Strategic Regional Water Resource Solutions: Annex B3.5: Invasive Non-Native Species (INNS) Assessment

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

Date: November 2022

SEVERN TRENT | Thames Water | United Utilities

Severn to Thames Transfer

INNS Assessment

STT-G2-S3-116

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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.

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SEVERN THAMES TRANSFER (STT) SOLUTION

INNS Assessment Report

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1. INTRODUCTION

1.1 BACKGROUND AND DESCRIPTION OF THE STT SCHEME

1.1.1 The River Severn to River Thames Transfer Description

The aim of the Severn Thames Transfer 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.

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

Figure 1.1 shows the investigations being 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 assessments; (ii) assessment reports were then produced using the evidence to determine the potential effect of the STT solution on the physical environment, water quality and ecological receptors (dark blue box in in Figure 1.1); (iii) based on the evidence and assessments, the informal statutory reports, and assessments required to meet the RAPID and regulatory expectations for solutions at Gate 2 were produced.

This report presents an assessment of the effect of the solution on INNS. It informs other assessments, including the statutory assessments.

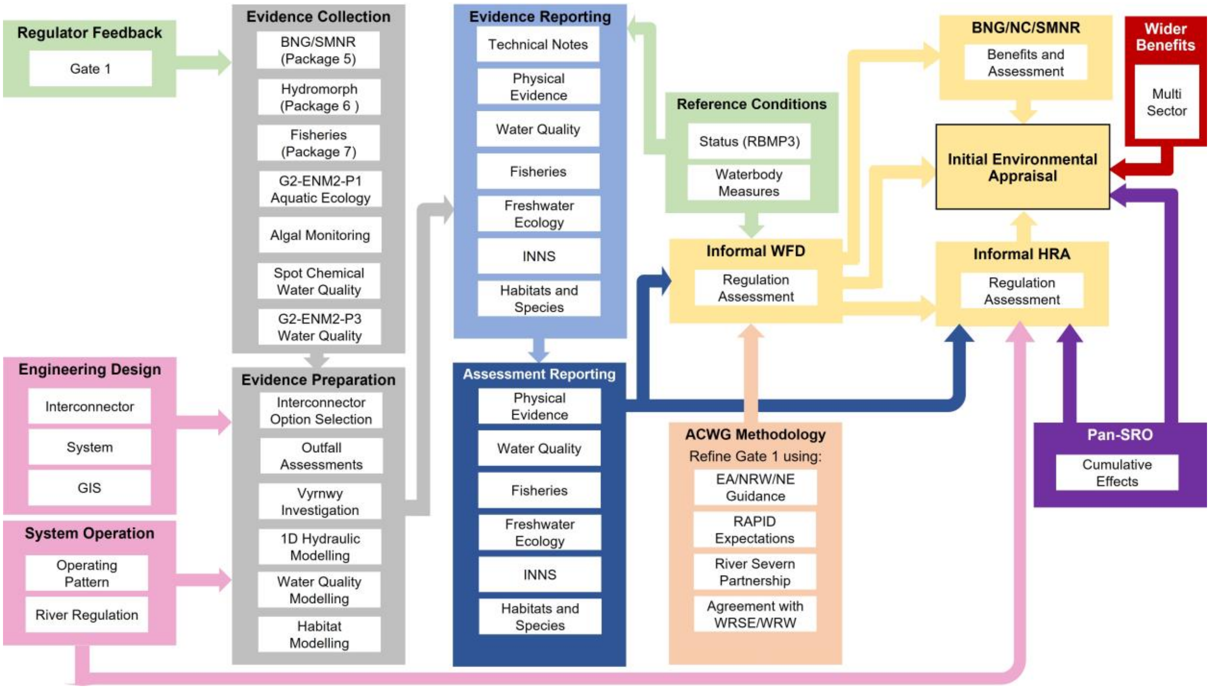

Figure 1.1 Flow chart showing the scope of investigations for STT Gate 2 and their interactions

1.2 STUDY AREA

The study area for the STT solution for Gate 2 ecology assessment is limited to specific reaches, as shown in **Figure 1.2**:

[1] RAPID (2022) Strategic regional water resource solutions guidance for Gate 32
[2] All Companies Working Group (2020) WRMP environmental assessment guidance and applicability with SROs

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

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 Solution Option and therefore excluded from the STT solution assessment.

Similarly, the STT solution assessment accounts for the effects from the relevant solutions 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 as this is included in Severn Trent Water's Minworth and Sources solution assessments.

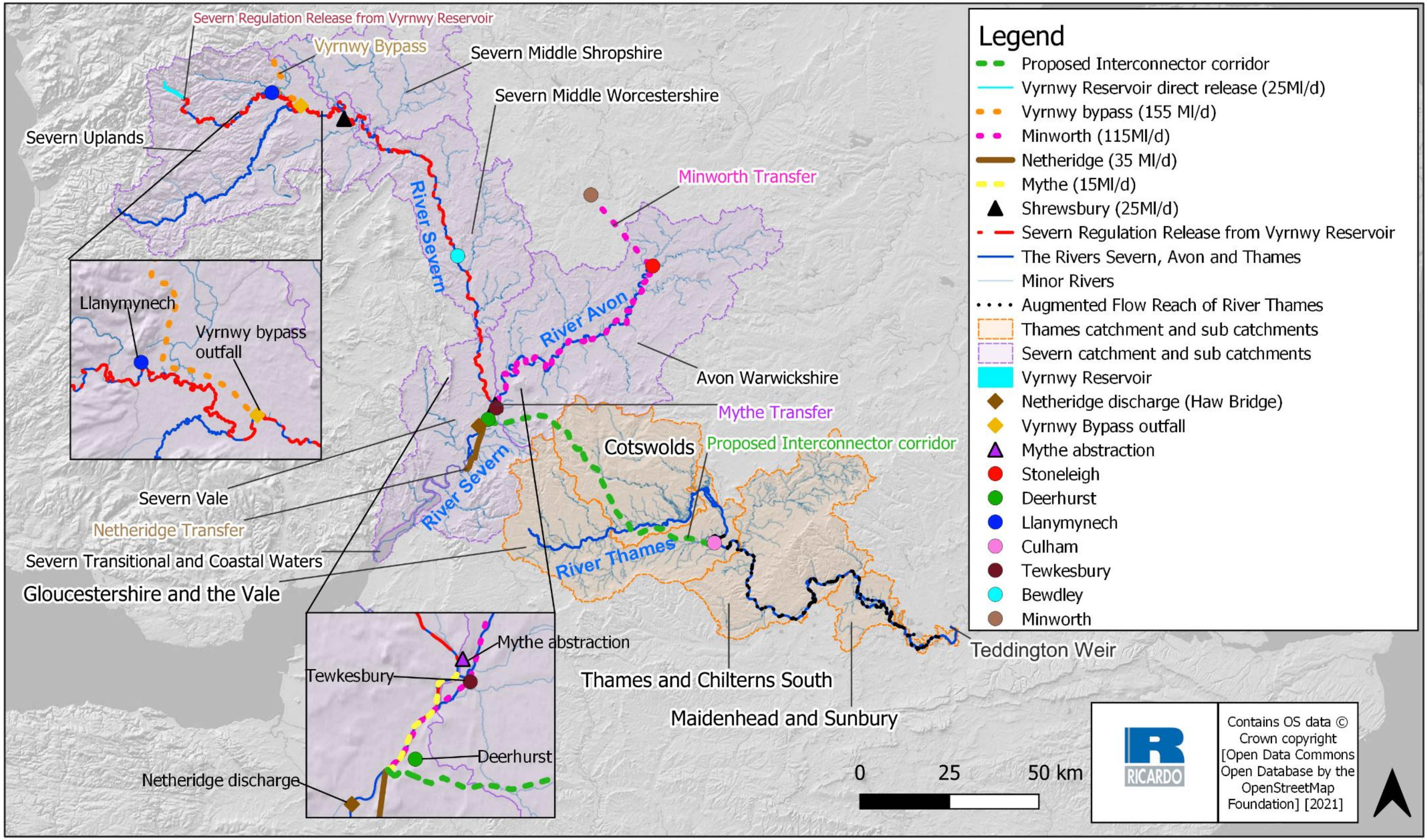

Figure 1.2 Map showing the proposed interconnector corridor

1.3 SUMMARY OF THE SOLUTION COMPONENTS AND OPERATION

The STT solution developed for Gate 2 is described through its engineering components in the Conceptual Design Report[3]. 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 1.1.

Supporting options would be operational at those times when the STT is transferring water from the River Severn to the River Thames, and when flows in the River Severn are lower than hands-off flow (HoF) thresholds in the River Severn. The EA has advised that a STT abstraction licence would be imposed so flows at Deerhurst flow gauging station do not drop below 2,568 Ml/d. Above this HoF, there is a maximum abstraction limit of 172 Ml/d, up to the next HoF condition of 3,333 Ml/d, where 335 Ml/d can be abstracted, in addition to the available 172 Ml/d unsupported[4]. This is summarised in Table 1.2.

The EA has advised the STT Group of appropriate values of "in-river losses" to include in the hydraulic modelling[5] and subsequent environmental assessments. The advised values include 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 1.1 Components of Early Phase and Full STT Operation

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

[3] STT-G2-S3-359-STT Gate 2 Design Principles

[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
	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

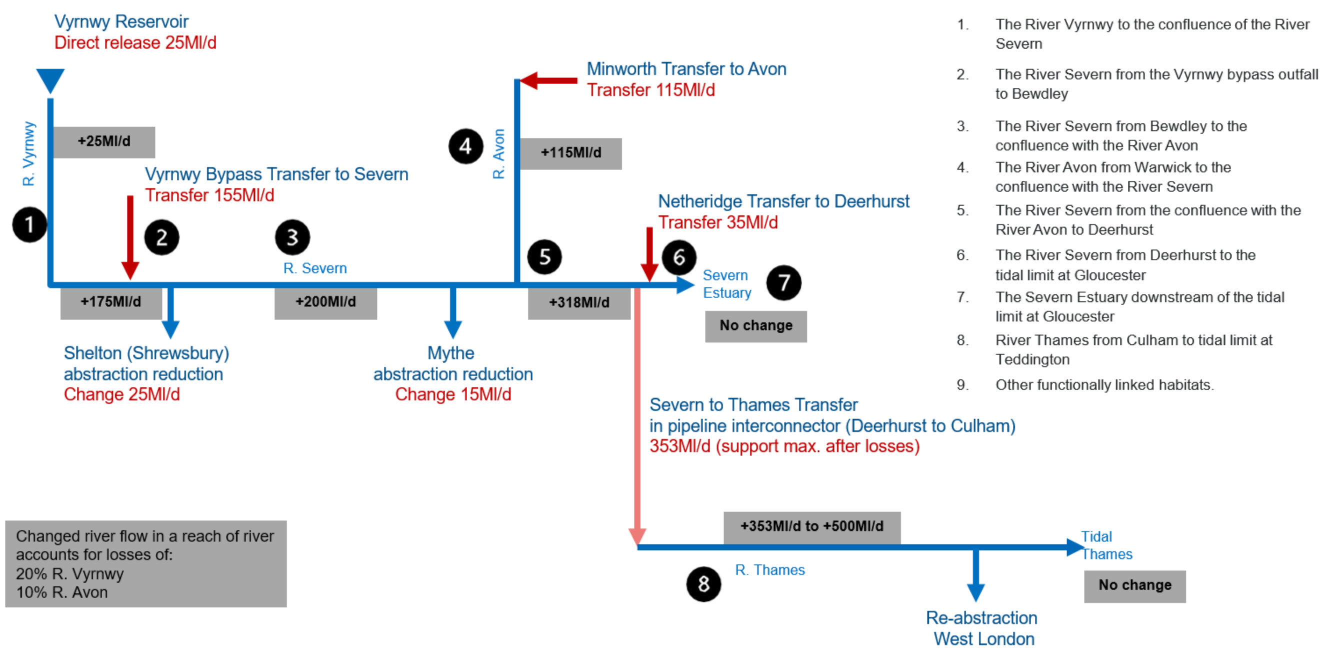

Figure 1.3 Schematic representing flow changes (accounting for losses) of STT Solution

Table 1.2 River Severn at Deerhurst: HoF conditions

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

To support the environmental assessments at Gate 2, an indicative operating pattern has been developed. The approach uses the 19,200 year stochastic flow series developed separately for the River Severn catchment for the Water Resources West (WRW) group and for the River Thames catchment for the WRSE group. The stochastic flow series 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 Physical Environment Assessment Report, with the derived representation of dates with the full STT in operation (for water resources purposes) as used in environmental assessment shown in **Figure 1.4.** It should be noted that this operating pattern is for the STT solution used on its own for Thames Water, without conjunctive use with other Thames Water solutions (such as the South East 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.

The general description in **Figure 1.4** identifies periods in purple when the early phase STT pattern would be in operation: the combined purple and blue periods shows the periods when the full STT operation pattern is being deployed. The review of river flows and operating patterns for the environmental assessment has identified that all support options would be on at the same time, rather than any selective or preferential use of support sources. These patterns of river flow and operational need inform the range of likely environmental effects of the scheme. Having identified these patterns, selected 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 WFD assessments and is thus not described further in this report.

The Gate 2 assessment also incorporates climate change scenarios into 1D hydraulic models for the assessment for the rivers 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 and are described in the Physical Environment Assessment Report. 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.

[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 environmental assessment

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

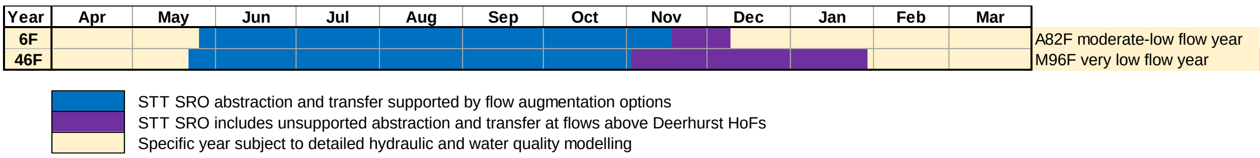

Figure 1.5 Representation of dates full STT solution would be on (for water resources purposes) for selected future scenarios as used in the environmental assessment

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

1.4 SCOPE OF THIS REPORT

This report presents analysis and findings from the examination of the information and data set out in the Evidence Report. It assesses the potential risks associated with the distribution of Invasive Non-Native Species (INNS) as informed by the EA's SRO Aquatic INNS Risk Assessment Tool (SAI-RAT)[7].

The findings of the analysis are presented for each of the STT solution components (unsupported abstraction and support options). The information is presented in this way so there is clarity over where effects from the scheme are observed.

This report also identifies where more confidence could be placed in the results, through further evidence collection and analysis. NB the Evidence Report also identifies remaining data/evidence gaps, provides a summary of the proposed programme of works and approach to address any data/evidence gaps as part of RAPID's gated assessment for the STT solution.

1.4.1 Link with other Reports

The INNS Evidence Report[8] sets out a data catalogue of the information sources that have been used to perform the assessment.

The results and findings presented in this report show the effects of the STT solution on the distribution of INNS as a result of the scheme's operation. These findings are used by many of the STT Gate 2 Environmental Assessment and Statutory reports which interpret the significance of the changes for their specific feature(s) or topic of interest.

[7] APEM (2021). SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) – User guide. November 2021.

[8] Ricardo Energy & Environment (2022). Severn to Thames Transfer SRO. Invasive Non-Native Species Evidence Report. Report for United Utilities on Behalf of the STT Group. February 2022.

2. ASSESSMENT

2.1 SUMMARY OF THE APPROACH

2.1.1 Context

Invasive non-native species of flora and fauna are considered the second biggest threat, after habitat loss and destruction, to biodiversity worldwide and have been identified as one of the most serious and rapidly growing threats to biodiversity, ecosystem services and food, health and livelihood security. The annual cost of INNS to Great Britain's economy was estimated in 2015 to be £1.7billion per year, of which around £5 million was attributed to the water industry management of INNS. New and existing INNS also pose a threat to achieving Water Framework Directive (WFD) objectives. The 2016 UKWIR project completed by Ricardo Energy & Environment (REE), provided further evidence of the implications of INNS to the water industry[9].

Subsequently, the Environment Agency (EA) (2017) set out a position paper on the assessment of the risks of spreading INNS through existing water transfers . The position paper set out the scope, outcomes and timelines expected for risk assessments raw water transfers and options appraisal that water companies should deliver in Asset Management Plan (AMP)7.

As a result, INNS became a new "driver" within the 2019 Price Review (PR19). In previous price reviews, there was some scope for limited INNS work, justified within the biodiversity drivers. Having a separate driver recognised the increasing evidence and understanding of the risks posed by INNS. The guidance supporting this driver is explicit in stating that "*the most cost-beneficial and least damaging way to manage invasive species is to prevent their arrival and spread*." This highlights the need to understand the pathways by which INNS can be transferred and hence be spread. Furthermore, the EA has specifically identified raw water transfers (RWTs) as a subgroup of pathways that should have priority risk assessments (RAs) to assess the potential for INNS to spread.

The INNS guidance indicates that all water companies will need to consider:

- Pathways of spread (understanding and reducing the risk from different pathways);
- Preventing spread (controlling, eradicating or managing INNS to prevent spread where this will contribute to WFD prevention of deterioration); and
- Action on INNS to achieve conservation objectives of Sites of Special Scientific Interest (SSSI) and sites protected under the Habitats Directive.

This has led to INNS being considered in the Water Industry National Environmental Programme across the water industry with a particular focus on investigating the risks of spreading INNS through the transfer, options appraisal for mitigation and companywide biosecurity plans to reduce the risk of distributing INNS through existing activities and operations.

A further position statement issued in 2022 has set the EA's position with regards water company raw water transfers. The position paper sets out the mitigation requirements and levels of assurance expected of water companies. This extends to connections between linked isolated catchments, already connected catchments and existing raw water transfers. The focus of the position statement is on the pathway that the transfers create, not on current INNS occurrence. Therefore the levels of assurance extend to all functional groups of INNS.

2.1.2 Gate 1 approach

Within Gate 1 a pathway-based INNS assessment approach was used to assess the possible pathways for the introduction of INNS for each element associated with the STT solution. This was accomplished using the INNS risk assessment tool developed by REE. This tool was subject to independent review and verification, provided by INNS specialist Dr David Aldridge, and was agreed for use by the EA to assess the risk of INNS transfer for several solutions for the Gate 1 assessment[10].

[9] Ricardo Energy & Environment (Formally Cascade (Environment and Planning) Ltd) on behalf of UK Water Industry Research (2016). Invasive Non-Native Species (INNS) Implications on the Water Industry. 2016.

[10] Ricardo Energy & Environment (2021). Severn to Thames Transfer SRO. Environmental Assessment Report: Appendix B3.5 INNS. July 2021.

The risk assessment tool was developed using previous examples of similar assessment tools and EA guidance[11]. The risk assessment tool considers a pathway approach, advocated in EA guidance. This grouping approach recognises that certain types of assets or RWTs provide a range of pathways, with some having greater relevance, and thus risk spread, for certain INNS groups. These pathways may include new or existing pathways and may be related directly to the operation of the solution or related to the usage of the asset by the public e.g. leisure craft. The combination of pathway risk associated with groups of INNS and occurrence of this pathway at/within an asset/RWT allowed INNS risk assessment and INNS risk scores to be developed. This grouping approach provided efficiencies for INNS and individual assessments. It also allowed for the consideration of the current environment associated with each intake and discharge location of the system components. The risk to WFD (objectives, status and measures) and protected sites were also considered in the tool.

The tool was intended to provide a rapid, transparent assessment of the theoretical risk of transfer of INNS. The tool was applied to the STT solution components to quantify the relative risk of each transfer connection **before** the application of mitigation measures.

2.1.3 Gate 2 approach (SAI-RAT Tool)

Following the Gate 1 STT solution assessment, and a process of stakeholder review including input from internal experts within Ricardo, the EA released an INNS risk assessment tool for solutions which the EA has indicated should be used at Gate 2 for assessing INNS risks across all solutions.

The tool named the "SRO Aquatic INNS Risk Assessment Tool", or SAI_RAT, was developed to account for the diversity of assets and RWTs which may comprise any one solution and uses a single assessment process via a modular approach, to provide a quantitative score of relative risk. The Microsoft Excel-based tool accounts for the diversity of assets and raw water transfers which may comprise any one solution and uses a single assessment process via a modular approach, to provide a quantitative score of relative risk.

The assessment of RWTs using the SAI-RAT takes a pragmatic pathway and source-pathway-receptor model approach, respectively, building upon other assessment tools such as the Northumbrian Water Group (NWG) RWT assessment tool and the Wessex Water asset assessment tool, adopting similar approaches to the quantification of INNS risk. Similar to these tools, an extended functional group mechanism has been incorporated to account for future risks rather than only examining species known to be currently present. The detailed assessment conducted using this tool is therefore based on the individual components of the STT solution and the potential source-pathways, rather than a reach-by reach approach to assessment as for ecological receptors.

2.1.4 Engagement with Stakeholders

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 Environment Agency (EA), Natural Resources Water (NRW) and Natural England (NE), in addition to topic-specific sessions and workshops with technical specialists. The regulators were asked to provide insights and inputs on specific aspects where needed in order to ensure the work undertaken is as robust as possible. They will review the Gate 2 assessment reports and findings.

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.

[11] PR19 - Assessing the risks of spread of Invasive non-native species posed by existing water transfers – OFFICIAL. Environment Agency. 2017.

3. DETAILED INNS ASSESSMENT

3.1 LAKE VYRNWY DIRECT DISCHARGE

The Lake Vyrnwy discharge involves the release of 25Ml/d into the river Vyrnwy at Lake Vyrnwy. Lake Vyrnwy currently discharges to the river Vyrnwy during regulatory releases and compensation flows. Therefore, the assessment of risk in relation to INNS is not relevant for this component as there is no action which may be perceived to have a measurable effect on the distribution of INNS beyond that which currently occurs during normal operation. The risk of transfer of INNS resulting from the abstraction of water made available through the lake Vyrnwy discharge will be assessed as part of the Deerhurst abstraction (Section 3.7).

3.2 RIVER VYRNWY BYPASS (SHREWSBURY – OPTION 27)

The River Vyrnwy Bypass (Shrewsbury – Option 27) component involves the transfer of raw water from Lake Vyrnwy, via infrastructure that currently forms part of Oswestry WTW, and into the River Severn downstream of the Vyrnwy confluence.

This proposed option to bypass the River Vyrnwy is to avoid any impacts on habitats within the River Vyrnwy which are considered to provide the structure and function to support the anadromous and catadromous fish species that are qualifying features of the Severn Estuary European Marine Site. It must be noted that the raw water will not undergo treatment at Oswestry WTW, therefore the full length of the transfer will be assessed for risk in relation to the transfer of INNS. The Vyrnwy Bypass pipeline route travels through three operational catchments. Raw water originates from the Vyrnwy Reservoir within the Severn Upper and Vyrnwy River operational catchment and travels via pipeline through the Severn Upper and Tanat operational catchment before terminating at the Morda and Severn North Shropshire operational catchment. The pipeline route includes three major river crossings and eight minor river crossings. There are currently four-valve chambers proposed for the scheme. Therefore, should an unintentional discharge occur during operation there is a potential for raw water to be discharged and INNS to enter new catchments and watercourses in which no upstream hydrological link exists.

3.2.1 Baseline

The River Vyrnwy Bypass has the potential to transfer INNS from the Vyrnwy Reservoir (via the aqueduct) to the River Severn downstream of the confluence with the River Vyrnwy. Within 500m of the River Vyrnwy and the lake Vyrnwy catchment, the most recorded INNS is Himalayan balsam (*Impatiens glandulifera*), which has been recorded 74 times. Other notable species that can be transferred by a RWT include Rhododendron (*Rhododendron ponticum),* Butterfly Bush (*Buddleja davidii*), Canadian Pondweed (*Elodea canadensis*) and Japanese Knotweed (*Fallopia japonica*).

In the River Severn, baseline data indicates that 72 different INNS have been recorded within 500m of the river between the confluence with the river Vyrnwy and the Deerhurst abstraction. Of these, the most prevalent INNS was Himalayan Balsam, which was recorded 1043 times. Other prevalent INNS recorded that can be transferred by a RWT include New Zealand mud snail (*Potamopyrgus antipodarum*), Japanese knotweed, Asian clam (*Corbicula fluminea*) and Nuttall's waterweed (*Elodea nuttallii*).

The operation of the scheme is likely to occur during summer and autumn when the majority of these species are most prevalent and would likely encompass the reproductive season of most species.

3.2.2 SAI-RAT Assessment Tool results

The abstraction and transfer of raw water via the proposed pipeline from the Vyrnwy Reservoir (via the aqueduct) to the River Severn poses a risk in relation to the transfer of INNS from the Vyrnwy Reservoir to the River Severn. The assessment considered a 180Ml/d and a 205Ml/d transfer. Inputs used to assess the Vyrnwy Bypass using the SAI-RAT are provided in **Annex A**.

Both scenario volumes were assessed using the SAI-RAT. During both assessments, a number of variables were kept the same such as:

- The transfer source, in both scenarios water, is to be abstracted from the same location, therefore the likely pathways that occur at the abstraction point that might distribute INNS to the source remain the same e.g., boats and angling;

- The transfer mechanism remains the same in both scenarios, being a pipeline transfer. As such, the pipeline distance and route are also the same, therefore the presence of priority habitats, designations, and priority INNS along said route and at the source and destination of the transfer remains the same;
    - The transferred water, in both scenarios, is to be discharged into the same receptor at the same location; and
    - The operational frequency and duration in both scenarios remain the same as defined by the scaling within the tool.
    - The number of washout pints (>3) remains the same for both options.

The SAI-RAT tool assigns a risk value based on the characteristics of the transfer option. Information is inserted for each variable within the tool for each solution element/component to match the characteristics of the proposed routes as closely as possible (as permitted by the scaling within the tool).

Variables within the tool are weighted differently based on their inherent risk to the distribution of INNS. Within the River Vyrnwy Bypass component, factors that contribute heavily to the risk score are as follows:

- Transferring between operational catchments: a difference in the source and receptor catchments of the option resulted in a higher risk score;
- Activity at source: due to the source of the option being navigable by boat, and having angling and watersport activity, it is assigned a higher risk score. Species may utilise distribution pathways associated with the use of boats and leisure craft at the connection source habitat where they may establish and further distributed by the RWT; and
- Functional group scores - source, pathway and receptor: calculations for the functional group scores consider the differences in types of sources, pathways and receptors. Due to the transfer source being a reservoir and the receptor being a river, this category scores higher when compared to other types of water bodies.

As expected, the SAI-RAT assesses the 205Ml/d volume as a greater risk when compared to the 180Ml/d option, although the risk is only slightly higher (see **Table 3.1**). The 205Ml/d scenario scores 1% higher than the 180Ml/d scenario. Volume remains the only independent variable accounting for the difference observed between the two options. The Vyrnwy Bypass component will discharge raw water abstracted from the Vyrnwy Reservoir (via the aqueduct) to the River Severn, bypassing the River Vyrnwy entirely and more than 40km of the upper River Severn. Although hydrologically connected to the River Severn, the River Vyrnwy represents a significant barrier for INNS which inhabit or may in the future inhabit Lake Vyrnwy and are not able to establish within fast-flowing upland watercourses. At the very least, the River Vyrnwy will act to delay the downstream migration of certain INNS to the River Severn. The bypass pipeline route travels through three operational catchments. The raw water originates from the Vyrnwy Reservoir within the Severn Upper and Vyrnwy River operational catchment and travels via pipeline through the Severn Upper and Tanat operational catchment before terminating at the Morda and Severn North Shropshire operational catchment. The pipeline route includes three major river crossings and eight minor river crossings. There are currently four-valve chambers proposed for the scheme. Therefore, should an unintentional discharge occur during operation there is a potential for raw water to be discharged and INNS to enter new catchments and watercourses in which no upstream hydrological link exists.

In most RWT scenarios an increased volume equates to a greater INNS propagule transfer potential. It should be noted that the scaling applied to the volume within the SAI-RAT is subject to ordinal scaling with the 180Ml/d River Vyrnwy Bypass option falling within the 151-200Ml/d categorisation and the 205Ml/d River Vyrnwy Bypass option falling within the 201 – 250Ml/d categorisation. Therefore, the SAI-RAT tool would assess a 200Ml/d River Vyrnwy Bypass option as having the same risk as 180Ml/d.

Table 3.1 Summary of the risk scores for the River Vyrnwy Bypass (180Ml/d and 205Ml/d options) as obtained from the SAI-RAT tool

Name	Risk (%)
River Vyrnwy Bypass (Shrewsbury – Option 27) – 180Ml/d	52
River Vyrnwy Bypass (Shrewsbury – Option 27) – 205Ml/d	53

3.3 SHREWSBURY REDEPLOYMENT

The Shrewsbury Redeployment component involves the diversion of 25Ml/d UU Oswestry WTW treated water to supply STW customers normally supplied from STW's Shelton WTW thus reducing abstraction from the River Severn and temporary transfer of the licence to the Deerhurst abstraction. The redeployment of licensed abstraction does not require the construction of infrastructure, transfer of water or maintenance to implement. Therefore, the assessment of risk in relation to INNS is not relevant for this component as there is no action which may be perceived to affect the distribution of INNS. The risk of transfer of INNS resulting from the abstraction of water made available through the Shrewsbury Redeployment component will be assessed as part of the Deerhurst abstraction (Section 3.6).

3.4 MYTHE REDEPLOYMENT

The Mythe Redeployment component involves the diversion of 15Ml/d of licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst. The redeployment of licensed abstraction does not require the construction of infrastructure, transfer of water or maintenance to implement. Therefore, the assessment of risk in relation to INNS is not relevant for this component as there is no action which may be perceived to affect the distribution of INNS. The risk of transfer of INNS resulting from the abstraction of water made available through the Mythe Redeployment component will be assessed as part of the Deerhurst abstraction (Section 3.7).

3.5 MINWORTH TREATED EFFLUENT TRANSFER

The Minworth treated effluent transfer component involves a pipeline diversion of 115Ml/d of treated sewage derived effluent which is to be discharged into the River Avon downstream of Stoneleigh. The Gate 2 engineering conceptual design of the Minworth SRO states the inclusion of ferric dosing, CoMAG cloth filter filtration, and granular activated carbon (GAC) prior to discharge. The SAI-RAT does contain options within the RWT tool to assess water sourced from water treatment works or sewage treatment. However, during the operation of this option water is treated to a far superior standard compared to standard treated wastewater before release and as such is not perceived as a raw water transfer in the context of INNS. Therefore eliminating all pathways that are likely to introduce or transfer INNS during normal operation. Additionally INNS risk has been assessed within the Minworth report therefore, the application of the SAI-RAT RWT risk assessment is not relevant for this component.

3.6 NETHERIDGE TREATED EFFLUENT TRANSFER

The Netheridge treated effluent transfer component involves a piped diversion of 35Ml/d of final effluent from Netheridge WwTW for discharge to the River Severn at Haw Bridge. The Gate 2 engineering conceptual design of the Severn Trent Sources SRO states the inclusion of ferric dosing, CoMAG cloth filter filtration, and granular activated carbon (GAC) prior to discharge. The SAI-RAT does contain options within the RWT tool to assess water sourced from water treatment works or sewage treatment. However, during the operation of this option water is treated to a far superior standard compared to standard treated wastewater before release and as such is not perceived as a raw water transfer in the context of INNS. Additionally INNS risk has been assessed within the Netheridge report therefore, the application of the SAI-RAT RWT risk assessment is not relevant for this component.

3.7 DEERHURST ABSTRACTION

The Deerhurst abstraction component involves the abstraction of raw water from the River Severn near Deerhurst, the abstracted water is to be transferred to the River Thames at Culham via a pipeline. During the transfer, raw water will pass through water treatment works where it will be treated by Inlet screening, ferric chloride coagulation, clarification in flat-bottomed clarifiers, rapid gravity filtration and washwater recovery. Traditional treatment process that is effective at removing suspended solids, organic matter, and nutrients, as well as some removal of other pollutants i.e., heavy metals. RGFs can provide effective removal (>80%) of particles greater than 15 microns, enabling good removal of INNS. This treatment process would likely be 100% effective in removing INNS propogules. As such the assessment of risk in relation to INNS does not consider the length of the pipeline after treatment has taken place and before discharge into the River Thames. The water treatment process is sufficient to remove all INNS and propagules from the raw water and therefore there will be no perceived risk of distribution of INNS beyond this point. The assessment of risk will therefore focus on the Deerhurst to the WTW section of the transfer. In addition to water abstracted for drinking water supply a continuous abstraction from River Severn at Deerhurst of 20Ml/d will provide a pipeline maintenance flow, with continuous transfer to River Thames at Culham. This water will also be subject to a tertiary treatment process.

3.7.1 Baseline

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 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.

The operation of the scheme is likely to occur during summer and autumn when the majority of these species are most prevalent and would likely encompass the reproductive season of most species.

3.7.2 SAI-RAT Assessment tool results

The abstraction of water and transfer via the proposed pipeline from the River Severn to the WTW pose a risk in relation to the transfer of INNS, as raw untreated water is being transferred. The scheme is currently being assessed in a capacity of 300Ml/d, 400Ml/d and 500Ml/d as well a continuous abstraction from River Severn at Deerhurst of 20Ml/d to provide a pipeline maintenance flow, with continuous transfer to River Thames at Culham. The WTW will be located at Deerhurst approximately 1.2km from the abstraction source. Inputs used to assess the Deerhurst abstraction using the SAI-RAT are provided in **Annex A**.

All three water transfer scenario volumes and the sweetening flow volume were assessed using the SAI-RAT. In all scenarios a number of variables remain the same, as follows:

- The transfer source, in both scenarios, is the same location, therefore the likely pathways that occur at the abstraction point that might distribute INNS to the source remain the same e.g., boats and angling;
- The transfer mechanism remains the same in both scenarios, being a pipeline transfer. As such, the pipeline distance and route are the same, therefore the presence of priority habitats, designations, and priority INNS along said route and at the source and destination of the transfer remains the same.
    - The transfer destination, in both scenarios, is a water treatment plant therefore no waterbody ID was inputted to the tool; and
    - The operational frequency and duration in all water transfer scenarios remain the same as defined by the scaling within the tool as "*Occasional i.e. infrequent, regulatory compliance*". The sweetening flow was assessed as a continuous transfer operating all year round.

The SAI-RAT tool assigns a risk value based on the characteristics of the transfer option. Information is inserted for each variable within the tool for each solution element/component to match the characteristics of the proposed routes as closely as possible (as permitted by the scaling within the tool).

Variables within the SAI-RAT are weighted differently based on their inherent risk to the distribution of INNS. Within the Deerhurst abstraction option, factors that contribute to the SAI-RAT risk score include:

- Activity at source: due to the source of the option being navigable by boat, and having angling and watersport activity, a higher risk score is assigned. Species may utilise distribution pathways associated with the use of boats and leisure craft at the connection source habitat where they may establish and further distributed by the RWT; and
- Functional group scores - source, pathway and receptor: calculations for the functional group scores consider the differences in types of sources, pathways and receptors. Due to the transfer source being a river, it scores higher when compared to other types of water bodies.

As expected, the SAI-RAT assesses the 500Ml/d volume as a greater risk when compared to the 300Ml/d and 400Ml/d options as can be seen within **Table 3.2**. The 500Ml/d scenario scores 2% higher than the 400Ml/d scenarios and 3% higher than the 300Ml/d scenarios. In most RWT scenarios an increased volume equates to a greater propagule transfer potential. Interestingly the sweetening flow scored the same risk score as the 400Ml/d water transfer volume on account of the higher frequency, despite the lower operational daily volume.

It should be noted that the scaling applied to the transfer volume within the SAI-RAT is subject to ordinal scaling. The 300 Ml/d Deerhurst abstraction option falls within the 251-300 Ml/d categorisation and the 400Ml/d Deerhurst abstraction option falls within a 301 – 400Ml/d categorisation. Therefore, the SAI-RAT tool would assess a 251 or 275 Ml/d Deerhurst abstraction option as having the same risk as the 300 Ml/d option.

In addition, the destination of the transfer is a WTW which is located within the same operation catchment as the abstraction location. Thus, the risk of transferring INNS during all three scenarios is considered to be low during the normal operation of the transfer. The SAI-RAT distinguishes RWTs which terminate at a WTW works based upon the perceived risk of INNS persisting at the transfer destination: the relative impact to the risk score from this aspect of the assessment is relatively small. When within the context of the Deerhurst abstraction component the fact that the transfer terminates at a WTW within the same operational catchment substantially reduces the risk that INNS may be distributed by the transfer. Furthermore, the SAI-RAT tool applies a greater risk scoring to shorter transfers when compared to longer transfers, so in the context of the Deerhurst abstraction, the risk score is increased based upon the short pipeline length despite the transfer terminating at a WTW.

Table 3.2 Results of the SAI-RAT assessment of the Deerhurst abstraction component of the STT solution

Name	Risk (%)
Deerhurst abstraction 300 Ml/d	47
Deerhurst abstraction 400 Ml/d	48
Deerhurst abstraction 500 Ml/d	50
Deerhurst sweetening flow 20Ml/d	48

4. CONCLUSIONS

4.1 SUMMARY OF THE INNS RISK ASSESSMENT

Two of the six STT components of the solution have been assessed using the SAI-RAT tool. The Shrewsbury and Mythe redeployment components were not assessed, as the redeployment of licensed abstraction does not require the construction of infrastructure, transfer of raw water or maintenance to implement. Therefore, the SAI-RAT assessment is not relevant for these components as there is no action required to implement the scheme which may be perceived to affect the distribution of INNS.

The Minworth and Netheridge effluent transfer components were also not assessed using the SAI-RAT tool. It is not likely that the introduction or transfer of INNS will occur during the operation of these options as the water is derived from sewage effluent and will be subject to further treatment before release, eliminating all pathways that are likely to introduce or transfer INNS during normal operation.

The final two components, the River Vyrnwy Bypass and Deerhurst abstraction, both being RWTs, were assessed using the SAI-RAT. A summary of the SAI-RAT results can be seen in Table 4.1. The Vyrnwy Bypass component was assessed based on two potential operational volumes, 180Ml/d and 205Ml/d, scoring 52% and 53% respectively. The Deerhurst abstraction component was assessed based upon three operational volumes of 300, 400 and 500Ml/d, scoring 47%, 48% and 50% respectively. The Deerhurst abstraction sweetening flow of 20Ml/d was also assessed scoring 48%. The Vyrnwy Bypass options score marginally higher than all Deerhurst abstraction volumes.

Table 4.1 Results of the SAI-RAT assessment of the Deerhurst abstraction and River Vyrnwy bypass components of the STT solution.

Name	Risk (%)
River Vyrnwy Bypass (Shrewsbury – Option 27) – 180Ml/d	52
River Vyrnwy Bypass (Shrewsbury – Option 27) – 205Ml/d	53
Deerhurst abstraction 300 Ml/d	47
Deerhurst abstraction 400 Ml/d	48
Deerhurst abstraction 500 Ml/d	50
Deerhurst sweetening flow 20Ml/d	48

4.2 UNCERTAINTY AND CONFIDENCE DATA GAPS

The SAI-RAT assessment spreadsheet does not allow the user to interpret how variables impact the risk score, therefore confidence in the tool is based solely upon the final output scoring and the perception of its accuracy. Insight into the formulas used to calculate scores is hidden from the user therefore it is not clear how the risk score is calculated and therefore it is not possible to scrutinise the results of the SAI-RAT fully.

The outcome of the assessment suggests that the Vyrnwy Bypass is marginally riskier than the Deerhurst abstraction options. When comparing the lowest-scoring Deerhurst abstraction option of 300Ml/d to the highest scoring 205Ml/d Vyrnwy Bypass option the difference in risk amount of approximately 6%. Several factors may suggest that in reality, the Vyrnwy Bypass has a much greater potential to transfer INNS when compared to the Deerhurst abstraction, implying that the SAI-RAT tool may not be accurate when comparing solution components of different types. There are several factors which support this viewpoint:

- The Vyrnwy Bypass component will discharge raw water abstracted from the Vyrnwy Reservoir (via the aqueduct) to the River Severn, bypassing the River Vyrnwy entirely and more than 40km of the upper River Severn. Although hydrologically connected to the River Severn, the River Vyrnwy represents a significant barrier for INNS which inhabit or may in the future inhabit Lake Vyrnwy and are not able to establish within fast-flowing upland watercourses. At the very least, the River Vyrnwy will act to delay the downstream migration of certain INNS to the River Severn. The Vyrnwy Bypass would therefore form a rapid transport pathway for INNS to be transported directly to the lower reaches of the Severn. In contrast, the Deerhurst abstraction has a very low potential to transport INNS to new habitats as the component terminates at a WTW within 1.2km of the source at which water will be treated before onward transport to the River Thames; and

- The Vyrnwy Bypass pipeline route travels through three operational catchments. Raw water originates from the Vyrnwy Reservoir within the Severn Upper and Vyrnwy River operational catchment and travels via pipeline through the Severn Upper and Tanat operational catchment before terminating at the Morda and Severn North Shropshire operational catchment. The pipeline route includes three major river crossings and eight minor river crossings. There are currently four-valve chambers proposed for the scheme. Therefore, should an unintentional discharge occur during operation there is a potential for raw water to be discharged and INNS to enter new catchments and watercourses in which no upstream hydrological link exists. In contrast, the Deerhurst abstraction begins and terminates within the same operational catchment, therefore the potential to transport INNS to new catchments before water treatment is zero.

4.3 RECOMMENDATIONS FOR GATE 3

The SAI-RAT assessment spreadsheet does not allow the user to interpret how variables impact the risk score, therefore confidence in the tool is based solely upon the final output scoring and the perception of its accuracy. It is recommended that the SAI-RAT tool is reviewed and updated before the Gate 3 assessments to account for wider comments from other users following implementation during Gate 2.

Annexes

Annex A

Table A1 SAI-RAT RWT risk assessment inputs used to assess the Vyrnwy Bypass and Deerhurst abstraction components of the STT solution

RWT Name	Deerhurst abstraction 300Ml/d	Deerhurst abstraction 400Ml/d	Deerhurst abstraction 500Ml/d	Deerhurst Sweetening Flow 20Ml/d	Vyrnwy Bypass 180Ml/d	Vyrnwy Bypass 205Ml/d
Source Name	River Severn				Lake Vyrnwy	
Source Management Catchment	Severn Vale				Severn Uplands	
Source Operational Catchment	Severn River and tributaries				Severn Uplands	
Source Type	River				River	
Number of RWT inputs into source	Unknown				None	
Pathway Type	Pipeline				Pipeline	
Receptor Name	WTW				River Severn	
Receptor Management Catchment	Severn Vale				Severn uplands	
Receptor Operational Catchment	Severn River and tributaries				Morda and Severn North Shropshire	
Receptor Waterbody ID	N/A				GB109054049142	
Receptor Type	Water treatment works				River	
Isolated receptor catchment	No				No	
Volume of water	251-300 Ml/d	301-400 Ml/d	401-500Ml/d	20 Ml/d	151-200 Ml/d	201-250 Ml/d
Frequency of operation	Occasional i.e. infrequent, regulatory compliance			Year round - continuous, full flow	Occasional i.e. infrequent, regulatory compliance	
Transfer distance (Km)	1.1-5				>30	
Washout/maintenance points outside of catchments	None				>3	
Source Navigable	Yes				Yes	
Pathway Navigable	No				No	
Angling at Source	Members and day ticket holders, international events				Members and day ticket holders, no matches	
Angling on Pathway	No				No	
Water sports at Source	National events				Casual use by individuals/clubs	
Water sports on Pathway	No				No	
Presence of high priority INNS Source	Known to be present				Known to be present	
Presence of high priority INNS Pathway	Known to be present				Known to be present	
Highest order site designation Receptor	International				International	
Presence of priority habitat Pathway	Known to be present				Known to be present	
Presence of priority habitat Receptor	Known to be present				Known to be present	
Other existing connections between source and receptor	None				1	
Risk Score (%)	**47**	**48**	**50**	**48**	**51**	**52**