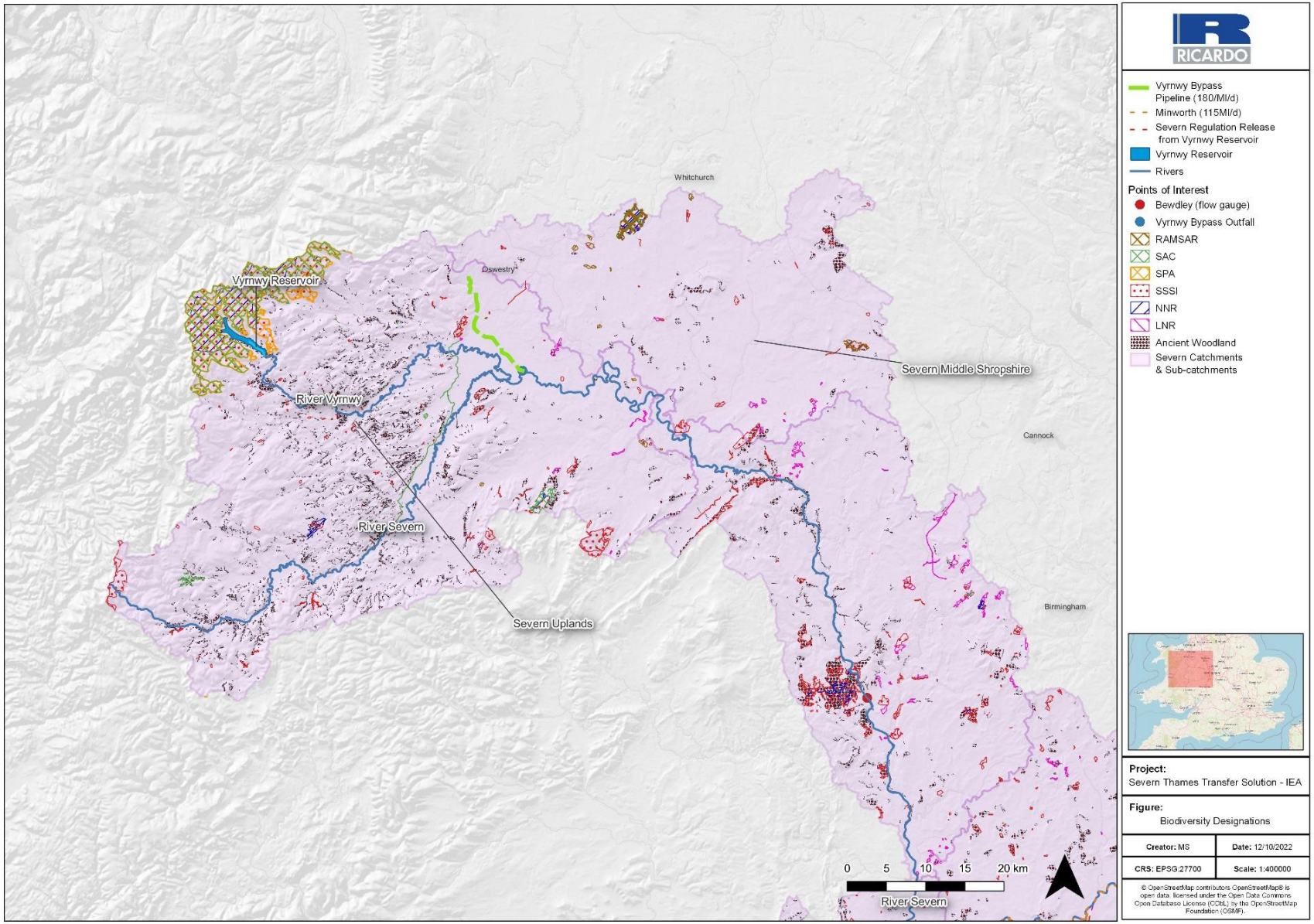

Figure 5.1 Biodiversity Designations - North

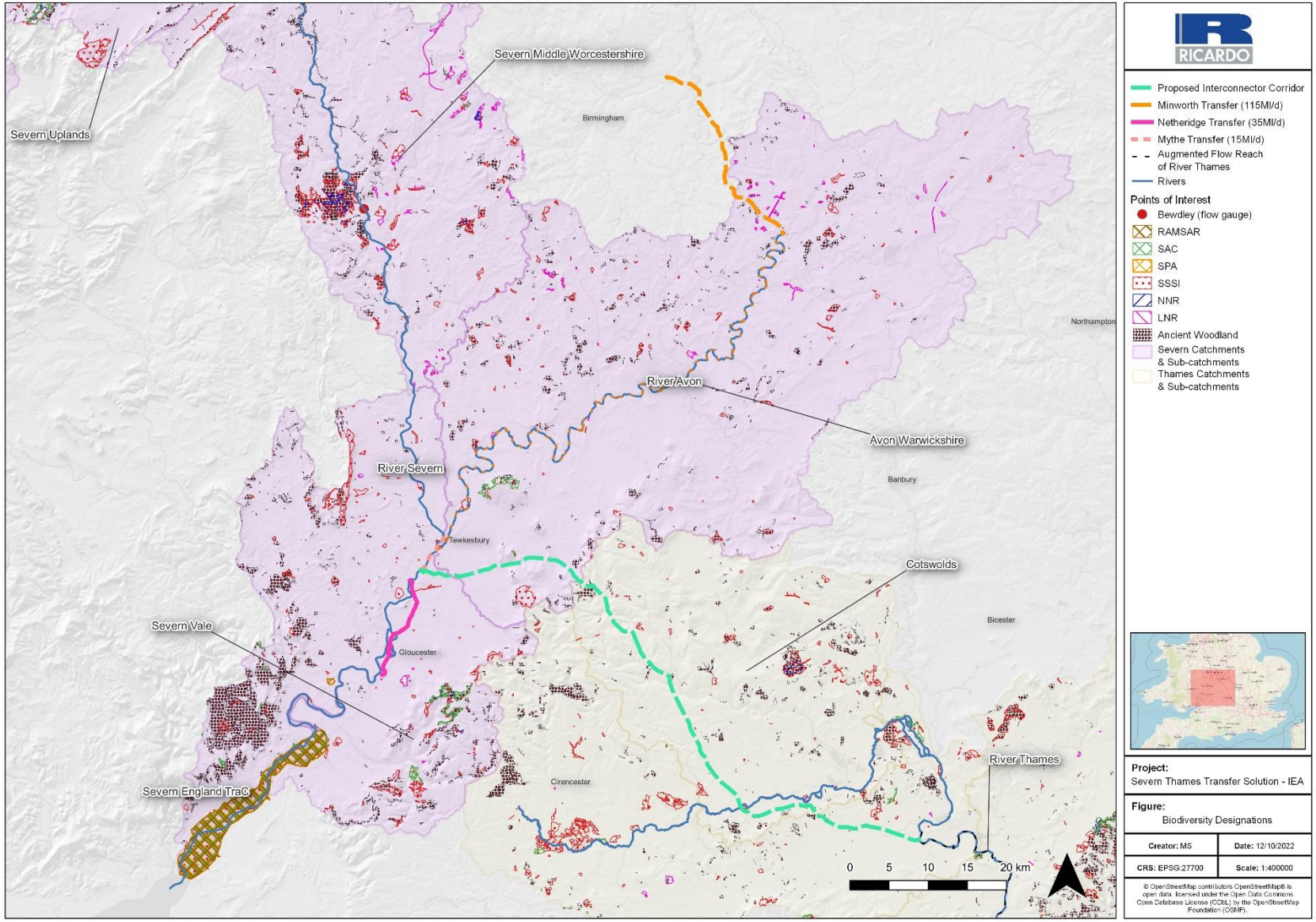

Figure 5.2 Biodiversity Designations – Central

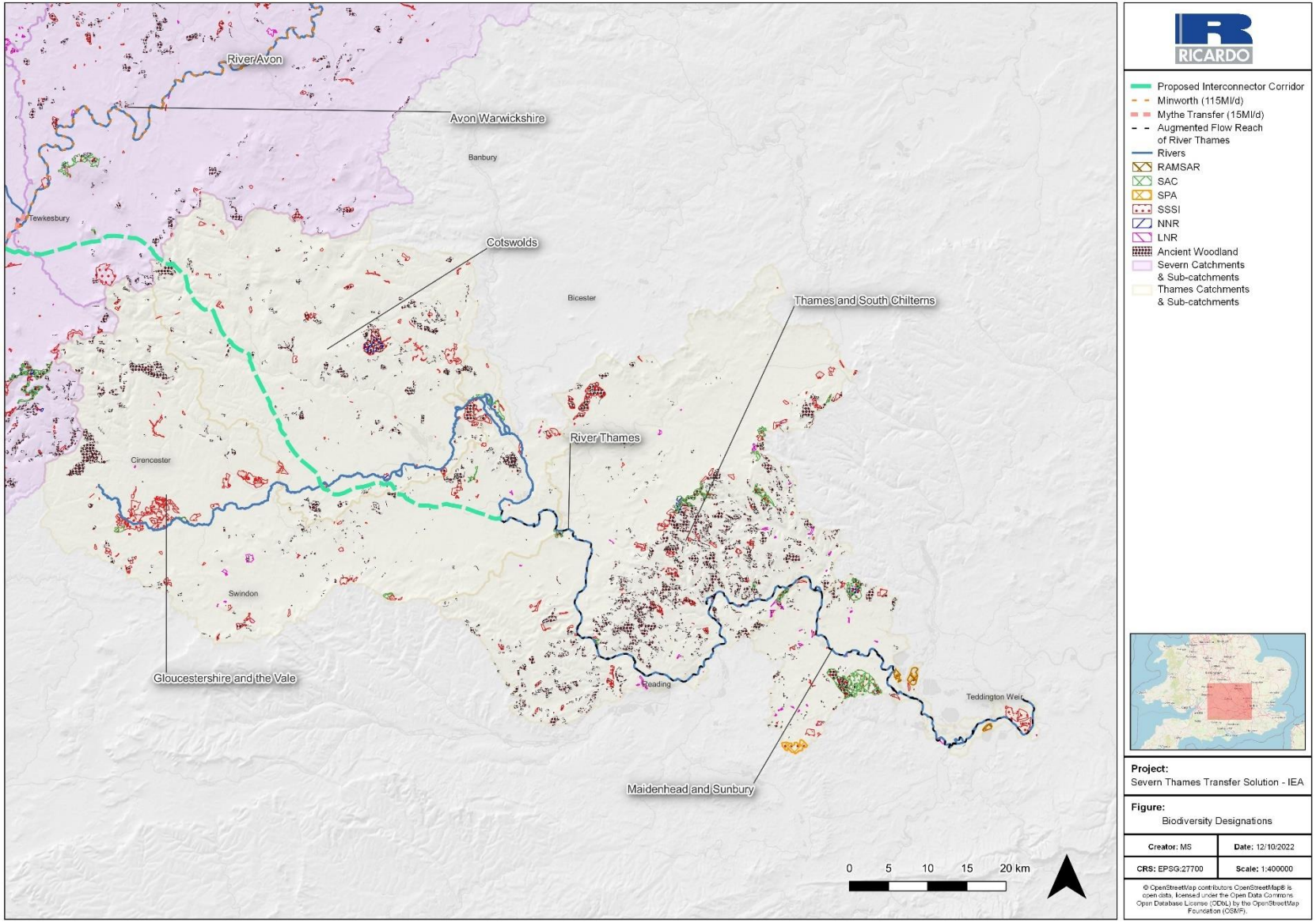

Figure 5.3 Biodiversity Designations – South

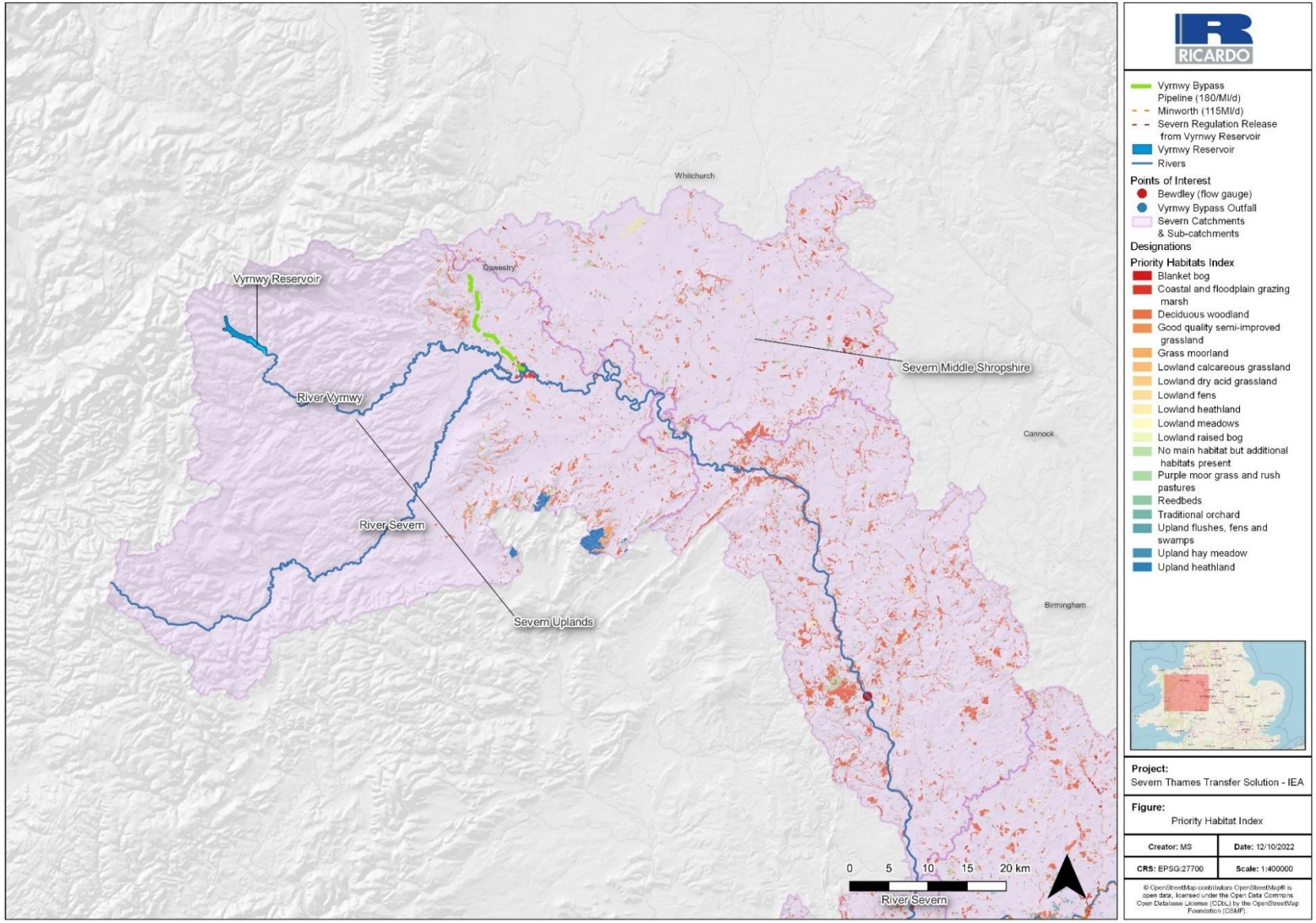

Figure 5.4 Priority Habitats Inventory - North

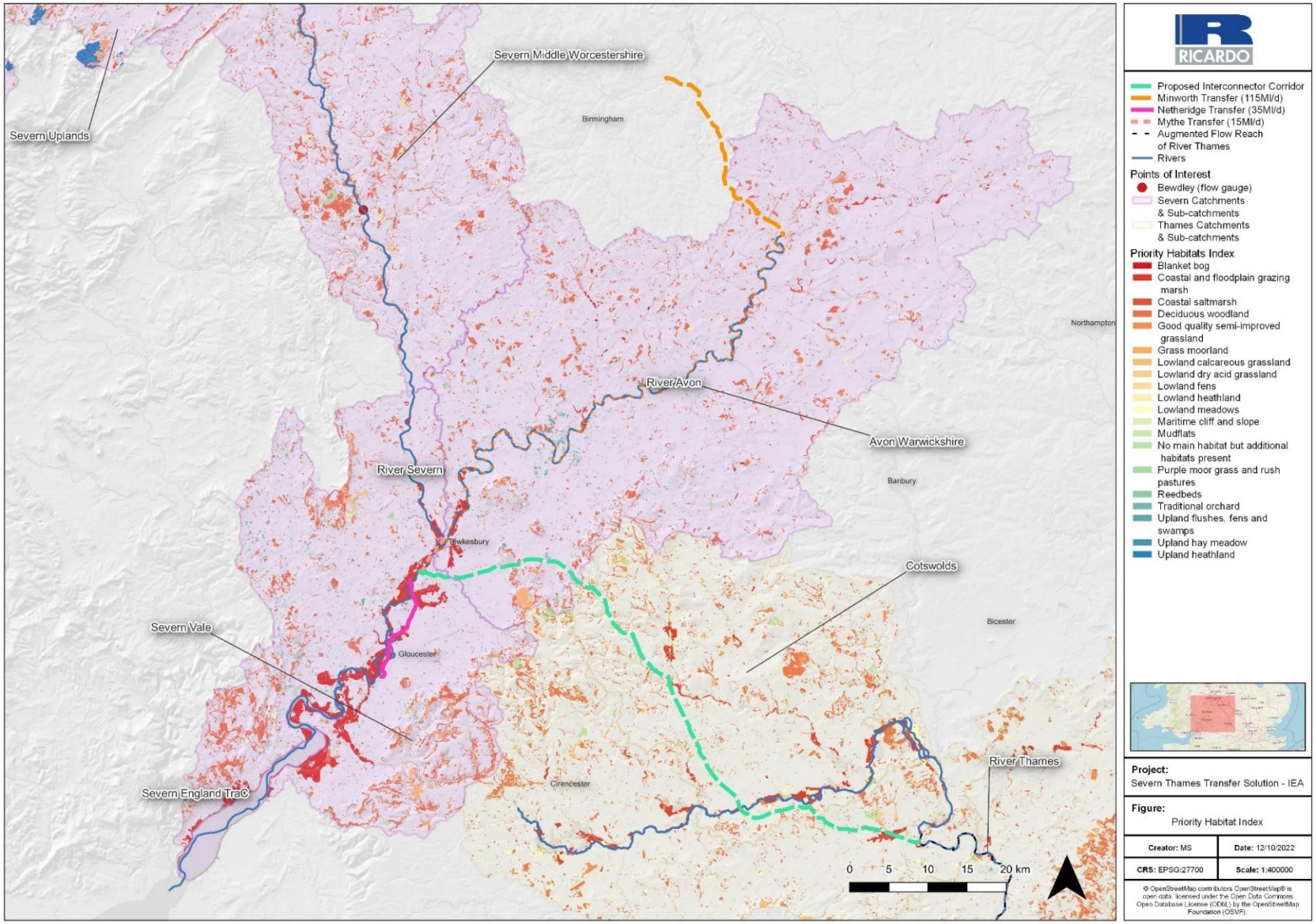

Figure 5.5 Priority Habitats Inventory - Central

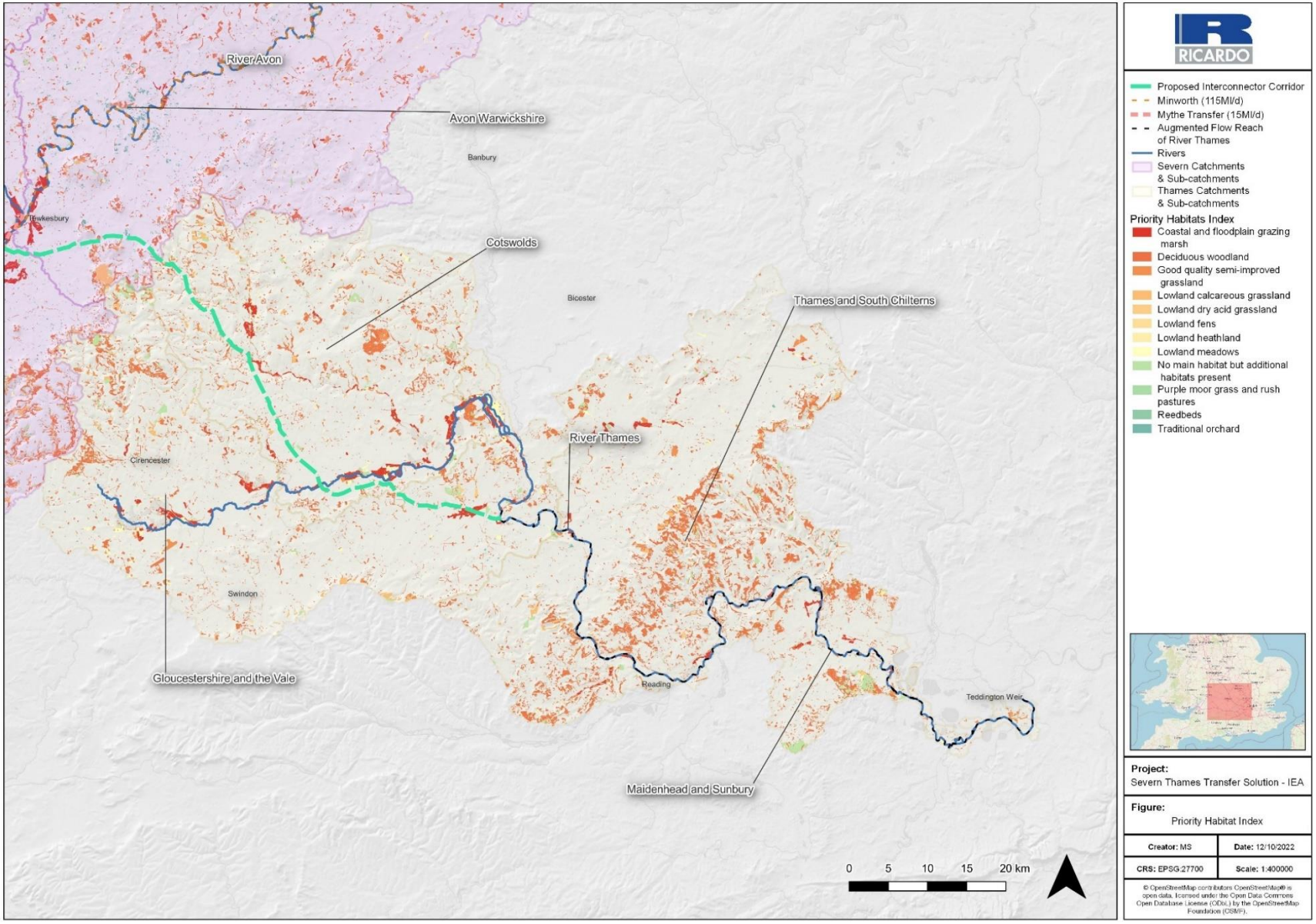

Figure 5.6 Priority Habitats Inventory - South

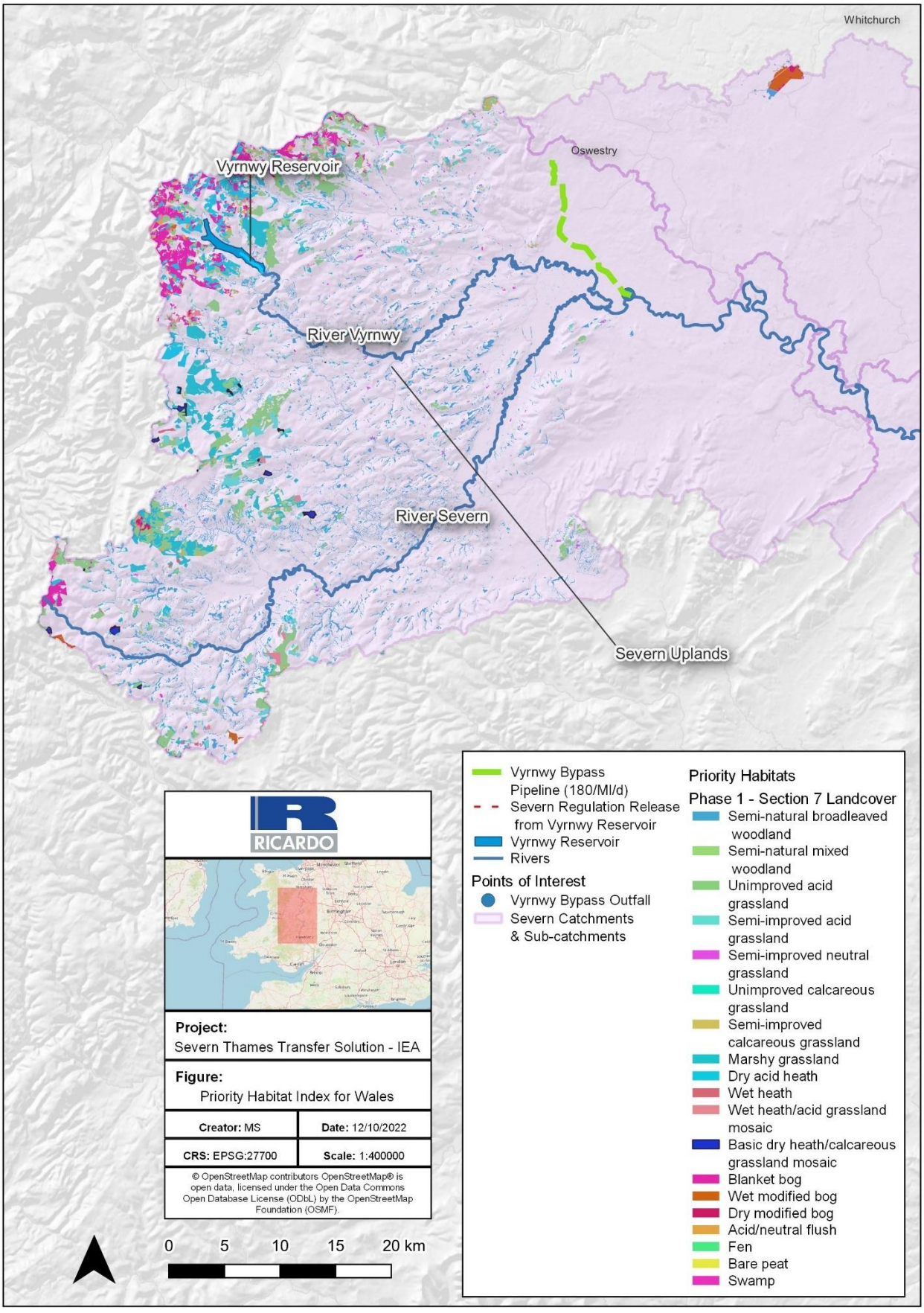

Figure 5.7 Priority Habitats Inventory - Wales

5.1.2 Soil and Land Cover

The underlying geology of the study area is varied and diverse. The western edge of the study area, in mid-Wales, comprises of mudstone, siltstone and sandstone from the Ordovician and Silurian periods. In the Warwickshire / Worcestershire area, the geology comprises mudstone, siltstone and sandstone from the Triassic and Jurassic periods. In the south-eastern parts of the study area, the underlying geology is predominantly sand, silt and clay from the Palaeogene period and white chalk from the Cretaceous period. There is a small area of aquifer to the north which is designated as low productivity.

The Soil Map of England identifies dominant soil subgroups. In terms of agricultural land quality, planning policy seeks to protect the best and most versatile agricultural land (categorised as Grades 1, 2 and 3a of the Agricultural Land Classification (ALC)). Good soil structure is beneficial to water retention and crop yield. Grade 3 agricultural land underpins the majority of the pipeline components of the scheme, accompanied by smaller pockets of higher-grade (Grade 2) soils, as demonstrated in **Figure 5.8, Figure 5.9** and **Figure 5.10**. The ALC Grade of the land within the study area is predominantly ALC Grade 3, with smaller areas of Grade 2 and Grade 1. The Grade 1 areas are concentrated in small pockets along the River Severn and River Avon, and in proximity to the Interconnector pipeline.

Soil quality and structure is affected by changes in land use, groundwater levels and farming practices. Soil quality can influence run-off rates and therefore flooding and water quality.

Contaminated land is defined as land where substances could cause significant harm to people or protected species; or significant pollution of surface waters or groundwaters. Some types of contaminated land can be designated as special sites for a variety of reasons, including land that seriously affects drinking water, surface waters (e.g., lakes and rivers) and important groundwater sites. Data on contaminated land are compiled for the Government by the British Geological Survey.

Historic landfill sites can pose an ongoing threat to the environment and have the potential to pollute surface and groundwaters. In general, the majority of these sites can be dated between 1800 and 1990, when approaches to control contamination were not as stringent. There are 34 historic landfill sites within 10km of the Vyrnwy Bypass pipeline route, with the nearest located 1.1km away. There are 148 historic landfill sites within 10km of the Interconnector pipeline, with the nearest (Sutton Wick No.1) directly adjacent to the proposed route (**Figure 5.8, Figure 5.9** and **Figure 5.10**).

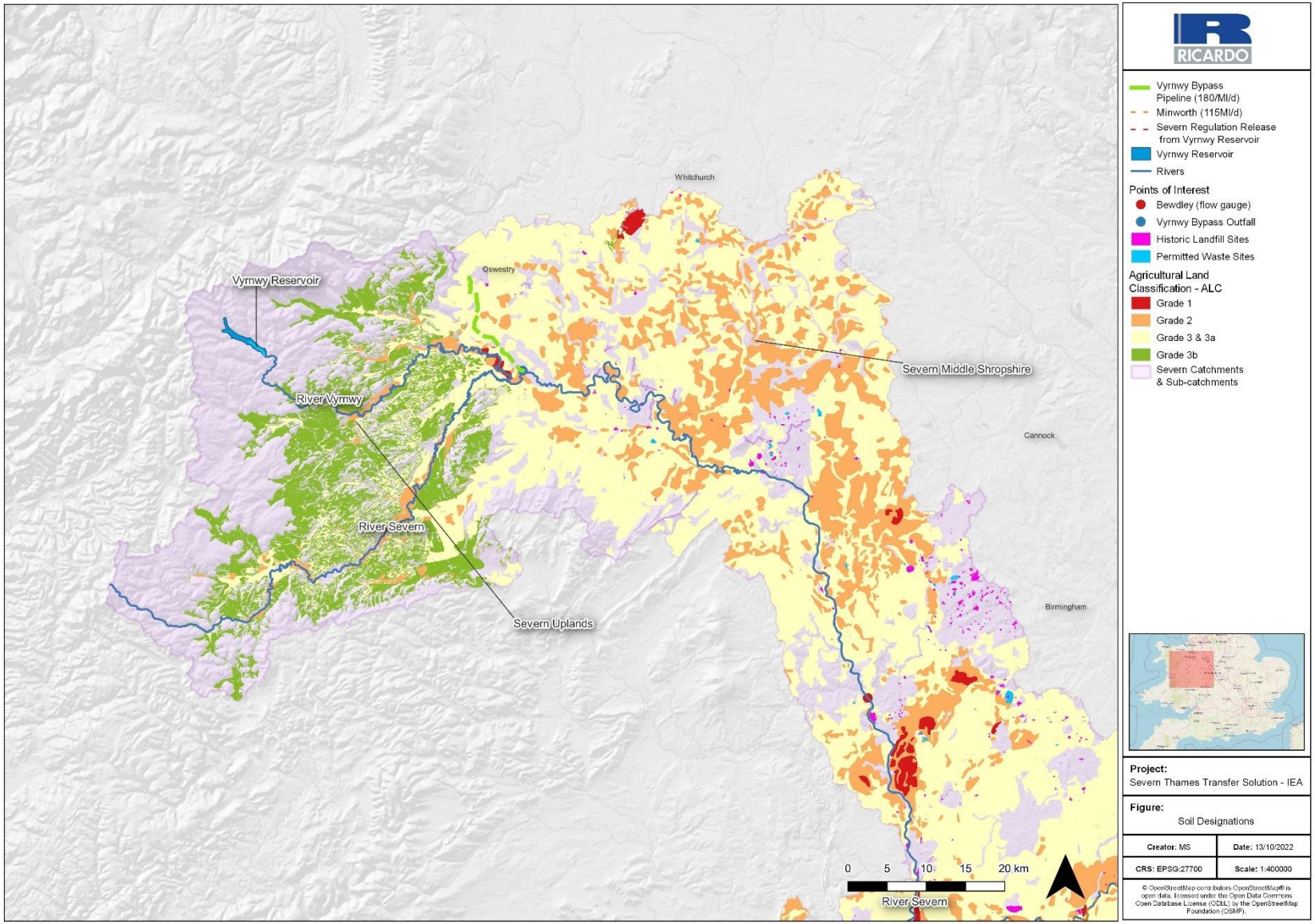

Figure 5.8 Agricultural Land Classification and Landfill Sites - North

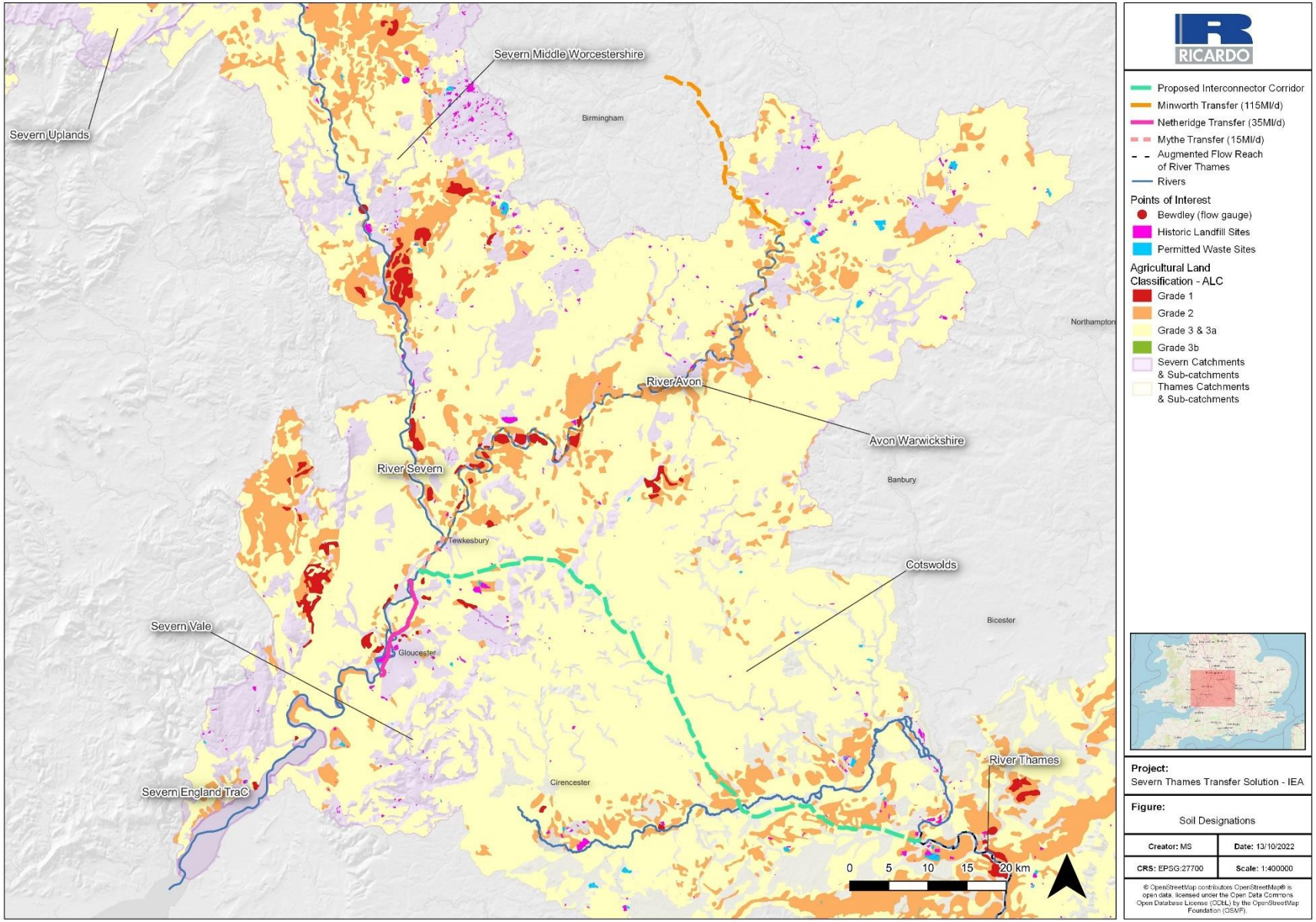

Figure 5.9 Agricultural Land Classification and Landfill Sites - Central

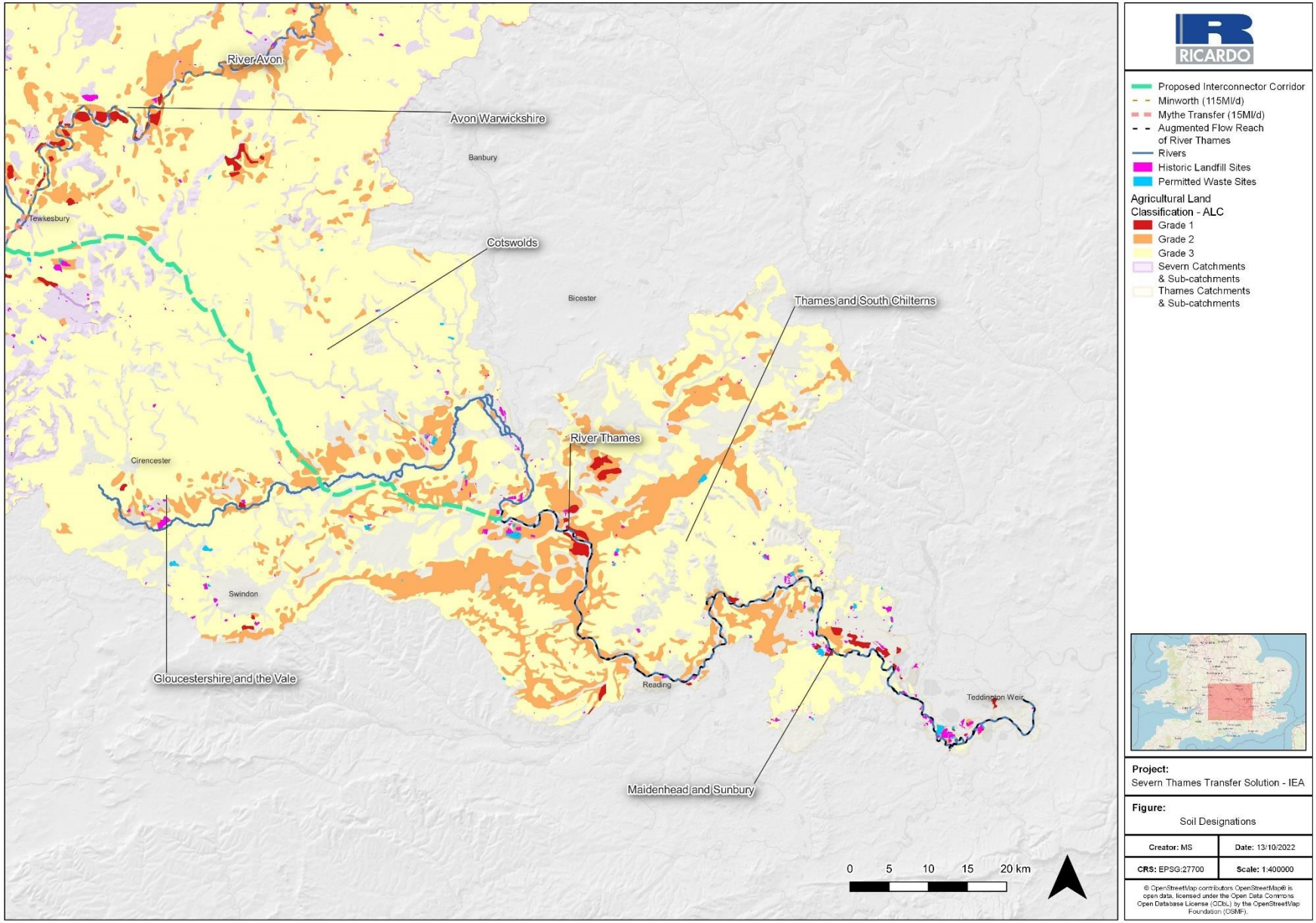

Figure 5.10 Agricultural Land Classification and Landfill Sites - South

5.1.3 Water

The baseline reflects the inter-related nature of water quality, water resources (quantity) and flood risk within the overall water environment. The water environment in the study area is described in the *STT-G2-S3-112-Modelling / Physical Environment Assessment* report and the *STT-G2-S3-113-Water Quality Assessment* report. A baseline summary is provided below.

The assessment area spans eight Management Catchments, including:

- Severn Uplands
- Severn Middle Shropshire
- Severn Middle Worcestershire
- Avon Warwickshire
- Severn Vale
- Cotswolds
- Maidenhead to Sunbury
- Vale of White Horse

For surface waters, there are two separate status classifications for water bodies: ecological and chemical. Ecological classification considers the condition of biological quality elements (e.g., fish and invertebrates), the hydromorphology of supporting habitat and the physio-chemical quality elements. Chemical classification considers priority hazardous substances and other pollutants. **Table 5-2** demonstrates the latest classification data for waterbodies within the study area.

Table 5-2: WFD classification data[47] for waterbodies in the STT solution area (2019, Cycle 2)

WFD Waterbody	WBID	Overall Ecological Status	Overall Chemical Status
Vyrnwy - Lake Vyrnwy to conf Afon Cownwy	GB109054049880	Moderate	High
Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy	GB109054049720	Good	High
Afon Vyrnwy DS of Banwy confluence	GB109054049852	Good	High
Afon Vyrnwy - conf Afon Tanat to conf R Severn	GB109054049800	Moderate	High
Severn – conf Bele Bk to conf Sundorne Bk	GB109054049142	Moderate	Fail
Severn – Sundorne Bk to conf M Wenlock-Farley Bk	GB109054049141	Moderate	Fail
Severn conf M Wenlock-Farley Bk to conf R Worfe Water Body	GB109054049143	Moderate	Fail
Severn – conf R Worfe to conf R Stour Water Body	GB109054049145	Poor	Fail
Severn – conf R Stour to conf River Teme Water Body	GB109054049144	Moderate	Fail
Severn – conf R Teme to conf R Avon Water Body	GB109054039760	Moderate	Fail
Severn – conf R Avon to conf Upper Parting Water Body	GB109054044404	Moderate	Fail

[47] Draft river basin management plan data

WFD Waterbody	WBID	Overall Ecological Status	Overall Chemical Status
Thames (Evenlode to Tame) Water Body	GB106039030334	Moderate	Fail
Thames Wallingford to Caversham Water Body	GB106039030331	Moderate	Fail
Thames (Reading to Cookham) Water Body	GB106039023233	Moderate	Fail
Thames (Cookham to Egham) Water Body	GB106039023231	Moderate	Fail
Thames (Egham to Teddington) Water Body	GB106039023232	Poor	Fail

Further details of the waterbodies summarised in **Table 5-2** can be found in the *STT-G2-S3-122-Water Framework Directive (WFD) Assessment* report.

The STT solution does not contain any activities relevant to the consideration of WFD groundwater bodies during the operational phase. The groundwater bodies that are within proximity of construction are as follows; Severn Uplands – Carboniferous Oswestry, Severn Uplands – PT Sandstone Knockin, Severn Middle Shropshire - Permo-Triassic Sandstone East Shropshire, Severn Vale – Secondary Combined, Warwickshire Avon – Secondary Mudlocks, Avon Warwickshire - Jurassic Limestones Cotswold Edge North, Burford Jurassic, Chipping Norton Jurassic, Thames Upper Gravels and Shrivenham Corallian.

The *STT-G2-S3-112-Modelling / Physical Environment Assessment* report provides a detailed description of the physical characteristics of each river reach that may be impacted by the STT scheme. The descriptions are summarised in **Table 5-3**. The Physical Environment Assessment Report contains the overview characteristics in greater detail.

Table 5-3: Overview of the physical characteristics of river reaches potentially affected by the STT solution

Reach Name	Characteristics
River Vyrnwy, Vyrnwy Reservoir to the confluence with the River Severn	Several large tributaries. Steep sided V-shaped valley for first 20km and then widens out. Middle of the reach is very low gradient. Runs and riffles predominate. Abundant sediment bars. 9 bridges.
River Severn, Vyrnwy Bypass Outfall to Bewdley	One very large tributary with the River Tern and five smaller tributaries. Inputs from two wastewater treatment works. Very low gradient. Fairly sinuous. Deep glides and runs, occasional riffles. 48 bridges. 2 weirs.
River Severn, Bewdley to confluence with River Avon	One very large tributary with the River Teme and two smaller tributaries. Inputs from one wastewater treatment works. Very low gradient. River widths of 40-60m. Passes through Worcester and other urban areas. Deep glides, sediment bars are rare. 12 bridges and four weirs.
River Severn, Stoneleigh to confluence with River Avon	Eight medium tributaries. Inputs from four wastewater treatment works. Very low gradient. River widths of 25-35m. Passes through Warwick and other urban areas. Mixture of glides and runs, occasional riffles and rapids. Sediment bars are rare. Approximately 50 bridges and 26 weirs.
River Severn. Confluence with River Avon to Deerhurst	Very short reach of only 2.6km. Deep glides.
River Severn, Deerhurst to the tidal limit at Gloucester	Very low gradient and low sinuosity. River widths of 50-65m. Some areas have extensive riparian tree cover. Deep glides and runs, occasional rapids. No sediment bars. One bridge and two weirs.

Reach Name	Characteristics
Severn Estuary downstream of the tidal limit at Gloucester	Severn estuary covers 55,700ha. Tide dominated. Twice-daily high-low-high tides. Main freshwater flow is over Maisemore Weir.
River Thames, from Culham to the tidal limit at Teddington	Culham to Windsor reach is of a very low gradient, falling 35m over its length and is fairly sinuous. River widths vary from ~25-30m at the start of the reach, increasing to around 50m in the middle of the reach and increasing again to 50-60m at the end of the reach, with localised widths around impounding structures being well over 60m. From Windsor to Teddington the reach is of a very low gradient, falling 13m over its length, and is fairly sinuous. River channel widths vary from ~50-65m across the reach, however localised widths can be much larger (up to ~80m) around islands and impounding structures. Both reaches are characterised by a mixture of deep glides and runs, with occasional rapids over weirs.

The *STT-G2-S3-113-Water Quality Assessment* report provides a detailed description of the water quality in each river reach that may be impacted by the STT solution. For many of the reaches, it is stated that there is no pathway where the STT solution could impact upon water quality, and they are not assessed further.

Flooding can result from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources. The extreme floods of 2007 prompted the Pitt Review (2008) and the subsequent Flood and Water Management Act 2010 which in part regulates the implementation of sustainable drainage systems to increase infiltration and reduce flooding from surface water runoff. Across the country, the Government budgeted £2.3bn on 1,500 flood defence schemes between 2015 -2021. Approximately half of the Vyrnwy Bypass pipeline will be within Flood Zones 2 and 3 (See **Figure 5.11**). The Interconnector passes through some areas of Flood Zones 2 and 3 also (See **Figure 5.12** and **Figure 5.13**).

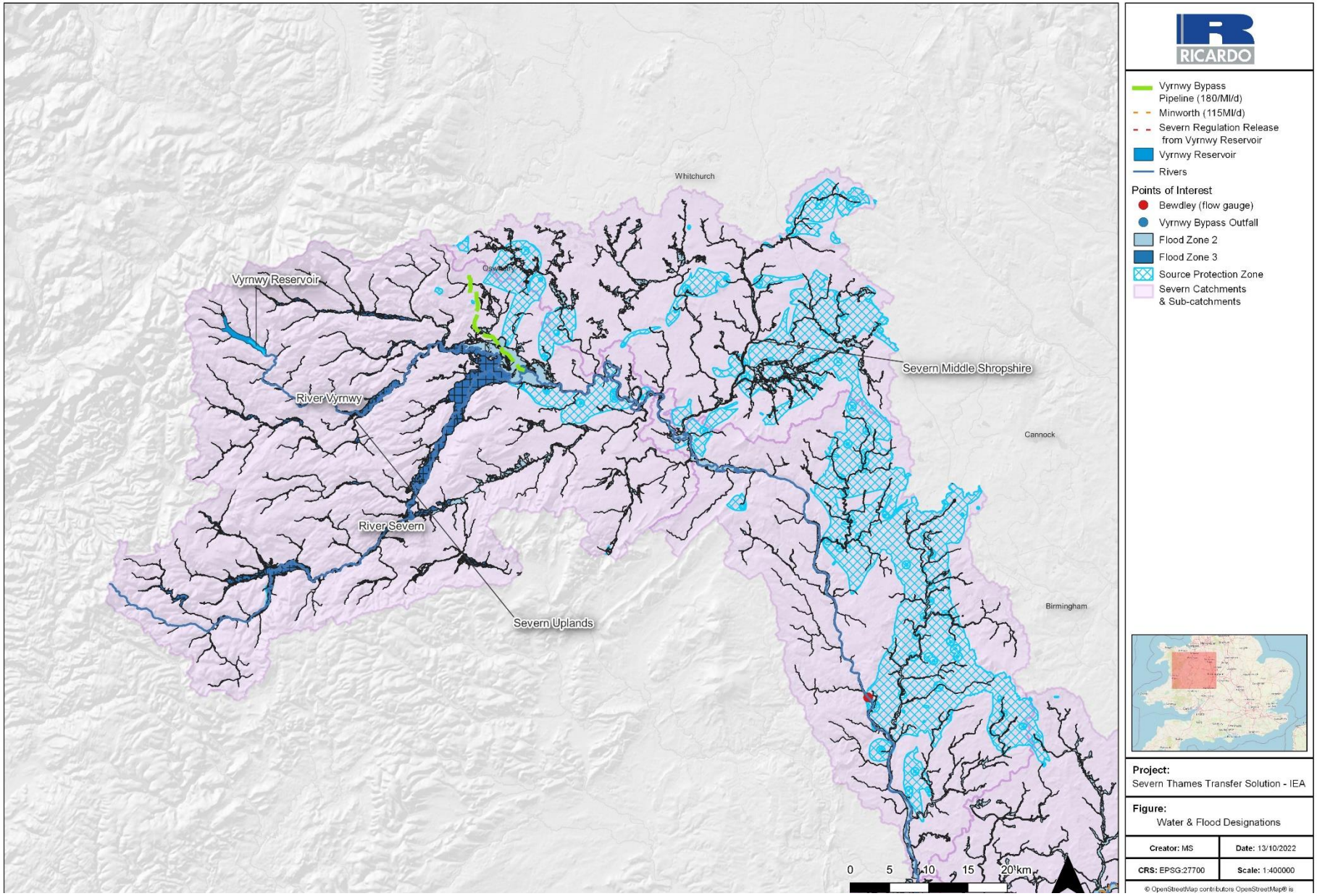

Figure 5.11 Water Environment and Flood Risk - North

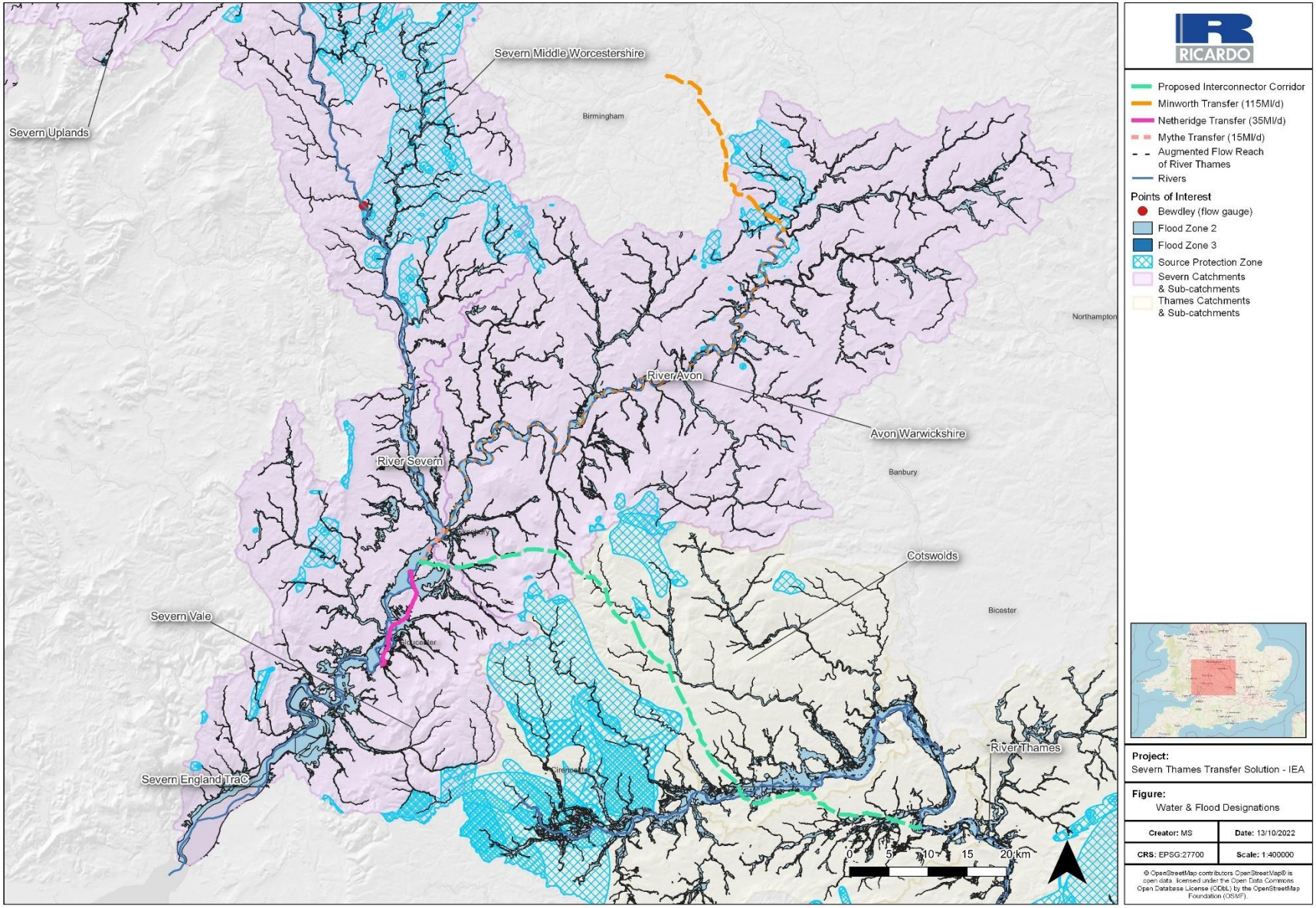

Figure 5.12 Water Environment and Flood Risk - Central

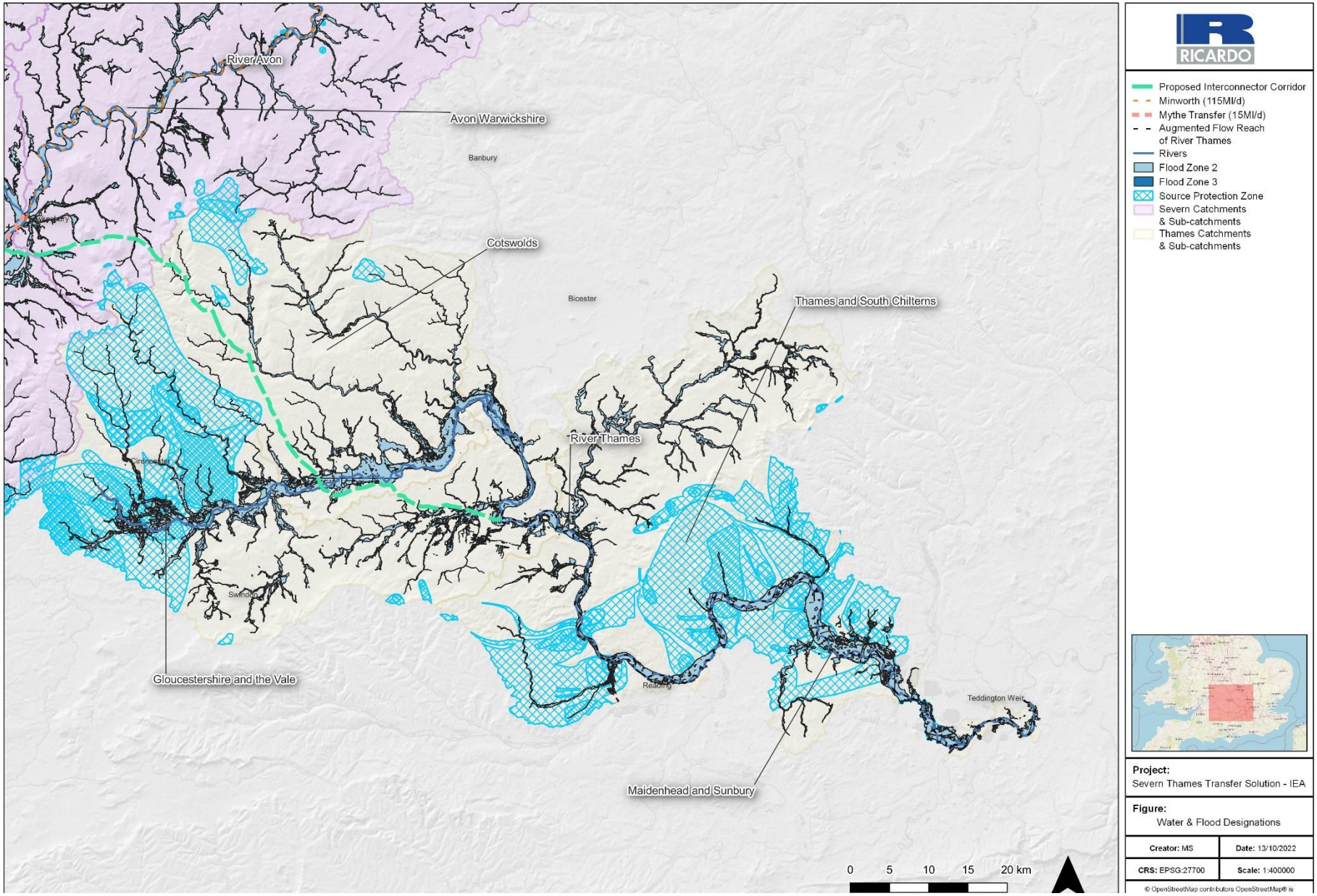

Figure 5.13 Water Environment and Flood Risk - South

5.1.4 Air

The activities associated with the construction and operation of this scheme have the potential to lead to adverse effects on local air quality through emissions associated with construction activities (including vehicle movements) or through the operation of various components of the scheme.

The local air quality baseline can be described through the presence of designated Air Quality Management Areas (AQMA). A local authority declares an AQMA when UK national air quality targets are unlikely to be met. **Figure 5.14, Figure 5.15** and **Figure 5.16** indicate the AQMAs in the assessment area. There are six AQMAs within 10km of construction areas which are marked in **Table 5-4***.

Table 5-4 AQMAs* in assessment area

Local Authority	AQMA
Birmingham City Council	Birmingham AQMA
Bracknell Forest Borough Council	Area 1: The Bagshot Road (A322) Horse and Groom Roundabout Downshire Way AQMA
Bristol City Council	Bristol AQMA
Bromsgrove District Council	Lickley End AQMA
Bromsgrove District Council	Redditch Road AQMA Stoke Heath
Bromsgrove District Council	AQMA No 4 Worcester Road
Buckinghamshire	Stoke Road AQMA
Buckinghamshire	Friarage Road AQMA
Buckinghamshire	Tring Road AQMA
Buckinghamshire	AQMA No.2 (High Wycombe)
Buckinghamshire	AQMA No.3 (Marlow)
Buckinghamshire	AQMA No.1 (M40)
Buckinghamshire	South Bucks AQMA
Cheltenham Borough Council	***Cheltenham Whole Borough AQMA***
Cotswold District Council	Birdlip AQMA
Cotswold District Council	Thames Street, Lechlade
Coventry City Council	Coventry City-Wide AQMA
Dudley Metropolitan Borough Council	Dudley AQMA
Elmbridge Borough Council	Walton Road, Molesey AQMA
Elmbridge Borough Council	Weybridge AQMA
Elmbridge Borough Council	Hampton Court AQMA
Elmbridge Borough Council	Walton AQMA
Forest of Dean District Council	Lydney AQMA
Gloucester City Council	Priory Road AQMA
Gloucester City Council	Barton Street AQMA
Gloucester City Council	Painswick Road AQMA
Harborough District Council	Lutterworth AQMA
London Borough of Hounslow	Hounslow AQMA
London Borough of Richmond	Richmond AQMA
Oxford City Council	***The City of Oxford***
Reading Borough Council	Reading AQMA
Royal Borough of Kingston upon Thames	Kingston upon Thames AQMA
Royal Borough of Windsor & Maidenhead	Maidenhead AQMA
Royal Borough of Windsor & Maidenhead	Bray/M4 AQMA

Local Authority	AQMA
Royal Borough of Windsor & Maidenhead	Windsor AQMA
Royal Borough of Windsor & Maidenhead	Imperial/St Leonards Road Junction
Royal Borough of Windsor & Maidenhead	Wraysbury/M25
Rugby Borough Council	Rugby AQMA (NO2)
Runnymede Borough Council	M25 AQMA
Sandwell Metropolitan Borough Council	Sandwell AQMA
Shropshire Council	***Shrewsbury Town Centre AQMA***
Shropshire Council	Bridgnorth AQMA
Slough Borough Council	Slough AQMA No.1
Slough Borough Council	Slough AQMA No. 4
Slough Borough Council	Slough AQMA No. 3 Extension
South Oxfordshire District Council	Wallingford AQMA
South Oxfordshire District Council	Watlington AQMA
South Oxfordshire District Council	Henley AQMA
Spelthorne Borough Council	Spelthorne AQMA
Stratford on Avon District Council	Studley AQMA
Stratford on Avon District Council	Stratford upon Avon District Council (No 1) 2010
Swindon Borough Council	Kingshill Road, Swindon AQMA
Tewkesbury Borough Council	***Tewkesbury Town Centre AQMA***
Vale of White Horse District Council	***Abingdon AQMA***
Vale of White Horse District Council	Botley AQMA
Vale of White Horse District Council	***Marcham AQMA***
Warwick District Council	Leamington Spa AQMA
Warwick District Council	Warwick AQMA (Amended 2008)
Warwick District Council	Warwick Road (Kenilworth) AQMA
Warwick District Council	Warwick Coventry Road
Warwick District Council	New Street (Kenilworth) AQMA
West Oxfordshire District Council	Chipping Norton AQMA
West Oxfordshire District Council	Witney AQMA
Wolverhampton City Council	Wolverhampton Air Quality Management Area 2005
Worcester City Council	Worcester City (Political Boundary)
Wychavon District Council	Worcester Road, Wychbold AQMA
Wyre Forest District Council	Welch Gate AQMA
Wyre Forest District Council	Kidderminster (Ring Road) AQMA

5.1.5 Climate

Water resource schemes have the potential to create beneficial effects on climate change mitigation and adaptation through the provision of additional water resource which reduces vulnerability to water supply risks attributed to climate change. Adverse effects are also possible as the operation of the schemes rely on energy usage for treatment and pumping processes. Water companies have commitments to achieve net zero in line with government targets.

Climate monitoring and risk assessments have improved significantly over the last two decades but there are still limits to the understanding of future climate change impacts. Whatever happens to future 'greenhouse gas' emissions, there is already a certain amount of global warming "locked in" due to historic emissions due to the inertia and lags in the global climate system. Mitigation through reduction in greenhouse gas emissions will contribute to risk reduction over the long term (100 years). Adaptation is, however, needing to start now,

to reduce the costs and damages of potential impacts and to take advantage of opportunities that result from a changing climate.

The 2018 UK Climate Projections (UKCP18) to 2100 estimate that there will be:

- More intense rainfall events;
- Hotter, drier summers;
- More flooding of low-lying coastal areas;
- Milder and wetter winters;
- Less snowfall and frost;
- Lower groundwater levels.

Climate resilience has been considered for the STT solution as requested by regulators. For the environmental assessments, this has included the modelling of a selected version of 2070s meteorological patterns using RCP8.5. Demands and abstractions are set at RCM08 scenario 1 in 500 deployable output level. Representative Severn Regulation pattern was set by the water resource model. The future climate change scenarios modelled for the River Severn were Moderate-low flow (1:5-1:10 return period) and for the River Thames Very low flow (1:20 return period).

5.1.6 Landscape and Visual Amenity

National Character Areas (NCAs) divide England into distinct natural areas, each defined by a unique combination of landscape, biodiversity, geodiversity, history, and cultural and economic activity. The STT solution study area is covered by a number of these NCAs including the Oswestry Uplands, Shropshire, Cheshire and Staffordshire Plain, Severn and Avon Vales, Cotswolds, Thames and Avon Vales and Midvale Ridge[48].

The intake at Shrewsbury is located within the Shropshire, Cheshire and Staffordshire Plains NCA, which is described as an expanse of flat or gently undulating, lush, pastoral farmland. Bounded by hills of the Welsh borders and urban settlements. A series of small sandstone ridges cut across the plain and are very prominent features within this open landscape. The Vyrnwy Bypass pipeline falls within this NCA along with the Oswestry uplands NCA (steep-sided, flat-topped hills mainly of limestone and narrow, wooded valleys and streams).

The interconnector pipeline crosses four NCAs. The characteristics of these areas are described below:

- Severn and Avon Vales - *The lower valleys of the rivers Severn and Avon dominate this low lying open agricultural vale landscape made up of distinct and contrasting vales, including Evesham, Berkeley, Gloucester, Leadon and Avon.*
- Cotswolds - *Predominantly oolitic Jurassic Limestone belt that stretches from the Dorset coast to Lincolnshire. The dominant pattern of the Cotswold landscape is of a steep scarp crowned by a high, open wold; the beginning of a long and rolling dip slope cut by a series of increasingly wooded valleys.*
- Upper Thames Clay Vales - *A broad belt of open, gently undulating lowland farmland on predominantly Jurassic and Cretaceous clays. There are contrasting landscapes, including enclosed pastures of the claylands with wet valleys, mixed farming, hedges, hedge trees and field trees and more settled, open, arable lands. Mature field oaks give a parkland feel in many places.*
- Midvale Ridge - *A band of low-lying limestone hills stretching east–west from the Vale of Aylesbury in Buckinghamshire to Swindon. It is surrounded by the flat lands of the Oxfordshire clay vales, giving extensive views across the surrounding countryside.*

The Oxford greenbelt and Birmingham greenbelt are directly adjacent to the scheme. The Cheltenham and Gloucester greenbelt is within 500m.

The Shropshire Hills AONB is intersected by the River Severn and is 8km from proposed construction works. The proposed interconnector pipeline intersects the Cotswold AONB (See **Figure 5.18**). There are four additional AONBs within the STT study area: Chilterns, Wye Valley, Malvern Hills and North Wessex Downs.

[48] Natural England (2014) National Character Area Profiles https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making/national-character-area-profiles

5.1.7 Historic Environment

The scheme has the potential to affect historic landscape character and historic structures associated with the water environment. Archaeological remains are sensitive to changes in water quality, water levels (such as waterlogged deposits), pollution and land use practices.

The National Planning Policy Framework (NPPF[49]) defines the historic environment as: '*All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora.*'

Listed buildings are designated for their special architectural and historic interest in order for them to be protected for future generations. Listed buildings are graded Grade I (approximately 3% of all listings), Grade II* (5.8% of listings) and Grade II (approximately 92% of listings)[50]. There are 662 listed buildings within proximity to the scheme (See **Figure 5.20,Figure 5.21** and **Figure 5.22**). For the Shrewsbury scheme, there are 18 listed buildings within 1km of the scheme with 4 being within 500m. The Interconnector has 166 listed buildings within 500m and a further 395 that are within 1km. There are a total of 83 listed buildings in proximity to the Vyrnwy scheme; 21 are within 500m and 62 are within 1km.

Conservation areas are created to manage and protect the special architectural and historic interest of a place[51]. Most Conservation areas are designated by local planning authorities. The Cotswold district, located within the STT study area, has the third highest number of conservation areas (145)[52]. There are multiple conservation areas within the STT study area given the coverage of numerous local planning authorities, however, only 17 conservation areas are within 1km of proposed construction works for the STT scheme (**Table 5-5**).

Table 5-5 Overview of Conservation Area that may be impacted by the STT solution

Conservation Area	Associated Schemes
Oswestry	Vyrnwy Bypass
Shrewsbury	Shrewsbury Intake
Gretton	Deerhurst to Culham Interconnector
Farmcote	Deerhurst to Culham Interconnector
Temple Guiting	Deerhurst to Culham Interconnector
Guiting Power	Deerhurst to Culham Interconnector
Naunton	Deerhurst to Culham Interconnector
Cold Aston	Deerhurst to Culham Interconnector
Sherbourne	Deerhurst to Culham Interconnector
Windrush	Deerhurst to Culham Interconnector
Filkins and Broughton Poggs	Deerhurst to Culham Interconnector
Langford	Deerhurst to Culham Interconnector
Buckland	Deerhurst to Culham Interconnector
Marcham	Deerhurst to Culham Interconnector
Drayton	Deerhurst to Culham Interconnector
Culham	Deerhurst to Culham Interconnector
Sutton Courtenay	Deerhurst to Culham Interconnector

In addition to sites identified above, due to the scale of the study area, there remains possibility that construction works could impact upon previously unknown, undesignated heritage assets and archaeological remains.

[49] MHCLG (2021) National Planning Policy Framework

[50] Historic England (2022) What are Listed Buildings? https://historicengland.org.uk/listing/what-is-designation/listed-buildings/

[51] Historic England (2022) What is a Conservation Area? https://historicengland.org.uk/listing/what-is-designation/local/conservation-areas/

[52] Historic England (2022) What is a Conservation Area? https://historicengland.org.uk/listing/what-is-designation/local/conservation-areas/

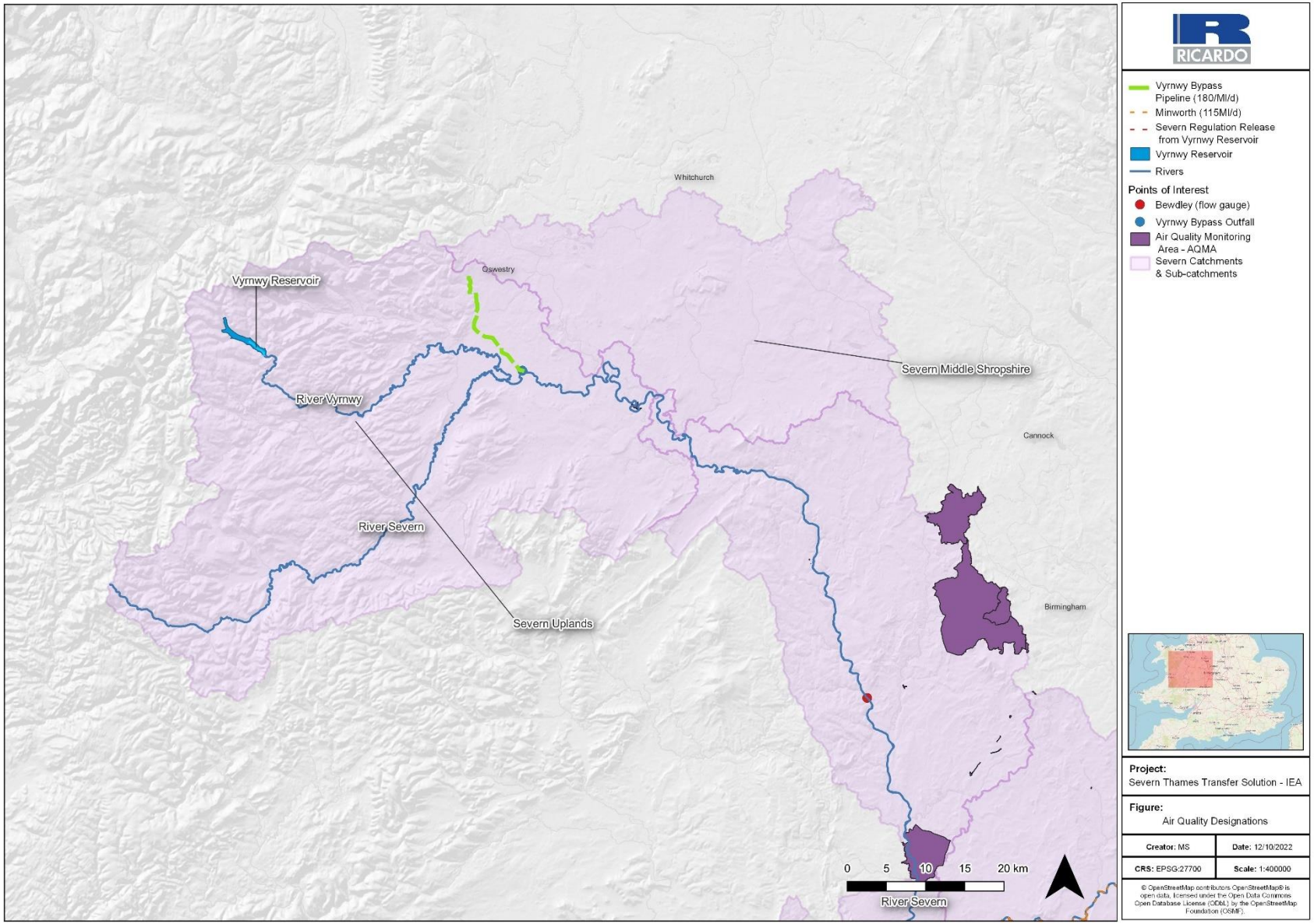

Figure 5.14 Air Quality – North

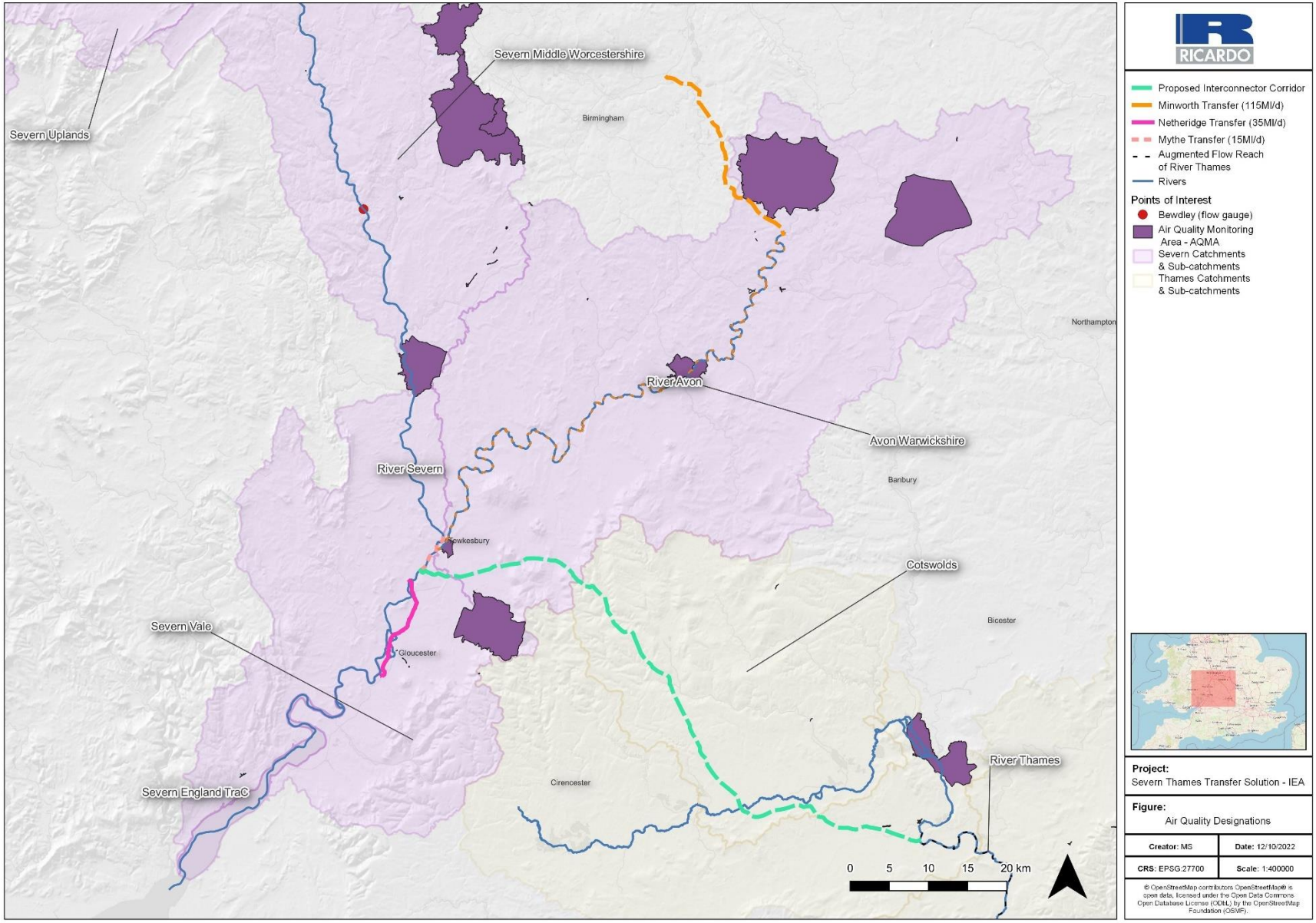

Figure 5.15 Air Quality – Central

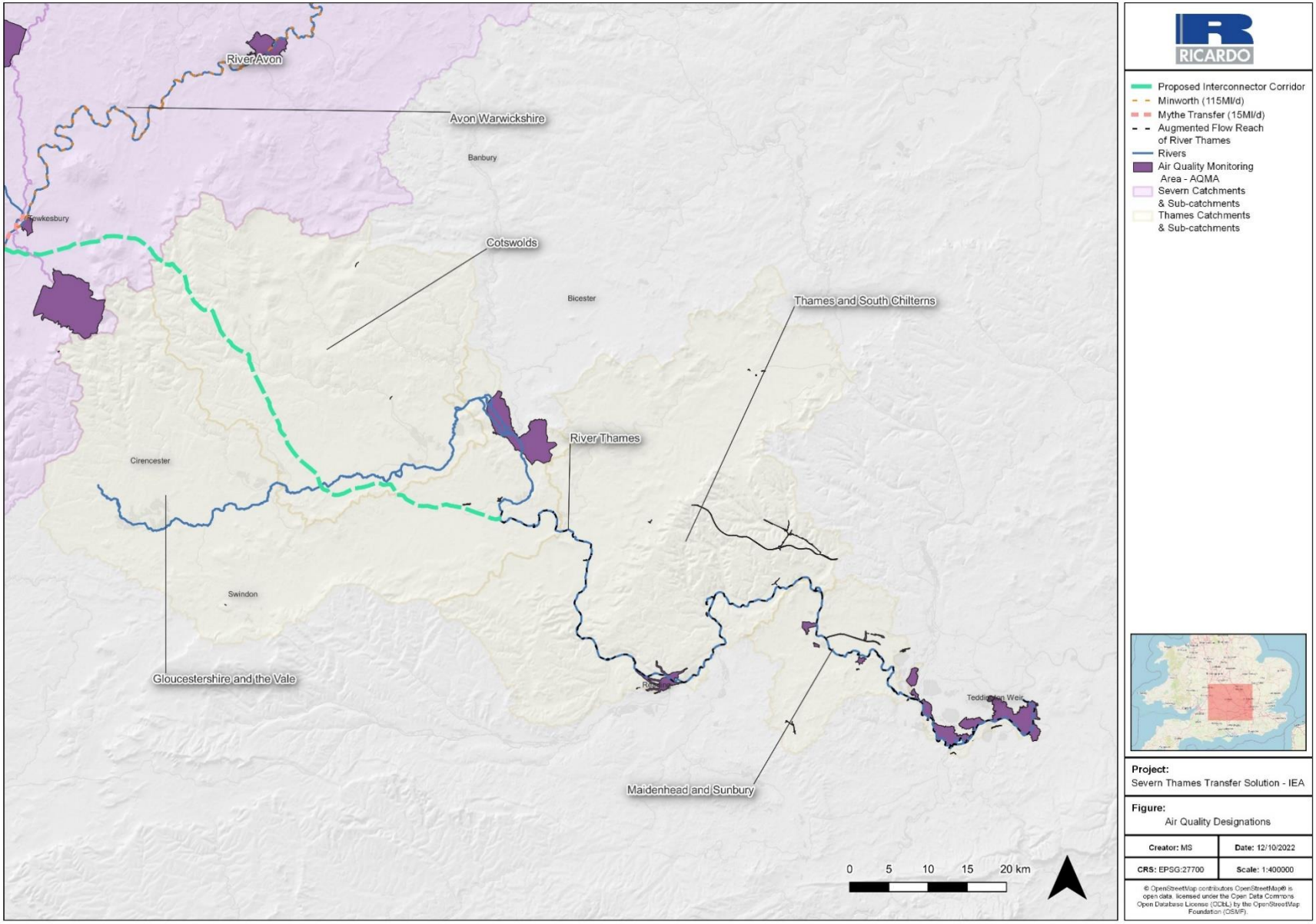

Figure 5.16 Air Quality - South

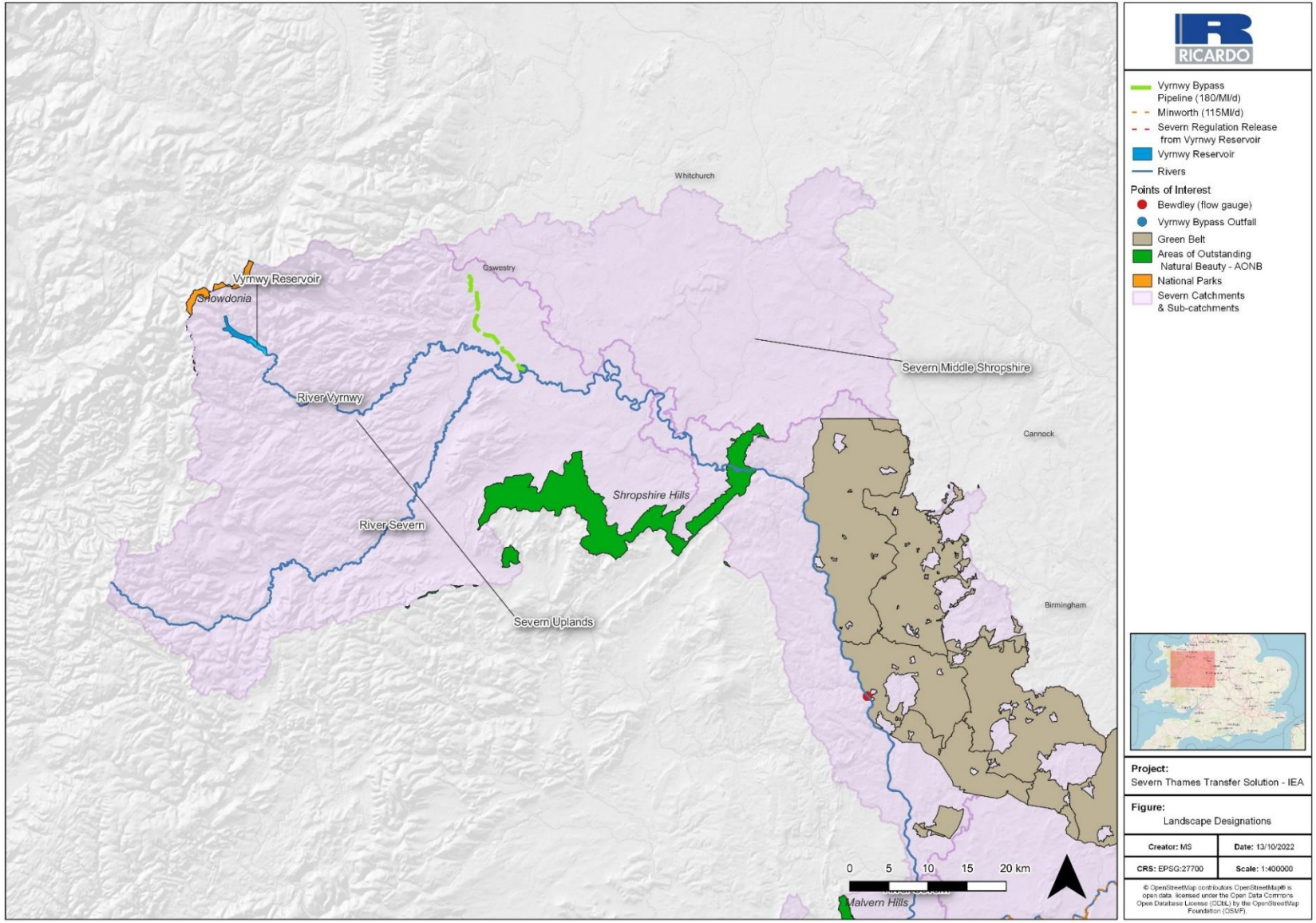

Figure 5.17 Landscape Designations - North

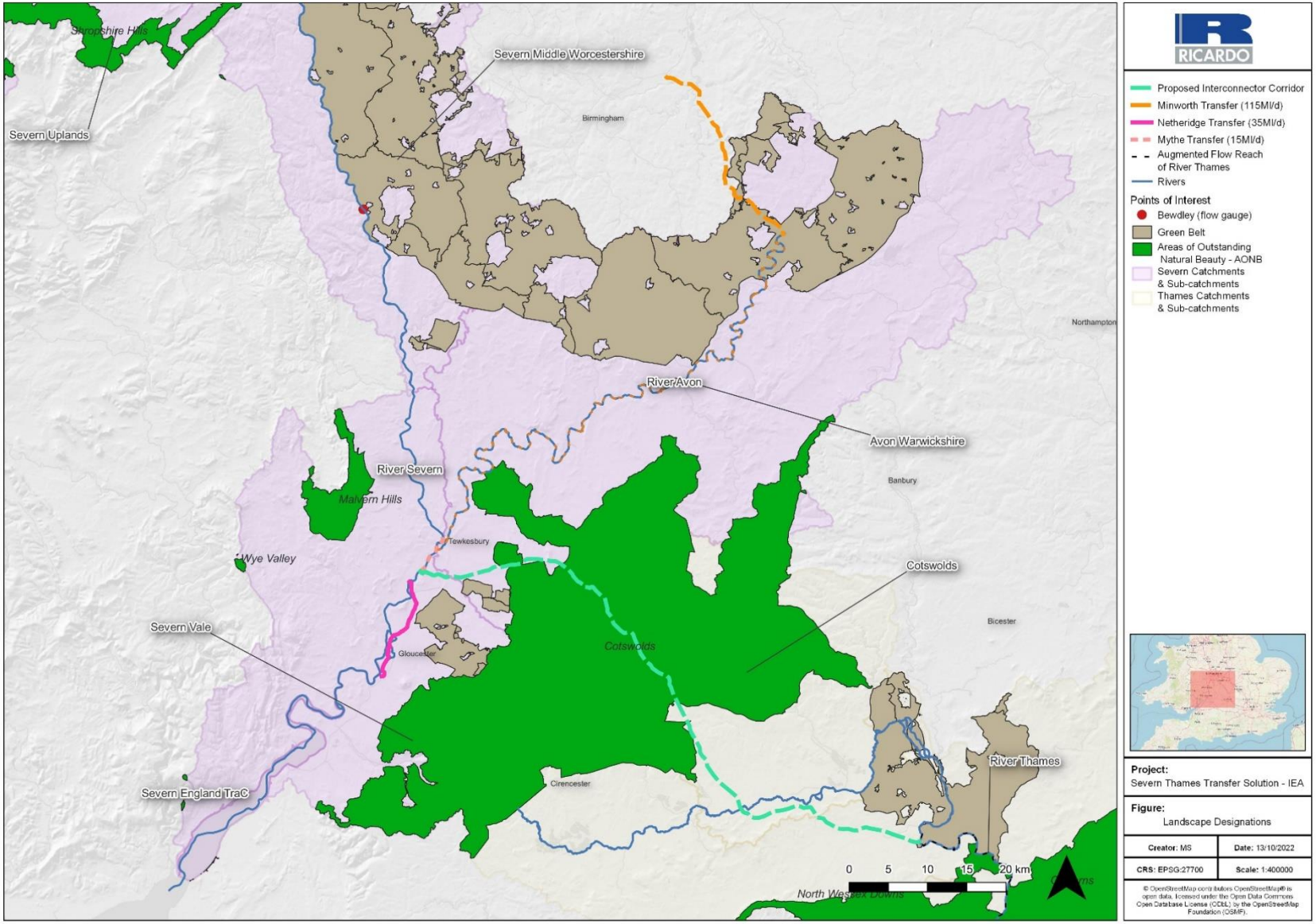

Figure 5.18 Landscape Designations - Central

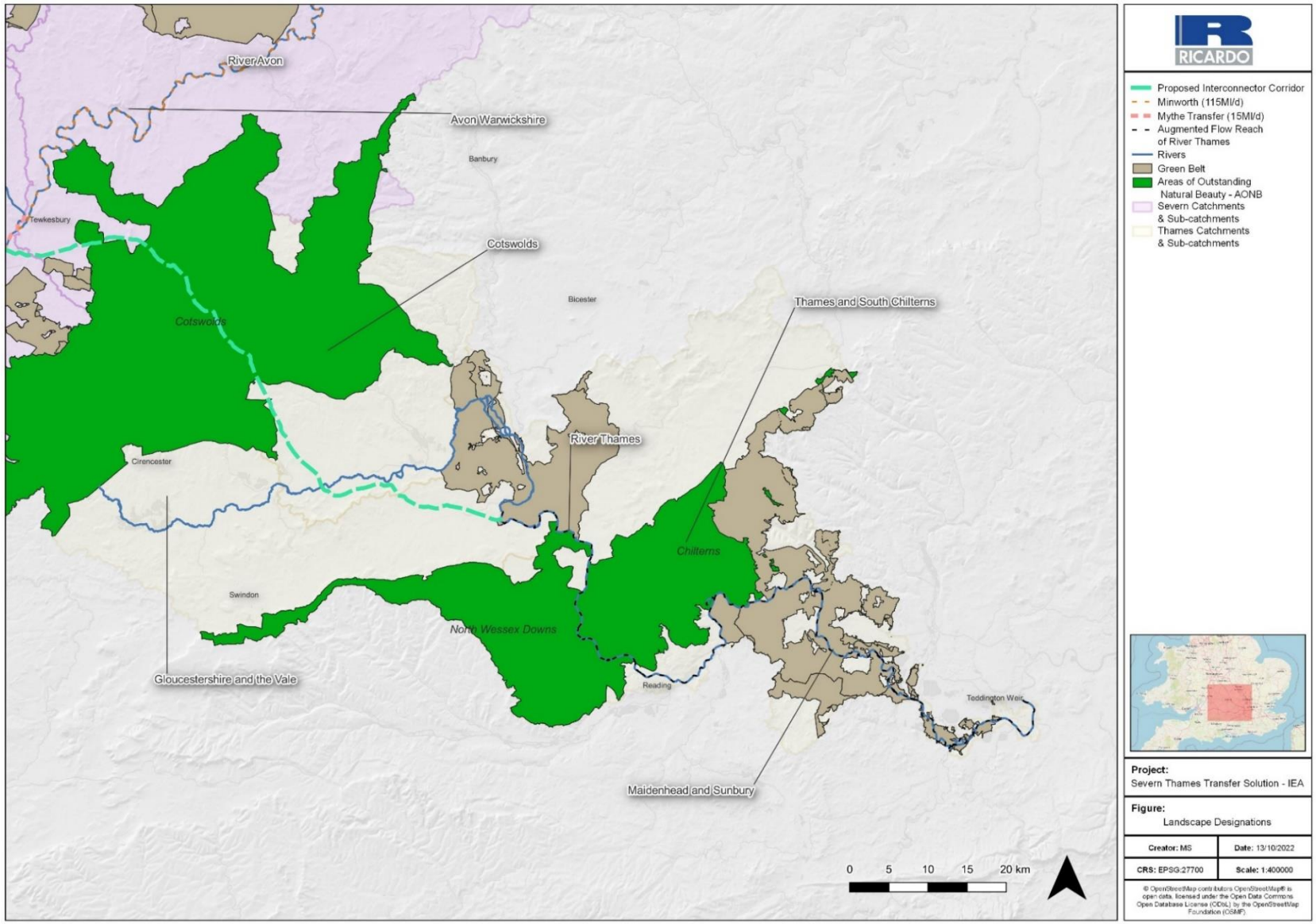

Figure 5.19 Landscape Designations - South

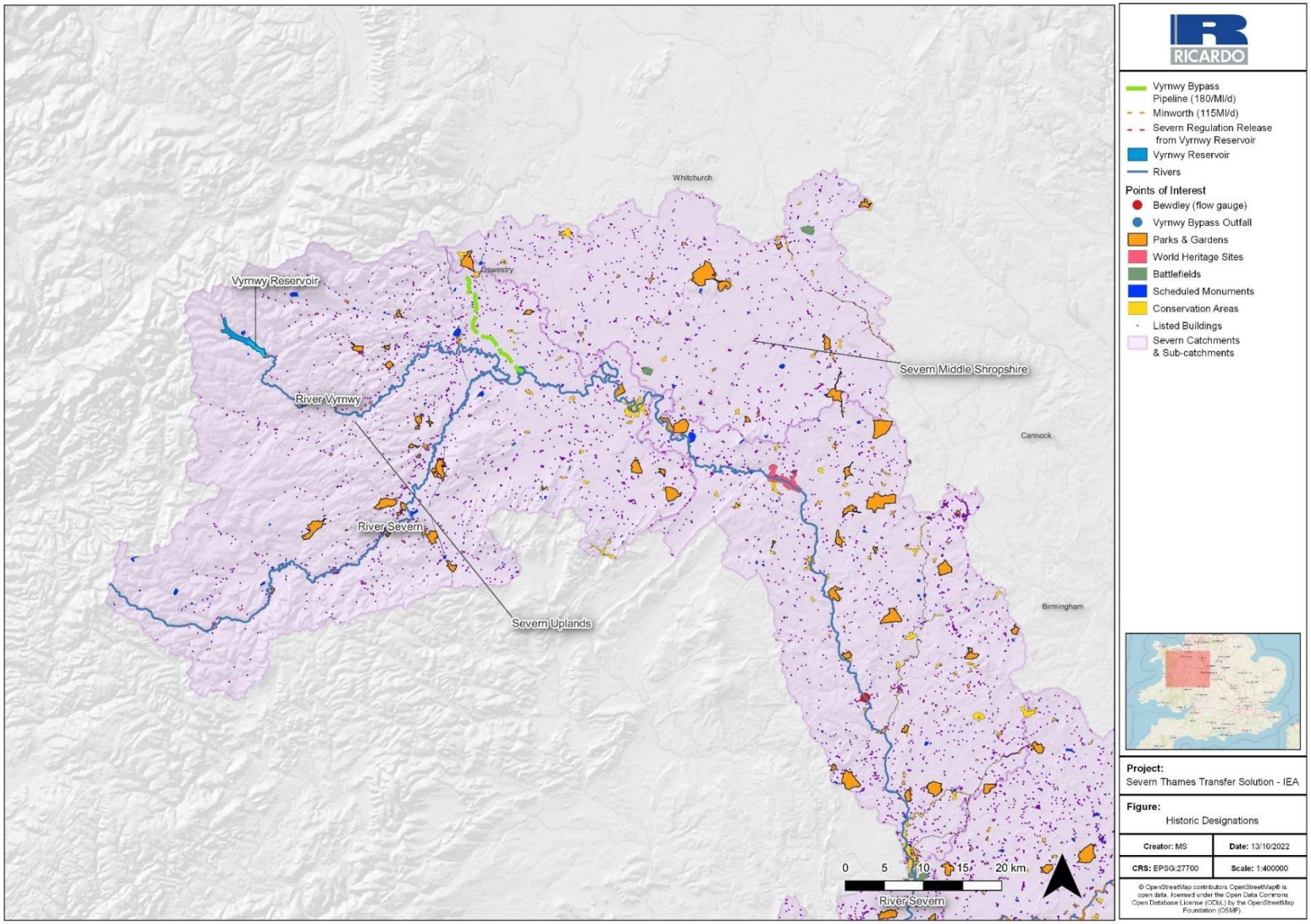

Figure 5.20 Historic Designations - North

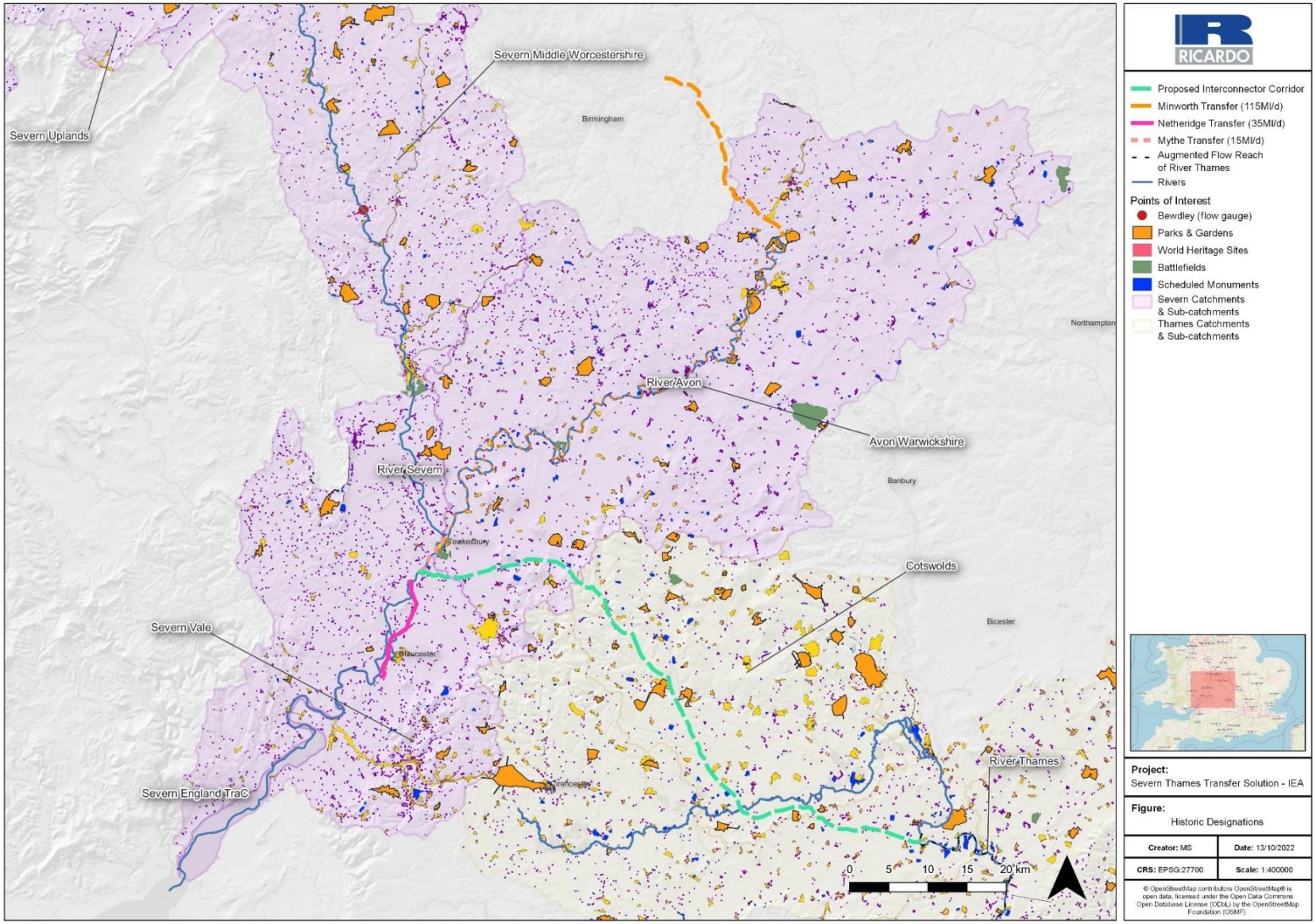

Figure 5.21 Historic Designations - Central

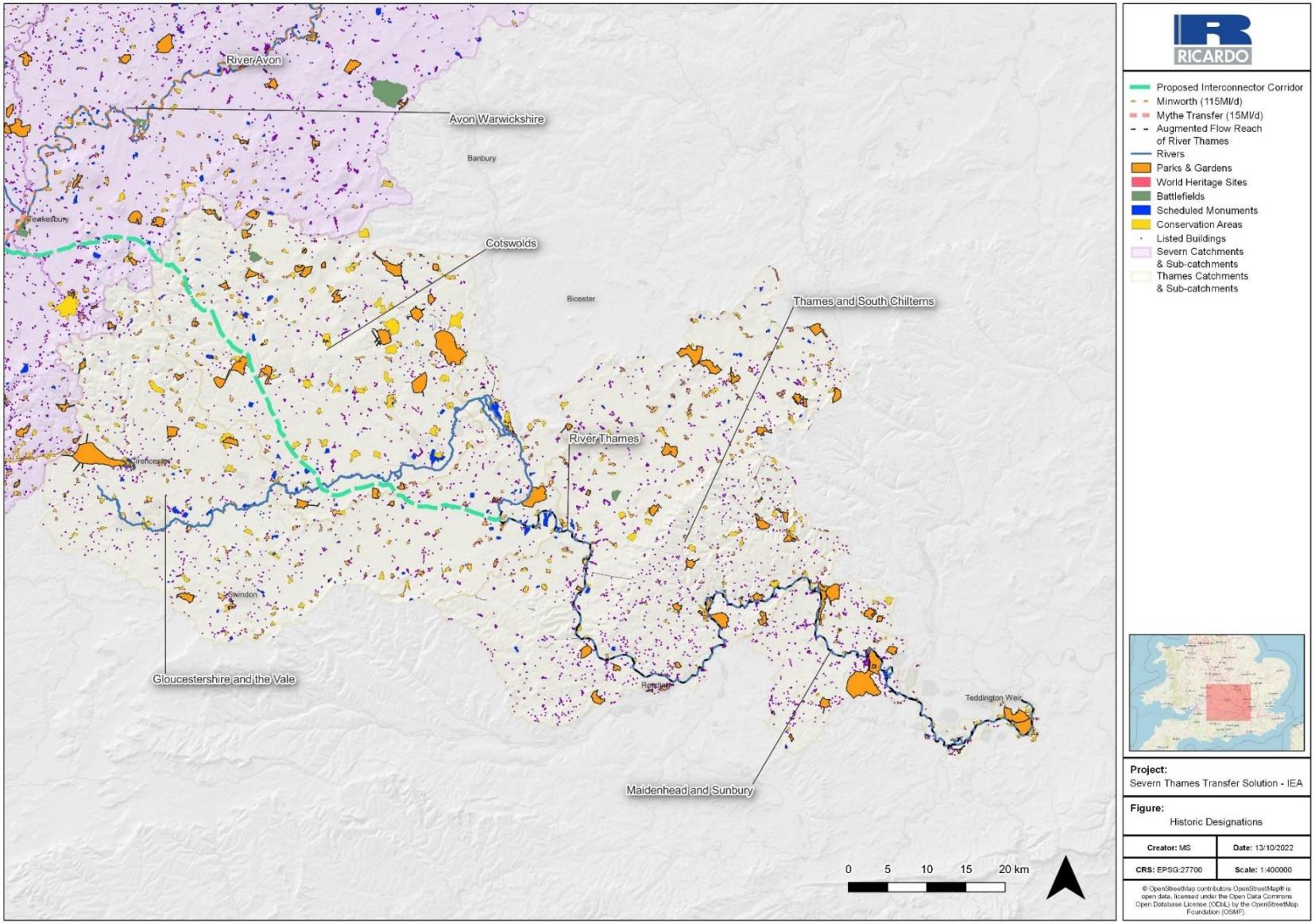

Figure 5.22 Historic Designations - South

5.1.8 Population and Human Health

Population

The study area covers a vast area, and the impacted reaches span a number of population centres from North Wales through Shropshire and down to Greater London. Current population estimates and future projections are available at a national and subnational level and are exhibited in **Table 5-6.** The local planning authority areas provided below are those where construction works have been proposed.

Table 5-6 Population estimates and future projections within the STT solution study area[53]

Area	2018	2028	Population change (%)
Shropshire	320,274	349,224	9
Cotswold	89,022	101,493	14
Vale of White Horse	133,732	151,139	13
Tewkesbury	92,599	107,693	16.3
Oxfordshire	687,524	721,004	4.8
England	55,977,178	58,751,651	4.9
Wales[54]	3,138,631	3,222,596	2.6

Human Health

Construction and operation of the scheme has the potential to influence quality of life, including human health, well-being, amenity, and community. Beneficial impacts could occur through the provision of additional supply of water to safeguard public health whereas adverse impacts may occur at the construction stage (e.g., noise and disruption). The elements of the scheme requiring construction are located within close proximity to a number of built-up areas (BUA), see **Table 5-7** below.

Table 5-7 Overview of Built-up Areas that may be impacted by the STT solution

Site	Designation	Associated Schemes
Oswestry	BUA	Vyrnwy Bypass
Shrewsbury	BUA	Shrewsbury Intake
Apperley	BUA	Deerhurst to Culham Interconnector
Stoke Orchard	BUA	Deerhurst to Culham Interconnector
Gotherington	BUA	Deerhurst to Culham Interconnector
Gretton	BUA	Deerhurst to Culham Interconnector
Winchcombe	BUA	Deerhurst to Culham Interconnector
Naunton	BUA	Deerhurst to Culham Interconnector
Filkins	BUA	Deerhurst to Culham Interconnector
Langford (West Oxfordshire)	BUA	Deerhurst to Culham Interconnector

[53] ONS (2020) Subnational population projections for England, 2018-based

[54] Stats Wales (2022) Population Projections https://statswales.gov.wales/Catalogue/Population-and-Migration/Population/Projections/National/2018-based/populationprojections-by-year-age

Site	Designation	Associated Schemes
Marcham	BUA	Deerhurst to Culham Interconnector
Drayton	BUA	Deerhurst to Culham Interconnector
Culham	BUA	Deerhurst to Culham Interconnector

Life expectancy at birth is one of the main indicators used to determine the status of health and economic development amongst a demographic. The data provided is for the period 2018 to 2020. Both the Vyrnwy Bypass and Shrewsbury Intake fall within Shropshire. Life expectancy at birth in the Shropshire area was 80.2 for males and 83.7 for females (both higher than the England average)[55].

For the five areas the Interconnector crosses, life expectancy at birth is provided below:

	Tewkesbury	Cotswolds	West Oxfordshire	South Oxfordshire	Vale of White Horse	England
Men	80.7	82.2	81.5	82.2	82.3	79.4
Women	85.4	84.8	85.2	85.5	85.3	83.1

Source:https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/lifeexpectancyforlocalareasoftheuk/between2001to2003and2018to2020

The greatest life expectancy for men is in the Vale of White Horse area; for women the greatest life expectancy is in South Oxfordshire. All areas have greater life expectancies than the England average.

Recreation and Tourism

Public open space, Rights of Way, walking and cycle routes are important with respect to recreation and tourism. The National Planning Policy Framework (NPPF)[56] states planning policies should protect and enhance public rights of way and access.

The scheme has the potential to impact areas with recreational value either during construction or in operation. There are opportunities for recreation within the assessment area which are shown in **Figure 5.23, Figure 5.24** and **Figure 5.25,** including national walking trails and sport's facilities; a list is provided below.

Site	Designation	Associated Schemes
Cotswolds Way	National Trail	Deerhurst to Culham Interconnector
Thames Path	National Trail	Deerhurst to Culham Interconnector
NCN Route 57	National Cycle Route	Deerhurst to Culham Interconnector
Naunton Down's Golf Club	Recreational Asset	Deerhurst to Culham Interconnector

[55] Life expectancy for local areas of the UK: between 2001 to 2003 and 2018 to 2020 (2021) https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/lifeexpectancyforlocalareasoftheuk/between2001to2003and2018to2020

[56] Ministry for Housing, Communities and Local Government (2021) National Policy Planning Framework

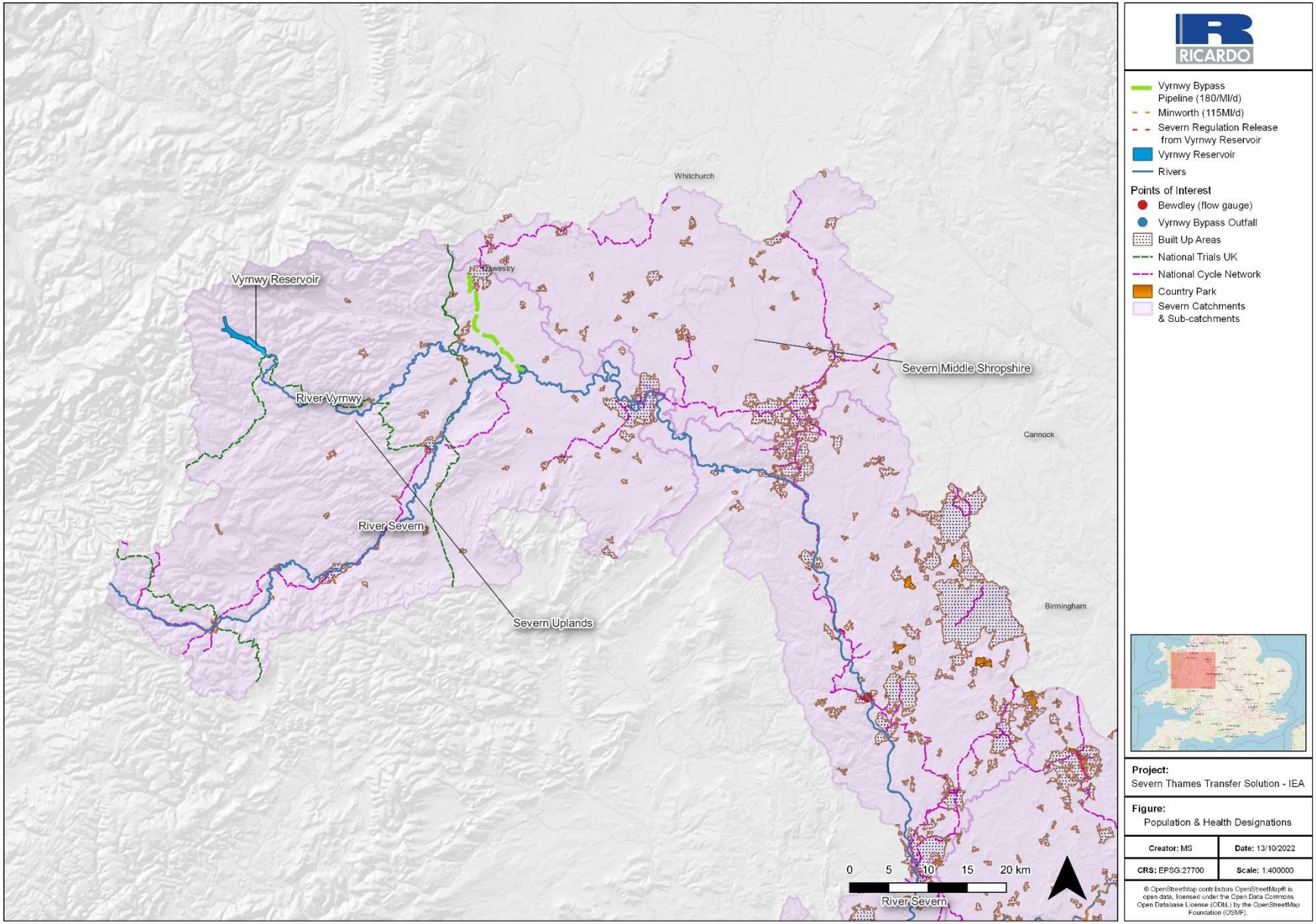

Figure 5.23 Population and Health - North

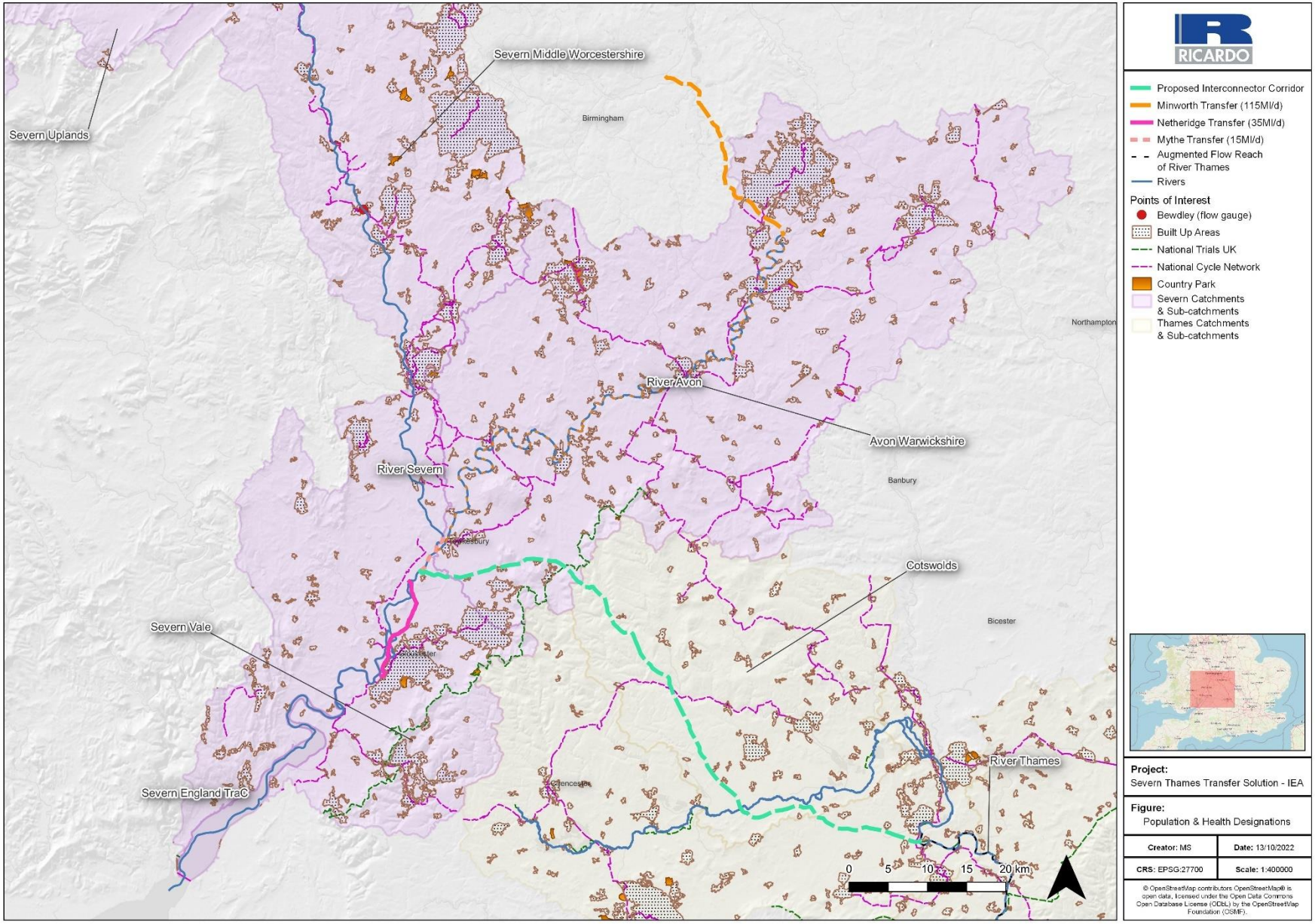

Figure 5.24 Population and Health - Central

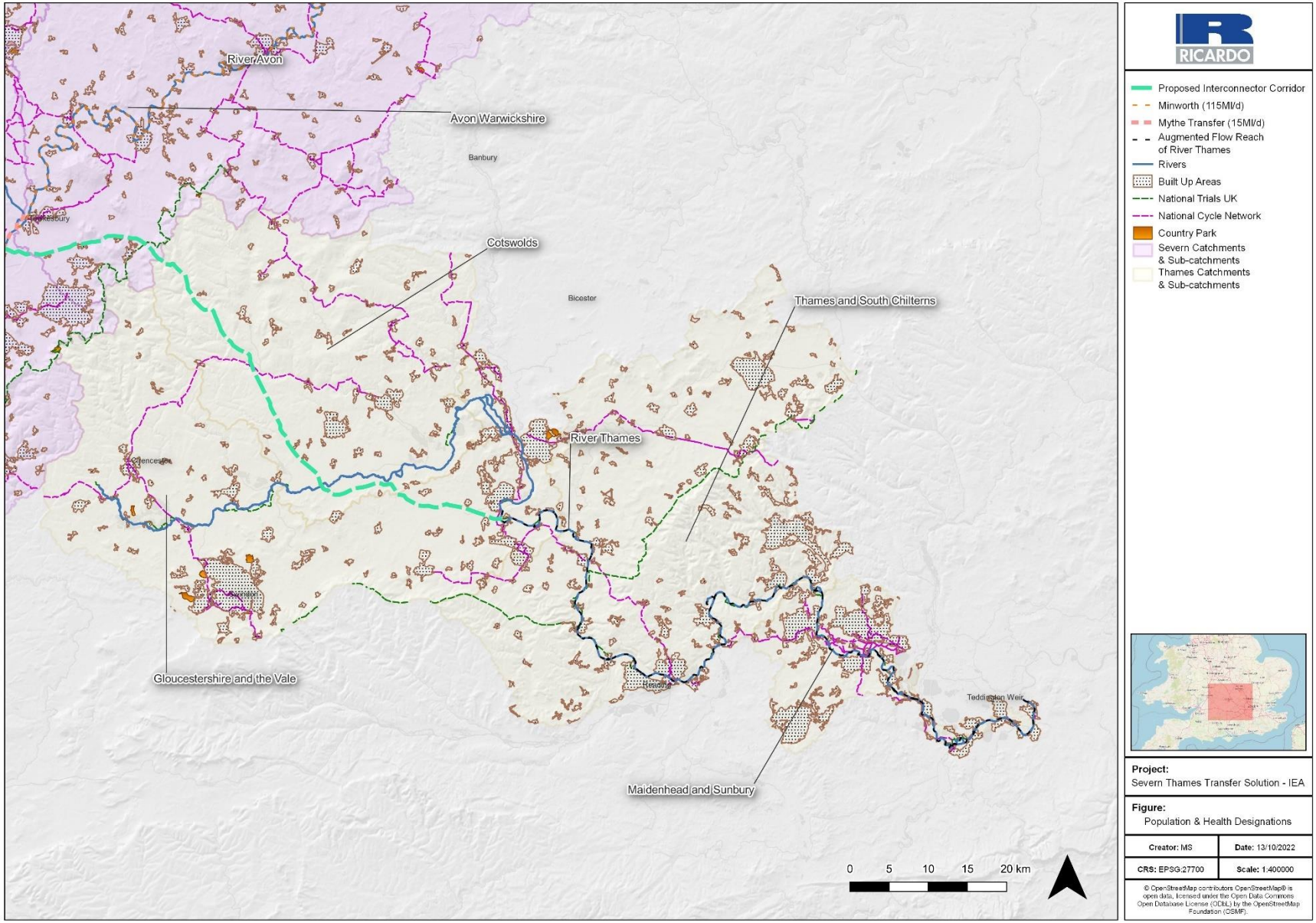

Figure 5.25 Population and Health - South

5.1.9 Material Assets

The Vyrnwy Bypass and Shrewsbury Intake are both within the Shropshire Council area. According to the Shropshire Council website, Shropshire residents recycled approximately 53% of all their waste in 2020-21[57]. Shropshire is ranked 54th out of the 345 local authorities in England. This recycling rate is much higher than the national average of around 43%[58].

In 2020-21, only 4% of rubbish was sent to landfill. The remaining 96% of waste was sent to the energy recovery facility located in Battlefield, Shrewsbury. Energy generated by the facility powers 10,000 homes per year[59].

The Interconnector crosses through five local planning authorities LPAs); Tewkesbury, Cotswolds, West Oxfordshire, South Oxfordshire, and Vale of White Horse. Recycling rates for each LPA for 2020-21 are shown in **Table 5-8** below:

Table 5-8 Approximate recycling rates across LPAs in the assessment area

	Tewkesbury	Cotswolds	West Oxfordshire	South Oxfordshire	Vale of White Horse	England
Recycling Rate	49%	59%	57%	63%	62%	42%

Source: https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

The recycling rates of all LPAs the interconnector crosses are significantly above the national average. South Oxfordshire District Council is ranked 2nd and Vale of White Horse District Council is ranked 4th in England.

Oxfordshire County Council's (South Oxfordshire and Vale of White Horse) food waste is turned into energy that can power up to 4,800 homes on an ongoing basis (at full plant capacity). In West Oxfordshire, recycling is sent to manufacturers in the UK who reprocess it into new products (around 85%). Tewkesbury is within the Gloucestershire County Council area and contributes towards the Gloucester Energy from Waste (EfW) facility which generates enough electricity to power around 25,000 homes a year, in addition to diverting 90% of household residual waste from landfill.

The option lies within the Severn Trent Strategic Grid area, this has been allocated as 'high vulnerability' status in the Severn Trent WRMP (2019).

5.2 KEY RECEPTORS

Table 5-9 shows a summary of the receptors per environmental topic for each of the sources discussed in this report.

[57] Shropshire Council (2022) What Happens to my Recycling? https://shropshire.gov.uk/recycling-and-rubbish/what-happens-to-my-recycling/

[58] Local authority collected waste: annual results tables (2021) https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

[59] Shropshire Council (2022) What Happens to my Rubbish? https://shropshire.gov.uk/recycling-and-rubbish/what-happens-to-my-rubbish/

Table 5-9: Summary of receptors located in the area of the STT solution

Environmental Topic	Key Receptor(s) (scheme responsible for impact)
Biodiversity – Designated sites	Berwyn SPA, SAC (Vyrnwy) Berwyn and South Clwyd Mountains SAC (Vyrnwy) Bredon Hill SAC (Interconnector) Chilterns Beechwoods SAC (Interconnector) Cothill Fen SAC (Interconnector) Dixton Wood SAC (Interconnector) Hartslock Wood SAC (Interconnector) Little Wittenham SAC (Interconnector) Montgomery Canal SAC (Vyrnwy) Midland Meres & Mosses Phase 1 SPA, Ramsar (All schemes) River Clun SAC (all components) River Dee and Bala Lake SAC (Vyrnwy) River Usk SAC (all components) River Wye SAC (all components) Severn Estuary SAC, SPA, Ramsar, SSSI (all components) Tanat and Vyrnwy Bat sites SAC (Vyrnwy) Garden Cliff SSSI (all components) Lydney Cliff SSSI (all components) Purton Passage SSSI (all components) Old River Severn, Upper Lode SSSI (Interconnector) Rectory farm Meadows SSSI (Interconnector) Severn Ham, Tewkesbury SSSI (all components) Upham Meadow & Summer Leasow SSSI (all components) Upper Seven Estuary SSSI (all components) Wainlode Cliff SSSI (Interconnector)
Biodiversity flora and fauna – habitats and species	Migration patterns of Atlantic salmon, trout, European eel and shad (all components). Non-migratory fish populations (all components). 53.8ha of the Priority Habitat Coastal & floodplain grazing marsh (CFGM) and Lowland Fens within 500 m of the River Severn from the confluence with the River Vyrnwy to Bewdley (Vyrnwy). 160.4 ha of the Priority Habitat (13 areas of Coastal & floodplain grazing marsh listed in the PHI) within 500 m of the River Severn from the confluence with the River Avon to Deerhurst (Shrewsbury).

Environmental Topic	Key Receptor(s) (scheme responsible for impact)
	667.9 ha of the Priority Habitat (128 areas of Coastal & floodplain grazing marsh listed in the PHI) within 500 m of the River Severn from Deerhurst to the tidal limit at Gloucester (Shrewsbury). Populations of protected species in impacted river reaches (all components). Populations of INNS in impacted river reaches (all components).
Soil	ALC Grade 2 land near Oswestry (Vyrnwy) ALC Grade 2 land between Lechlade and Abingdon (Interconnector) Russell Mr C S Permitted Waste Site (Interconnector) Gotherington Site Historic Landfill (Interconnector) Kingston Bagpuize (Historic Landfill) Sutton Wick No.1 Historic Landfill (Interconnector) CEMEX UK Materials Ltd Permitted Waste Site (Interconnector)
Water	Afon Vyrnwy - conf Afon Tanat to conf R Severn WFD Surface Waterbody (Vyrnwy) Severn – conf Bele Bk to conf Sundorne Bk WFD Surface Waterbody (Vyrnwy) Severn – Sundorne Bk to conf M Wenlock-Farley Bk WFD Surface Waterbody (Vyrnwy, Shrewsbury) Severn conf M Wenlock-Farley Bk to conf R Worfe Water Body WFD Surface Waterbody (Vyrnwy, Shrewsbury) Severn – conf R Worfe to conf R Stour Water Body WFD Surface Waterbody (Vyrnwy, Shrewsbury) Severn – conf R Stour to conf River Teme Water Body WFD Surface Waterbody (Vyrnwy, Shrewsbury) Severn – conf R Teme to conf R Avon Water Body WFD Surface Waterbody (Vyrnwy, Shrewsbury) Severn – conf R Avon to conf Upper Parting Water Body WFD Surface Waterbody (Vyrnwy, Shrewsbury) Thames (Evenlode to Tame) Water Body WFD Surface Waterbody (Interconnector (construction), all components) Thames Wallingford to Caversham Water Body WFD Surface Waterbody (Interconnector (construction), all components) Thames (Reading to Cookham) Water Body WFD Surface Waterbody (Interconnector (construction), all components) Thames (Cookham to Egham) Water Body (Interconnector (construction), all components) Thames (Egham to Teddington) Water Body (Interconnector (construction), all components) Severn Uplands – carboniferous Oswestry WFD Groundwater Body (Vyrnwy) Severn Uplands – PT Sandstone Knockin WFD Groundwater Body (Vyrnwy) Severn Middle Shropshire - Permo-Triassic Sandstone East Shropshire WFD Groundwater Body (Shrewsbury) Severn Vale – Secondary Combined WFD Groundwater Body (Interconnector) Warwickshire Avon – Secondary Mudlocks WFD Groundwater Body (Interconnector) Avon Warwickshire - Jurassic Limestones Cotswold Edge North WFD Groundwater Body (Interconnector) Burford Jurassic WFD Groundwater Body (Interconnector) Chipping Norton Jurassic WFD Groundwater Body (Interconnector) Thames Upper Gravels WFD Groundwater Body (Interconnector) Shrivenham Corallian WFD Groundwater Body (Interconnector)

Environmental Topic	Key Receptor(s) (scheme responsible for impact)
	The physical environment of the River Severn, Vyrnwy Bypass Outfall to Bewdley (Vyrnwy) The physical environment of the River Severn, Bewdley to confluence with River Avon (Vyrnwy) The physical environment of the River Severn. Confluence with River Avon to Deerhurst (all components) The physical environment of the River Severn, Deerhurst to the tidal limit at Gloucester (all components) The physical environment of the Severn Estuary downstream of the tidal limit at Gloucester (all components) The physical environment of the River Thames, from Culham to the tidal limit at Teddington (all components) Areas of Flood Zone 2 and 3, southern edge of the Vyrnwy bypass (Vyrnwy) Areas of Flood Zone 2 and 3 along the eastern end of the Interconnector pipeline (Interconnector) Water quality in the Severn Estuary downstream of the tidal limit at Gloucester Water quality in the River Thames downstream of Culham to tidal limit at Teddington
Air	Within 10km - Marcham AQMA, Cheltenham Whole Borough AQMA, Abingdon AQMA, City of Oxford AQMA, Tewkesbury Town Centre AQMA (Interconnector) Within 10km – Shrewsbury Town Centre AQMA (Shrewsbury and Vyrnwy)
Landscape and Visual Amenity	Cotswold AONB (Interconnector) Oxford Greenbelt (Interconnector) Birmingham Greenbelt
Historic Environment - Listed Buildings*	For the Shrewsbury Intake, there is one grade II listed building within 500m of the proposed upgrades to Ford pumping station and an additional two within 50m of Shelton WTW. 20 Grade II listed buildings are within 500m of the Vyrnwy scheme. For the Interconnector scheme, there are 7 Grade II* listed buildings within 500m alongside, 1 Grade I and 156 Grade II
Historic Environment – Conservation Areas	There are 17 Conservation areas within 1km of construction areas: Sherbourne (Deerhurst to Culham Interconnector) Guiting Power (Deerhurst to Culham Interconnector) Filkins and Broughton Poggs (Deerhurst to Culham Interconnector) Gretton (Deerhurst to Culham Interconnector) Farmcote (Deerhurst to Culham Interconnector) Culham (Deerhurst to Culham Interconnector) Langford (Deerhurst to Culham Interconnector) Windrush (Deerhurst to Culham Interconnector) Marcham (Deerhurst to Culham Interconnector) Naunton (Deerhurst to Culham Interconnector) Drayton (Deerhurst to Culham Interconnector) Cold Aston (Deerhurst to Culham Interconnector) Sutton Courtenay (Deerhurst to Culham Interconnector)

Environmental Topic	Key Receptor(s) (scheme responsible for impact)
	Shrewsbury (Shrewsbury Intake) Oswestry (Vyrnwy Bypass) Buckland (Deerhurst to Culham Interconnector) Temple Guiting (Deerhurst to Culham Interconnector)
Population and Human Health	Oswestry BUA (Vyrnwy Bypass) Shrewsbury BUA (Shrewsbury) Apperley BUA (Deerhurst to Culham Interconnector) Stoke Orchard BUA (Deerhurst to Culham Interconnector) Gotherington BUA (Deerhurst to Culham Interconnector) Gretton BUA (Deerhurst to Culham Interconnector) Winchcombe BUA (Deerhurst to Culham Interconnector) Naunton BUA (Deerhurst to Culham Interconnector) Filkins BUA (Deerhurst to Culham Interconnector) Langford (West Oxfordshire) BUA (Deerhurst to Culham Interconnector) Marcham BUA (Deerhurst to Culham Interconnector) Drayton BUA (Deerhurst to Culham Interconnector) Culham BUA (Deerhurst to Culham Interconnector) Cotswolds Way (Deerhurst to Culham Interconnector) Thames Path (Deerhurst to Culham Interconnector) NCN Route 57 (Deerhurst to Culham Interconnector) Naunton Down's Golf Club (Deerhurst to Culham Interconnector)

** Refer to **Annex B** for full list of Heritage Assets identified as key receptors*

6. ASSESSMENT

6.1 INTRODUCTION

Using a RAG based approach (see **Section 2** for further information), the key risks of the STT solution during construction and operation have been identified under each environmental topic. The approach seeks to understand the mechanisms (activities and pathways) by which activities arising from the scheme might affect the identified receptors. **Table 6-1** presents the RAG assessment of the STT solution with further detail provided in **Annex C**.

Annex C summarises mitigation that has been specifically included within the design that avoids or reduces the impact for the environmental topic as well as additional mitigation identified through the assessment process.

Any uncertainties with the assessment completed to date are also highlighted (such as lack of data, uncertainty over how solution operates, uncertainty over level of impact).

6.2 FUTURE CLIMATE SCENARIOS

Future physical environment conditions have been included in the assessment presented in the *STT-G2-S3-112-Modelling / Physical Environment Assessment* report. The future scenario requested by the regulators is the RCP 8.5 Business As Usual emissions scenario. Extensive water resources modelling has been used to define potential future operating patterns of the STT solution and future river flows.

In comparison with the A82 scenario, the A82 Future scenario would include a 40% longer period of flow augmentation releases from support elements of a STT solution. This amends the seasonality of the potential need for STT support options in late spring, early summer and later into autumn which is considered to be a significant change. The magnitude of change in flows is not significantly greater than for current climate scenarios, but the regularity and duration of effects are most likely to drive habitat change. As most of the differences for the Future Scenario relate to the use of support options there would remain insignificant change to the pass-forward flow regime to the Severn Estuary.

Overall, changes in freshwater flow into the Severn Estuary will be minimal and the supporting habitats for the migratory species of the Severn Estuary European Marine Site (and the River Wye, River Usk, and River Clun SAC), will not be affected by the STT operation.

6.3 OVERALL ASSESSMENT SUMMARY

A table of the risks assessed across each environmental topic is provided in **Table 6-1** (see **Annex C** for further detail).

In relation to the RAG assessment, no red risks have been identified. Amber risks have been identified for several receptors across the Biodiversity and Water topics and these are summarised by topic in the sections below.

Other receptors have been assessed as being at green risk where the effects of the STT solution during construction and operation are predicted to be minor or embedded and/or additional mitigation measures are considered sufficient, with a high level of confidence, to mitigate effects. **Annex C** provides further detail for each receptor under each topic.

6.3.1 Biodiversity

Several amber risk ratings have been identified under the Biodiversity topic after consideration of currently embedded mitigation measures. These include risks to the River Clun SAC, the River Usk SAC, the River Wye SAC and the Severn Estuary SAC, SPA and RAMSAR, Grafton Lock Meadows SSSI and for protected species (fish) and macroinvertebrate, macrophyte, and phytobenthos communities. The relevant activities and impacts are described in **Annex C** and include:

- River Clun SAC: Operational STT (operation of supported or unsupported STT) specifically the Minworth WwTW discharge diversion (transfer of water that is currently discharged into the River Tame to the River Avon) has potential to impact on migratory cues (chemical) for migratory species and

Atlantic salmon which may impact on the number of juvenile salmonids in the watercourse which contribute to the lifecycle of freshwater pearl mussel.

- River Usk and River Wye SAC: Operational STT, specifically the Minworth WwTW discharge diversion has potential to impact on migratory cues (chemical) for migratory species.
- Severn Estuary SAC, SPA and RAMSAR: Operational STT, specifically the Minworth WwTW discharge diversion may have potential to impact on migratory cues (chemical) for migratory species (in the case of the SAC and RAMSAR) and/or on supporting habitats of the Severn Estuary (the latter in the case of the SAC, SPA and RAMSAR).
- Grafton Lock Meadows SSSI: The Deerhurst to Culham (Interconnector) pipeline construction may cause disruption to groundwater flows/levels as vegetation within the site is driven by groundwater levels (site within 180m of working area). Additional mitigation has been identified in this case and includes pipeline optimisation informed by habitat mapping and condition surveys. Discussions with Natural England are recommended to agree additional mitigation measures.
- Protected species (fish): Operational STT specifically the Minworth WwTW discharge diversion may have potential to impact on migratory cues (chemical) for migratory species of fish within the River Severn and tributaries.
- Macroinvertebrate, macrophyte, and phytobenthos communities: Operational STT has the potential to impact on habitat availability/suitability for macrophytes and macroinvertebrates with a preference for marginal habitats (slow flowing water) within reaches of the River Avon upstream of Alveston.

6.3.2 Water

Several WFD waterbodies have been identified as being at amber risk. The detailed receptors are described in **Annex C** and the relevant activities and impacts include:

- Operational STT, specifically the Minworth WwTW discharge diversion may have potential impact on migratory cues (chemical) for migratory fish species within the River Severn and tributaries (potentially affecting six WFD waterbodies).
- Operational STT has potential pass forward effects into the River Severn from the Minworth WwTW discharge diversion (potentially affecting two WFD waterbodies).
- Operational STT has potential impacts on habitat availability/suitability for macrophytes and macroinvertebrates with a preference for marginal habitats (slow flowing water) within reaches of the River Avon upstream of Alveston (potentially affecting three WFD waterbodies). Operational STT has potential changes in environmental water quality, velocity, and depth during scheme operation (potentially affecting five WFD waterbodies).

Further development of operating rules is identified as an additional mitigation.

6.3.3 Uncertainties and further information requirements

Uncertainties and further information requirements identified for the amber risks are consolidated in the list below. Uncertainties and further information requirements are shown in **Annex C** against the relevant amber and green risk ratings for each receptor.

- The need for better understanding of the distribution of interest features across designated sites, and for habitat and condition surveys.
- The need to improve understanding of hydrological connectivity.
- The need to complete SSSI assessment with detailed design information.
- There is limited data on the proportionate change in load and performance efficacy and operational reliability for the planned treatment processes at Netheridge WwTW and Minworth WwTW, with no cases to date in the UK of reduction performance efficacy and operational reliability for the planned treatment processes.
- Continued need to review the evidence base in relation to endocrine disruptors which may act as olfactory inhibitors.
- Monitoring of determinands that are known to be olfactory inhibitors and/or act as endocrine disruptors to continue at the current monitoring locations to ensure that sufficient data is available to complete further modelling and assessment in Gate 3.

- For some WFD chemicals, there are difficulties with commercially available limits of detection not being sufficiently low compared to EQS values.
- For potential olfactory inhibitors in fish, it is recognised that the commercially available limit of detection may be altogether too high to draw conclusions.
- There is no measured data to inform the risk to weir pool habitats in the River Avon and associated with the physical changes upstream of Alverston.
- Gate 2 hydraulic modelling of the River Thames is of limited reliability, and outcomes have been assessed with low confidence. This may have repercussions for the reliability of water quality modelling in the River Thames. The hydraulic model itself requires further work for use in Gate 3 and further flow scenarios will be required to progress the assessment made at Gate 2.

6.3.4 Summary

Based on the STT solution assessed at Gate 2, there are no 'showstoppers' i.e., red risks in the RAG rating, or unsurmountable obstacles that mean the scheme is unfeasible due to environmental reasons at this stage. Across all topics, environmental impacts have been avoided or mitigated and opportunities for enhancements have been highlighted. Where uncertainty remains, including within the HRA and WFD compliance assessment, a robust plan to address those uncertainties in Gate 3 has been presented. Environmental stakeholders and regulators who have participated in workshops and discussed the assessment results have commented that there is no reason not to progress to Gate 3.

Table 6-1: Assessment of risks across environmental topics

Topic	Receptor	Risk RAG Rating
Biodiversity	Berwyn and South Clwyd Mountains SAC	Not applicable, no impact pathway.
Biodiversity	Berwyn SPA	Not applicable, no impact pathway.
Biodiversity	Bredon Hill SAC	Not applicable, no impact pathway.
Biodiversity	Chilterns Beechwoods SAC	Not applicable, no impact pathway.
Biodiversity	Cothill Fen SAC	Not applicable, no impact pathway.
Biodiversity	Cotswold Beechwoods SAC	Not applicable, no impact pathway.
Biodiversity	Dixton Wood SAC/SSSI	
Biodiversity	Hartslock Wood SAC	Not applicable, no impact pathway.
Biodiversity	Little Wittenham SAC	Not applicable, no impact pathway.
Biodiversity	Montgomery Canal SAC	Not applicable, no impact pathway.
Biodiversity	Midland Meres and Mosses Phase 2 Ramsar	
Biodiversity	River Clun SAC	
Biodiversity	River Dee and Bala Lake SAC	Not applicable, no impact pathway.
Biodiversity	River Usk SAC	
Biodiversity	River Wye SAC	
Biodiversity	Severn Estuary SAC	
Biodiversity	Severn Estuary SPA	
Biodiversity	Severn Estuary Ramsar	
Biodiversity	Tanat and Vyrnwy Bat sites SAC	Not applicable, no impact pathway.
Biodiversity	Walmore Common SPA	Not applicable, no impact pathway.
Biodiversity	Walmore Common Ramsar	Not applicable, no impact pathway.
Biodiversity	Grafton Lock Meadows SSSI	
Biodiversity	Chimney Meadows SSSI	
Biodiversity	Turvey’s Piece SSSI	
Biodiversity	Dixton Wood SSSI	
Biodiversity	Lark Wood SSSI	
Biodiversity	Morton Pool and Pasture SSSI	
Biodiversity	Llanymynech Llynclys Hills SSSI	
Biodiversity	Croft Mills Pasture SSSI	
Biodiversity	Sweeney Fen SSSI	

Topic	Receptor	Risk RAG Rating
Biodiversity	Rectory Farm Meadows SSSI	
Biodiversity	Upham Meadow and Summer Leasow SSSI	
Biodiversity	Guy's Cliffe SSSI	Not applicable, no impact pathway.
Biodiversity	Racecourse Meadows SSSI	
Biodiversity	Welford Field SSSI	
Biodiversity	Tiddesley Wood SSSI	
Biodiversity	Severn Ham, Tewkesbury SSSI	
Biodiversity	Old River Severn, Upper Lode SSSI	
Biodiversity	Upper Severn Estuary SSSI	
Biodiversity	Severn Estuary SSSI	
Biodiversity	Ancient woodland	
Biodiversity	Priority habitats – coastal floodplain grazing marsh	
Biodiversity	Priority habitats – traditional orchards; lowland meadows, lowland calcareous grassland;	
Biodiversity	Priority habitats – coastal floodplain grazing marsh	
Biodiversity	Priority habitats – Lowland Fens	Not applicable, no impact pathway.
Biodiversity	Priority habitats – purple Moor grass and rush pastures	
Biodiversity	Priority habitats – wet woodland	
Biodiversity	Protected species - fish	
Biodiversity	Protected species - otter, water vole, waterbirds, macrophytes	
Biodiversity	Protected species - amphibians, birds, mammals, terrestrial invertebrates	
Biodiversity	Macroinvertebrate, macrophyte, and phytobenthos communities	
Biodiversity	INNS	
Soil and Land	Harford Railway Cutting SSSI	Not applicable, no impact pathway.
Soil and Land	Lamb and Flag Quarry SSSI	
Soil and Land	Wainlode Cliff SSSI	Not applicable, no impact pathway.
Soil and Land	Agricultural land	
Soil and Land	Agricultural land	
Soil and Land	Permitted and Historic Waste Sites: •Russell Mr C S Permitted Waste Site •Gotherington Site Historic Landfill •Kingston Bagpuize Historic Landfill •Sutton Wick No. 1 Historic Landfill •CEMEX UK Materials Ltd Permitted Waste Site	

Topic	Receptor	Risk RAG Rating
Water	WFD waterbodies: •Avon - ClaycotonYelvertoft Bk to conf R Sowe - GB109054043920 •Avon (Warks) - conf R Sowe to conf R Leam - GB109054043840 •Avon (Wark) conf R Leam to Tramway Br, Stratford - GB109054044402 •Avon- Tramway Br Stratford to Workman Br Evesham - GB109054044401 •Mary Bk - source to conf R Avon - GB109054044403 •Avon - Tolsey Lane to conf R Severn - GB109054039800	
Water	WFD waterbodies: •Severn - conf R Avon to conf Upper Parting - GB109054044404 •Severn (E Channel) - Horsebere Bk to Severn Est - GB109054032750	
Water	WFD waterbodies: •Avon - ClaycotonYelvertoft Bk to conf R Sowe - GB109054043920 •Avon (Warks) - conf R Sowe to conf R Leam - GB109054043840 •Avon (Wark) conf R Leam to Tramway Br, Stratford - GB109054044402	
Water	WFD waterbodies: •Vyrnwy - Lake Vyrnwy to conf Afon Cownwy - GB109054049880 •Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy - GB109054049720 •Afon Vyrnwy DS of Banwy confluence - GB109054049852 •Afon Vyrnwy - conf Afon Tanat to conf R Severn - GB109054049800 •Severn - conf Bele Bk to conf Sundorne Bk - GB109054049142 •Severn - Sundorne Bk to conf M Wenlock-Farley Bk - GB109054049141 •Severn conf M Wenlock-Farley Bk to conf R Worfe - GB109054049143 •Severn - conf R Worfe to conf R Stour - GB109054049145 •Severn - conf R Stour to conf River Teme - GB109054049144 •Severn - conf R Teme to conf R Avon - GB109054039760	
Water	WFD waterbodies: •Thames (Evenlode to Thame) - GB106039030334 •Thames Wallingford to Caversham - GB106039030331 •Thames (Reading to Cookham) - GB106039023233 •Thames (Cookham to Egham) - GB106039023231 •Thames (Egham to Teddington) - GB106039023232	
Water	WFD waterbodies: • Severn - conf Bele Bk to conf Sundorne Bk - GB109054049141 • Afon Vyrnwy - conf Afon Tanat to conf R Severn - GB109054049142 • Morda - conf unnamed trib to conf Afon Vyrnwy - GB109054049800 • Weir Bk - source to conf R Severn - GB109054049142 • Morda trib - Morton Common - GB109054049930 • Morda - source to conf unnamed trib - GB109054049930 • Childrey and Woodhill Brooks - GB106039023370 • Childrey Brook and Norbrook at Common Barn - GB106039023380 • Ock (to Cherbury Brook) - GB106039023400 • Frilford and Marcham Brook - GB106039023420 • Ock and tributaries (Land Brook confluence to Thames) - GB106039023430	

Topic	Receptor	Risk RAG Rating
	• Cow Common Brook and Portobello Ditch - GB106039023360 • Letcombe Brook - GB106039023350 • Wadley Stream (Source to Thames at Duxford) - GB106039023770 • Leach (Source to Thames) - GB106039030040 • Radcot Cut - GB106039030231 • Broadwell Brook - GB106039030232 • Slade Barn Stream (Source to Windrush) - GB106039037440 • Windrush (Source to Slade Barn Stream) - GB106039037460 • Thames (Leach to Evenlode) - GB106039030333 • Thames (Evenlode to Thame) - GB106039030334 • Ginge Brook and Mill Brook - GB106039023660 • Windrush and tributaries (Little Rissington to Thames) - GB106039030440 • Sherbourne Brook - GB106039030460 • Windrush (Slade Barn Stream to Dikler) - GB106039030480 • Swilgate - source to conf R Avon - GB109054039780 • Tirle Brook - source to the conf River Swilgate - GB109054039810 • Isbourne - source to conf R Avon - GB109054039631 • Severn - conf R Avon to conf Upper Parting - GB109054044404	
Water	Flood risk	
Air Quality	Local populations, in particular in the vicinity of urban areas (Oswestry, Pant and Llanymynech)	
Air Quality	Local populations, in particular in the vicinity of several urban areas and Marcham AQMA, Cheltenham Whole Borough AQMA, Abingdon AQMA, City of Oxford AQMA, Tewkesbury Town Centre AQMA	
Landscape & Visual Amenity	Cotswold AONB, South Oxfordshire Green Belt, Tewkesbury Green Belt, Vale of White Horse Green Belt	
Historic Environment	Listed Buildings (21 Grade I and II within 500m of the route) Conservation Areas (Oswestry)	
Historic Environment	Listed Buildings (three Grade II within 500m of the construction locations) Conservation Areas (Shrewsbury, Ford) Registered Park and Garden (Berwick Park)	
Historic Environment	Scheduled Monuments: •Gretton Church (ruins of) •Earthwork N of Lyne's Barn •Sutton Wick settlement site •Milhampost Roman site •Dixton Hill camp •Site SE of Noah's Ark Inn, Frilford •Enclosures and trackways •Ring ditches	

Topic	Receptor	Risk RAG Rating
	•Bowl barrow 310m SSW of Pinnock Wood Farm •Round barrow 300m west of Church Farm •Hailes Abbey and ringwork •Dovecote at Culham Manor, 110m south west of St Paul's Church Listed buildings (166 Grade I and II within 500m of pipeline route) Conservation Areas (Guiting Power, Sherbourne, Langford, Filkins and Broughton Poggs) Registered Park and Garden Grade II* (Sherbourne House)	
Population and Human Health	Local communities, including •Oswestry, Pant and Llanymynech (in proximity to Vyrnwy Bypass pipeline) •Apperley, Stoke Orchard, Gretton, Winchcombe, Naunton, Filkins, Langford (West Oxfordshire), Marcham, Drayton, Culham (in proximity to Deerhurst to Culham (Interconnector) pipeline) •Shrewsbury, Pant and Ford (in proximity to Shrewsbury Redeployment)	
Population and Human Health	Recreation, including • playing fields, public parks east of Llynclys, PRoWs including to the west of Oswestry, east of Pant, west of Maesbrook and upon approach to the discharge location in the River Severn (in proximity to Vyrnwy Bypass pipeline) •Cotswold Way, Thames Path, the Severn Way, a number of other PRoWs, two Sustrans cycle routes near Northleach and Culham, playing fields, a golf course, local parks and common land, rivers (in proximity to Deerhurst to Culham (Interconnector) pipeline)	

7. ASSESSMENT OF CUMULATIVE EFFECTS

7.1 INTER-RELATIONSHIPS BETWEEN EFFECTS

Potential effects of the STT solution on key sensitive receptors are identified in Section 6.

The cumulative effects and in-combinations assessment draw on the proposed approach outlined in the SRO Cumulative effects methodology note[60] (see Section 2.2). Using a receptor-based approach as detailed in Section 2, the assessment of interrelationships between effects (scheme specific effects) is provided within **Table 7-1**.

Potentially, local communities (including schools) could be affected by multiple environmental effects during the construction of the project (see **Table 7-1**). Further assessment will be required during Gate 3 to establish cumulative effects on specific receptors.

Table 7-1: Inter-relationships between effects cumulative assessment matrix

Receptor Type	Receptor	Potential cumulative effects	Mitigation
Residential	Local communities	Noise – potential for noise during construction. Vibration – potential for vibration during construction. Air Quality – potential for dust and emissions during construction. Visual – potential for visual effects during construction.	No additional mitigation is likely to be required beyond standard good practice construction measures.

7.2 CUMULATIVE EFFECTS ASSESSMENT WITH OTHER PLANS AND DEVELOPMENTS

The cumulative effects and in-combinations assessment draw on the proposed approach outlined in the SRO Cumulative effects methodology note[61] (see Section 2.2 above). As described, where appropriate, the SRO cumulative effects assessments will refer to the cumulative effects assessments undertaken for Regional Plans and Water Company WRMPs and acknowledge that the outcome of such assessments will need to be updated as SROs detailed designs develop and as part of the EIA-stage cumulative effects assessment. The conclusions of the Regional Plan and WRMPs are not available at the time of drafting this IEA.

It is assumed that the Regional Plan and WRMP24 assessments have concluded no significant in-combination and cumulative effects at a plan level, enabling the SRO to progress. This SRO specific cumulative effects assessment looks in further detail at the sites and surrounding area in terms of local and site-specific information including large development allocations within Local Plans and larger planning applications.

The Vyrnwy Bypass and Intake at Shrewsbury are located within the Shropshire Council area. The Interconnector pipeline crosses through five local authorities: Cotswold District Council, West Oxfordshire District Council, Vale of White Horse District Council, Tewkesbury Borough Council and South Oxfordshire District Council.

In line with the cumulative effects methodology, it is considered that the scope of 'other developments' considered in the cumulative effects assessment for Gate 2 should focus on larger developments foreseen in the long-term rather than smaller developments that are likely to be consented and/or built before the anticipated DCO or TCPA application submission for the SRO or its sub-options, as it is considered that it is these larger, longer-term developments that have the potential for significant cumulative effects that may require additional mitigation.

The following information sources have been used to identify the list of other developments and plans that could be included in the cumulative effects assessment. A 2km ZOI has been used to reflect the guidance and

[60] The latest version of the note was circulated on 5 April 2022, with a subsequent meeting with the NAU Leads to formally agree its adoption for the SRO process.

[61] The latest version of the note was circulated on 5 April 2022, with a subsequent meeting with the NAU Leads to formally agree its adoption for the SRO process.

to initially capture a maximum search area for developments and plans[62]. The list of other developments and plans within the ZOI of the STT solution construction areas are shown in **Table 7-2**. This section considers the cumulative effects of construction of these developments in combination with the strategic solution. Where appropriate, further assessment regarding cumulative effects during operation will be carried out during Gate 3, although effects are considered unlikely as water resource requirements associated with planned developments and growth will have been considered in preparing the WRMP.

Interconnector

- **Cotswold District Council Website** - Nothing within 2km of interconnector.
- **West Oxfordshire District Council Website** - Nothing within 2km of interconnector.
- **Vale of White Horse District Council Website** - Science Vale area which has been allocated as a strategic development site (with a strategic focus for economic and employment growth) is within 2km of the interconnector. There are no current/ongoing developments at this time. There are no EIA projects within 2km of interconnector.
- **Tewkesbury Borough Council Website** - Nothing within 2km of interconnector.
- **South Oxfordshire District Council** Website - Valley Park, Didcot – Space allocated for 4,254 homes adjacent to Great Western Park. This is approximately 3.5km away from the interconnector (Outline Application – **P14/V2873/O**). Nothing within 2km of interconnector.
- **Planning inspectorate** - Nothing within 2km of interconnector.
- **Hybrid Bills** – HS2 is not within 2km of the Interconnector.
- **Transport and Works Act (TWA) applications and decisions** – Nothing within 2km of the Interconnector.

Vyrnwy Bypass

- **Shropshire Council Website** (Advanced Search: EIA, Full Applications, Outline Applications) – Nothing within 2km of the Vyrnwy Bypass.
- **Planning Inspectorate** - Reinforcement to the North Shropshire Electricity Distribution Network located 2.9km from the Vyrnwy bypass, no cumulative impacts are expected.
- **Hybrid Bills** – HS2 is not within 2km of the Vyrnwy Bypass.
- **Transport and Works Act (TWA) applications and decisions** – Nothing within 2km of the Vyrnwy Bypass.

Shrewsbury Intake

- **Shropshire Council Website** (Advanced Search: EIA, Full Applications, Outline Applications).
- Shrewsbury Northwest Relief Road **21/00924/EIA** (Pending Consideration), the new road development will be approximately 150m from the intake, cumulative impacts are likely.

  - Proposed Residential Development Land On The West Side Of Ellesmere Road Shrewsbury Shropshire **22/01432/OUT** (Pending Consideration) is located 2.4km from the intake, cumulative effects are unlikely.

  - Flax Mill Spring Gardens Shrewsbury, Shropshire hybrid application **20/05065/OUT** (Granted) is located approximately 3km from the intake, cumulative effects are unlikely.
- **Hybrid Bills** – HS2 is not within 2km of the Intake.
- **Planning Inspectorate** – Nothing within 2km of the intake.
- **Transport and Works Act (TWA) applications and decisions** – Nothing within 2km of the intake.

The list of developments and plans used to assess the cumulative effects of the STT solution is presented in **Table 7-3**. At this stage, there are no significant cumulative effects identified with other developments or plans. This assessment will need to be reviewed during Gate 3.

[62] It is noted that this ZOI may need to be increased for the future Gate 3 assessments which may also require bespoke ZOI defined across each assessment topic.

Table 7-2: Schedule of Developments

Application reference	Planning Authority	Applicant and brief description	Closest distance from scheme boundary and orientation	Planning status	Overlap in temporal scope?	Scale and nature of development likely to have a significant effect?	Potential receptors affected	Other factors	Progress to cumulative assessment? (Y/N))
21/00924/EIA	Shropshire Council	Northwest Relief Road scheme. comprising - construction of approx. 7km single carriageway (approx. 7m wide) road; severance of local roads and footpaths; provision of combined footway/cycleway; erection of three bridged structures over carriageway; diversion of existing bridleway/footpath via an underpass; climbing lane on westbound approach; 670m long viaduct; bridge over railway; two flood storage areas; provision of two new roundabout junctions and improvements to two existing roundabouts; associated traffic calming measures, landscaping and drainage schemes.	150m south of Shrewsbury Intake	Not yet decided – Pending Consideration	Not yet known	Y	Midland Meres & Mosses Ramsar (Hencott Pool SSSI) is approx. 250m from road scheme. Old River Bed SSSI. Community within the Shrewsbury Built up Area (BUA) National Cycle route 81 Berwick Park	Access to the Intake site may be disrupted by the road scheme	Y
22/01432/OUT	Shropshire Council	Outline application for the residential development of up to 450 dwellings; strategic infrastructure to include: open space, drainage and engineering works with some matters (landscaping, appearance, layout, scale) reserved apart from strategic access	2.4km North-East of Shrewsbury Intake	Outline Application – Pending Consideration	Not yet known	N - Development is outside of ZOI	N/A	None	N
P14/V2873/O	South Oxfordshire District Council	Valley Park, Didcot – Space has been allocated for 4,254 homes adjacent to Great Western Park	3.5km from Interconnector	Outline Application – Pending Consideration	Not yet known	N - Development is outside of ZOI	N/A	None	N
N/A	Vale of White Horse District Council	Science Vale area which has been allocated as a strategic development site (with a strategic focus for economic and employment growth).	Within 2km of Interconnector	Strategic development site – There are no current/ongoing developments	Not yet known	N - Scale of development not known	N/A	None	N

Table 7-3: Cumulative Effects Assessment Matrix

Application Reference	Planning Authority	Applicant and brief description of development	Potential for cumulative effects with the scheme	Potential mitigation
21/00924/EIA	Shropshire Council	North-West Relief Road scheme. Comprising - construction of 6.9km single carriageway (approx. 7m wide) road; severance of local roads and footpaths; provision of combined footway/cycleway; erection of three bridged structures over carriageway; diversion of existing bridleway/footpath via an underpass; climbing lane on westbound approach; 670m long viaduct; bridge over railway; two flood storage areas; provision of two new roundabout junctions and improvements to two existing roundabouts; associated traffic calming measures, landscaping and drainage schemes.	The development is located approximately 150m from the Shrewsbury intake site. The construction programme of the development is unknown. Commencement of construction activities (upgrades) to the Shrewsbury intake is not yet known either. Therefore, there is potential for overlap between the construction of the Northwest Relief Road Scheme and the Shrewsbury intake upgrades. This element of the STT solution may be visually intrusive to the landscape and may compound the impacts of the proposed road scheme. Combined with the Road Scheme residential receptors in the nearby area (Shrewsbury BUA) are likely to be impacted during operation. Construction of the Intake upgrades, along with the road scheme works, may cause impacts (e.g., noise, vibration, dust, visual) to nearby residents in Shrewsbury. The Midland Meres & Mosses Ramsar site/ SSSI is located approximately 250m from the proposed road scheme, thus mitigation measures may need to be implemented to reduce the impact of the development on the protected site. Old River Beds SSSI, National Cycle Route 81 and Berwick Park (registered park) are all within in close proximity to both the road scheme and the intake. No significant adverse residual effect have been identified as a result of the Northwest Relief Road Scheme. It is not expected that when combined with the STT scheme the effects would result in significant cumulative effects.	An agreement will likely be required between both schemes to ensure there is viable access to the Intake development site throughout construction. No further mitigation has been identified above the measures which would be included within a Construction Environmental Management Plan.

8. NEXT STEPS AND FORWARD LOOK TO GATE 3

8.1 NEXT STEPS AT GATE 3

Table 8.1 provides an overview of the additional work required to inform the Gate 3 environmental assessment and development of the SRO, focusing on the key risks considered in Section 6.

The Regional Plan modelling suggests that the STT solution is required from 2040-2060 and therefore a planning application, most likely a Development Consent Order, will be required to be prepared in the near future. As such, a wider breadth of environmental topic areas than those identified below (e.g., noise, socio-economics) will need to be considered as part of any EIA to support the planning process. The scope of this assessment, and supporting baseline surveys and modelling work, will be discussed and agreed with the regulators in due course.

Table 8-1: Gate 3 Lookahead

Topic/Receptor	Data gaps/uncertainties	Proposed work at Gate 3
Biodiversity, flora and fauna		
Dixton Wood SAC	• How significant would air quality and noise disturbance issues be during construction • Confirmation of methods employed to install pipeline to determine extent of potential air quality impacts • No publicly available records of violet click beetle within the woodland and uncertainty over suitability of habitat in the area • Uncertainty over dispersal dynamics of violet click beetle	UKHab survey Site condition assessment and mapping of interest features. Review pipeline routing and construction methods near SAC
River Usk SAC / River Wye SAC / River Clun SAC / Severn Estuary SAC, Ramsar, SSSI	• Further assessment and modelling of the risk to olfaction is required as data from the ongoing monitoring programmes becomes available	Monitoring of determinands that are known to be olfactory inhibitors and/or act as endocrine disruptors to continue at the current monitoring locations to ensure that sufficient data is 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)63 requires further investigation at Gate 3.
Severn Estuary SAC, SPA, Ramsar, SSSI	• Uncertainty over current condition of features of Severn Estuary SAC • Gaps in understanding the possible scheme operation • Uncertainty around presence of suitable ammocoete habitat at the Vyrnwy Bypass discharge outfall location • Uncertainty around wintering bird species present at designated site	UKHab survey River MoRPH and fish surveys. Further scenario modelling using 1D hydraulic models to further understand scheme operation 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. Additional wintering bird surveys to determine if qualifying bird populations are present at the site. 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,

[63] 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.

Topic/Receptor	Data gaps/uncertainties	Proposed work at Gate 3
		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.
Grafton Lock Meadows SSSI	• Uncertainty around potential for disruption of groundwater flows and potential for impacts on protected species or habitats from pipeline construction	Site condition assessment and mapping of interest features. Improve understanding of hydrological connectivity.
Old River Severn Upper Lode SSSI	• Uncertainty over whether changes to the scheme will have adverse effects to site if changes to the scheme identify potential for changes in river levels	Undertaking Common Standards monitoring, macrophyte surveys and ADCP surveys if changes to the scheme identify the potential for change in river levels and confirm potential for changes from water quality
Ancient woodland	• Uncertainty regarding loss/disturbance of ancient woodland during construction phase	Tree and woodland surveys following further route optimisation. Desk based assessment with ground truthing of acceptable crossing points of the watercourses (where there is existing infrastructure, no wetland habitat) to identify common crossing points to be used by all pipelines where possible. Commence habitat mapping, UKHab surveys and identification of Tree Protection Orders/trees of value. Coastal floodplain grazing marsh – hydroecological assessment at pipeline crossings to ensure no localised drying of priority habitats.
Priority habitats	• Uncertainty regarding loss of priority habitats; not currently quantified. • Multiple crossings of river and streams priority habitat; cumulative effect. • Data not publicly available for linear features e.g. hedgerows and arable field margins.	Where common pipeline corridors can be determined, and following further route optimisation, quantify types and areas of priority habitat that could be lost. Obtain relevant biological record centre data once common pipeline corridors are identified, to aid pipeline route optimisation. Desk based assessment with ground truthing of acceptable crossing points of the watercourses (where there is existing infrastructure, no wetland habitat) to identify common crossing points to be used by all pipelines where possible. Commence habitat mapping, UKHab surveys and identification of Tree Protection Orders/trees of value. Coastal floodplain grazing marsh – hydroecological assessment at pipeline crossings to ensure no localised drying of priority habitats.
Priority species	• Currently only considered in relation to designated sites. • Baseline datasets from NBN Atlas were not deemed sufficient in this instance with limited protected species returns within 100 m of potentially affected watercourses.	It is recommended that protected species records are sought from relevant Local Environmental Records Centres within the operational and construction footprint of STT scheme to ensure that baseline datasets are representative of the diversity associated with the River Severn, River Avon and River Thames.

Topic/Receptor	Data gaps/uncertainties	Proposed work at Gate 3
		Where site selection and common pipeline corridors can be determined, obtain relevant protected species information and commence targeted survey work.
Fisheries / Aquatic	• Remaining uncertainty in assessments completed at Gate 2, particularly no measured data to inform risk to weir pool habitats in the River Avon • Concerns over suitability of 1D model used to inform assessments e.g., single point hydraulic outputs • Insufficient information to derive critical levels for fish passage at fish passes in River Severn and River Avon • Remaining uncertainty with regards to the impact of selected determinants on olfaction as there is a lack of data to inform modelling and assessment • Uncertainty over potential effect of concentrations of some determinands in the Seven Estuary and the significant total regime and potential increase in load • Commercially availability limits of detection not sufficiently low compared to EQS values for some chemicals • Uncertainty over potential change to weir pool wetted habitat or weir passability within the River Thames	River MoRPH and fish surveys. Repeat monitoring programme Water vole surveys at crossing points 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. Undertaking ADCP measurements upstream, downstream, and within weir pool habitats and bifurcations at representative weirs/locks in the River Avon to improve the uncertainty in the current assessments with regards to potential changes in habitat quality More ADCP measurements at a larger number of sites on River Vyrnwy, River Avon and River Severn including original five sites plus additional sites to cover range of flow habitats which characterise reach. Also, increased number of repeat surveys at these sites to cover capture wider range of flows. If possible, use a more detailed model to provide higher resolution outputs of velocity and depth If possible, include assessment of extreme low flows that are considered to be less regular than once every fifty years, and to consider pressures from climate change going forward. Further assessment of species-specific habitat change/loss per reach, dependent on model scenario. This would include an review of potential flow scenarios which may result in stable/static flows during dry summers that may impact on the level of temporal and spatial variability of fish habitats. Collate further information on fish pass design to inform critical levels for operation at each fish and eel pass Review of the Diglis fish pass data in order to support the movements of migratory fish within the Severn catchment. Baseline monitoring period for macroinvertebrate, macrophyte and phytobenthos continues to provide minimum 3-year baseline Further assessment and modelling of the risk to olfaction is required as data from the ongoing monitoring programmes becomes available

Topic/Receptor	Data gaps/uncertainties	Proposed work at Gate 3
		Continue to review evidence base in relation to endocrine disruptors which may act as olfactory inhibitors. Underwater noise assessment. Collection of bathymetry and hydraulic data under suitable flow conditions at selected weir pool reaches on the River Thames for inclusion in a 2D model.
Terrestrial	*Uncertainties and gaps covered through other topics/receptors e.g. chalk grasslands, coastal floodplain grazing marsh and violet click beetle*	UKHab survey along pipeline routes and at infrastructure sites Aerial survey with ground truthing e.g. hedgerow surveys, protected species surveys
Ornithology	• Limited information in use of area around Deerhurst by Severn Estuary SPA bird species	Review WeBS data Wintering and breeding bird surveys Targeted surveys where hedgerow/woodland loss Farmland birds
INNS	• Limited confidence in SAI-RAT assessment tool	Review SAI-RAT tool and update before Gate 3 assessments to account for wider comments from other users following implementation during Gate 2
Arboriculture	• No existing data/evidence	Mapping of veteran trees Mapping of TPOs (if readily available from LPAs websites) Tree surveys at key sites
Local designations	• Lack of understanding as to effect on local sites.	Obtain data for Sites of Importance for Nature Conservation.
Soil and Geology	• Proximity of construction to CEMEX UK Materials Ltd Permitted Waste Site – uncertainty over whether this could result in land contamination	Establish composition of waste in existing/historic landfills and risk of encountering contaminated soils, landfill gas and leachate. Carry out site investigations and Envirocheck review where pipeline cannot be re-routed to avoid areas.
	• Unknowns around contaminated land/ground conditions	Review of local plan allocations Desk based assessment (conceptual site models), review of historical mapping, British Geological Survey data, UXO screening.
	• Uncertainty over impact to mineral safeguarding areas	Mineral resources – safeguarded areas. Review plans, discuss with LPA and restrictions
Landuse	• Potential to disrupt agricultural practices, existing drainage networks, and adversely affect Grade 2 and 3 land. • The extent of temporary severance during construction for each individual landholding is unknown at present.	Review pipeline routing within individual field boundaries (arable) to establish whether existing paths/boundaries could be followed to minimise severance and temporary exclusion/sterilisation of areas.

Topic/Receptor	Data gaps/uncertainties	Proposed work at Gate 3
		Engage with land agents at earliest opportunity to establish landowner requirements (e.g., crop rotation/removal, drainage, and likely compensation package).
Water environment		
Water	• Minor uncertainties exist with regards to a lack of measured data to inform the risk to weir pool habitats in the River Avon associated with the physical changes upstream of Alverston	Undertake ADCP measurements upstream, downstream and within weir pool habitats and bifurcations at representative weirs/locks in the River Avon will improve the uncertainty in the current assessments.
Water	• Hydraulic modelling of the River Thames at Gate 2 is of limited reliability • This may have repercussions for the reliability of water quality modelling in the River Thames.	Further work on the hydraulic model for use in Gate 3 and further flow scenarios will be required
Water Quality	• Likely there are remaining gaps in water quality data and understanding of scheme operation • Short-term events may not be represented or exaggerated in duration if data quality is not sufficient. • Significant missing data for environmental water quality model on for River Severn and Avon • No cases to date in UK of reduction performance efficacy and operational reliability of planned treatment processes – therefore a limitation with chemical data in Gate 2 assessment	Further analysis of the water quality measured data, environmental modelling and enhanced definition of planned treatment processes to address the concerns raised by the EA on water quality permitting. The Minworth SRO and the STT interconnector are not compliant with current load-based permitting for physico-chemical water quality, specifically total ammonia and phosphorus.
Flood Risk	• Requirement for permanent infrastructure within Flood Zone 2 and 3 uncertain (e.g. pumping station, telemetry kiosks, valves for pipeline).	Obtain Environment Agency Product 4 data (detailed flow rates, flood levels and flood extents) for Flood Risk Assessment. Site visits and liaison with Lead Local Flood Advisor(s)
Air quality	• Uncertainty over routes for construction-related traffic in relation to Marcham AQMA • No quantification of impacts to residential receptors.	Desk based air quality assessment with identification of key receptors and likely impacts. Indicative modelling at other locations. Targeted AQ surveys at key construction sites/receptors – human and ecological.
Transport	• No quantification of impacts to residential/population receptors.	Desk based Transport Assessment
Climate change	• Uncertainty around GHG emissions	Identify GHG emission sources and establish baseline
Landscape and visual amenity	• Determine whether STT constitutes a 'Major development' as would contradict NPPF • Uncertainty around how scheme may impact Big Chalk vision	Desk based assessment (policy review, local designations, key issues) Early consultation with LPA/AONB about mitigation requirements

Topic/Receptor	Data gaps/uncertainties	Proposed work at Gate 3
Including Cotswold AONB (intersected by Interconnector)	• Localised impact of construction route through National Character Area not fully understood • Impact to visual amenity from loss of trees and hedgerows uncertain – temporary but long-term effect • Impacts to visual amenity uncertain as final designs of key infrastructure sites unconfirmed e.g., height of WTW, size of intake/discharge structures	Initial desk-based Landscape and Visual Impact Assessment Site visits Photographs late summer/winter for photomontages Professional assessment of whether proposed development will impact AONB Potential refining of pipeline route to limit impacts to chalk grassland and minimise overall damage Review siting and overall design specifications of pumping stations to avoid visual impacts
Historic environment	• Proximity of new WTW to scheduled monument at Deerhurst – uncertainty over how the setting may be impacted • Potential for unknown archaeology along pipeline routes • Uncertainty of whether the setting of other heritage features e.g., listed buildings could be impacted during construction phase	Early desk-based study / initial walkovers will determine sensitivity of the site and help identify if there is a need for any geophysical surveys or intrusive investigations or if pipeline routes need to be altered Desk based assessment of local designations (GLAAS data, HE data, Local Authority data) Site visits to key sites Identification of areas for targeted geo-physical surveys – through consultation with local authorities / archaeological trusts Local archaeological designations to be considered.
Population and human health		
Health	• Uncertainty over range of impacts to human health	HUDU (Rapid Risk Assessment) / Health Impact Assessment Desk based air quality assessment Desk based noise assessment
Recreation and Tourism	• Uncertainty over range of impacts to recreational resources during construction.	Desk based assessment of recreational impacts Surveys at key locations (visitor counts e.g., car parks/recreational facilities that will be closed, PRoW)
Socio-economics	• Uncertainty over number of construction-related jobs	Data review of Index of multiple deprivation and ONS statistics Desk based study

ANNEXES

ANNEX A: SEA TABLES

Please note the document that comprises this Annex is provided separately to this document Ref: STT-G2-S3-120-Initial Environmental Appraisal Report-Annex A.

ANNEX B: HERITAGE ASSETS

Please note the spreadsheet that comprises this Annex is provided separately to this document Ref: STT-G2-S3-120-Initial Environmental Appraisal Report-Annex B.

ANNEX C: GATE 2 RISK ASSESSMENT

Please note the spreadsheet that comprises this Annex is provided separately to this document Ref: STT-G2-S3-120-Initial Environmental Appraisal Report-Annex C.