



Grand Union  
Canal Transfer

# Minworth SRO Gate 3 Annex B3 Environmental Assessment Report

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# Grand Union Canal Transfer

## Minworth Strategic Resource Option

Gate 3 Environmental Assessment Report

Affinity Water

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### Quality information

Prepared by	Checked by	Verified by	Approved by
Technical Leads	[Redacted] Technical Director, Aquatic Ecology	[Redacted] Specialist Water Resource Adviser	[Redacted] Technical Director, Aquatic Ecology

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### Distribution List

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**Prepared for:**

Affinity Water  
Affinity Water Limited  
Tamblin Way, Hatfield, Hertfordshire AL10 9EZ

**Prepared by:**

AECOM Limited  
12 Regan Way  
Chetwynd Business Park  
Nottingham NG9 6RZ  
United Kingdom

T: +44 (115) 827 8000  
aecom.com

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# Executive Summary

This report summarises the results and recommendations of Environmental Assessments for Gate 3 of the RAPID (Regulators' Alliance for Progressing Infrastructure Development) gated process, for the Minworth Strategic Resource Option (SRO) scheme, on behalf of Affinity Water (AfW), and Severn Trent (ST).

The purpose of the environmental assessments is to assess the Minworth SRO as a potential supply-side option, alongside the Grand Union Canal (GUC) SRO, within the RAPID Gated process. This report collates and summarises the results and recommendations of technical environmental assessments, which are described in detail in the accompanying technical reports (referenced herein).

Minworth SRO includes a new Advanced Water Treatment Plant (AWTP) that will treat recycled water from Minworth Wastewater Recycling Centre (WwRC). Recycled water will be transferred to the existing canal waterways in the northern section of the GUC route. Minworth SRO will be the source of recycled water to support the new abstraction for the GUC SRO. Minworth SRO is one of several SROs currently being considered under the RAPID gated process. The scheme is under consideration as part of a portfolio of solutions to ensure that a reliable and resilient water supply is provided to water-stressed areas; in particular, the southeast of England.

Minworth SRO is a 'source option', providing transfer of up to 115 Ml/d via GUC, and the option to transfer 115 Ml/d to support the Severn to Thames Transfer (STT). Assessment through Gate 1 and Gate 2 has considered the in-combination impacts on the Rivers Tame and Trent of Minworth supporting both GUC and STT (230 Ml/d combined). Minworth SRO offers a source of recycled water for GUC SRO, STT SRO, or both.

Defining the scope of Gate 3 environmental assessments has considered the environmental assessments completed at Gate 1 and Gate 2, comments from Regulators and assurance processes, and recommendations for further work. Previous work forms the basis of the Gate 3 monitoring and assessment programme, with key results and recommendations summarised as follows and detailed further in this report.

## Environmental Impact Assessment (EIA)

The Gate 3 environmental assessments effectively provide a precursor to EIA to support the Development Consent Order (DCO) submission. The assessments signpost further work for Gate 4 and provide direct input to EIA Scoping. Further technical disciplines will be brought into the EIA Scoping assessment to provide holistic assessment of the Scheme for Gate 4.

## Water Quality (including Sediment and Turbidity)

Baseline water quality monitoring has been undertaken at selected locations on the Rivers Tame and Trent. Several parameters show a marked difference in concentrations between the monitoring locations immediately upstream and downstream of the Minworth WwRC discharge. Water quality modelling has used SIMCAT to assess potential changes in orthophosphate and ammonia, demonstrating minimal effects, with no impacts in terms of WFD compliance. Changes in Minworth WwRC recycled water discharge rates will have minor impact on downstream water quality for the assessed substances apart from those currently already exceeding the EQS which will continue to breach compliance. The Minworth discharge can be considered to have no influence on turbidity peaks in the River Tame.

Further water quality monitoring is on-going and proposed, including reduced limits of detection to allow greater accuracy of assessment against environmental quality standards for some determinands.

## Fisheries Assessments

### Fish Passage

Twenty-five potential barriers to fish migration in the Minworth SRO study area were identified during Gate 1 and then visited and appraised during Gate 2, which recommended to undertake 2D modelling to consider more closely the relative effects of the SROs on fish passage at the 22 remaining barriers. Hydraulic models for each of the assets were developed using TUFLOW to simulate the hydraulic conditions of multiple flow events for three different scenarios, including a baseline scenario.

Fish passability was assessed through a review of the obstacle characteristics; 2D plan views of modelling outputs including depth and velocity; and review of hydraulic parameters such as hydraulic head, water depth,

velocities and pool depth along long sections, informed by industry standard guidance and expert judgement, in the context of the seasonality of fish migration.

The assessments show that the implementation of the SRO would have a negative impact on fish passability at Sites 7 and 8, though neither would have an impact on lamprey passability. The SRO would have a positive impact at sites 3 and 12, with the latter improving lamprey passability. For the remaining 15 sites, the fish passability assessments show that the SRO would not have an impact on passability of any fish species. The operation of the new Holme Sluices fish pass may be affected on average 2-3 days each year.

Recommendations include investigating options to improve fish passage at the barriers shown to be affected, and habitat enhancements in the catchment informed by biodiversity net gain (BNG) and other assessments through EIA at Gate 4.

### **Fish Olfaction**

It is considered unlikely that there would be significant adverse effects upon olfaction in migratory fish as a result of changes in the concentrations of chemicals in the River Tame in the context of the fish community currently present in the catchment, although further investigation of cypermethrin is required at the reduced LoD. Minworth will continue to provide a benefit to the River Tame in diluting several chemicals emanating from upstream in the river, notably glyphosate, lead, mancozeb, manganese, and zinc.

### **Connectivity of Local Environmental Features**

An assessment was made of the connectivity of designated sites with water dependent habitats (identified at Gate 2) to the River Tame, informed by hydrological modelling. All sites were concluded not to be at risk of reduced flows in the River Tame, with the exception of Tameside Local Nature Reserve (LNR), where further investigation of the connection between the river and the water body on the site is recommended. Mitigation and potential enhancements in relation to these sites would be informed by BNG assessment at Gate 4.

### **River Habitat Surveys and macrophyte surveys**

River Habitat and macrophyte surveys were carried out to complete the baseline assessment from Gate 2, which will feed into EIA at Gate 4. Recommendations have been made for potential mitigation or enhancement options for further consideration through EIA. Macrophyte surveys demonstrate that the River Tame and Trent are generally of Moderate to Poor indicative WFD status, and the identification of Invasive Non-Native Species (INNS) has informed the INNS risk assessment at Gate 3.

### **Invertebrates of Exposed Riverine Sediments**

Surveys were conducted at targeted locations of exposed riverine sediments (ERS) to demonstrate potential benefits of reduced flows in the Rivers Tame and Trent. Wet weather and diurnal flow variation led to significant constraints to surveys, however notable invertebrate species were identified, including through literature review, reinforcing the importance of these habitats, which are rare in the heavily modified Tame and Trent catchment.

### **WFD Assessment**

Water Framework Directive (WFD) assessment concluded risks to WFD compliance through the Scheme are low. Further assessment is required through water quality modelling, which is on-going, for example to assess potential changes in temperature and dissolved oxygen in the River Tame. With the implementation of mitigation measures to improve fish passage, impacts to biological elements can be adequately mitigated.

### **Habitats Regulations Assessment (HRA)**

The Gate 3 HRA concluded that there was no likely impact on Habitats Sites from the operation of the Minworth SRO (Humber Estuary Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site, River Mease SAC, Ensor's Pool SAC). It is recommended that the HRA is reviewed and updated as required in the light of any additional information provided at Gate 4 prior to DCO submission.

### **Invasive Non-Native Species (INNS)**

The INNS risk assessment concludes that there is negligible risk of INNS transfer from Minworth to the canals. The Biosecurity Management Plan (BMP) for Minworth WwRC should be further developed for the scheme, and biosecurity measures implemented during construction. The Operation of the scheme does not modify INNS risk given the inability of INNS to survive or pass through the AWTP. A strict biosecurity protocol for the construction of the AWTP and wetland should be established and agreed with all stakeholders, and the implementation of a Rapid Response process for INNS treatment where required, is recommended.

# 1. Introduction

## 1.1 Context

- 1.1.1 This report details the results and recommendations of Environmental Assessments for Gate 3 of the RAPID<sup>1</sup> gated process, for the Minworth Strategic Resource Option (SRO) scheme. The Services to be delivered are for Affinity Water (AfW) and Severn Trent (ST), collectively referred to as the Programme Management Board (PMB). Further detail of the SRO schemes is provided below.
- 1.1.2 The purpose of the environmental assessments is to assess the Minworth SRO as a potential supply-side option, alongside the GUC Transfer SRO, within the RAPID Gated process. This report collates and summarises the results and recommendations of technical environmental assessments, which are described in detail in the accompanying technical annexes.

## 1.2 Background

- 1.2.1 Minworth SRO includes a new AWTP that will treat recycled water from Minworth Wastewater Recycling Centre (WwRC). This flow will then be transferred to the existing canal waterways in the northern section of the GUC route (Coventry Canal → Oxford Canal → GUC). Upgrades to existing canal assets are required to facilitate additional flows and to ensure sufficient freeboard to the canal is maintained. Minworth SRO will be the source of recycled water to support the new abstraction for the GUC SRO. The Minworth SRO was reported separately to GUC in its own gate two submission.
- 1.2.2 In the southern section of the GUC, water will be abstracted from the canal and treated prior to distribution to AfW customers (refer to Figure 1-1 for Scheme Layout) via an underground reservoir near Luton.
- 1.2.3 The RAPID gated process has allowed these SRO schemes to develop at pace, making significant progress since investigations began in April 2020. Through Gate 2, it was demonstrated that the GUC SRO offers drought resilience to AfW customers and to the GUC by utilising enhanced recycled water.
- 1.2.4 A key element of the GUC and Minworth SROs is to investigate the environmental risks and opportunities associated with delivery of the schemes. Previous environmental assessments at Gate 1 and Gate 2 have considered Water Framework Directive (WFD) related impacts and benefits, baseline ecological data, and in particular the potential impacts of changes in flow to ecological receptors such as designated sites and their qualifying features, protected and notable species, and constraints from the presence or future spread of Invasive Non-Native Species (INNS). Gate 2 environmental assessments also informed Biodiversity Net Gain (BNG) and Natural Capital assessments, Habitats Regulations Assessment (HRA) screening, and WFD assessment to support the Environmental Assessment Reports for Gate 2 submission. Environmental assessments at Gate 1 and Gate 2 have been informed by regular engagement with Regulators and stakeholders to provide direction and buy-in for the on-going assessments.

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<sup>1</sup> RAPID <https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/>

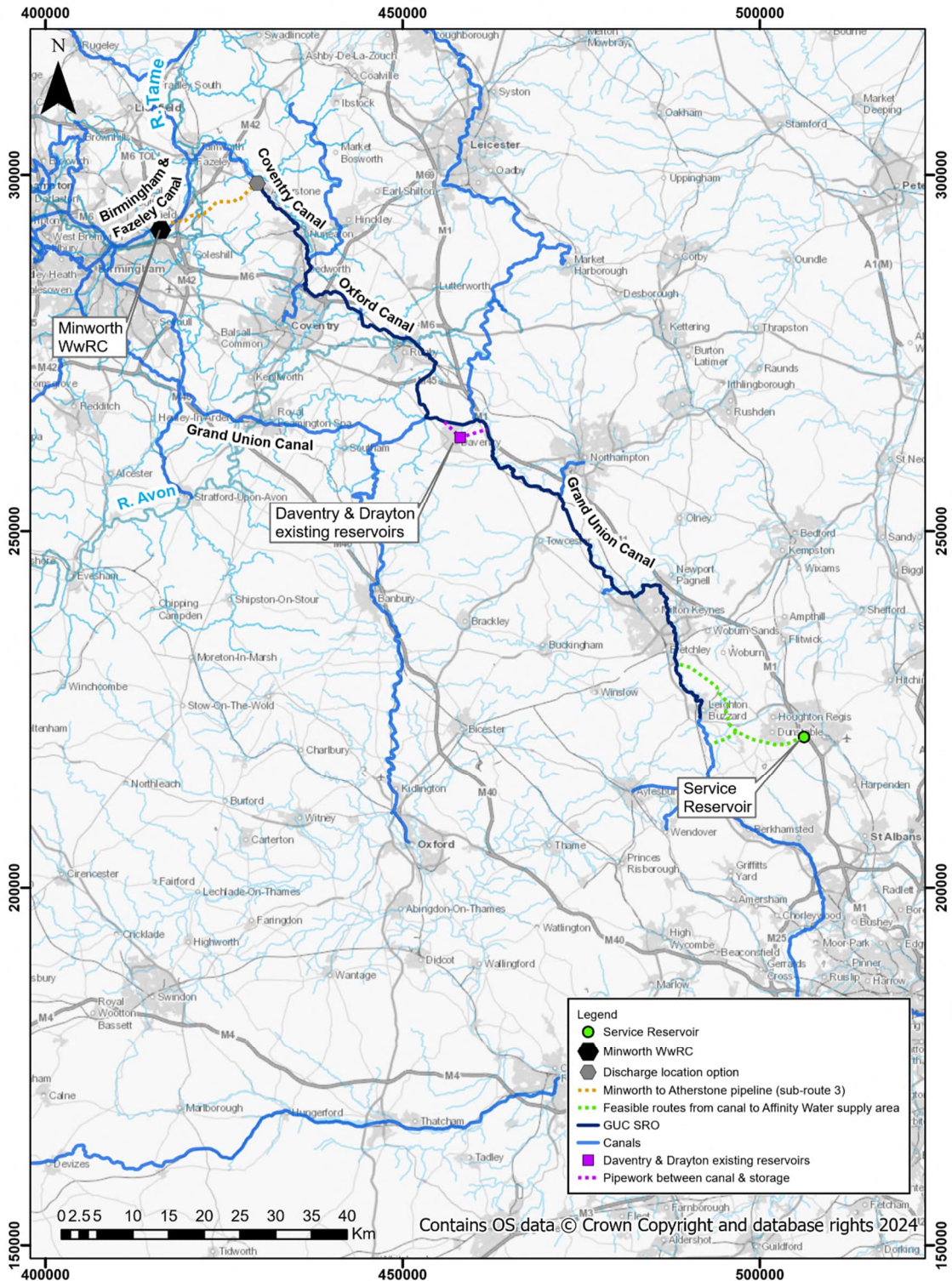


Figure 1-1 Scheme layout (provided by AfW August 2024)

## Minworth SRO

1.2.5 Minworth SRO is one of several SROs currently being considered under the RAPID gated process. The scheme is under consideration as part of a portfolio of solutions to ensure that a reliable and resilient water supply is provided to water-stressed areas; in particular, the south-east of England.

- 1.2.6 Minworth SRO is a 'source option', providing up to 115 MI/d via GUC. Minworth SRO also includes the option to transfer an additional 115 MI/d to support the STT SRO, and therefore assessment through Gate 1, Gate 2, and Gate 3 has considered the in-combination impacts on the River Tame and Trent system of Minworth supporting both GUC and STT (230 MI/d combined). Minworth SRO will provide a source of recycled water to STT SRO, GUC SRO, or both.
- 1.2.7 Minworth SRO consists of new treatment processes at Minworth WwRC for both GUC SRO and STT SRO. Previous analysis shows that the two receiving watercourses, the Coventry Canal (for GUC SRO) and the River Avon (for STT SRO), require the same level of additional treatment to meet the likely discharge standard.
- 1.2.8 Minworth WwRC currently discharges recycled water to the River Tame, with a consented dry weather flow of c. 450 MI/d. Between 57 MI/d and 230 MI/d of recycled water will be diverted into new additional treatment process units, providing the additional treatment required to meet the likely discharge standard for the receiving watercourse(s). The recycled water will then be transferred via new pumping stations and pipelines to the Coventry Canal (GUC), the River Avon (STT), or both.
- 1.2.9 Recycled water will be transferred from Minworth WwRC, in ST's supply area, to a delivery point in AfW's supply area. For much of its length, the transfer will make use of existing canals owned by the Canal & River Trust ('the Trust'), with interventions as necessary along its route.
- 1.2.10 Three routes for transferring recycled water from Minworth WwRC to the canal network were shortlisted in gate one. A pipeline from Minworth WwRC to the Coventry Canal at Atherstone is assessed as the current route. This option has the lowest environmental risk, with the lowest whole-life carbon, cost and use of materials compared to the other options.

## GUC SRO

- 1.2.11 The draft WRSE (Water Resources South-East) Regional Plan selects the GUC to meet the deployable output requirements of the region by 2032. The scheme has been sized and costed for the transfer of up to a total of 115 MI/d, resulting in a deployable output of up to 100 MI/d.
- 1.2.12 The GUC SRO will be designed to accept a maximum of 115 MI/d from Minworth SRO as per the Water Resource Management Plan 2024 (WRMP24), PR24 and regional water resource planning regulatory submissions. The utilisation of the scheme will vary over the course of a given year, with expected 80-100% utilisation in the summer months and a lower tick-over flow around 25% of capacity throughout the winter. The 115 MI/d capacity generates a 100 MI/d Deployable Output (DO) for abstraction from the GUC.
- 1.2.13 GUC is a 'transfer option' and will receive recycled water from Minworth WwRC AWTP to transfer via the canal network (Coventry Canal, Oxford Canal, GUC) to an abstraction location near Bletchley. A new pipeline and existing canal infrastructure will be utilised to convey recycled water from Minworth SRO in ST's supply area to Affinity Water's supply area. Water will be abstracted from the GUC and treated prior to distribution to customers.

## Daventry and Drayton Reservoirs

- 1.2.14 Drayton Reservoir and Daventry Reservoir currently operate as header reservoirs for the GUC, the purpose for which they were constructed and are operated by the Trust. It is proposed that the reservoirs are also to be used as a 'Storage Option' to support the GUC transfer, whereby flows can be released, in place of operation of the GUC transfer, for short periods of time; either when there is an outage in the GUC transfer system, or the transfer needs to be temporarily ceased to mitigate additional days of Hands of Flow (HoF) impact at North Muskham. It is proposed that a semi-continuous transfer of 28 MI/d from the GUC to the reservoirs will be maintained to ensure they are full to provide draw-down support as and when required.
- 1.2.15 The current proposal consists of transfer from Braunston Top Lock on the GUC into the upstream end of both reservoirs, providing options to control the storage and supply of water and reduce drawdown of water over extended periods of time. Water would then be drawn-down from the reservoirs to the GUC via existing connections to the GUC to the northeast of the reservoirs. It is currently assumed that fluctuations in reservoir levels will remain within current ranges, with maximum water levels controlled by reservoir restrictions, and a current draw-down limit of 30% capacity on Drayton Reservoir due to angling and recreational activities.

## STT SRO

- 1.2.16 The STT is a water transfer from the Northwest and Midlands to the Southeast to support the Southeast of England during drought events. The water would be provided from the River Severn itself, with additional sources of water provided by ST and United Utilities. The water would be moved from the River Severn to the River Thames either by a new pipeline or restoration of the Cotswold canals. The diversity of sources provides resilience and means the scheme can be developed in a phased manner.
- 1.2.17 The STT SRO includes a transfer option from Minworth WwRC to the River Avon, and ultimately to the River Severn, to a maximum volume of 115 Ml/d, the same volume as the transfer to GUC. The modelled utilisation for STT has also been incorporated into the hydraulic and hydrological modelling for the Rivers Tame and Trent, as the diversion of recycled water from Minworth will also result in reduced discharge to the River Tame.
- 1.2.18 The STT SRO is being assessed separately at Gate 3, but this report considers the in-combination effects on the Rivers Tame and Trent of the combined GUC and STT transfers, informed by hydraulic and hydrological modelling at Gate 3.

## 1.3 Environmental Assessment

- 1.3.1 Through defining the scope of Gate 3 environmental assessments, the outcomes of environmental assessments completed for the SRO schemes at Gate 1 and Gate 2 have been considered, together with comments from regulators and through the assurance processes, and any recommendations for further work. This understanding of the background to the Minworth and GUC SROs forms the basis of the Gate 3 monitoring and assessment programme.
- 1.3.2 A summary of the potential impacts, impact pathways, and rationale for each element of the following assessments is provided in Table 1-1 below, and includes:
- River Surveys: Connectivity of designated sites and water dependent habitats to the River Tame (Gate 3 Annex B3.1);
  - River Surveys: River Habitat Surveys (RHS) and aquatic macrophyte surveys (Gate 3 Annex B3.2);
  - Assessment of Exposed Riverine Sediments (ERS) and the invertebrate assemblages that they support, in the context of altered flow regime in the River Tame (Gate 3 Annex B3.3);
  - Fish passage assessment for the Rivers Tame and Trent, informed by hydraulic and hydrological modelling, and considering predicted utilisation of the GUC and STT schemes (Gate 3 Annex B3.4);
  - River Tame fish olfaction assessment (Gate 3 Annex B3.5);
  - Water Quality monitoring and modelling of the River Tame, including sediment and turbidity assessment (Gate 3 Annex B3.6);
  - Habitats Regulations Assessment (HRA), update for Gate 3 (Gate 3 Annex B3.7));
  - Invasive Non-Native Species risk assessment for the Minworth site and AWTP (Gate 3 Annex B3.8); and
  - Water Framework Directive (WFD) assessment, update for Gate 3 (Gate 3 Annex B3.9).
- 1.3.3 Each of the assessments above has been supported by hydraulic and hydrological modelling (Gate 3 Annex B1.6) of the Rivers Tame and Trent, and water quality modelling (Gate 3 Annex B1.5), the results of which are reported in detail separately, but whose context is described here where relevant to the technical assessments.

## Rationale for Gate 3 Assessment

- 1.3.4 Each component of the Gate 3 environmental assessments is justified following consideration of the potential impacts of the proposed scheme, which are summarised in Table 1-1 below.

**Table 1-1 Potential impacts of the Minworth SRO on environmental receptors**

Potential impact	Impact pathway	Rationale for assessment
<b>Water Quality (including Sediment and Turbidity)</b>		
Effects on water quality in the Rivers Tame and Trent as a result of changed discharge regime from Minworth WwRC (reduced discharge).	Some water quality parameters are present in Minworth recycled water; others present from upstream in the River Tame are diluted by Minworth recycled water. Therefore, resulting water quality in the River Tame may be impacted.	Build on water quality monitoring at Gate 2; provide robust understanding of baseline water quality upstream and downstream of Minworth WwRC. Further 12-months baseline monitoring at Gate 3 in the River Tame, and at intervals downstream. Parameters of relevance to the Water Supply (Water Quality) Regulations 2018 and for determining WFD compliance. Continuous monitoring of dissolved oxygen, electrical conductivity, temperature, and turbidity with water quality sondes.
Effects on water quality in the Rivers Tame and Trent as a result of changed discharge regime from Minworth WwRC (reduced discharge).	As above, with potential corresponding effects to WFD status and aquatic ecology.	To model the impact of reduced recycled water discharges from Minworth WwRC to the River Tame, to determine the likelihood of WFD non-compliance in relation to changes in water quality under different predicted Minworth flow scenarios. To understand the sediment and turbidity baseline of the River Tame, and potential implications this may have on the Minworth SRO scheme. To support other environmental assessments for the Minworth SRO scheme, including assessment of impacts on fish olfaction and WFD compliance.
<b>Fisheries Assessments</b>		
<b>Fish Passage – rationale for assessment at each weir/barrier on the Rivers Tame and Trent</b>		
Site 3. Lea Marston Weir Impacts on fish passage due to reduced flow in the river caused by the diversion of treated recycled water from Minworth WwRC – same for all weirs below.	There are no fish passes present at this site. The current head drop and hydraulics makes fish passage difficult. Modelling results indicate that the SRO (Scenario B) will negatively affect fish passability. It should be noted that the restoration plan of Lea Marston includes a bypass from upstream of Site 3 to the downstream lake. If suitably designed, should improve fish passage at this site.	The suitability of the bypass design has been investigated to assess fish passability at this site, informed by 2D modelling of baseline situation and SRO scenarios. This has been undertaken along with other restoration options downstream (e.g., removal of Sites 4 and 6). Hydraulics and fish passability at the barriers present at Lea Marston Lakes has been assessed considering the system (from site 3 to site 8) as a whole, to evaluate the impact of the restoration plan.
Site 4 and 6. Coton Weirs (E) & (W)	There are no fish passes present at these sites. Similar to Site 3, the current conditions at this site are challenging for fish passage and the reduction of flows (Scenario B) will have negative effects. It should be noted that the restoration plan of Lea Marston includes removal of these weirs which might highly improve fish passage.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site. Lea Marston restoration plans have been evaluated in order to assess fish passability impacts.
Site 5. Coton Weir (Central)	There are no fish passes present at this site. Although the head drop at this site is relatively low, the current hydraulics at	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.

Potential impact	Impact pathway	Rationale for assessment
	<p>this site are deemed too difficult for fish passability. Modelling results indicated that reduction in flow will negatively affect fish passability.</p> <p>It should be noted that the restoring plan of Lea Marston includes removal of Coton Weir (E) &amp; (W) which will improve fish passability upstream</p>	Lea Marston restoration plans have been evaluated to assess fish passability impacts.
Site 7. A4097 Weir	<p>There are no fish passes present at this site.</p> <p>The head drop could be passable by salmonids. Nonetheless, upstream elver and lamprey passage may find this more challenging. Modelling results predict reduction in levels which will negatively affect fish passability.</p>	<p>Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.</p> <p>Fish may be able to pass upstream bypassing this barrier via Site 8. Also bypassing this barrier through the northern channel that flows the northern area via Site 6.</p> <p>Lea Marston restoration plans have been evaluated in order to assess fish passability impacts.</p>
Site 8. Nether Whitacre Weir	<p>There are no fish passes present at this site.</p> <p>The hydraulics at the weir apron are no uniform. Without 2D modelling it is difficult to determine impacts on fish passage.</p>	<p>Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.</p> <p>Fish may also pass upstream via Site 7 and through the northern bypass via Site 6.</p> <p>Fish passage improvements at the site should be sought as part of the wider restoration (noting that attractant flow seems to be focused on this weir, based on observed aerial imagery) or firefighters rescue works planned at the site (e.g., the removal of dragon's teeth to enable personnel training should consider fish passability).</p>
Site 9. Broad Meadow LNR <sup>2</sup> Upstream Weir	There is a Larinier fish pass and eel pass on the LHB	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 10. Broad Meadow LNR Upstream Weir	There are no fish passes present at this site	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site, when considered in combination with Site 9.
Site 11. Meadow Weir	There is a rock ramp fish pass on the LHB	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 12. Newton Weir	There are no fish passes present at this site.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 13. Sawley Weir	There are no fish passes present at this site.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 14. Thrumpton Weir	There are no fish passes present at this site.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 15. Beeston Weir	The main weir has a defunct denil fish pass near the RHB. There is a vertical slot fish pass between the HEP and the side weir.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 16 Holme Sluices Colwick	At the time of the Gate 2, there was no fish pass present at this site though construction works for the installation of a twin vertical slot fish pass had begun	These were to be determined during Gate 3, noting complexities of the site.
Site 17. Stoke (Bardolph) Weir	There are no fish passes present at this site.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.

<sup>2</sup> Local Nature Reserve LNR

Potential impact	Impact pathway	Rationale for assessment
Site 18. Gunthorpe Weir	A triangular pool and traverse fish pass comprising three pools and four traverses is located at the LHB although is sub-optimal.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 19. Hazelford Weir (South)	There are no fish passes present at this site.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 20. Hazelford Weir (North)	There is an eel pass installed on the canoe footprint on the RHB.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 21. Averham Weir	There are no fish passes present at this site.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 22. Newark Weir	There are no fish passes present at this site.	The weir can be bypassed by fish that migrate through the left-hand (north-westerly) channel; however, these fish will encounter the Averham weir. Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 23. Nether Lock Weir	There is a fish pass installed as part of the HEP on the LHB.	The weir can be bypassed by fish that migrate through the left-hand (north-westerly) channel; however, these fish will encounter the Averham weir. Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
Site 24. Cromwell Weir	There is a pool and traverse fish pass located on the LHB although considered sub-optimal.	Further modelling (2D) has been completed to assess the impact of SRO on fish passability at this site.
<b>Fish Olfaction Assessment</b>		
Effects of changes in water quality in the River Tame on fish due to changes in olfactory cues.	Changes in water quality due to changes in discharge from Minworth WwRC under the operational scenarios. Changes in the concentrations of chemicals including cypermethrin and mancozeb.	Water quality modelling at Gate 2 showed that the concentrations of some chemicals in the River Tame would change as a result of the scheme. Updated water quality modelling at Gate 3 was required to assess the extent of these changes and potential effects on resident and migratory fish in the Rivers Tame and Trent.
<b>River surveys</b>		
<b>Connectivity of local environmental features</b>		
Reduced water levels within the River Tame as a result of the diversion of recycled water from Minworth WwRC.	Loss of connection and reduced inundation of water dependent designated sites, potentially leading to a deterioration in site condition.	Hydraulic modelling of River Tame levels at connection channels to designated sites to assess any loss of connectivity and inform mitigation where required to maintain connectivity.
<b>River Habitat Surveys and macrophyte surveys</b>		
Impacts to habitats and species, and water quality, in the River Tame.	Reduced recycled water discharge from Minworth WwRC results in lower flows at times of low flow, altered flow regime, and changes to water quality.	River Habitat Surveys identify opportunities for river enhancement and habitats to support protected, notable, and invasive species. Macrophyte surveys assess aquatic plant assemblage for WFD biological status, and biological water quality. Completion of RHS and macrophyte surveys not completed at Gate 2 or completed under sub-optimal conditions.
<b>ERS Invertebrates</b>		
Potential for altered flow regime in the Rivers Tame and Trent, which may result in a change in the extent and prevalence of ERS habitats).	Operation of the Minworth SRO may result in reduced flows and levels in the Rivers Tame and Trent, to be confirmed by hydraulic modelling at Gate 3.	River Habitat Surveys (RHS) show that the Rivers Tame and Trent are largely heavily modified, straightened, over-deepened, and canalised. Therefore,

Potential impact	Impact pathway	Rationale for assessment
If ERS habitats increase in extent, or the time for which they are exposed, this could result in a benefit for ERS invertebrates and species that depend on them, e.g., predators.	Reduced flows caused by diverting treated recycled water away from the River Tame may result in lower levels at low flows – higher flows are likely to remain unaffected.	natural features such as exposed sediments and gravel bars are relatively rare in the catchment and therefore represent valuable habitats for invertebrates and other species. River shingle invertebrate surveys at targeted locations (identified through Gate 2 RHS) with existing exposed gravel/sediment on Rivers Tame and Trent. Impact assessment and demonstration of potential benefits in relation to habitats for notable invertebrate communities
<b>Water Framework Directive Assessment</b>		
Changes to channel footprint	A change in flow conditions may incur a change in erosive and depositional processes within the watercourse and so change the channel footprint	A change in channel footprint would have the potential to impact WFD status through effects on biological quality elements such as fish and macroinvertebrates through the creation of different habitats within the watercourse and physico-chemical quality elements such as dissolved oxygen by altering flow conditions. The likelihood of a change in channel footprint and its likely impact will be based on hydraulic modelling results.
Changes in flow volume and velocity	Reduction of water from Minworth WwRC will likely lower current flows within the receiving watercourse	A change in flow volume and velocity would have the potential to impact WFD status through effects on biological quality elements such as fish and macroinvertebrates through the creation of different habitats within the watercourse and physico-chemical quality elements such as dissolved oxygen by altering flow conditions. The likelihood of a change in flow volume and velocity and its resulting impact will be based on hydraulic modelling results.
Change in sedimentation and deposition	Changes in flow may alter sediment dynamics, either leading to increased deposition or remobilisation of previously settled sediments	A change in sedimentation and deposition would have the potential to impact WFD status through effects on biological quality elements if sediment is either mobilised or deposited onto fine gravel habitat and chemical quality elements if settled contaminants are remobilised. The likelihood of a change in sedimentation and deposition and its resulting impact will be based on the findings of a sedimentation assessment.
Changes to hydromorphology leading to changes in river processes and habitats	A change in flow conditions may incur a change in erosive and depositional processes within the watercourse and so change geomorphological conditions	A change in hydromorphology leading to changes in river processes and habitats would have the potential to impact WFD status through effects on biological quality elements such as fish and macroinvertebrates through the creation of different habitats within the watercourse and physico-chemical quality elements such as dissolved oxygen by altering flow conditions. The likelihood of a change to hydromorphology leading to changes in river processes and habitats and its likely impact will be based on hydraulic modelling results.
Changes in water quality	Reduction of water from Minworth WwRC has the potential to reduce the	A change in water quality would have the potential to impact WFD status through effects on biological quality

Potential impact	Impact pathway	Rationale for assessment
	dilution of existing contaminants in the receiving watercourse	elements such as fish and invertebrates, physico-chemical quality elements such as BOD and dissolved oxygen, and a range of chemical quality elements and priority substances.
<b>Habitats Regulations Assessment</b>		
Impacts on European Sites (SAC, SPA, Ramsar) as a result of reduced flows in the Rivers Tame and Trent: Humber Estuary SAC, SPA, Ramsar River Mease SAC Ensor's Pool SAC	Reduced recycled water discharge from Minworth WwRC results in reduced flows in the Rivers Tame and Trent, and corresponding effects on fish passage and other receptors relevant to the European Sites.	Update of HRA at Gate 3 from Screening completed at Gate 2. Gate 3 assessment informed by environmental assessments, notably fish passage assessment, and hydraulic / hydrological modelling.
<b>INNS Risk Assessment</b>		
Spread of INNS	Construction and operation of Minworth SRO	INNS can result in negative environmental and economic impacts and facilitating the spread of INNS can result in breaches of legislation.
Construction of the AWTP and associated wetlands facilitating the spread of INNS.	Accidental spread of INNS due to construction activity overlapping areas with INNS.	Development works are a recognised key pathway for the spread of INNS, and INNS have been previously identified in close proximity to the site (e.g. along the River Tame).
Spread of INNS to the GUC, from where they become widely dispersed across the canal network.	Water is proposed to be transferred from Minworth WwRC to the GUC. Many INNS can spread in water.	Requirement to assess the risk of INNS being spread by the proposed transfer, between Minworth WwRC and the GUC.
Spread of INNS in byproducts of water treatment, i.e. sludge, to, for example, farmland.	Solids are removed from water as part of the treatment process, ultimately creating sludge, some of which can be re-used away from Site (e.g. being spread on farmland)	Recycled water could contain INNS propagules, and/or INNS propagules could be introduced at some other point along the treatment process (e.g. if they were allowed to grow next to areas where sludge was being stored).

## Stakeholder Engagement

1.3.5 The scope of assessment is also informed by on-going regulator and stakeholder engagement, both through Gate 1 and Gate 2, and through developing the scope for Gate 3 assessment. Regulator and stakeholder comments relevant to this assessment are summarised in Table 1-2 below, with responses in relation to the rationale for assessment.

**Table 1-2 Regulator and stakeholder comments and rationale for assessment scope**

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
<b>Water Quality</b>			
Environment Agency	Gate 3 Scope – EA Combined Comments	<i>Why only two sondes on the Tame? None proposed on the Trent?</i>	Two sondes were scoped in to build on the water quality monitoring and modelling completed at Gate 2 and the targeted scope for assessment at Gate 3. Two water quality sondes on the River Tame was therefore considered appropriate, i.e. upstream, and downstream of the Minworth discharge. However, a third sonde has since been introduced at Ladywalk Nature Reserve, which allows monitoring of the reach of the Tame which is to be subject to dissolved oxygen modelling. Further water quality monitoring is being undertaken by Anglian Water on the River Trent for the Lincs Reservoir SRO.
Environment Agency	Gate 3 Scope – EA Combined Comments	<i>The Gate 2 Water Quality report 8.1.7 indicated "Potential impacts on water temperature and dissolved oxygen in the River Tame as a result of reducing recycled water discharge, in combination with climate change effects, are recommended for investigation at Gate 3. This will inform the assessment of potential effects on aquatic ecology, notably fish, and in turn the WFD assessment." - Where is the assessment of temperature and DO effect on fish to be covered at Gate 3? WQ report or fish report?</i>	Results of the water quality monitoring including water temperature and dissolved oxygen monitoring are presented in this water quality report. Effects of water quality on fish are presented in the Minworth Fisheries Report.
Environment Agency	Gate 3 Scope – EA Combined Comments	<i>Potentially turbidity and sediment mobilisation raised but what about disturbing sediments in the GUC and increasing concentration of mobile pollutants as opposed to suspended solids per se. Will this form part of the water quality assessment ?</i>	The scope of this water quality report is restricted to the River Tame and Trent, with water quality within the GUC being addressed by other consultants. Turbidity and sediment mobilisation considerations with regard the Rivers Tame and Trent is included within this report.
Environment Agency	Gate 3 Scope – EA Combined Comments	<i>Phosphate is not being monitored. Can this be included too using a phosphate sonde unit which takes samples? it is an element of WFD.</i>	Phosphate (which cannot currently be monitored using a sonde) was included in detailed water quality monitoring and modelling at Gate 2, the outcomes of which have informed the scope for Gate 3 assessment. Gate 2 Water Quality reports (GUC Annex B1, Minworth Annex B5), provide detail of water quality monitoring and modelling, including WFD Assessment for the Minworth EAR (Minworth Annex B4).

Further engagement with the Environment Agency has occurred through bi-monthly engagement meetings throughout the monitoring period. Within these meetings interim results and progress updates have been presented to the Environment Agency regarding water quality (along with the range of environmental assessments being undertaken with regard to the Gate 3 scope). Discussions have included whether certain determinands of importance to fish olfaction are included in the monitoring suite (e.g. cypermethrin, nonylphenol and mancozeb). The Environment Agency has also provided useful contextual information including recent issues with significant sediment pulses being identified in the River Blythe, which enters the River Tame within the study reach, and also the River Anker. Through the finalisation of this Gate 3 report, the Environment Agency has agreed the on-going scope of water quality modelling at Gate 4 including the use of the most recent Simcat and Aquator models to represent AMP8 and AMP9 scenarios and Green Recovery objectives.

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
<b>Fisheries Assessments</b>			
<b>Fish Passage</b>			
Ofwat / RAPID	Gate 2 Final Decision	<i>Action – to be addressed in standard gate three submission: Detailed investigation of the potential impact on fish passage and fish passes on the Tame and Trent is necessary, and any identified impact should have feasible mitigation proposed in detail.</i>	The scope of assessment at Gate 3 has been designed accordingly and agreed with the Environment Agency at the outset of Gate 3 – see responses below.
Ofwat / RAPID	Gate 2 Final Decision	<i>Site features must be considered even outside of the designated site boundary, particularly in relation to migratory fish species as this functional linkage can extend throughout catchments.</i>	Completed at Gate 2
Environment Agency	Gate 2 comments log	Comments relating to the completeness of fish records in the Rivers Tame and Trent following aquatic ecological monitoring at Gate 2, including eDNA and conventional fish surveys, and data searches for fish records at Gate 1 and Gate 2.	Comprehensive aquatic ecological surveys have been completed, acknowledging the limitations of eDNA (and other) surveys. This, combined with data searches including data requests to the EA, angling groups, etc., has provided a detailed picture of fish assemblages and distribution in the Rivers Tame and Trent to inform this assessment.
Environment Agency	Gate 2 comments log	<i>No reference to lamprey [in the Gate 2 reports]. River and Sea lamprey both present in the lower and tidal Trent and part of the Humber SAC. eDNA might not have picked them up depending upon time of year/ samples taken outside of their migratory period? Hull University have recent data on them.</i>	Samples were taken late Summer therefore would have been taken too early to record any upstream lamprey migrations. Additional data on lamprey was requested from the EA and has been incorporated into further assessments, where made available. The assessment has considered lamprey species and their importance in the context of the Humber SAC, which has also been assessed through HRA.
Environment Agency	Gate 2 comments log	<i>Weir crests heights? have these come from your surveys? If so, have you used lowest or average points across weirs?</i>	Weir crest levels were not picked up by the bathymetry survey and were added using data from the Environment Agency's existing 1D model. Additional detail was added around the fish passes, using design drawings obtained from the Environment Agency. Further 2D modelling work which has been commissioned is adding weir and fish pass crest levels to the survey scope.
Environment Agency	Gate 2 comments log	<i>I would like to reiterate the importance of obtaining good bathymetry for the rest of the rest of the Trent and from this the identification of any areas where there is a risk with regard to fish passage or navigation. Modelling at these locations then used to calculate the impact on depth and velocity due to the SROs.</i>	Additional bathymetry and channel plus structure topography data has been collated for weir locations at Sawley and Thrumpton to allow further 2D modelling at these locations; this has supported assessment of fish passage in relation to effects on velocity of flow over weirs, but also depth. Further survey and further 2D modelling at all remaining weirs downstream to Cromwell has been completed in Gate 3.
Environment Agency	Gate 2 comments log	<i>No reference to the backwatering effect identified from the River Tame. Report states "However, behaviourally the occurrence of reverse / no discernible flow will have a greater influence on the migration of fish up the Blythe due the potential for greater attraction flows from the River Cole meaning upstream moving fish may preferentially select that watercourse over the Blythe."</i>	The River Blythe was scoped out of further assessment at Gate 2 (refer also to Hydrological and Hydraulic modelling reports), due to the demonstrated lack of significant effects at the confluence.

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
Environment Agency	Gate 2 comments log	<i>Some consideration should be given to biological elements (e.g. fish) in waterbodies in which they're not formally classified (e.g. fish), if there's a plausible impact mechanism. They may not be classified for purely practical reasons (e.g. impossible to fish to WFD standards) but still need protecting.</i>	The fish element of WFD classification is assessed in the Gate 3 WFD report update, informed by the fish passage assessment.
Environment Agency	Gate 2 comments log	<i>A deterioration on the fish element for the Tame would be a massive concern and one that i would certainly suggest the impact score moved to 2. Reason: In 2009 the fish status was Poor so the fact that the measure of success has now moved to Good Status is a fantastic achievement and speaks a lot about the river recovery and quality under its current conditions, however augmented it is. A river which was dead to life in the 70's is now recovering. Any deviation from this is a huge impact for the waterbody. The joint work funded over the last 15 years to create connected fish refuge areas along the river corridor and install fish passage is surely a supporting factor of this good status improvement. Therefore, the hydraulic regime is an important consideration even if it is being returned to a more natural state. Unfortunately, the Tame has not been in a natural state since the development of Birmingham in the 1800's.</i>	Further assessment of hydrological regime and fish passage in particular has been completed in the form of 2D modelling at targeted locations. This aims to increase the level of data confidence at Gate 3 to 'High', as per ACWG Guidance. It is not currently considered that the reduction in discharge from Minworth would result in a deterioration of fish status, especially given the modelled improvements in water quality (although further assessment of temperature and dissolved oxygen changes is required). Following the outcome of on-going assessments, recommendations can be made for appropriate mitigation to ensure fish passage upstream of Tamworth and Lea Marston for example.
Environment Agency	Gate 2 comments log	<i>Acknowledge and support the recommendations in the summary for the three scenarios that are shown to have an impact on WFD especially from fish element which would also explore the impacts around seasonality requirements and fish passage impacts.</i>	The assessment of hydrological regime and fish passage has been completed through targeted 2D modelling, and Gate 3 water quality assessment.
Environment Agency	Gate 3 Scoping feedback	<i>The Gate 2 Water Quality report 8.1.7 indicated "Potential impacts on water temperature and dissolved oxygen in the River Tame as a result of reducing recycled water discharge, in combination with climate change effects, are recommended for investigation at Gate 3. This will inform the assessment of potential effects on aquatic ecology, notably fish, and in turn the WFD assessment." - Where is the assessment of temperature and DO effect on fish to be covered at Gate 3? WQ report or fish report?</i>	The concurrent Gate 3 water quality assessment will inform further updates of the fisheries assessment post-Gate 3 submission, as temperature and dissolved oxygen modelling of the River Tame has been completed at Gate 3 and will be reported early in Gate 4.
Environment Agency	Gate 3 Scoping feedback	<i>There need to be section for flow impacts. The flow impacts need to be assessed along the River Tame and its impacts on Hydromorphology</i>	Flow impacts have been assessed as part of the fisheries assessment, alongside the hydraulic modelling workstream, which has assessed wider flow impacts to further feed into the assessment (building on the hydraulic modelling assessment completed at Gate 2).
Environment Agency	Gate 3 Scoping feedback	<i>Please provide the details of why Water Orton has been excluded from barriers for Fish passage. We had an internal discussion about barrier removals for Fish passages in River Tame, Water Orton was mentioned as one need so more work.</i>	Site 1: Orton Weir was scoped out of further assessment: 'The Environment Agency advised that achieving improved fish passability at this site at low flows (Q70 or lower) is not critical. In addition, it is also located just upstream of the main Minworth discharge. As such it can be screened out.' As the site is around 500m upstream of the discharge from Minworth WwRC no significant changes in

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
			levels or velocities at the site are predicted. As such, it is considered that there would be no impact on fish passage at this weir as a result of either SRO. Site 2: Water Orton Lane Road Bridge was scoped out of further assessment: Through the site visit it was determined that the site is not a barrier to fish passage. In addition, it is upstream of the Minworth WwRC discharge, so any upstream effects would likely be muted. As such, no impacts to fish passage are anticipated as a result of [the SRO scheme].
<b>Fish Olfaction Assessment</b>			
Environment Agency	Gate 2 assurance log	<i>Acknowledgement of migratory Habitats Directive species in the Humber but no mention of an assessment of impact of olfactory chemicals from Minworth discharge and how this impact could be mitigated against.</i>	Completion of the fish olfaction literature review and assessment at Gate 3, supported by Gate 3 water quality monitoring (on-going at the time of reporting) and water quality modelling (SIMCAT <sup>3</sup> and mass balance calculations).
Environment Agency	On-going consultation through Gate 3	The Environment Agency has reviewed the olfaction assessment and provided feedback at Gate 3: Comments in relation to the risks posed by Cypermethrin and Mancozeb in particular in the River Tame. Comments relating to the limit of detection (LoD) of Cypermethrin and the validity of conclusions of the quoted academic studies.	Continued water quality monitoring and modelling (both for the River Tame/Trent and GUC (including Minworth recycled water monitoring) has informed the assessment at Gate 3. The potential to reduce the LoD for Cypermethrin has been explored, and on-going monitoring will look to utilise the lower LoD for this determinand, which would be one eighth of the EQS, but may still be higher than the Lowest Observed Effect Concentration (LOEC).
<b>River surveys</b>			
<b>Connectivity of local environmental features</b>			
Environment Agency	Comments on Gate 3 Scoping Technical Note	<i>There needs to be a section for flow impacts. The flow impacts need to be assessed along the River Tame and its impacts on Hydromorphology</i>	Flow impacts will be assessed as part of the fisheries assessment, as for the scope of this workstream. We will work alongside the hydraulic modelling workstream, which will assess wider flow impacts to further feed into the assessment (building on the hydraulic modelling assessment completed at Gate 2).
Environment Agency	Gate 2 Assurance Log	<i>We would like to see the effects on individual protected sites assessed with their unique characteristics and any potential effects on hydrology considered.</i>	Recommendations have been made for further work to investigate the connectivity of sites such as Whitacre Heath, Ladywalk, and Tameside, to the River Tame through backwater connections, side channels, fish refuges, etc.
Environment Agency	Gate 2 assurance log	<i>Further investigation required related to flood events from the Tame to create wetland habitat at Whitacre Heath. For River Tame Local Wildlife Site (LWS) river restoration opportunities. This will need to include the improvement of river habitats and features and to connectivity of terrestrial wetlands which are currently used as fish refuge sites e.g. Ladywalk LWS, Coton Pools LWS and Kingsbury Water Park.</i>	Recommendations have been made for further work to investigate the connectivity of sites such as Whitacre Heath, Ladywalk, and Tameside, to the River Tame through backwater connections, side channels, fish refuges, etc.

<sup>3</sup> The Environment Agency's randomised water quality river model, SIMCAT (SIMulation of CATchments).

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
Warwickshire Wildlife Trust	Gate 3 (pers. comm.)	<i>We think that Whitacre Heath nature reserve is drying out, whether that be through changing rainfall patterns/vegetation succession/ something else affecting drainage. It's a wetland and we want to keep the site wet.</i>	Recommendations have been made for further work to investigate the connectivity of sites such as Whitacre Heath, Ladywa k, and Tameside, to the River Tame through backwater connections, side channels, fish refuges, etc.
<b>River Habitat Surveys and macrophyte surveys</b>			
Environment Agency	Gate 3 Scope comments log	<i>RHS survey has been planned for only two locations in River Tame. (1) what are criteria used to choose these two locations and (2) will two locations gives you sufficient data to understand the impacts. For how long do RHS surveys remain valid – 3 years before they need to be repeated?</i>	A detailed suite of aquatic ecological surveys was completed at Gate 2, in addition to comprehensive desk study. The proposed RHS surveys are to complete those outstanding from Gate 2. Given the heavily modified and consistent nature of the River Tame, RHS results would remain valid for at least 3 years, and up to 5 years.
Environment Agency	Gate 3 Scope comments log	<i>Recommend consulting the EA as to whether any additional RHS have been completed in the study area.</i>	RHS survey results were requested from the EA, and all available RHS data was downloaded from the data portal at Gate 2.
<b>ERS Invertebrates</b>			
The scope of assessment is informed by on-going regulator and stakeholder engagement, both through Gate 1 and Gate 2, and through developing the scope for Gate 3 assessment. Formal comments from the Environment Agency have been received in relation to this assessment through the completion of the Gate 3 report, and the Environment Agency has communicated through engagement workshops that they are in agreement with the scope and rationale of the assessment. The assessment has been updated according to the comments received through Gate 3.			
<b>Water Framework Directive Assessment</b>			
Ofwat / RAPID	Gate 2 Final Decision	<i>Recommendation: Modelling and monitoring should inform updated WFD and Habitats Regulations Assessment (HRA). Further assessment of temperature and dissolved oxygen is recommended for gate three. Targeted bathymetric surveys at weir locations and detailed investigation of gauging station issues are recommended to improve understanding of potential impacts.</i>	The Gate 3 WFD assessment has been informed by monitoring, modelling, and environmental assessments, and will continue to be refined through Gate 4 for EIA.
Ofwat / RAPID	Gate 2 Final Decision	<i>The solution owner is required to confirm any additional treatment at Minworth WwRC to comply with discharge consents and the Water Framework Directive (WFD)and to detail how this will be funded.</i>	Treatment at Minworth through the AWTP is being designed by the engineering workstream and has been taken into consideration for both the Minworth and GUC WFD assessments.
Environment Agency	Gate 2 Assurance Log	<i>I would like to see the River Blythe waterbody included please; Do you need to add in the River Mease waterbody - even to just rule it out.</i>	River Blythe and River Mease were scoped out of further assessment at Gate 2.
Environment Agency	Gate 2 Assurance Log	<i>I think it be good to see where we could see improvements? i.e. bringing flows back towards the natural regime.</i>	The WFD and other environmental assessments aim to accurately assess impacts while also demonstrating benefits where this is the case.
Environment Agency	Gate 2 Assurance Log	<i>Why are water bodies downstream the confluence with the Derwent not being considered? Is Minworth recycled water redirection not have potential to affect the Tame and Trent all the</i>	Impacts downstream of the Trent from Dove to Derwent water body are scoped out at the WFD water body scale, and have been assessed in other topics - i.e., HRA and aquatic ecology. It is considered that the reduction in river level downstream of the Derwent as a result of Minworth alone does not represent a

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
		<i>way to the Humber estuary? Please explain the rationale for the selected (and unselected) water bodies.</i>	WFD impact, but there may be in-combination effects that will be assessed in detail at Gate 3.
Environment Agency	Gate 2 Assurance Log	<i>In any relevant HWMBs the assessment should include consideration of the "Mitigation Measures Assessment" element - i.e. whether the scheme could prevent any future measures related to mitigating impacts associated with designated uses of the waterbody(ies) or compromise any existing ones.</i>	Only the 'Tame - R Rea to R Blythe' water body has a Mitigation Measures Assessment element, which has been included in the assessment matrix. In the case of the Tame - R Rea to R Blythe water body, the Mitigation Measures Assessment element for the HMWB is classified as Moderate. Objectives for Mitigation Measures are deemed 'Disproportionately expensive: Unfavourable balance of costs and benefits. Therefore, it is considered that the SRO schemes would not prevent any future measures related to mitigating impacts associated with designated uses of the water body or compromise any existing measures.
Environment Agency	Gate 2 Assurance Log	<i>Some consideration should be given to biological elements (e.g. fish) in waterbodies in which they're not formally classified (e.g. fish), if there's a plausible impact mechanism. They may not be classified for purely practical reasons (e.g. impossible to fish to WFD standards) but still need protecting</i>	Biological elements including fish have been fully assessed in the WFD assessment, supported by other Gate 2 and Gate 3 environmental assessments.
Environment Agency	Gate 2 Assurance Log	<i>There doesn't seem to be any discussion of impacts on chemical status elements in the report, but relevant data gaps are noted in some of the assessment spreadsheets. The rationale for ruling out chemical impacts needs to be set out more clearly.</i>	With reference to the Water Quality - Baseline Monitoring and Modelling report, which has informed the WFD assessment. The WFD assessment matrices (spreadsheets) present the holistic WFD assessment, including chemical status.
Environment Agency	Gate 2 Assurance Log	<i>It's unlikely that the Minworth scheme would result in a deterioration in status of the hydrological regime element to "does not support good" as flows downstream are so heavily augmented above natural (and even further above the Environmental Flow Indicator). The question is whether a "within status" deterioration of the hydrological regime supporting element could result in a status class deterioration of any of the elements which it supports (especially biology, but potentially also phys-chem or chemical) - or, in the case of elements already in their lowest possible class, any further deterioration.</i>	Your comments are noted, and further assessment of hydrological regime and fish passage in particular is on-going in the form of 2D modelling at targeted locations. This aims to increase the level of data confidence at Gate 3 to 'High', as per ACWG Guidance. The results of this on-going modelling will feed into further assessment of EQIs to refine the WFD assessment at Gate 3. Water quality modelling has taken into account flow changes and the results of this are generally optimistic, with only a small number of determinands increasing due to reduced dilution, and these remain well below EQS.
Environment Agency	Gate 2 Assurance Log	<i>A deterioration on the fish element for the Tame would be a massive concern and one that i would certainly suggest the impact score moved to 2. Reason: In 2009 the fish status was Poor so the fact that the measure of success has now moved to Good Status is a fantastic achievement and speaks a lot about the river recovery and quality under its current conditions, however augmented it is. A river which was dead to life in the 70's is now recovering. Any deviation from this is a hug impact for the waterbody. The joint work funded over the last 15 years to create connected fish refuge areas along the river corridor and install fish passage is surely a supporting factor of this good status improvement. Therefore, the hydraulic regime is an important consideration even if it is being returned to a more natural state.</i>	Further assessment of hydrological regime and fish passage in particular is on-going in the form of 2D modelling at targeted locations. This aims to increase the level of data confidence at Gate 3 to 'High', as per ACWG Guidance. It is not currently considered that the reduction in discharge from Minworth would result in a deterioration of fish status, especially given the modelled improvements in water quality (temperature and dissolved oxygen modelling has been completed at Gate 3 and will be reported early in Gate 4). Following the outcome of on-going assessments, recommendations can be made for appropriate mitigation to ensure fish passage upstream of Tamworth and Lea Marston for example.

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
<b>Habitats Regulations Assessment</b>			
Environment Agency	Minworth EA Comments Log	<i>No reference to lamprey. River and Sea lamprey both present in the lower and tidal Trent and part of the Humber SAC. eDNA might not have picked them up depending upon time of year/ samples taken outside of their migratory period? Hull University have recent data on them.</i>	<p>eDNA samples were taken late Summer therefore may have been too early to record upstream lamprey migrations; however, desk study data was also sought from multiple sources, including data requests to the Environment Agency.</p> <p>Please provide the Hull University data if available so this can be incorporated into on-going assessments post-Gate 3. The presence of lamprey species is known, as is their importance in the context of the Humber SAC, which has been assessed through HRA for Minworth, including discussion with Anglian Water in terms of the corresponding HRA for Lincs Reservoir, and the assessment of in-combination effects post-Gate 3.</p> <p>An assessment on the impact of the SRO on fish passage has been undertaken and the findings relevant to river/sea lamprey has been included as part of the Gate 3 HRA assessment.</p> <p>Further update to the HRA will be required at Gate 4 to support DCO submission.</p>
Environment Agency	Minworth EA Comments Log	<i>Concerned by the overall results of the ecological surveys for fish and the reference to this as being acceptable for a baseline. The SRO needs to be careful that it does not use limited data collected in isolation to form a baseline and creating a shifting baseline scenario.</i>	<p>The electric fishing data obtained for these surveys indicate the fish assemblages present at these sites; it is supported by eDNA surveys and desk study data from multiple sources. It is considered that the use of eDNA survey, together with desk study information, has provided a comprehensive indication of fish assemblages at the surveyed locations. Data searches will be updated as required throughout the assessment process.</p> <p>As described above, a comprehensive baseline of data and anecdotal records has been collated. This has informed the aquatic ecology assessment, fish passage assessment, and WFD and HRA assessments for Minworth through Gate 2 and into Gate 3.</p> <p>An assessment on the impact of the SRO on fish passage has been undertaken and the findings relevant to river/sea lamprey has been included as part of the Gate 3 HRA assessment.</p> <p>The fish passage assessment is 'future-proofed,' assessing fish passage for all species at all barriers to account for the potential return of migratory species higher in the Tame/Trent catchment in the future.</p>
Environment Agency	Minworth EA Comments Log	<i>Consider adding an assessment on ecology for the elements of the SAC designation e.g. bullhead, spined loach, white claw crayfish, otter, and water crowfoot. the confluence area was a known white claw crayfish location, but no assessment has been carried out since 2014. maybe a RHS for the confluence area to include the mease and Trent would cover the baseline for the habitat and species-specific study at the confluence mease and Trent which will help with baseline information and can be referred to in future monitoring if pump out occurs. please be advised that NE are commissioned bullhead and spined loach assessments as</i>	<p>Noted, but it is concluded in the Gate 2 HRA report that a reduction in flow in the Mease would contribute to achieving the CSMG targets and therefore would be likely to benefit the qualifying features of the SAC/SSSI. It is therefore considered that further habitat and/or species surveys are not justified to inform the impact assessment or HRA.</p> <p>The HRA for the River Mease SAC has been revisited at Gate 3 and will be reassessed at Gate 4 supported by on-going hydraulic and hydrological modelling, including AMP8 and AMP9 scenarios for ST through use of the latest Aquator model.</p>

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
		<i>part of the assessment of the pump out using the CSM survey methods in September/October 2022</i>	
Environment Agency	Minworth EA Comments Log	<i>Some consideration should be given to biological elements (e.g. fish) in waterbodies in which they're not formally classified (e.g. fish), if there's a plausible impact mechanism. They may not be classified for purely practical reasons (e.g. impossible to fish to WFD standards) but still need protecting!</i>	<p>Noted - fish have been considered in detail in other aspects of the Minworth and the Tame and Trent assessments, for example in the Aquatic Ecology assessment in terms of fish passage, and in the HRA in relation to potential effects on lamprey (qualifying features of the Humber Estuary SAC).</p> <p>It is only the most downstream water body, Trent from Dove to Derwent, in which fish are not classified, and it is here where those other assessment workstreams are most relevant.</p> <p>Impact pathways for qualifying fish species have been assessed in this HRA, which will be updated at Gate 4 supported by on-going hydraulic and hydrological modelling, as described above.</p>
Environment Agency	Minworth EA Comments Log	<i>Why are water bodies downstream the confluence with the Derwent not being considered? Is Minworth recycled water redirection not have potential to affect the Tame and Trent all the way to the Humber estuary? Please explain the rationale for the selected (and unselected) water bodies.</i>	<p>Clarified that impacts downstream of the Trent from Dove to Derwent water body are scoped out at the WFD water body scale, and have been assessed in other topics - i.e., HRA and aquatic ecology. It is considered that the reduction in river level downstream of the Derwent as a result of Minworth alone does not represent a WFD impact, but there may be in-combination effects that will be assessed in detail at Gate 3 and Gate 4.</p> <p>At Gate 1: 'Impacts on the River Trent are considered negligible downstream of the River Derwent confluence' - a consistent approach has been taken at Gate 2, with the assessment refined and appropriate recommendations made for Gate 3.</p> <p>Impact pathways for qualifying fish species have been assessed in this HRA, which will be updated at Gate 4 supported by on-going hydraulic and hydrological modelling, as described above.</p>
<b>INNS Risk Assessment</b>			
Environment Agency	Communication at Gate 3 with ST	<i>The EA has requested to [if possible] definitively evidence zero risk of transfer, rather than using the same assumption as at Gate 2, particularly in relation to seed transfer via various potential pathways.</i>	This report goes into the details of each stage of the water treatment process and assesses INNS survivability at each stage.
Ofwat / RAPID	Gate 2 Final Decision	<i>Action – to be addressed in standard gate three submission: Continue investigating the risk presented by invasive non-native species (INNS) both with the transfers and also on changes in temperature and flow regime in the River Tame.</i>	This report goes into the details of each stage of the water treatment process and assesses INNS survivability at each stage, providing a comprehensive risk assessment of the potential transfer of INNS from Minworth WwRC, including to the River Tame and the GUC.
Environment Agency	Gate 2 Comments Log (Minworth)	<i>It is not believed that any life stages of INNS would be able to live through the treatment at Minworth, so there is no risk of transfer to the new catchments as part of the SRO'. This sentence carries uncertainty. Suggest rewording or removing. EA INNS policy requires 'mitigation... to be fail safe, resilient and completely</i>	This has informed the detailed INNS Risk Assessment at Gate 3, to provide further confidence in the assessment and recommend mitigation measures as appropriate to minimise the risk of INNS transfer.

Regulator / Stakeholder	Source	Comment	Response and rationale for assessment
		<i>effective for all life stages (large fragments/animals/microscopic organisms and larval stages)'</i>	
Environment Agency	Gate 2 Comments Log (GUC)	<i>Backwash - there is a risk associated with this that there could also be a concentration of INNS (dependent on backwash design). This should be considered in the risks/impacts.</i>	The Gate 3 assessment has been informed by the design of the AWTP at Minworth WwRC, in consultation with the engineering design team.
Environment Agency	Gate 2 Comments Log (GUC)	<i>INNS - can control for species (where there is a method for control) be included rather than just reducing risk of spread</i>	Appropriate mitigation recommendations have been made in this INNS Risk Assessment.
Environment Agency	Gate 2 Comments Log (GUC)	<i>There is remaining concern for the transfer of INNS (potentially both ways?) The GUC is already a conveyor, but increased volume/passage is likely to increase risk. It's good to see the baseline assessments carried out to date will cover also GUS and interacting rivers. What monitoring will be carried out/ mitigation implemented to address any increased residual risk from the scheme, also in the section downstream of Leighton Buzzard?</i>	This has informed the detailed INNS Risk Assessment at Gate 3, to provide further confidence in the assessment and recommend mitigation measures as appropriate to minimise the risk of INNS transfer from Minworth WwRC to the canal network. A separate INNS Risk Assessment has been completed for the GUC Transfer route at Gate 3.
Environment Agency	Gate 2 Comments Log (GUC)	<i>The aim of targeted INNS surveys is to be thorough, and I'm concerned that excessive time restrictions may impede a thorough assessment.</i>	Detailed and widespread INNS surveys have been completed at Gate 2 and Gate 3, both for Minworth and GUC, together with detailed desk study. It is considered that the data obtained has informed a robust INNS Risk Assessment.
Environment Agency	Gate 3 Comments	<p>Communication of list of viral and bacterial INNS for fish from the Environment Agency, suggesting the requirement to assess the risk of transfer from Minworth to the canals and throughout the transfer route.</p> <p><i>Spread of diseases: the water transfer could also spread other diseases apart from crayfish plague.</i></p> <p><i>Spread of diseases: other disease species should be considered here. Given the commercial value of the match fishing activity on Drayton Reservoir the spread of virus such as Koi Herpesvirus (KHV) would have significant impact.</i></p> <p><i>Should there be some work to cover off emerging amphibian diseases such as Bsal [Batrachochytrium salamandrivorans] which is likely to be spread from captive exotic animals into the wild via illegal introduction?</i></p>	Pathogens fall outside the scope of this report, which is specific to plants and animals. While certain steps with the AWTP are relevant to pathogens, we have not assessed their capacity to survive the treatment process directly. However, information provided in this report, see Section 3.2.7 (bullets on Ozonation and Floc-Sed), are relevant (as these processes have properties of disinfection). A targeted assessment should be carried out at Gate 4. This topic is not considered further in this document.

## 2. Scope and Approach

### 2.1 Projects and Work Completed to Date

- 2.1.1 Environmental assessments have been completed through Gate 1 and Gate 2, and these have been referenced in Gate 3 assessments where relevant. Previous assessments have informed the scope of continuing assessment at Gate 3, together with input from Regulators and stakeholders, notably the Environment Agency and Natural England as described above.
- 2.1.2 The sections that follow summarise the Gate 3 assessment methods for each of the technical assessments. Refer to the relevant technical report for further detail.
- 2.1.3 Gate 1 and Gate 2 assessments are available via the RAPID and Affinity Water websites:
- RAPID: The RAPID gated process and the proposed water resource solutions<sup>4</sup>
  - Affinity Water: Strategic Resource Options<sup>5</sup>

### 2.2 Methodology

- 2.2.1 This section sets out the scope of environmental assessment for Minworth SRO at Gate 3, as summarised from the individual technical assessments.
- 2.2.2 Gate 3 assessments have followed the appropriate methodology where set out in specific Gate 3 Guidance, and also best-practice and industry standard methods for each assessment. Over-arching Gate 3 Guidance includes:
- Strategic regional water resource solutions guidance for Gate 3 (version 2)<sup>6</sup>

### 2.3 Water Quality

#### Projects and Work Completed to Date

- 2.3.1 The following assessments (available via the RAPID website<sup>7</sup>) were completed at Gate 1 and Gate 2, and these have informed the scope of continuing assessment at Gate 3:
- Gate 2: Minworth Annex B5 Water Quality Monitoring Report;
  - Gate 2: Minworth Annex B4 Water Framework Directive Assessment; and
  - Gate 1: Minworth Environmental Assessment Report.

#### Methodological Overview

##### Locations

- 2.3.2 The project brief required ongoing monthly water sample collection for laboratory analysis, which continued and expanded upon that undertaken at Gate 2. As such, sampling was undertaken at the same seven locations as used at Gate 2, which were broadly as follows:
- Upstream of Minworth WwRC discharges;
  - Downstream of Minworth WwRC discharge, upstream of Coleshill WwRC discharge;

<sup>4</sup> RAPID: <https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/>

<sup>5</sup> Affinity Water: <https://affinitywater.uk.engagementhq.com/strategic-resource-options>

<sup>6</sup> RAPID Gate 3 Guidance (V3 January 2024) available at: <https://www.ofwat.gov.uk/publication/rapid-strategic-regional-water-resource-solutions-guidance-for-gate-three-version-3/>

<sup>7</sup> RAPID <https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/>

- Coleshill WwRC discharge;
- Downstream of Coleshill WwRC discharge;
- Downstream of the River Blythe confluence with the River Tame;
- Downstream of the River Anker confluence with the River Tame; and
- Downstream of the River Trent confluence with the River Tame.

2.3.3 The grab sampling was augmented for Gate 3 by the installation of water quality sondes (AquaTroll 500's manufactured by In Situ). The initial scope planned for these to be installed upstream and downstream of the Minworth WwRC discharge. Locations were chosen at Water Orton and upstream of the Lea Marston lakes. A third sonde was later added to support dissolved oxygen monitoring, located downstream of the River Blythe confluence with the River Tame at Ladywalk Nature Reserve.

## Parameters

2.3.4 The parameters monitored at Gate 2 considered the Water Supply (Water Quality) Regulations 2018 that apply to all treated water for human consumption to meet the wholesomeness criteria but also and in particular the specified requirements for new sources. Parameters were classified into several groups, with each parameter to be analysed during each round of monitoring. Recommendations were made within the Gate 2 report for monitoring of additional parameters, and these have been incorporated into the Gate 3 analytical suite.

2.3.5 Table 2-3 shows the full list of parameters for the Minworth SRO monitoring. Those additional to Gate 2 monitoring are shown in red.

## Sample and Sonde Locations

2.3.6 The sampling locations adopted in this study are shown in Table 2-1 and Appendix A Figure A-1.

2.3.7 These are consistent with those monitored for 12-months at Gate 2, allowing for comparison across the two monitoring periods. Please refer to the Gate 2 Annex B5 Water Quality Monitoring Report (2022) for further detail regarding the location selection.

**Table 2-1 Gate 3 sampling locations**

Sample Location ID	Description	Approximate NGR	Comment
MIN-01	R Tame upstream of Water Orton Lane (second sampling visit onwards)		Upstream of the Minworth WwRC discharge
MIN-02A	R Tame Coleshill WwRC, u/s of discharge		Downstream of Minworth WwRC discharge, upstream of Coleshill WwRC discharge
MIN-02B	Coleshill WwRC discharge		
MIN-02C	R Tame Coleshill WwRC, d/s of discharge		Downstream of Coleshill WwRC discharge
MIN-03	R Tame Kingsbury Rd, Kingsbury Village		Downstream of River Blythe confluence with the River Tame
MIN-04	R Tame at Hopwas		Downstream of the River Anker confluence with the River Tame
MIN-05	Non-Tidal R. Trent Burton, on Trent		Downstream of the River Trent confluence with the River Tame

2.3.8 Multiparameter water quality sondes were installed at the locations shown in Table 2-2 and Appendix A Figure A-1.

**Table 2-2 Gate 3 Multiparameter Sonde Locations**

Sample Location ID	Description	Approximate NGR	Comment
WO	Water Orton		Upstream of the Minworth WwRC discharge
LNR	Ladywalk Nature Reserve		Downstream of Minworth WwRC discharge, downstream of Bourn and Blythe confluences
LM	Lea Marston		Upstream of the Lea Marston lakes, and downstream of the Minworth WwRC discharge.

## Monthly Sampling

2.3.9 For collection of each sample, the following procedure and methodology was employed:

- Retrieve water from the watercourse using a clean stainless-steel bucket.
- Measurement of field parameters (pH, electrical conductivity, temperature, dissolved oxygen, redox potential, turbidity) using a calibrated portable multiparameter probe (In Situ Aqua Troll 500) and recording of observations.
- Decanting of water into laboratory-supplied containers, including on-site filtering for dissolved metals. Containers are then stored and transported in cool boxes to maintain the required sample temperature. Couriers were used that could provide next day-delivery.

2.3.10 This methodology is in accordance with the following British Standards:

- BS EN ISO 5667-14:2016 (Guidance on quality assurance and quality control of environmental water sampling and handling)
- BS EN ISO 5667-6:2016+A11:2020 - Water Quality – Sampling: Part 6: Guidance on sampling of rivers and streams,
- BS EN ISO 5667-3:2018 - Water Quality – Sampling: Part 3: Preservation and handling of water samples.

2.3.11 Sample analysis was undertaken by ALS Global and Element Materials Technology.

## Multi Parameter Sonde Monitoring

2.3.12 Multi-parameter sondes have been obtained for continuous (15-minute frequency) in channel monitoring of the River Tame. This is primarily to support ongoing dissolved oxygen modelling and turbidity/total suspended solid analysis but also provides useful understanding regarding the temporal dynamics of water quality change in the River Tame. The chosen monitoring system consists of the following:

- In Situ AquaTROLL 500 equipped with autowiper;
- In Situ AquaTROLL temperature / conductivity sensor;
- In Situ AquaTROLL RDO sensor;
- In Situ AquaTROLL turbidity sensor; and
- VuLink telemetry system.

**Table 2-3 List of Parameters (bold italicised text indicates new additions to the analytical suite at Gate 3)**

Parameter type	Phys-Chem			
Parameters	Hardness Turbidity Electrical Conductivity	pH <b>Total Suspended Solids</b> <b>True Colour</b>	Alkalinity Biochemical Oxygen Demand (BOD)	Salinity Total organic carbon Dissolved organic carbon
Parameter type	Pesticides, Herbicides, Insecticides			
Parameters	2,4-D Aldrin Atrazine Bentazone Carbendazim Carbetamide Chlormequat Chlorotoluron Chlorothalonil Clopyralid Cypermethrin	Dieldrin Diuron Flufenacet Fluroxypyr Glyphosate Hexachlorocyclohexane (HCH) Heptachlor Heptachlor epoxide Isoproturon Linuron	Mancozeb MCPA MCPB Mecoprop Metaldehyde Metazachlor Monuron <b>Permethrin</b> Propazine Propyzamide	Prosulfocarb Quinmerac Simazine <b>Terbutryn</b> Triallate Clothianidin Imidacloprid Omethoate
Parameter type	Fuels			
Parameters	Benzene	Benzo(a)pyrene	Polycyclic Aromatic Hydrocarbons	
Parameter type	Solvents and other organics			
Parameters	1-2-dichloroethane Epichlorohydrin Acrylamide	Tetrachloroethene Trichloroethene	Tetrachloromethane <b>Trichloromethane</b>	Trihalomethanes (total) EDTA
Parameter type	Metals (dissolved)			
Parameters	Aluminium Antimony Arsenic Boron	Cadmium Chromium <b>Chromium III</b> Copper Iron	Lead Manganese Mercury Nickel	Selenium Sodium Cobalt Zinc
Parameter type	Microbiology			
Parameters	Clostridium perfringens Colony counts	Coliform bacteria Cryptosporidium	Enterococci	E. coli
Parameter type	Nutrients			
Parameters	Ammonium Nitrate	Nitrite Phosphorus (total)	Orthophosphate (as P)	Orthophosphate (as PO <sub>4</sub> )
Parameter type	Algal indicators			
Parameters	Chlorophyll-a	Cyanobacteria		
Parameter type	Surfactants and Retardants			
Parameters	Perfluorooctane sulfonic acid (PFOS) and its derivatives Nonylphenols Hexabromocyclododecane (HBCDD)			
Parameter type	Radiological Parameters			
Parameters	Gross alpha activity Gross beta activity	Cyanide (total)	Indicative dose Radon	Tritium
Parameter type	Anions			
Parameters	Bromate Bromide	Fluoride Chloride	Sulphate	Vinyl chloride

- 2.3.13 The three water quality sondes that have been installed are equipped with sensors to monitor dissolved oxygen, electrical conductivity, temperature, and turbidity.

### Programme

- 2.3.14 The scope proposed 12 baseline monitoring rounds to be completed for Gate 3. The first monitoring visit was completed in September 2023, with the final round completed in August 2024. Data received back from the laboratories for the first seven visits is presented in this report, and the remaining rounds of sampling will be reported as an update at the start of Gate 4.
- 2.3.15 The sampling programme is summarised in Table 2-4.

**Table 2-4 Sampling Programme**

Visit Number	Date(s)
1	14 September 2023
2	11 October 2023
3	08 November 2023
4	14 December 2023
5	17 January 2024
6	21 February 2024
7	14 March 2024
8	18 April 2024
9	22 May 2024
10	26 June 2024
11	30 July 2024
12	12 September 2024 (delayed)

- 2.3.16 Water quality multiparameter sondes have been monitoring reliably at Ladywalk Nature Reserve and Lea Marston from 02 February 2024 until the date of publication of this report. The Water Orton sonde has been operational since 03 April 2024. The intention is for these to run continuously, monitoring at 15-minute intervals, for a further 12-months through Gate 4.

## Water Quality Modelling

- 2.3.17 The water quality monitoring data collected under the above scope of works has been used to inform modelling of the impacts of reducing discharges from Minworth WwRC on downstream flow and water quality. Changes in flow and concentrations of orthophosphate and ammonia downstream of Minworth WwRC have been assessed using SIMCAT catchment modelling and the results are presented in terms of absolute change in concentrations and compliance with WFD status limits. Impacts for other parameters have been assessed based on mass balance mixing calculations and review of percent changes in downstream concentration.
- 2.3.18 Following the approach adopted at Gate 2, the water quality monitoring data set out above has been combined with Environment Agency water quality data to model the water quality impacts of the potential future reductions in recycled water discharges from Minworth WwRC to the River Tame. Catchment scale modelling (SIMCAT) has been used to inform an assessment of the impacts of the proposals on orthophosphate and ammonia concentrations<sup>8</sup> and a simplified percentage change approach has been undertaken to assess impacts for other pollutants where data is more limited.

<sup>8</sup> BOD concentrations were previously assessed as part of Gate 2; however, BOD is no longer used to classify water body status under the WFD and therefore has been removed from the Gate 3 water quality modelling assessment.

## SIMCAT Water Quality Modelling

- 2.3.19 Catchment scale water quality modelling has been carried out to determine the impacts of reducing flows from Minworth WwRC to the River Tame on downstream concentrations of orthophosphate and ammonia. This allows an assessment of whether reduced pollutant loading due to lower flows from Minworth WwRC results in improved river water quality, or whether reduced downstream river flow results in reduced water quality if there is less water available to dilute more polluted downstream inputs. The Environment Agency's SIMCAT models of the Tame and Trent catchments have been used to assess the cumulative downstream impacts of reducing flows from Minworth WwRC under different future discharge scenarios. The resulting downstream mean concentrations of orthophosphate and 90%ile ammonia concentrations have been compared with the relevant water quality status limits to assess the impacts of changing WwRC flows on compliance with Water Framework Directive (WFD) requirements. It is acknowledged that these sub-elements only make up part of the overall WFD status classification for river water bodies, and that there are other sub-elements (e.g., Fish, Dissolved Oxygen, etc.) which are the main cause for water body target status as set by the Environment Agency.
- 2.3.20 The Tame and Trent catchment SIMCAT model covers an extremely large geographic area (Figure 2-1) and includes major additional watercourses and their tributaries, including the River Soar, River Dove, and River Derwent catchments. Changes to outputs from Minworth WwRC will not have any effect on water quality within these catchments and therefore the results presented below are limited to the River Tame, and the River Trent downstream of the Tame-Trent confluence. The SIMCAT model extends to the tidal section of the River Trent near East Ferry and includes several WwRC discharges direct to the Tame and Trent. A full discussion of the input data, and model update and calibration process is provided in the Gate 2 report<sup>9</sup>.
- 2.3.21 The Environment Agency provided two separate SIMCAT models for the River Trent catchment, one allowing for modelling of orthophosphate concentrations and one allowing for modelling of ammonia concentrations. The catchment models take into account the changes in flows from Minworth WwRC as well as diffuse pollution from surrounding land (including urban runoff, agricultural run-off, etc.) as well as Combined Sewer Overflows (CSOs) and storm tank discharges.
- 2.3.22 The models supplied by the Environment Agency were updated to reflect the available river water quality, WwRC recycled water discharge flow and quality and river flow statistics as part of the Gate 2 study. A full discussion of the input data, and model update and calibration process is provided in the Gate 2 report. The supplied model was not found to take account of recent improvements to wastewater treatment at a number of works within the study area, particularly at Ray Hall WwRC which is upstream of Minworth WwRC. The improvement works had been carried out prior to the Gate 2 modelling but subsequent to construction of the SIMCAT model. The SIMCAT model was therefore revised to account for these changes and provide an appropriate updated baseline for scenario testing. At the time of the Gate 2 report there was insufficient spot sample data to show the impact of the improvements on river water quality and it was acknowledged that the updated model was still likely to overestimate the impacts of wastewater discharges, particularly in the upstream reaches of the River Tame where river flows are smaller. The river quality datasets collected by the time of the current Gate 3 modelling remain very short and therefore the updated Gate 2 model has been retained as the baseline against which the potential combined impacts of climate change and flow reduction from Minworth WwRC will be assessed. It is anticipated that sufficient data will be collected by the time of Gate 4 modelling to allow for a more complete update of the Gate 2 model which will show the impacts of wastewater treatment improvements. Further, the Environment Agency are in the process of updating their own SIMCAT model of the Tame and Trent catchment, but the updated model is not yet available. This Gate 3 analysis, therefore, focusses on assessing the potential impacts of climate change against the Gate 2 baseline and the overall conclusions will be checked at Gate 4 following further updates to the SIMCAT model (if available at that time).

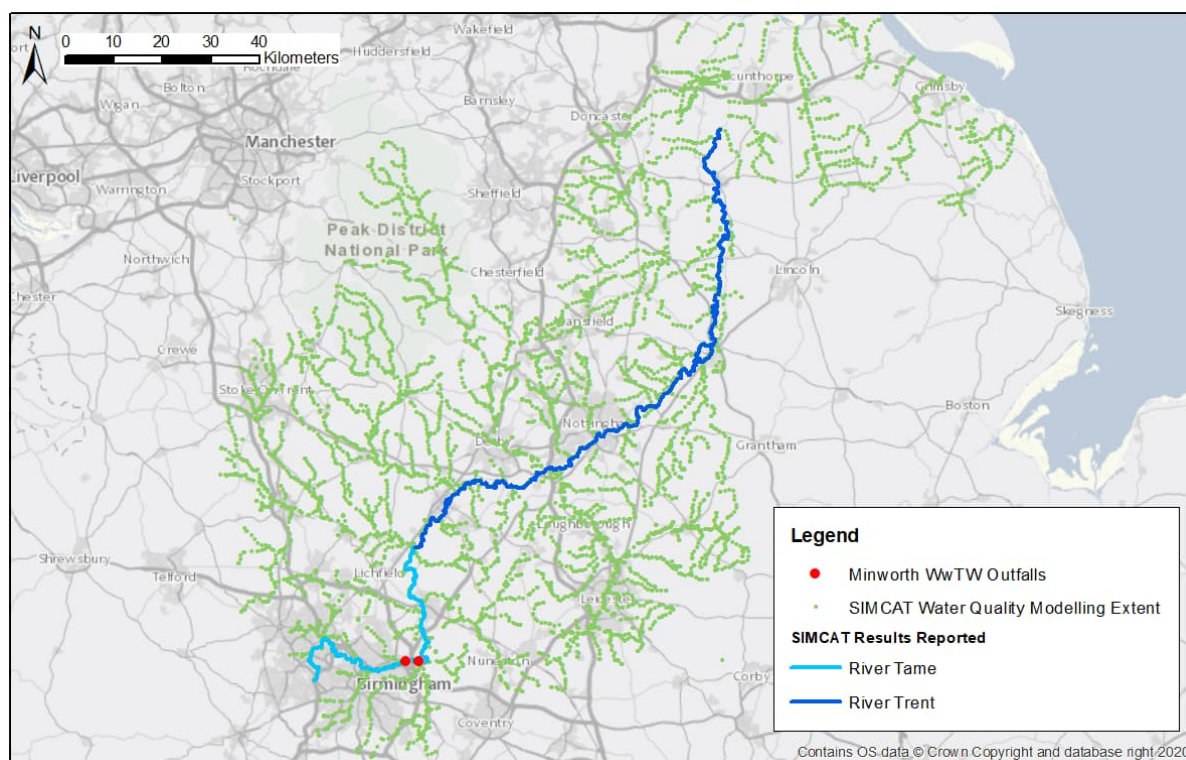
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<sup>9</sup> Gate 2 Minworth Annex B5 Water Quality Monitoring. Report to Affinity Water by AECOM Ltd.

2.3.23 The modelling scenarios undertaken are detailed in Table 2-5 below. Figure 2-1 shows the watercourses included in the Trent catchment SIMCAT models along with the section of the model for which results are reported.

**Table 2-5 SIMCAT Modelling Scenarios**

Scenario	Description
Baseline Scenario	SIMCAT model showing existing water quality in the Rivers Tame and Trent, based on Environment Agency water quality datasets <sup>10</sup> , ST WwRC flow data and National River Flow Archive (NFRA) river flow gauge data <sup>11</sup> . This model was developed at Gate 2 and provides a baseline showing the current impact of existing recycled water flows from Minworth WwRC on water quality in the Rivers Tame and Trent, against which possible future impacts can be assessed.
Climate Change Scenario	Model run to show the impacts of reducing flows from Minworth WwRC from climate change impacts only (5% reduction in flow applied to both mean and Q <sub>95</sub> river gauges flow based on UK Climate Projection results as summarised in the Future Flows Project <sup>12</sup> and found to be consistent with the Aquator simulations, see below)
TREAT115	Model run to show the impacts of reducing flows from Minworth WwRC by 115MI/d
TREAT230	Model run to show the impacts of reducing flows from Minworth WwRC by 230MI/d



**Figure 2-1 Watercourse and Key Location Schematic for SIMCAT Modelling**

## Conditions and Limitations

2.3.24 Following a reconnaissance visit to determine suitable and safe locations for monitoring, sondes were initially deployed at Water Orton and Lea Marston (see Table 2-2 for locations) on 13 September 2023. Installations consisted of a stilling well made from robust downpipe with perforations drilled along their

<sup>10</sup> <https://environment.data.gov.uk/water-quality/view/landing>, data from 2014-2022 were used where available, otherwise the entire record from each data point was applied.

<sup>11</sup> <https://nrfa.ceh.ac.uk/data/search>, daily mean flow data were used to calculate the mean and Q<sub>95</sub> flows

<sup>12</sup> <https://www.ceh.ac.uk/our-science/projects/future-flows-and-groundwater-levels>

- entire length on all sides. The stilling wells were secured to the bank of the channel using metal stakes and brackets. The sondes were programmed to monitor at a frequency of every 15 minutes.
- 2.3.25 Initial deployment was unsuccessful given that data returned was not deemed plausible and did not truly represent in-channel conditions. Following investigation, this was determined to be a result of the stilling well creating a micro-environment with insufficient throughflow of water and inadequate space between the pipe wall and sonde and as such reinstallations were required.
- 2.3.26 During Storm Babet on 20 October 2023, the Lea Marston sonde was lost, with maximum mean daily flow recorded by the Environment Agency as 136 m<sup>3</sup>/s. A replacement sonde was obtained, but this instrument had an internal fault and so required a further replacement through In Situ prior to reinstallation. The replacement sonde was installed on 6th February 2024 with a greater degree of security with the instruments chained to Environment Agency signage at the site. Delays occurred due to obtaining replacement units through insurance and lead in times from the manufacturer for the two replacement instruments (given the first replacement was faulty).
- 2.3.27 The Water Orton sonde was believed to be stolen or vandalised on 1st January 2024. Vandalism was suspected given that the sonde stopped transmitting via the telemetry system during a period of relatively low flows. A replacement sonde was obtained and installed further upstream than the original location away from public view on 3rd April 2024, with a delay due to obtaining insurance and lead in times from the manufacturer. As with Lea Marston, additional security has been applied through chaining to nearby tree trunks and roots.
- 2.3.28 A third sonde was installed at Ladywalk Nature Reserve on 6th February 2024 to support DO modelling between the River Blythe confluence and Lea Marston lakes. This is required for a period of 12-months.
- 2.3.29 Given the above troubleshooting and damage/theft issues, the data considered for this report as robust and reliable spans the period 6th February 2024 to 12th June 2024 for Ladywalk Nature Reserve and Water Orton, and 3rd April to 12th June 2024 for Water Orton. Monitoring is ongoing and further data will be presented in a later iteration / addendum to the report.
- 2.3.30 Within the period since 6th February 2024, calibration and maintenance visits have been undertaken regularly. Site visits have taken place on 5th March, 14th March, 3rd April, 7th May, and 30th May. This has included removing any inundations of sediment from the stilling well, cleaning the sensors, battery changes and re-calibrating where necessary in line with the manufacturer's guidance.
- 2.3.31 Data has been downloaded for the sondes periodically using the VuLink telemetry system. The data has been subject to quality assurance to remove spurious values associated with calibration and maintenance and where there are clear errors (e.g., where turbidity peaks for a single value without any surrounding trend thus indicating disturbance in the stilling well) or where inundation has resulted in unreliable data.
- 2.3.32 It should be noted that sediment inundation has been an issue at Lea Marston and resulted in a data gap being recorded between 26th April and 13th May 2024. For Water Orton there has been a data gap in the dissolved oxygen record between 14th May and 12th June due to overly noisy data indicating a potential need for recalibration. At the time of writing (June 2024) this was yet to be resolved due to inaccessibility of the sonde due to water levels during site visits and the extent of vegetation growth. Repeat visits are scheduled with additional vegetation clearance tools to ensure access.

## 2.4 Fisheries Assessments

### Fish Passage

#### Protected and notable species of interest

- 2.4.1 A review of fish data records and fish surveys during previous gates identified over 35 different fish species that have been recorded within the Rivers Tame and Trent.

- 2.4.2 Protected and notable fish species of interest are listed below in Table 2-6. These eight species exhibit diadromous or potamodromous (also ‘potadromous’) movements within their life cycles which could be potentially disrupted by the presence of the multiple barriers along the two river systems. Definitions of the classes of migratory fish are as follows:
- 2.4.3 Anadromous fish are born in freshwater, then migrate to the ocean as juveniles where they grow into adults before migrating back into freshwater to spawn, e.g., Atlantic salmon, sea trout, river/sea lamprey.
- 2.4.4 Catadromous fish are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back into the ocean to spawn, e.g., European eel.
- 2.4.5 Potamodromous fish complete their entire lifecycle in freshwater, often migrating upstream or downstream as juveniles to grow into adults before migrating back upstream/downstream to spawn, e.g., brown trout, grayling.
- 2.4.6 These are split into two categories; migratory species classified as ‘high significance’; and cyprinid coarse fish, classified as ‘medium significance’ but with high socioeconomic value in the study area due to angling.
- 2.4.7 It should be noted that one record of European sturgeon (*Acipenser sturio*) was found within the study area in 2016. Sturgeon are thought to be extremely rare within this river network and across the UK as a whole and although they have been occasionally caught by anglers in the River Trent, they are not included in the assessments for barrier passability due to their rarity and likelihood of their absence upstream of the tidal limit of Cromwell Weir.

**Table 2-6 Protected and notable species of interest within the Rivers Tame and Trent**

Category	Fish Species
Migratory	Atlantic salmon ( <i>Salmo salar</i> ) Sea/ brown trout ( <i>Salmo trutta</i> ) European eel ( <i>Anguilla anguilla</i> ) River lamprey ( <i>Lampetra fluviatilis</i> ) Sea lamprey ( <i>Petromyzon marinus</i> ) European sturgeon ( <i>Acipenser sturio</i> )
Non-migratory (Potamodromous)	European barbel ( <i>Barbus barbus</i> ) (Cyprinidae) Grayling ( <i>Thymallus thymallus</i> ) (Salmonidae) Brook lamprey ( <i>Lampetra planeri</i> )

### Barriers scoped in for assessment

- 2.4.2 Multi-species fish passage and distribution for protected and notable species in the study area are considered to be constrained by the presence of multiple barriers in the Rivers Trent and Tame; primarily weirs and one set of sluices.
- 2.4.3 25 potential barriers to fish migration in the Minworth SRO study area were identified during Gate 1 and then visited and appraised during Gate 2 (utilising the results of the site visit and 1D hydraulic modelling). The 25 barriers are listed below (numbers indicated are also used as site references).
- Site 1 – Orton Weir
  - Site 2 – Water Orton Lane Road Bridge
  - Site 3 – Lea Marston Weir
  - Site 4 - Coton Weir (E)
  - Site 5 – Coton Weir (Central)
  - Site 6 - Coton Weir (W)
  - Site 7 - A4097 Weir
  - Site 14 - Thrumpton Weir
  - Site 15 - Beeston Weir
  - Site 16 - Holme Sluices Colwick
  - Site 17 - Stoke (Bardolph) Weir
  - Site 18 - Gunthorpe Weir
  - Site 19 - Hazelford Weir (South)
  - Site 20 - Hazelford Weir (North)

- Site 8 - Nether Whitacre Weir
- Site 9 - Broad Meadow LNR Upstream Weir
- Site 10 - Broad Meadow LNR Downstream Weir
- Site 11 - Meadow Weir
- Site 12 - Newton Weir
- Site 13 - Sawley Weir
- Site 21 - Averham Weir
- Site 22 - Newark Weir
- Site 23 - Nether Lock Weir
- Site 24 - Cromwell Weir
- Site 25 - River Blythe submerged weir

## Methodology

### Overview

2.4.5 An approach focused on hydraulic modelling was taken for the assessment of the impact of the SRO on fish passability.

2.4.6 Further details on the approach taken for the hydraulic modelling and fish passability assessment are provided in the following sections.

### Hydraulic modelling

2.4.7 Hydraulic models for each of the assets were developed to simulate the hydraulic conditions at the following flow events:  $Q_{99}$ ,  $Q_{95}$ ,  $Q_{\text{mean}}$ , and  $Q_{10}$ . These were simulated under each of the following operational scenarios:

- Baseline (BL);
- Scenario A (SA) – either the STT or GUC SRO operating at its maximum value (115 MI/d reduction); and,
- Scenario B (SB) – Worst case of both STT and GUC SROs operating combined at their maximum value (230 MI/d reduction).

2.4.8 Hydraulic models were developed at each of the asset locations. Further details of the hydraulic modelling undertaken can be found in the Gate 3 Annex B1.6 Hydrological and Hydraulic Modelling Report.

2.4.9 At those locations where assets are located in close proximity, models have been developed including a group of assets. A list of the hydraulic models developed is provided below:

- Sites 3 to Site 8 - Lea Marston, Coton Weirs (E, C, W), A4097 Weir and Nether Whitacre Weir
- Sites 9 and 10 - Broad Meadow LNR Upstream and Downstream Weirs
- Sites 11 and 12 – Meadow and Newton Weirs
- Site 13 - Sawley Weir
- Site 14 - Thrumpton Weir
- Site 15 - Beeston Weir
- Site 17 - Stoke (Bardolph) Weir
- Site 18 - Gunthorpe Weir
- Site 19 and 20 - Hazelford Weirs (South & North)
- Site 21 - Averham Weir
- Site 22 - Newark Weir
- Site 23 - Nether Lock Weir
- Site 24 - Cromwell Weir

2.4.10 Hydraulic models were developed and run using TUFLOW, which is industry-standard 2D modelling software. The software uses a grid to represent the underlying ground or river levels of an area, and calculations are performed at each grid cell to provide the hydraulic outputs which can include water level, depth and velocity. This approach was used as 2D models typically provide greater detail on predicted hydraulics both across a river channel or structure and longitudinally through the river, as results are not limited to locations of surveyed cross sections. Given that only typical interannual flows (and not flood flows) are modelled, it was not expected that much flow would spill into the floodplain, and therefore the topographic survey and model efforts were focused on the channel and weirs rather than the floodplain.

2.4.11 Following the model development, the Digital Elevation Model (DEM) remained consistent across the three scenarios so that any changes in flow conditions could be directly compared. Baseline and scenarios were run for each flow event to compare resulting flow depths and velocities and evaluate if there are any anticipated changes in structure passability.

**Fish passage review**

2.4.12 A fish passability assessment was undertaken for the species of interest at each of the barriers scoped in for assessment.

2.4.13 Fish passability was assessed through a review of the obstacle characteristics; 2D plan views of modelling outputs including depth and velocity; and review of hydraulic parameters such as hydraulic head, water depth, velocities and pool depth along long sections placed based on expert judgement. The fish passability assessment was undertaken against guidelines within the WFD111 (2a) Coarse resolution rapid-assessment methodology (hereafter SNIFFER assessment).

2.4.14 The sections below describe the SNIFFER assessment applied and the migratory requirements considered and integrated within the assessment.

**SNIFFER assessment**

2.4.15 A fish passability assessment at each of the 22 obstacles have been undertaken using species-specific SNIFFER guidelines (SNIFFER, 2010). In addition, the assessment provides passability guidance for the general characteristics of the structure and challenges presented to fish, classifying the obstacles as a vertical drop/jump obstacle, a slope/swim obstacle, or a steps/series of jumps obstacle (Table 2-7).

**Table 2-7 Parameters that have been assessed for each type of obstacle within the SNIFFER assessment**

2.4.16	Type of obstacle	2.4.17	Parameter that have been assessed
2.4.18	Vertical drop/jump	2.4.19	Water depth and velocity
		2.4.20	Hydraulic head
		2.4.21	Effective pool depth
2.4.22	Slope/swim	2.4.23	Water depth and velocity
		2.4.24	Obstacle length
		2.4.25	Obstacle slope
		2.4.26	Effective pool depth
2.4.27	Steps/series of jumps	2.4.28	Water depth and velocity
		2.4.29	Effective pool depth
		2.4.30	Individual step characteristics including:
			- Step hydraulic head - Step water depth - Step minimum length

2.4.31 The SNIFFER method generates a passability score for each parameter assessed (Table 2-8). The overall score is the lowest scoring parameter of those assessed for each structure.

**Table 2-8 SNIFFER guidance for passability scoring**

	No Barrier	Partial low impact barrier	Partial high impact barrier	Complete barrier
Score	1	0.6	0.3	0

- 2.4.32 The SNIFFER assessment was undertaken for each barrier based on the baseline and Scenario A and B flow duration curve values ( $Q_{99}$ ,  $Q_{95}$ ,  $Q_{\text{mean}}$ ,  $Q_{10}$ ) in order to investigate potential passability impacts arising from the operation of the SRO.

### Fish pass characteristics

- 2.4.33 Existing fish passes were present at some of the barriers of interest.
- 2.4.34 Where details on the fish pass are available, a review of the fish pass and assessment of fish passage have been undertaken using guidance of best-practice fish pass design contained within the Institute of Fisheries Management's Fish Pass Manual (FPM). For each of the fish passes included within the FPM, there are different parameters of assessment (i.e., slot widths, slope, velocity, etc.) The FPM provides guidance on optimal values for the parameters of assessment. Therefore, fish passes have been evaluated as "optimal" where all the parameters of assessment meet FPM guidance, or "suboptimal" where guidelines are not met. A summary of the barriers with technical fish passes installed is provided below in Table 2-9.

**Table 2-9 Summary of technical fish passes installed at the barriers scoped in at Gate 3 for assessment**

Asset	Type of fish pass	Information available
Site 9 - Broad Meadow LNR Upstream Weir	Lariniere & eel pass	Yes – Topographic survey available
Site 11 - Meadow Weir	Rock ramp	Yes – Topographic survey available
Site 15 - Beeston Weir	Vertical slot	Yes – Topographic survey available
Site 16. Holme Sluices	Twin vertical slot'	Fish pass constructed during Gate 3. It is considered the fish pass will operate as hydraulically designed, as per information received at Gate 3, which has supported this assessment
Site 23 - Nether Lock Weir	Eel and lamprey tiles	No design information available at the time of the survey
Site 24 - Cromwell Weir	Pool & traverse	Yes – Topographic survey available

### Hydrological context to inform fish passage assessment

- 2.4.35 We have interrogated the Aquator modelling to examine potential effects to the hydrology at each model node relevant to the fish passage structures. The main assessment considers the specific impact at each structure, though this hydrological, and subsequent fish passage review, considers the potential general effects on key species upstream and downstream migration. A summary of key migration windows for the different species is provided in Figure 2-2 below. These migration windows are indicative of the life history cycles of the key fish species. Although a good guide migration is often triggered by temperature and flow triggers that can vary year upon year and between river catchments.
- 2.4.36 The key (green) migration windows are the vital times when upstream migrations can be disrupted by barriers and regulated flow regimes. These windows are crucial for successful spawning migrations to be completed and overall fitness of the populations within each river system.
- Green = normal migration window
  - Orange = 'Off-peak' migration window

**Upstream migration**

Common name	Latin name	Life stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sea trout	<i>Salmo trutta</i>	Adult												
Atlantic salmon	<i>Salmo salar</i>	Adult												
European eel	<i>Anguilla anguilla</i>	Elver												
European eel	<i>Anguilla anguilla</i>	Glass eel												
River lamprey	<i>Lampetra fluviatilis</i>	Adult												
Sea lamprey	<i>Petromyzon marinus</i>	Adult												

**Figure 2-2: A summary of key migration windows for different species**

**Aquator modelling**

2.4.37 The model uses a regression analysis based on catchment size to translate a given Q value from an Aquator output to each weir. The output locations are at gauging stations, and the analysis uses the Aquator location nearest to each weir. The model simulates daily mean flow at the locations described, and these are based on stochastic time-series data adjusted for climate change (using RCP6.0-RCM08 UKCP18 outputs) – this has 19,200 years of daily flow outputs. For this climate change condition, three scenarios have been run: the 19,200 years for a baseline (no SROs), with the GUC added, and with both GUC and STT.

2.4.38 Simulations have been run from 1902 to 4310 (i.e. 2400 years). Results from Batch 1 have been used within this appraisal.

**Study area and relevant model node locations**

2.4.39 Figure 2-1 shows the weirs being considered as part of the Gate 3 Fish Passage review (Note: River Blythe submerged weir, Orton Weir, and Water Orton Lane road bridge were screened out during earlier Gates). Hydrological modelling results for each node (refer to the Hydraulic and Hydrological Modelling report for detail of model nodes) were obtained and the closest to each structure has been used to provide the hydrological context for each structure being considered during Gate 3 (e.g. Tame at Hopwas Bridge for the two Broad Meadow LNR weirs). The remainder of this review is split by the relevant model node.

**Fish Olfaction Assessment**

2.4.8 The purpose of this document is to source peer-reviewed evidence on each of these parameters to better understand whether increased concentrations could affect olfaction (i.e., sense of smell) in notable and/or protected species of migratory fish that are recorded within the River Tame and River Trent, which the Tame joins downstream of Tamworth. The species of interest are:

- Atlantic salmon (*Salmo salar*)
- Sea trout (*Salmo trutta*)
- European eel (*Anguilla anguilla*)
- River lamprey (*Lampetra fluviatilis*)
- Sea lamprey (*Petromyzon marinus*)

2.4.9 Following discussions with the Environment Agency, the species of interest were widened to include grayling (*Thymallus thymallus*) and barbel (*Barbus barbus*), which are resident (non-migratory) species present in the Rivers Tame and Trent. Migratory fish use the olfactory signature of a river, among other cues, for navigation, homing, and river entry. Anthropogenic impacts on water quality can alter the olfactory signature of a river, altering the ability of fish to home-in on natal streams (Scholz et al., 1976). Furthermore, some chemicals may cause changes in olfactory function, contributing to (1) anosmia, or an inability to smell; (2) hyposmia, or a reduced capacity to smell; and (3) dysosmia, where olfactory information is processed incorrectly (Tierney et al., 2010).

- 2.4.10 The chemicals that are currently modelled to increase in concentration within the River Tame in response to proposed reductions in discharges from Minworth WwRC (because these pollutants are present in the river upstream of the WwRC) are predominantly pollutants. Therefore, it is considered that these parameters will be associated with their potential to change or disrupt olfactory function rather than relating to changes in the olfactory signature of the river, which is dependent upon the overall combination of chemicals (natural and artificial) in the river, in particular underlying geology. As discussed later, it is also the case that there is currently a very limited community of migratory fish species in the River Tame due to barriers to fish passage downstream and historic water quality issues. Therefore, it is possible that migratory fish may adapt to the olfactory signature of the river system under current or future conditions, if and when they penetrate further up the catchment upon the reinstatement of fish passage (acknowledging that salmonid species and river/sea lamprey may already be present in the lower catchment of the River Trent).
- 2.4.11 This assessment focuses on water quality in the River Tame, upstream of its confluence with the River Trent. Given the relatively minor changes in concentrations of most water quality parameters demonstrated in this report, it is considered that the fish assemblage in the River Trent, including migratory species, will not be affected by the changes resulting from the Minworth scheme. This is in consideration of the fish species currently present in the River Trent, including in the vicinity of the Tame confluence, including migratory species that are therefore adapted to the current olfactory signature of the river. It is also the case that there are numerous water quality inputs to the River Tame, including tributaries (notably the River Blythe and the River Anker), artificial discharges, and land drainage, that it is not feasible to model in the context of this assessment.
- 2.4.12 There are two dominant concerns generally relating to olfaction and migratory fish:
- 1) Olfactory inhibition by chemicals / metals etc.
  - 2) Changes to the olfactory signature of a river and olfactory cues that may affect homing of salmonids to natal rivers, and river entry for various migratory fish species (e.g., European eel, lamprey species, sea trout).

### Literature Search

- 2.4.13 The literature search was performed using the Google Scholar search engine (<https://scholar.google.com/>), searching for peer-reviewed literature only. Multiple separate searches were conducted using search terms as follows:
- "Species common name" OR "species Latin name" AND "chemical of interest" AND "olfactory"*
- 2.4.14 The first fifty results were reviewed (results in English only) for each species-chemical combination. A non-species-specific search ("fish" AND "chemical of interest" AND "olfactory") was also performed to capture any literature on other species resident in the Rivers Tame and Trent including roach, dace, chub, 10-spined stickleback, bleak, common bream, flounder, gudgeon, minnow, perch, spined loach and bullhead.
- 2.4.15 Any reported effects on olfaction were recorded where studies included information on the exposure duration and concentration at which the effects were observed.
- 2.4.16 Snowballing was used to gather further relevant references, whereby the reference lists of articles that were found in the initial Google Scholar search were reviewed to see if other relevant references on that topic existed and could be included in the results. The search process used was therefore systematic and reproducible but is not comparable to a full systematic review process.
- 2.4.17 There was no critical evaluation of the quality of the studies that were included, except where this was identified as presenting a constraint to the olfaction assessment.

### Review of Previous Studies

- 2.4.18 A previous review of the impacts of determinands on olfaction and fish populations in the Severn Estuary was completed for the independent but related STT SRO (Ricardo, 2022). The STT olfaction review summarised the role of olfaction/olfactory cues in migration and identified those determinands associated with the operation of the STT SRO that could impact on the migration and reproduction of

fish species in the Severn Estuary. The review determined that the transfer could potentially impact upon the downstream migration of salmonids and shad, lamprey, glass eels (under a late run), as well as the upstream migration of shad and lamprey.

2.4.19 The STT scheme represents notably different impacts on the receiving watercourses, primarily the River Avon, compared to the impacts of the Minworth SRO on the River Tame. STT involves the transfer of treated recycled water from Minworth direct to the River Avon, with the resulting transfer of any chemicals that are present within that recycled water. Impacts to the River Tame may arise from the diversion of recycled water away from the River Tame, and the corresponding reduction of discharge of recycled water into the receiving watercourse, thereby altering the dilution factors of contaminants already present in the Tame (largely to a very minor extent), as well as reducing the input of some chemicals from recycled water into the Tame.

2.4.20 A review of the STT report has been completed to include findings that may also be relevant to the River Tame.

### **Limitations**

2.4.21 The literature review is limited by the literature available at the time of reporting.

2.4.22 Water quality modelling is based on monthly spot samples of water quality monitoring in the River Tame through Gate 2 and Gate 3 and therefore does not allow for diurnal or less-than monthly variation in concentrations. Likewise, it is dependent upon flow conditions at the time of monthly spot sampling, but as such is considered a realistic indication of monthly concentrations in the River Tame.

2.4.23 Water quality monitoring is limited by the Limits of Detection (LoD) of determinands being monitored. For on-going monitoring, it is proposed to undertake monitoring at lower LoD for selected determinands, notably Cypermethrin in relation to this assessment.

## **2.5 River surveys**

### **Connectivity of local environmental features**

2.5.1 The ecological assessment for Gate 2 (Gate 2 Annex B3.1.2) focused on designated sites and priority/notable wetland (water dependent) habitats including those with hydrological connectivity to the Rivers Tame and Trent, and therefore with the potential to be impacted by reduced river flows as a result of the Minworth SRO scheme. Stakeholders stressed the importance of assessing these sites and habitats, in particular those where hydrological connectivity had been designed according to current flows in the Rivers Tame and Trent (most notably the River Tame), and therefore where reductions in flow may adversely impact upon those sites.

2.5.2 Based on results of Gate 2 Scoping, there are five water dependent designated sites (RSPB Middleton Lakes constitutes two Local Wildlife Sites (LWS) but has been described here as one site) (refer to Appendix B) that have the potential to be impacted due to reductions in flow in the River Tame and potential loss of connectivity. These sites were taken forward for further assessment in Gate 3.

2.5.3 Further assessment has been completed to determine the current connectivity of these sites and habitats to the River Tame, and whether these connections may be adversely affected by reduced water levels in the River Tame as a result of the proposed Minworth SRO scheme. Site visits and ecological surveys have been undertaken to all sites, including site visits accompanied by the Environment Agency and Natural England (in April 2022); however, further site investigations may be required to establish in more detail the levels of connecting features to the River Tame – i.e., connecting channels and pipes, should mitigation be required.

### **Methodology**

2.5.4 A scoping exercise was completed to identify high priority topographical survey locations where channels connect to the River Tame and have the potential to feed the five water dependent designated sites detailed in Appendix B that were scoped in at Gate 2 for further assessment.

Perennial tributaries connected to the River Tame were scoped out for further assessment as they will remain connected.

- 2.5.5 Twenty potential connection sites were identified, from desktop mapping and aerial imagery, to take forward for further analysis, to determine whether they would be influenced by changes in water levels in the River Tame. Where possible, a site visit was completed for all connection sites identified. Connection analysis has also been informed by consultation with the Environment Agency and Natural England, including a joint site visit in April 2022.
- 2.5.6 Topographical surveys were completed at 19 connection sites scoped in for further assessment. Hydrological modelling was then completed at each connection point identified to determine whether the potential changes in water levels within the River Tame could impact these water dependent designated sites.

### Topographical Survey

- 2.5.7 Detailed survey data at selected locations along a 3.3 km reach of the River Tame included topography at a maximum of 1 m resolution (i.e. no elevation points should be more than 1m apart), which captured the profile and depth of the connecting feature, up to and including the bank top, was completed. The survey was completed on the River Tame from just downstream of the outfall of the River Blythe (SP 21589 91593) to just upstream of Marston Lakes (██████████).

### Hydraulic modelling

- 2.5.8 The Gate 2 1D Flood Modeller Pro (FMP) model of the River Tame, which extends from Minworth WwRC to the confluence of the River Tame with the River Trent, has been updated at Gate 3 to include inflows derived from the latest Aquator model outputs. These updates have also included improvements to the representation of the weirs at Tamworth and Lea Marston Lakes, and to the georeferencing of model nodes within the 1D model.
- 2.5.9 The Aquator model has been developed to represent the present day and future management of water resources within the catchment as part of the ST WRMP 2024. Six climate change scenarios for the year 2040 and a historic re-run (01/01/1918 – 31/12/2014) have been simulated with the ST Aquator model at Gate 3.
- 2.5.10 The ST Aquator WRMP 2024 represents the management of water resources within the catchment, including existing abstraction licences, for present day water operations and for future planned operations.
- 2.5.11 The climate change scenarios have been run stochastically, such that for each tested climate change scenario, eight batches of differing flow inputs and parameters have been tested. For climate change scenario, flow estimates for different probabilistic event have been derived from the cumulative results for all eight batches.
- 2.5.12 The Aquator model outputs for the Representative Concentration Pathway (RCP) 6.0 Regional Climate Model (RCM) 08 (mid estimate) 2040 scenario have been used to derive the flow estimates for the following probabilistic flow events in the 1D FMP model of the River Tame:
- Q10 (the flow that is exceeded 10% of the time – a 'high' flow)
  - Mean
  - Q95 (the flow that is exceeded 95% of the time – a 'low' flow)
  - Q99
  - Extreme low flows (ELF) (Q99 - 20%)
- 2.5.13 Where the Aquator model outputs were not available, as was the case at Lea Marston Lakes and Water Orton, the derived relationships between the Aquator model outputs for the historic re-run at the nearest Aquator output location (Hopwas Bridge RR219) and the historical gauged flows (0/01/1987 – 18/10/2023) at Lea Marston for the equivalent probabilistic flow events have been used to scale the Aquator model outputs at Hopwas Bridge for the RCP 6.0 RCM 08 2040 climate change scenario.
- 2.5.14 Each probabilistic event has been run with the 1D FMP model for three operational scenarios:

- Baseline Scenario (no SROs operating)
- GUC SRO or STT SRO (Baseline flow estimates -115 MI/d)
- GUC SRO and STT SRO both in operation (Baseline flow estimates -230 MI/d)

2.5.15 To undertake the connectivity analysis, the results for the Q99, ELF, Mean, and Q10 events have been extracted at the nearest node in the 1D FMP model to the connecting channel/feature. As this approach effectively neglects the modelled longitudinal and transversal variations in water level within the channel, the uncertainty associated with the extracted water level at each node has been estimated via the following equation:

$$\text{Distance to nearest node (m)} * \text{Water surface slope (m/m)/0.01}$$

## Limitations

2.5.16 The following limitations have been identified in terms of the connectivity assessment:

- The analysis was based on the steady state water levels for a constant inflow (rather than a hydrograph). The Tame model has been run with a diurnal flow profile (derived for a 24-hour period in summer 2018) for Minworth WwRC over an 80-hour period. However, as the low flow events are likely to be the result of prolonged droughts and affect the Tame for a protracted period (days-weeks), the model is unable to capture the proportion of time that flows drop below a certain level. Therefore, the connectivity assessment is based on a worst-case scenario of the lowest predicted level to be reached at the connecting feature. In this sense, any suggested mitigation would effectively mitigate for the worst-case scenario.
- There is no further monitoring of groundwater levels; groundwater has been assessed separately at Gate 1 and Gate 2.
- Hydraulic modelling predictions have informed the potential impacts on connected water dependent designated sites. Refer to the report on hydraulic modelling (to be reported separately at Gate 3) to understand the assumptions and limitations of modelling.
- A topographical survey was not completed at Tameside LNR 4 as it could not be determined where or if this channel connected to the River Tame; therefore, no hydrological modelling has been completed for this site and it is scoped out of further assessment.
- The locations of Kingsbury Wetlands 4 and Kingsbury Wetlands 6 were uncertain from desk study alone; therefore, topographical survey results were taken at the nearest feature observed on site, where accessible.

## River Habitat Surveys and macrophyte surveys

2.5.17 Aquatic ecological monitoring of the River Tame and Trent system was completed as part of the Gate 2 assessments (Gate 2 Minworth Annex B1). The monitoring comprised:

- RHS at 35 pre-determined sites;
- Macroinvertebrate surveys at 20 pre-determined sites;
- Aquatic macrophyte surveys at nine sites;
- Electric fishing surveys and environmental DNA (eDNA) surveys for fish DNA up- and downstream of six weirs (where accessible); and
- Targeted surveys for Invasive Non-Native Species (INNS) were undertaken at 12 sites.

2.5.18 The assessments completed at Gate 2 have informed the scope of continuing assessment at Gate 3.

2.5.19 Due to identified limitations resulting from land access, weather, and flow constraints identified during the aquatic ecological monitoring of the River Tame and Trent system completed as part of the Gate 2 assessments, it was recommended that sub-optimal River Habitat Surveys (RHS) and macrophyte surveys be repeated during the optimal survey season or conditions to ensure the robustness and consistency of data and to inform the on-going environmental assessment.

## River Habitat Survey

- 2.5.20 River Habitat Surveys (RHS) were undertaken in August 2023 and led by an experienced and certificated RHS surveyor (Rachel Cooper; RHS certification code CRHS061) in accordance with the methodology as detailed in the Environment Agency (EA) RHS Manual (EA, 2003) at two survey locations (Table 2-10; Appendix C). Both sites were surveyed in optimal conditions; the weather was fair and flow conditions were generally low-normal.
- 2.5.21 For lowland rivers, May and June are considered optimal periods for RHS as the presence of key diagnostic features such as flowers and fruiting bodies facilitate the identification of macrophytes, while vegetation cover remains insufficient to obscure bank and channel features. RHS, however, can be conducted at any time of year.

**Table 2-10 RHS survey locations**

Watercourse	Site ID	Site Name	Survey reach central NGR	Date completed
River Tame	TA1	Castle Bromwich	[REDACTED]	29/08/2023
River Tame	TA2	Water Orton	[REDACTED]	29/08/2023

- 2.5.22 It should be noted that TA1 moved approximately 160 m downstream compared to the surveyed reach in 2021 due to improved access at the time of the 2023 survey, whilst TA2 largely the same surveyed reach across both years.
- 2.5.23 Sites TA1 and TA2 were both originally surveyed on 1 October 2021, outside of the optimal survey window for accurate identification of macrophytes. Furthermore, heavy overnight rainfall preceding the 2021 surveys resulted in increased flows and high turbidity impeding visibility of the riverbed and submerged features such as non-emergent vegetation at both sites. Consequently, the sites were resurveyed during optimal conditions in 2023.

## Aquatic Macrophyte Survey

- 2.5.24 Aquatic macrophyte (plant) surveys were undertaken between 1<sup>st</sup> August and 29<sup>th</sup> August 2023 at the locations shown in Table 2-11. The recommended survey season for aquatic macrophytes is 1st June to 30th September and surveys should not be undertaken during, or immediately after periods of high flow. Flow conditions were optimal during these surveys. Refer to Appendix C for survey locations.

**Table 2-11 Macrophyte survey locations on the River Tame**

Site Reference	Site Name	Water body	Date	NGR Start	NGR Finish
TA1	Castle Bromwich	River Tame	29/08/2023	[REDACTED]	SP1529590792
TA2	Water Orton	River Tame	29/08/2023	[REDACTED]	SP1738091409
TA4	Tamworth	River Tame	01/08/2023	[REDACTED]	SK2103401780
TA6	Alrewas	River Tame	01/08/2023	[REDACTED]	SK1906714911

- 2.5.25 TA1, TA2 and TA4 were all originally surveyed on 1 October 2021, outside of the optimal survey window. Furthermore, it was noted that heavy overnight rainfall preceding the survey resulted in increased flows and high turbidity impeding visibility of the riverbed and submerged vegetation. TA6 was originally surveyed on 29 September 2021, within the optimal survey window, however the survey was also impeded by high water turbidity. Consequently, the sites were all resurveyed during optimal conditions in 2023.

## Aquatic Macrophyte Survey Methodology

- 2.5.26 The aquatic macrophyte surveys followed guidance set out in the UKTAG River Assessment Method (Macrophytes and Phytobenthos) for use with LEAFPACS2 (WFD-UKTAG, 2014), which conforms to

BS EN 14184:2014 Water quality – Guidance for the surveying of aquatic macrophytes in running waters. The surveys were carried out by walking within the channel of each watercourse along a 100 m transect. Any inaccessible areas were bypassed as necessary before re-entering the channel at the next available access point. Where the watercourse could not be entered, a grapnel was used to survey the 100 m transect. A list of all macrophytes encountered was collated and their relative abundance was recorded using Taxon Cover Values (TCV).

### Limitations

- 2.5.27 The RHS completed at TA1 was completed from the right bank top due to the reach having steep banks. Additionally, approximately 100 m (not necessarily continuous) of the TA1 reach bank top was densely vegetated with bramble, and consequently the survey was marked as not visible at one spot check where it was not possible to sufficiently observe the watercourse, however this spot check was complemented where possible with details collected from aerial photography. At TA2 small areas of the reach were unsafe to wade due to water depth, and subsequently these locations were surveyed from the banks. It is considered that these limitations will not have impacted on the recorded general characteristics and details of the surveys or the overall outcomes of the analysis.
- 2.5.28 Three aquatic macrophyte survey reaches (TA1, TA4 and TA6) were surveyed from banktop rather than within channel due to excessive water depth. A grapnel was deployed where safe and practicable within the 100m survey extent to attain an accurate representation of the submerged aquatic macrophyte community present.

## 2.6 ERS Invertebrates

### Methodology

#### Desk Study and Literature Review

- 2.6.1 Exposed riverine sediment (ERS) is a distinctive riparian and in-river habitat that maintains a unique community of invertebrates, particularly Coleoptera (beetles) and Diptera (flies), many of which are rare in the UK (Bell & Sadler, 2001). Several species of both Coleoptera and Diptera are observed solely on ERS, and several species are rare and/or specialist. An ERS-specific habitat score can be determined for Coleoptera and Diptera species (Sadler and Bell, 2002) and is referred to as a fidelity score. These scores illustrate the importance of the habitat to the diversity and conservation of Coleopteran and Dipteran fauna in these habitats.
- 2.6.2 Exposed riverine sediment is an under-surveyed habitat, especially in urban settings. The majority of previous ERS surveys have been undertaken in Wales, Scotland, and rural northern England (e.g. Cumbria). In 2001, Bell & Sadler surveyed ERS to determine the effect of recently restored (1998) gravel pits along the River Tame for Coleoptera fauna.
- 2.6.3 Data provided by the Local Environmental Records Centres (LERC) were reviewed for the River Tame to ascertain the range of species previously observed on ERS.
- 2.6.4 Notable species from both data sets are assessed in terms of species fidelity to ERS. No relevant data was found from literature searches to date for ERS terrestrial invertebrates on the River Trent, presumably due to the paucity of such studies on the River Trent.

#### Field Surveys

- 2.6.5 Exposed riverine sediment occurs predominantly in Wales and Scotland with small, isolated pockets occurring in England. Only a small number of occurrences of ERS are present on the River Tame and River Trent, some of which are small in area. The survey sites were chosen as the best examples of ERS in terms of both their size and habitat quality and variety – ERS habitats constitute both unvegetated and vegetated components, each supporting diverse invertebrate communities.
- 2.6.6 Surveys of ERS were attempted at seven locations across the River Tame and River Trent (Table 2-12; Appendix D) in July 2023 and repeated in September/October 2023. These locations were identified from previous surveys and analysis of aerial imagery as suitable for ERS surveys; this habitat is rare in the Rivers Tame and Trent due to their heavily modified and channelised (deep) nature. Therefore,

they are important habitats in rivers of this type as they provide important but widely dispersed habitat for species that they support. These survey locations were chosen as some of the only, and the best, examples of such habitats in these rivers.

**Table 2-12 Exposed Riverine Sediment (ERS) survey locations**

Site location	National Grid Reference (NGR)	Watercourse	First survey date	Second survey date
Tame/Blythe confluence		River Tame	05/07/2023	05/10/2023
Middleton Lakes/Tamworth shooting ground		River Tame	06/07/2023	05/10/2023
Tame/Trent confluence - Alrewas		River Trent	05/07/2023	04/10/2023
Willington		River Trent	n/a	n/a
Sawley Weir		River Trent	20/07/2023	03/10/2023
Thrumpton Weir (left bank)		River Trent	21/07/2023	03/10/2023
Thrumpton Weir (right bank)		River Trent	21/07/2023	03/10/2023

2.6.7 A combination of survey methods was employed at each survey location to ensure all microhabitats on the ERS were included; comprising:

- **Pitfall trapping** – creating a small hole in the substrate using a trowel or bulb planter and placing in a 250 mL cup so the lip of the cup is flush with the substrate. Approximately 75 mL of antifreeze (ethylene glycol – or alternative preservative) is added to the cup to preserve any specimens caught. Where there was a risk of pitfall traps being disturbed by livestock and the preservative being ingested, non-toxic antifreeze was used as an alternative. The traps were left in-situ for one week before collection. For optimal success when pitfall trapping, the traps should be set during typical low flows and when these conditions are maintained during the subsequent seven days;
- **Sweep sampling** – the use of a sweep net on a long handle to sweep through the site and adjacent bankside vegetation to capture specimens, which were subsequently preserved;
- **Excavation of the ERS** – one square metre area, approximately 1 – 2 m from the water's edge, was excavated to the water table. This allows the shallow excavation to fill with water. Any specimens that appear on the water are removed using a small net or sieve. The excavation was back-filled before leaving site;
- **Suction sampling** – use of a small petrol-powered 26cc hand-held garden vac with a sturdy mesh over the intake, covering the survey area, capturing specimens for later identification; and
- **Hand searching** – targeted and timed search of habitat ecotones (vegetation edge/strand lines) with a pooter to capture specimens by sight.

2.6.8 All specimens collected were subsequently preserved in Industrial Methylated Spirit (IMS) for laboratory processing.

2.6.9 The samples collected were sorted and analysed in a laboratory setting by suitably trained and experienced ecologists. Lists of the invertebrate taxa present were produced. The invertebrate specimens were identified to 'mixed-taxon level' using a stereo-microscope. Most groups were identified to species level (where practicable).

2.6.10 Fidelity to ERS provides a measure of how strong an association a species has with ERS habitat, from total reliance on ERS for life cycle and overwintering, to partial reliance (can be found elsewhere), to low reliance ('accidental' occurrence on ERS). Table 2-13 presents details of the fidelity scores. Due to the low numbers of specimens from the surveys, data was interpreted in relation to each species' fidelity to ERS as has been completed in previous studies.

**Table 2-13 Exposed Riverine Sediment (ERS) fidelity scores and classes**

Fidelity score	Fidelity class
1	Total or virtual fidelity to ERS.
2	High fidelity (mostly found on ERS).
3	Moderate fidelity (frequently but not always found on ERS).
4	Low fidelity (not expected on ERS but found more frequently on other habitats).
5	Vagrant (occurrence on ERS is 'accidental').

## Limitations

- 2.6.11 Several limitations are noted that impeded or prevented survey completion and resulted in particularly low specimen counts. These are listed below.
- 2.6.12 Due to the nature of the River Tame in displaying diurnal flow fluctuation (as also noted by Bell and Sadler, 2001), combined with adverse weather conditions throughout 2023 (see below), there were significant limitations to the surveys completed. Therefore, this assessment has been complemented by a literature review of previous studies, and a desk study of available records of invertebrate species in the River Tame and Trent catchment. Therefore, it is considered that a satisfactory representation of the importance of ERS habitats in the catchment has been obtained.
- 2.6.13 Generally, all surveys on the River Tame were subject to limitations resulting from diurnal fluctuations in river levels – a known phenomenon on the River Tame which has been subject to hydraulic modelling at Gate 3 and is described in more detail below. Due to these diurnal fluctuations in levels, which were also described by Bell and Sadler (2001), pitfall trapping in particular, and other survey techniques, may be very difficult to complete due to the inundation of ERS habitats both during and between survey visits.
- 2.6.14 Similarly, surveys could not be completed in the appropriate survey season (May / June) in 2024 due to high river flows and inclement weather. However, further surveys are not considered necessary to inform the assessment of invertebrate communities in ERS habitats – surveys at the locations detailed in this report, due to the limitations described, have been bolstered with detailed desk study and literature review, which has demonstrated the importance of these uncommon habitats in the Tame and Trent catchments, which will support the Environmental Impact Assessment (EIA).
- 2.6.15 Land access at the Willington site could not be secured, despite several attempts. Consequently, surveys did not take place at this location.
- 2.6.16 The River Tame / Blythe confluence had unsafe access (vertical banks greater than 1.75 m in height composed of unstable sand/earth substrate), preventing effective surveys at this site. A subsequent survey attempt in October 2023 was further confounded by a 15 m wide wall of high and dense brambles, rendering the site inaccessible.
- 2.6.17 The River Tame / Trent confluence site at Alrewas is within a Staffordshire Wildlife Trust (SWT) reserve, Croxall Lakes, and consequently surveys could not be undertaken until the end of the breeding bird season (March - September), as requested by SWT. Surveys outside the breeding bird season were unsuccessful due to inundation of ERS habitats from a storm the weekend prior to surveys, and generally high flows at that time of year (see below).
- 2.6.18 RSPB Middleton Lakes / Tamworth shooting ground, Sawley Weir and Thrumpton Weir: these three sites experienced extreme weather and high river levels during 2023 (see below). Several rainstorms occurred during the first survey window, considerably raising river levels, and resulting in all pitfall traps being flooded. Storms also flooded all sites during the second survey window and so pitfall traps and other methods could not be deployed. This resulted in pitfall trapping not being successful at any site.

## Seasonality and Flow Fluctuations

- 2.6.19 It has been shown through hydraulic modelling and indicated by anecdotal evidence from the Environment Agency that the River Tame demonstrates diurnal flow fluctuation and unnatural seasonal variation as a result in part of discharges from WwRC, including Minworth. This and the associated constraints to surveys of ERS habitats is described in further detail below.
- 2.6.20 The Typical Low level for the River Tame (Tamworth Monitoring Station) is 0.86 m and the Typical High level is 1.3 m (RiverLevels.uk<sup>13</sup>, 2024). The Typical Low level for the River Trent (Shardlow Monitoring Station) is 0.41m and the Typical High level is 1.7m (RiverLevels.uk, 2024). In July 2023, during the time following the setting of pitfall traps, the river levels on both the River Tame and River Trent were high for four consecutive days following heavy rainfall, which resulted in the pitfall traps being inundated / washed away. In early October 2023, sites were re-visited to attempt pitfall trapping. In the preceding 5 days, river levels were above average following heavy rain, resulting in the ERS being under water. This was a repeating pattern of fluctuating river levels during the optimal survey periods in 2023 and 2024.
- 2.6.21 Very low numbers of Diptera (10 specimens) were captured during surveys and two were identifiable to genus/species level. These were from the superfamily Nematocera (gnats) and features such as antenna and legs that are required for Diptera identification were missing. As a result, the identified Diptera are included in species lists but have been excluded from interpretation; however, such species are available from the desk study and literature review and are therefore represented.
- 2.6.22 The analysis of hydrological modelling data to infer potential impacts to ERS habitats has been completed. Assumptions have been made on the likely increase in extent and duration of exposure of ERS based on model results.

## 2.7 Water Framework Directive Assessment

### WFD Assessment Methodology

#### Background

- 2.7.1 The Water Framework Directive (WFD) seeks to establish an integrated approach to the protection and sustainable use of the water environment. This requires a holistic approach to managing waters, looking at the wider ecosystem and taking into account the movement of water through the hydrological cycle. The WFD river basin planning process is summarised from an Environment Agency policy paper<sup>14</sup> below.
- 2.7.2 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 transpose, for England and Wales, the Water Framework Directive as well as aspects of the Groundwater Directive and Environmental Quality Standards Directive.
- 2.7.3 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (referred to as WFD Regulations) provide a framework for managing the water environment in England.
- 2.7.4 The European Union Withdrawal Act 2018 carries over the requirements of the WFD, into domestic law as retained EU law.
- 2.7.5 The WFD Regulations require the preparation and publication of river basin management plans, the setting of environmental objectives for groundwater and surface waters (including estuaries and coastal waters), and the devising and implementing of programmes of measures to meet those objectives.
- 2.7.6 The aims of the WFD Regulations are to:

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<sup>13</sup> River Levels UK [Online] Available at: <https://riverlevels.uk/>

<sup>14</sup> [River basin planning process overview - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/policies/river-basin-planning-process-overview) Policy paper updated 30 March 2023, accessed for this report in September 2024.

- Prevent further deterioration and protect and enhance the status of aquatic ecosystems and associated wetlands.
- Promote the sustainable consumption of water.
- Reduce pollution of waters from priority substances and phasing out of priority hazardous substances.
- Prevent the deterioration of the status and to progressively reduce pollution of groundwater.
- Contribute to mitigating the effects of floods and droughts.

2.7.7 The WFD Regulations environmental objectives, as set out in Regulation 13, are:

- Prevention of deterioration of the status of surface waters and groundwater.
- Achievement of objectives and standards for protected areas.
- Protect, enhance and restore each body of surface water with the aim of achieving good status for all water bodies by 2021. Where this is not possible and subject to the criteria set out in the WFD Regulations, aim to achieve good status by 2027 or set an objective less stringent than good status.
- Protect and enhance each artificial or heavily modified water body with the aim of achieving good ecological potential and good surface water chemical status for heavily modified water bodies and artificial water bodies. Where this is not possible and subject to the criteria set out in the WFD Regulations, aim to achieve good status or potential by 2027 or set an objective less stringent than good status or potential.
- Reversal of any significant and sustained upward trends in pollutant concentrations in groundwater.
- Aim progressively to reduce pollution from priority substances and aim to cease or phase out discharges of priority hazardous substances into surface waters.
- Progressively reduce the pollution of groundwater, prevent the input of hazardous substances, and limit the entry of non-hazardous pollutants to groundwater.

2.7.8 Under the WFD Regulations, a river basin management plan (RBMP) must be developed for each river basin district and reviewed and updated every six years. These plans were first published in December 2009. They were updated in February 2016 and December 2022.

2.7.9 The WFD aims to protect and enhance the water environment. The WFD takes a holistic approach to sustainable management of the water environment by considering interactions between surface water, groundwater, and water-dependent ecosystems. Ecosystem conditions are evaluated according to interactions between classes of biological, chemical, physico-chemical and hydromorphological elements known as 'Quality Elements'.

2.7.10 Within the WFD, 'water bodies' are the basic management units. These are defined as all or part of a river system or aquifer. Water bodies form part of a larger 'river basin district' (RBD) which are then used to summarise baseline conditions and set broad improvement objectives. RBMPs are produced every six years, in accordance with the river basin management planning cycle. The current RBMPs at the date of this assessment are the Cycle 3 plans. The most recent RBMP data available on the online Catchment Data Explorer is from 2022 (in some instances the latest data available for a water body is from 2019).

2.7.11 The EA is the government regulator for implementing the WFD in England, although many objectives are delivered in partnership with other relevant government (i.e., public) bodies as well as local planning authorities, water companies, rivers trusts, landowners, and developers.

2.7.12 The WFD requires water bodies to be classified according to their current condition, known as the 'Status' if not designated as an artificial or heavily modified water body (A/HMWB), or 'Potential' if they are a A/HMWB. The WFD also requires water bodies to have a series of objectives for maintaining or improving conditions so that water bodies maintain or reach good status or potential.

## WFD Assessment for SROs

- 2.7.13 The All Company Working Group (ACWG)<sup>15</sup> has developed a consistent framework for undertaking WFD assessments for SROs to demonstrate that options would not cause deterioration in status of any WFD water body. The assessment considers mitigation that would need to be put in place to protect water body status. The assessment also considers WFD future objectives. Two stages of assessment are completed under the ACWG WFD approach: an initial Level 1 basic screening and a Level 2 detailed impact screening. These are conducted/reported using a spreadsheet assessment tool which is automated based on option information for Level 1 and expert judgement for Level 2, with reference to baseline WFD classification and measures data as outlined in the RBMP.
- 2.7.14 The ACWG SRO assessment process must demonstrate that a scheme option will not cause a deterioration in status, or future achievement of Good Status/Potential, of any relevant water bodies as measured and defined by the WFD. This assessment should include and consider any mitigation methods that would be put in place to protect a water body status. The SRO assessment processes has four gate assessment stages. The GUC SRO assessment for WFD compliance is currently at Gate 3.
- 2.7.15 As an alternative to the standard WFD assessment methodology, the ACWG approach for WFD assessments has been developed so that a standard method is used to drive consistency and comparability between SRO schemes. This allows schemes to be compared easily to ensure options are uniformly assessed and presented.
- 2.7.16 The assessment is split into two levels. Level 1 provides a basic impact screening, with the identification of affected water bodies, potential impacts and embedded mitigation measures. The Level 2 assessment provides a detailed assessment of the impacts to each water body that was screened in at Level 1 and assesses those impacts against each WFD quality element. The Level 2 assessment also identifies further mitigation that may be required and assesses the impacts after mitigation.

### Level 1 – Basic Screening

- 2.7.17 The following steps are undertaken during the Level 1 screening assessment:
- Identify affected water bodies.
  - Review SRO activities.
  - Identify possible impacts.
  - Apply 'embedded' mitigation measures. Examples of embedded/assumed mitigation are included in the ACWG Level 1 screening spreadsheet and typically include construction stage mitigation and avoidance measures.
  - Calculate a screening score (using a six-point scale from -2 to 3) to 'screen out' water bodies and scheme activities with no or very minor potential impacts from further assessment. If the maximum impact score is greater than 1 (minor localised impact) then the water body is taken forward into level 2 screening.
- 2.7.18 Where a water body or impact is 'screened in' at Level 1 screening, they are taken forward to Level 2 WFD assessment. Water bodies that are not 'screened in' do not proceed to the next level and are considered of low risk.
- 2.7.19 The impact scoring system employed at Level 1 is provided in Table 2-14.

**Table 2-14 Impact scoring system for Level 1 screening assessment**

Confidence level	Description	Gate when level required
Very beneficial	-2	Impacts that, taken on their own, have the potential to lead to the improvement in the ecological status or potential of a WFD quality element for the entire water body.

<sup>15</sup> [ACWG WFD: Consistent framework for undertaking no deterioration assessments](#) [Accessed 27.6.2024]

Confidence level	Description	Gate when level required
Beneficial	-1	Impacts that, when taken on their own, have the potential to lead to a minor localised or temporary improvement that does not affect the overall WFD status of the water body or any quality elements.
No/minimal	0	No measurable change in the quality of the water environment or the ability for target WFD objectives to be achieved.
Low	1	Impacts that, when taken on their own, have the potential to lead to a minor localised, short-term and fully reversible effects none or more of the quality elements but would not result in the lowering of WFD status. Impacts would be very unlikely to prevent any target WFD objectives from being achieved.
Medium	2	Impacts that, when taken on their own, have the potential to lead to a widespread or prolonged effect on the quality of the water environment that may result in the temporary reduction in WFD status. Impacts have the potential to prevent target WFD objectives from being achieved.
High	3	Impacts when taken on their own have the potential to lead to a significant effect and permanent deterioration of WFD status. Potential for high impact on preventing target WFD objectives from being achieved.

## Level 2 – Detailed Impact Assessment

2.7.20 The second level of WFD assessment is the Level 2 impact assessment. The following steps are undertaken during the Level 2 assessment:

- Water body scale detailed assessment of impacts to each WFD quality element for each activity proposed as part of the current SRO option.
- Assessment of data confidence level and design certainty – confidence levels are assigned for each assessment, based on the quality and availability of both physical data and design information about the option at the time of assessment (note, confidence/certainty expected to be medium at Gate 2 assessment and increase over time). Where the confidence levels are medium or low, the requirements for further data or design information to raise this confidence level for future Gates will be listed.
- Identification of further mitigation needs.
- Assessment of impacts after mitigation (scoring on a six-point scale).
- Identification of activities to improve certainty of assessment outcomes.

2.7.21 The confidence levels are described in Table 2-15 along with the required confidence level for each Gate.

**Table 2-15 Explanation of WFD confidence levels based on ACWG methodology**

Confidence level	Description	Gate when level required
Low	Limited data and evidence available, based mainly or completely on expert judgement with many assumptions. Preliminary design information only, detailed information on location/routes, construction methods etc not yet available.	1
Medium	Some data and evidence available, based partially on expert judgement with some assumptions. Design progressed but some assumptions made on construction methods etc.	2
High	Lots of good data and evidence available, minimal assumptions. Design advanced minimal assumptions needed.	3 and 4

2.7.22 The ACWG methodology, shown in Table 2-16, was used in the WFD risk assessment at Gate 3 (to be consistent with the Gate 2 WFD assessment).

**Table 2-16 Description of WFD risk levels/outcomes, based on ACWG methodology<sup>16</sup>**

Deterioration between status classes	Compromises waterbody objectives	Assists attainment of waterbody objectives
Yes = activities have a clear potential to cause deterioration of WFD status	Yes = activities clearly conflict with delivery of future improvements in WFD status	Yes = activities unlikely to contribute to achieving 'Good' status or potential
Possible = activities could cause deterioration of WFD status but unclear extent/level of effect	Possible = activities conflict with future improvements in WFD status but unclear extent/level of effect	Possible = activities could contribute to achieving 'Good' status or potential but unclear extent/level of effect
No = activities unlikely to pose any risk of deterioration in status	No = activities unlikely to pose any risk of deterioration in status	Yes = activities could directly contribute to achieving 'Good' status or potential

Uncertain = Insufficient information or evidence to assess

### Framework Progression through Gates

2.7.23 The WFD compliance framework remains the same throughout the gated process. To pass through each Gate the confidence level in the data and design must reach an appropriate level as set out in Table 2-17; Gate 3 is highlighted in bold. The additional data required will be identified in the previous gate. Measures should be implemented immediately after assessment and the need identified to collect these data, whether from environmental sampling or computational modelling.

**Table 2-17 Data confidence levels required for each gate**

Gate number	Gate description	Confidence required
1	Initial concept design and decision making	No requirements
2	Detailed feasibility, concept design and multi-solution decision making	All confidence levels should aim to be medium
<b>3</b>	<b>Developed design, finalised feasibility, pre-planning investigations and planning applications</b>	<b>All confidence levels should aim to be high</b>
4	Planning applications, procurement, and land purchase	All confidence levels must be high

### Limitations and Assumptions

- 2.7.24 Two flow reduction options (115 MI/d and 230 MI/d) have been included within this WFD assessment. It is assumed that 230 MI/d would be the maximum flow reduction and the assessment does not include any impacts that may arise from any flow reduction greater than 230 MI/d.
- 2.7.25 Assessment has been made on the basis of the data that was available at the time of the review and is based on the most recent WFD classifications, that of Cycle 3. The assessment of possible WFD non-compliance is dependent on the outcome of further hydraulic and water quality modelling. Where possible, the results of the on-going assessments have been incorporated into the work undertaken for Gate 3; otherwise, the assessments will be refined further at Gate 4.
- 2.7.26 The assessment assumes that pipelines will be underground and utilise non-intrusive methods of crossing WFD water bodies. It is assumed there will be no above ground watercourse crossings. If any intrusive watercourse crossings are proposed, they will be subject to separate assessment during the construction phase to determine whether they are WFD compliant.
- 2.7.27 Groundwater bodies are unlikely to be significantly affected by the proposed works and have therefore not been included in this WFD assessment. Potential impacts to groundwater will be assessed through EIA at Gate 4 and the WFD assessment updated accordingly.

<sup>16</sup> [ACWG WFD: Consistent framework for undertaking no deterioration assessments](#) [Accessed 27.6.2024]

## 2.8 Habitats Regulations Assessment

### Introduction

- 2.8.1 The HRA has been carried out with reference to the general EC guidance on HRA<sup>17</sup> and general guidance on HRA published by the UK Government in July 2019 and February 2021<sup>18</sup>. The assessment has also been mindful of the implications of European case law in 2018, notably the *Holohan* ruling and the *People Over Wind* and *Sweetman* ruling, both discussed below.
- 2.8.2 There is no pre-defined guidance that dictates the physical scope of an HRA of a Proposed Development. Current guidance suggests that the following Habitats Sites should be included in the scope of an HRA assessment:
- All Habitats Sites within the boundary of the SRO scheme; and
  - Habitats Sites located outside of the SRO scheme boundary shown to be linked to the development in the SRO through a known 'pathway' (discussed below).
- 2.8.3 Development impacts can extend beyond 10 km where hydrological pathways and surface water catchments are involved, which is why the source-pathway-receptor concept is used to help determine whether there are potential pathways connecting development to Habitats Sites. Briefly defined, impact pathways are routes by which the implementation of a scheme can lead to an effect upon a Habitats Site. This takes site-specific sensitivities into account, including issues such as nutrient neutrality or water levels, quantity and flow.
- 2.8.4 The following Habitats Sites judged to have possible impact pathways present, are discussed in this HRA (distances are measured from the Minworth WwRC, noting that other elements of the Proposed Development are located closer – refer also to Annex B3.16 GUC HRA Report):
- River Mease SAC (22.8 km north of Minworth WwRC);
  - Humber Estuary SAC (136 km northeast of Minworth WwRC);
  - Humber Estuary SPA (146 km northeast of Minworth WwRC);
  - Humber Estuary Ramsar (136 km northeast of Minworth WwRC); and
  - Ensor's Pool SAC (18 km southeast of Minworth WwRC).

### Description of HRA Tasks

#### HRA Task 1 – Screening for Likely Significant Effects (LSEs)

- 2.8.5 Following evidence gathering, the first stage of any Habitats Regulations Assessment is the screening for Likely Significant Effects (LSEs), essentially a high-level assessment to decide whether the full subsequent stage known as Appropriate Assessment is required. The essential question is:
- *"Is the project, either alone or in combination with other relevant projects and plans, likely to result in a significant effect upon Habitats sites?"*
- 2.8.6 The objective is to filter out those Plans and projects that can, without any detailed appraisal, be concluded to be unlikely to result in any impacts upon Habitat Sites, usually because there is no mechanism for a negative interaction.

#### HRA Task 2 – Appropriate Assessment (AA)

- 2.8.7 Where a conclusion of 'no Likely Significant Effects (LSEs)' cannot be drawn, the analysis proceeds to the next stage of HRA known as Appropriate Assessment. Case law has clarified that 'Appropriate Assessment' is not a technical term. In other words, there are no particular technical analyses, or level

<sup>17</sup> European Commission (2021): Assessment of plans and projects significantly affecting Natura 2000 Sites: Methodological Guidance on the Provisions of Article 6(3) and 6(4) of the Habitats Directive.

<sup>18</sup> <https://www.gov.uk/guidance/appropriate-assessment> <https://www.gov.uk/guidance/habitats-regulations-assessments-protecting-a-european-site>

of technical analysis, that are classified by law as belonging to Appropriate Assessment compared to the screening stage.

- 2.8.8 By virtue of the fact that it follows screening for LSEs, there is a clear implication that the analysis will be more detailed than undertaken at the previous stage. One of the key considerations during Appropriate Assessment is whether there is available mitigation that would entirely address the potential effect. In practice, the Appropriate Assessment would take any proposed policies or identified and potential sites that could not be dismissed following the high-level screening and assess the potential for an effect in more detail, with a view to concluding whether there would be a potential for an adverse effect on site integrity (in other words, disruption of the coherent structure and function of the Habitats Site(s)). A decision by the European Court of Justice<sup>19</sup> concluded that measures intended to avoid or reduce the harmful effects of a proposed Plan or project on a Habitat (European) Site may no longer be considered by competent authorities at the screening for LSEs stage of HRA. That ruling has been taken into account in producing this HRA.
- 2.8.9 Also, in 2018 the Holohan ruling<sup>20</sup> was handed down by the European Court of Justice. Among other provisions paragraph 39 of the ruling states that '*As regards other habitat types or species, which are present on the site, but for which that site has not been listed, and with respect to habitat types and species located outside that site, ... typical habitats or species must be included in the appropriate assessment, if they are necessary to the conservation of the habitat types and species listed for the protected area*' [emphasis added]. Due account of this decision has been taken in this HRA.

### HRA Task 3 – Avoidance and Mitigation

- 2.8.10 Where necessary, measures are recommended for incorporation into the Plan in order to mitigate and / or avoid adverse effects on Habitats Sites.

### Confirming Other Plans and Projects That May Act In-Combination

- 2.8.11 It is a requirement of the Regulations that the effects of any land use plan being assessed are not considered in isolation but in-combination with other plans and projects that may also be affecting the Habitats Site(s) in question.
- 2.8.12 When undertaking this part of the assessment it is essential to bear in mind the principal intention behind the legislation, i.e. to ensure that those projects or plans (which in themselves may have minor effects) are not simply dismissed on that basis but are evaluated for any cumulative contribution they may make to an overall significant effect. In practice, in-combination assessment is therefore of greatest relevance when proposed Planning policies would otherwise be screened out because their individual contribution is inconsequential.
- 2.8.13 The following plans and projects are considered to have the potential to act in-combination with the SRO:
- GUC Strategic Resource Option (AfW);
  - Severn to Thames Transfer (Thames Water) SRO (as described in Section 1.2); and
  - Lincolnshire Reservoir (Anglian Water) SRO.
- 2.8.14 It should be noted that, while their broad potential effects are considered, this assessment does not undertake full HRA of each of these proposed schemes. Instead, existing HRAs that have been carried out were drawn upon. Future scenarios have also been considered where built into the currently utilised version of the Aquator model (refer to the Annex B1.6 Tame & Trent Hydrological and Hydraulic Modelling Report for further details). On-going modelling at Gate 4 will include the AMP8 and AMP9 scenarios that have been incorporated by ST.

## Limitations

- 2.8.15 The following limitations apply in relation to the flow impact analysis for the Minworth SRO:

<sup>19</sup> People Over Wind and Sweetman v Coillte Teoranta (C-323/17)

<sup>20</sup> Brian Holohan and Others v An Bord Pleanála (C-461/17)

- Hydrological models of the Tame and Trent system used to support assessments at Gate 3 are limited to the non-tidal sections of the Trent. Representation of additional flow between the tidal limit of the Trent at Cromwell Weir and the Trent-Humber confluence are therefore based on available gauging information. Accordingly, estimations of total flow into the Humber Estuary from the Trent catchment will be underestimated and conservative for the purposes of the HRA, thereby supporting assessment on a 'worst-case' basis. The on-going refinement of modelling at Gate 4 will inform update of the HRA.

## 2.9 INNS Risk Assessment

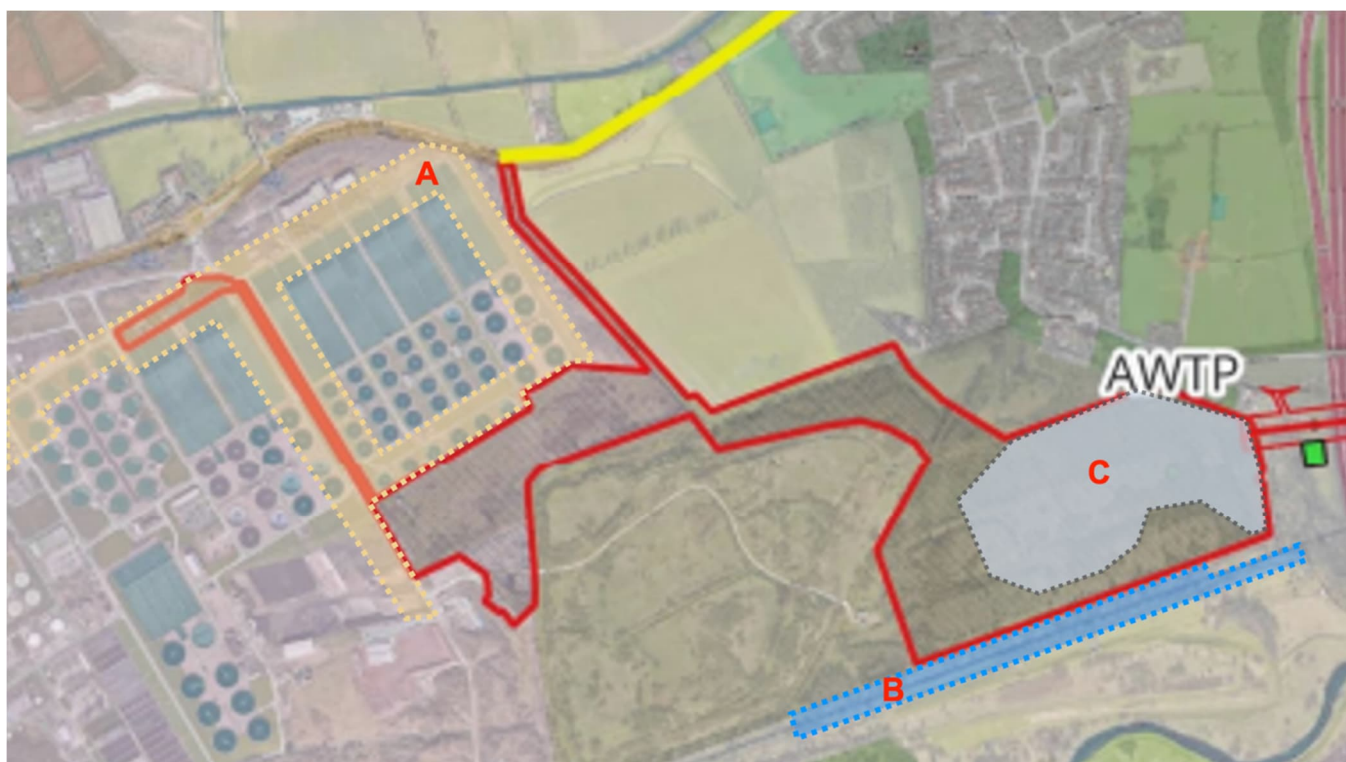
### Method

#### Previous INNS records

- 2.9.1 Details of INNS survey results and INNS desk study records are presented in the Gate 1 and Gate 2 reports and are not reproduced here. One finding of particular relevance was the observed widespread presence of INNS along the River Tame, including abundant Himalayan balsam, Japanese knotweed, and giant hogweed in the riparian zone, and ubiquitous non-native species in the River Tame including American signal crayfish.

#### Walkover survey

- 2.9.2 A survey within the area of the proposed AWTP (see Figure 2-3) was carried out on 17 June 2024. Additionally, various locations within the exiting WwRC were walked to assess how effectively the site Biosecurity Management Plan (BMP) was being implemented, specifically with respect to vegetation management with a focus on land adjacent to key site elements such as filter beds, settlement tanks, windrows, and recycled water canals. These additional survey locations are depicted in Figure 2-3, Polygons A and B.
- 2.9.3 The survey was conducted by a suitably qualified INNS specialist ecologist and focused on species covered by relevant INNS legislation. The survey comprised:
- a walkover of the areas specified above;
  - an inspection of the immediate surroundings of the area surveyed;
  - an assessment of features that might affect biosecurity; and
  - an assessment of all apparent features that may affect control action.



**Figure 2-3: Survey boundary (proposed Working Area) and additional survey locations (A and B)**

## Literature Review

- 2.9.4 A literature review was undertaken to investigate critical factors, relating to water treatment, for the viability and passage of INNS (plant) propagules (e.g. seeds and other viable parts of plants, such as rhizome fragments) and for various life stages of INNS (animal).
- 2.9.5 The review was conducted using a systematic approach and considered several different discrete areas with a focus on:
- water treatment methods;
  - invasive species survivability related to different water treatment processes;
  - invasive species and minimum propagule size.
- 2.9.6 A Teams call was also held with ST and the design engineering team, on 21<sup>st</sup> June 2024, to discuss the treatment processes to be employed at Minworth, including the new AWTP. Documentation on these treatment processes was also provided and reviewed.

## 2.10 Limitations

- 2.10.1 A good view of all parts of the site was not possible, and one area of the site was inaccessible (Figure 2-3, Polygon C). However, this is not considered to present a constraint to the INNS risk assessment as the focus is the AWTP and the existing WwRC. Risks associated with the presence of existing (or newly arrived) INNS on the site, for example during construction, will be controlled under the BMP.
- 2.10.2 The accuracy of recorded polygons is limited by the GIS accuracy of the handheld device used; typically, accuracy is between 3m to 6m depending on site conditions.

## 3. Results and Discussion

- 3.1.1 A summary of results and recommendations from the individual technical assessments is provided below. This includes conclusions of the likelihood of potential impacts identified through the Gate 3 assessments, potential mitigation options, and recommendations for further assessment at Gate 4 through Environmental Impact Assessment (EIA) for the Development Consent Order (DCO) submission.

### 3.2 Water Quality

#### Summary & Conclusions

##### Baseline Monitoring

- 3.2.1 Baseline water quality monitoring has been undertaken at selected locations on the Rivers Tame and Trent in support of the Minworth SRO. Sampling for laboratory analyses commenced in September 2023 and will conclude in September 2024. Seven rounds of monthly sample collection (up to March 2024) have been reported in this document. With this in mind, the outcomes reported herein should be considered interim and indicative, pending finalisation of the monitoring. The monthly sampling has been supported by continuous in situ monitoring at three locations using water quality multiparameter sondes. This baseline monitoring for Gate 3 complements 12-months' worth of monitoring undertaken for Gate 2 between August 2021 and May 2022, and which consisted of grab samples for laboratory analysis only.
- 3.2.2 The September 2023, November 2023, January 2024, March 2024 and April 2024 monitoring rounds took place during relatively low flow conditions when the rivers were at or close to base flow levels. Rounds undertaken in October 2023, December 2023 and February 2024 took place during periods of wetter weather during which flow was greater than the other sampling periods.
- 3.2.3 Several parameters show a marked difference in concentrations between the monitoring locations immediately upstream and downstream of the Minworth WwRC discharge. For some of these, generally fuels and metals, other land uses between the two monitoring locations may be impacting water quality in the Tame and account for the differences seen. For other parameters, specifically nitrate, phosphorus, orthophosphate (both as P and PO<sub>4</sub>), bromide, total organic carbon and dissolved organic carbon, the difference in concentrations between the upstream and downstream sampling locations may be attributable to the Minworth WwRC discharge.

##### Catchment Modelling

- 3.2.4 SIMCAT catchment modelling has been used to assess the impacts of reducing flows of treated recycled water from Minworth WwRC to the River Tame and the River Trent downstream (see below for a detailed summary of water quality modelling). An updated baseline model was developed using up to date water quality data, river flow data and WwRC recycled water flow and quality data. Two future discharge scenarios for Minworth WwRC recycled water have been tested as well as the impacts of climate change alone. The results have been compared to the current baseline model to assess the impacts of potential future water management strategies on downstream flow statistics, mean orthophosphate concentrations, and mean ammonia concentrations.
- 3.2.5 The modelling indicates that the impact of reducing discharges from Minworth WwRC on orthophosphate and ammonia concentrations is generally minor and localised. Orthophosphate concentrations in the River Tame were slightly reduced at Minworth WwRC outfall locations but slightly increased downstream due to reduced dilution capacity in the River Tame. There were no impacts in terms of WFD compliance and no significant impacts on orthophosphate concentrations in the River Tame.
- 3.2.6 Variations in ammonia concentrations were small, with slightly reducing ammonia concentrations in response to reduced discharges from Minworth WwRC. There were no impacts on the River Trent and no change in WFD status classification.

- 3.2.7 The SIMCAT modelling has therefore demonstrated the removal of recycled water flows from Minworth WwRC from the River Tame, of up to 230MI/d, will not have significant impacts on water quality in terms of orthophosphate and ammonia concentrations and WFD compliance.
- 3.2.8 An assessment of other pollutants has also been undertaken to determine the potential impact of reduced dilution of contaminants. A total of 30 substances were identified with EQS limits within the Minworth WwRC treated recycled water, however 23 are present at concentrations below the EQS so that the Minworth WwRC discharge does not impact WFD compliance.
- 3.2.9 Analysis was carried out for 30 substances for which Minworth recycled water and upstream River Tame concentrations are available. The analysis found that there are no increases in any pollutant concentrations by a significant percent of the EQS, there are also no new pollutant concentrations that exceed EQS values as a result of climate change or the proposed scenarios. Pollutants that currently exceed EQS values continue to breach limits, therefore climate change impacts alone or impacts from either proposed scenario does not result in compliance with the EQS for any of these pollutants.
- 3.2.10 Changes in Minworth WwRC recycled water discharge rates will therefore have minor impact on downstream water quality for the above assessed substances apart from those currently already exceeding the EQS which will continue to breach compliance.

## 3.3 Turbidity Assessment

- 3.3.1 Turbidity is low in the Minworth WwRC discharge, as would be expected for treated discharge. Turbidity is also consistently low at baseflow for all monitoring locations in the River Tame. This implies that the Minworth discharge is not important for diluting baseflow turbidity in the River Tame. Peaks in turbidity in the River Tame are associated with flood events, and the discharge volume from Minworth is proportionately insignificant compared with flood flows at catchment scale, so similarly, the Minworth discharge can be considered to have no influence on turbidity peaks in the River Tame.

## Water Quality Modelling

### SIMCAT Water Quality Modelling Results

#### Baseline Scenario

- 3.3.1 Minworth WwRC and Coleshill WwRC discharge into the same reach of the River Tame. A detailed review of the current impacts of the discharges on river flows and concentrations of orthophosphate and ammonia in the River Tame is contained in the Gate 2 report and summarised below.
- 3.3.2 The modelled mean River Tame flow is increased from 458.8 MI/d upstream of Minworth Outlet 1 to 715.7 MI/d downstream and flows are further increased downstream of Minworth Outlet 2 from 790.5 MI/d to 1,047.6 MI/d. The inputs from both WwRC discharges, plus small contributions from the surrounding catchments, result in an increase in mean flow of 228% over a distance of 3.2 km. Prolonged periods of dry weather which result in low Q95 river flows often also results in reduced WwRC discharges, so the absolute additional flow provided under these conditions is smaller. The modelled Q95 flow upstream of Minworth Outlet 1 is 182 MI/d, increasing to 352.0 MI/d downstream and the Q95 flow is further increased from 402.1 MI/d to 573 MI/d downstream of Minworth Outlet 2. Overall, the Q95 flow is increased by 314% by the addition of flows from Minworth WwRC and Coleshill WwRC; this is a larger proportional increase than under mean flow conditions because the upstream river flows are smaller.
- 3.3.3 WFD status limits for orthophosphate are set based on mean concentrations. The Minworth WwRC and Coleshill WwRC discharges increases mean orthophosphate concentrations in the River Tame from 0.15 mg/l at Water Orton (upstream of Minworth Outlet 1) to 0.31 mg/l. This is consistent with a shift from Moderate to Poor WFD status. However, Moderate status concentrations are only observed at Water Orton, and orthophosphate concentrations throughout most of the River Tame is consistent with Poor status under WFD. The concentrations of phosphate in the River Trent downstream of the Tame-Trent confluence are also consistent with Poor, and Moderate status concentrations are not currently observed at any location.

- 3.3.4 WFD status limits for ammonia are set based on 90%ile concentrations. The addition of recycled water from Minworth WwRC and Coleshill WwRC increases 90%ile ammonia concentrations from 0.58 mg/l to 0.68 mg/l. The upstream concentration of 0.58 mg/l is close to the Good Status limit of 0.6 mg/l and so the addition of flow at Outlet 1 increases River Tame ammonia concentrations from levels equivalent to Good Status to levels equivalent to Moderate Status. However, the addition of flow from the Rivers Blythe and Bourne reduces 90%ile concentrations back below the Good Status limit such that the Minworth and Coleshill discharges causes only a localised reduction in WFD status for ammonia over the 1.4km section of river between Outlet 2 and the River Blythe inflow. The majority of the River Tame has ammonia concentrations consistent with Good Status under WFD, improving to close to the High Status limit upstream of the Tame-Trent confluence. Modelled ammonia concentrations in the River Trent are consistent with High Status for almost the entire length downstream of the River Tame, with localised concentrations equivalent to Good Status.

## Proposed Scenario

- 3.3.5 Figure 3-1 shows the modelled mean and Q95 flow along the Rivers Tame and Trent for the climate change scenario and both proposed future scenarios and Figure 3-2 shows the same output for the River Tame only. Climate change flows were derived by a 5% reduction in mean and Q95 flows on all flow gauges based on the UK Climate Projection results which were found to be consistent with the Aquator modelling results for gauges along the Rivers Tame and Trent. This was required as the Aquator modelling only provides flow statistics at selected locations and not over the entire area of the SIMCAT model.
- 3.3.6 Along the River Tame there is still a significant increase in flow resulting from the combined recycled water discharges from Minworth WwRC and Coleshill WwRC, however, the downstream flows are still slightly reduced due to the modelled impacts of climate change. The modelled mean River Tame flow downstream of Minworth Outlet 1 is decreased from 715.7 MI/d (baseline) to 692.75 MI/d, while flows downstream of Minworth Outlet 2 decrease from 1,047.6 MI/d (baseline) to 1,024.6 MI/d. Modelled Q95 river flows also follow a similar trend to the baseline Q95 river flows, however, again flows are reduced due to the impacts of climate change particularly further downstream.
- 3.3.7 Reducing flows from Minworth WwRC in line with the potential future scenarios results in further decreases in mean flow and Q95 river flows. There is still a significant increase in flow in the River Tame downstream of Minworth WwRC and Coleshill WwRC outfalls, however the model shows a clear reduction in both mean and Q95 flows from this point downstream in both proposed future scenarios. The modelled mean River Tame flow downstream of Minworth Outlet 1 is decreased from 692.75 MI/d (climate change impact) to 635.25 MI/d when 115MI/d is diverted from Minworth and further decreased to 577.75 MI/d if 230 MI/d is diverted. The modelled reduction in flow in the SIMCAT model is based on simplified assumptions and a more detailed review of flow impacts downstream of Minworth is contained in the Hydraulic and Hydrological Modelling Report (Gate 3 Annex B1.6).



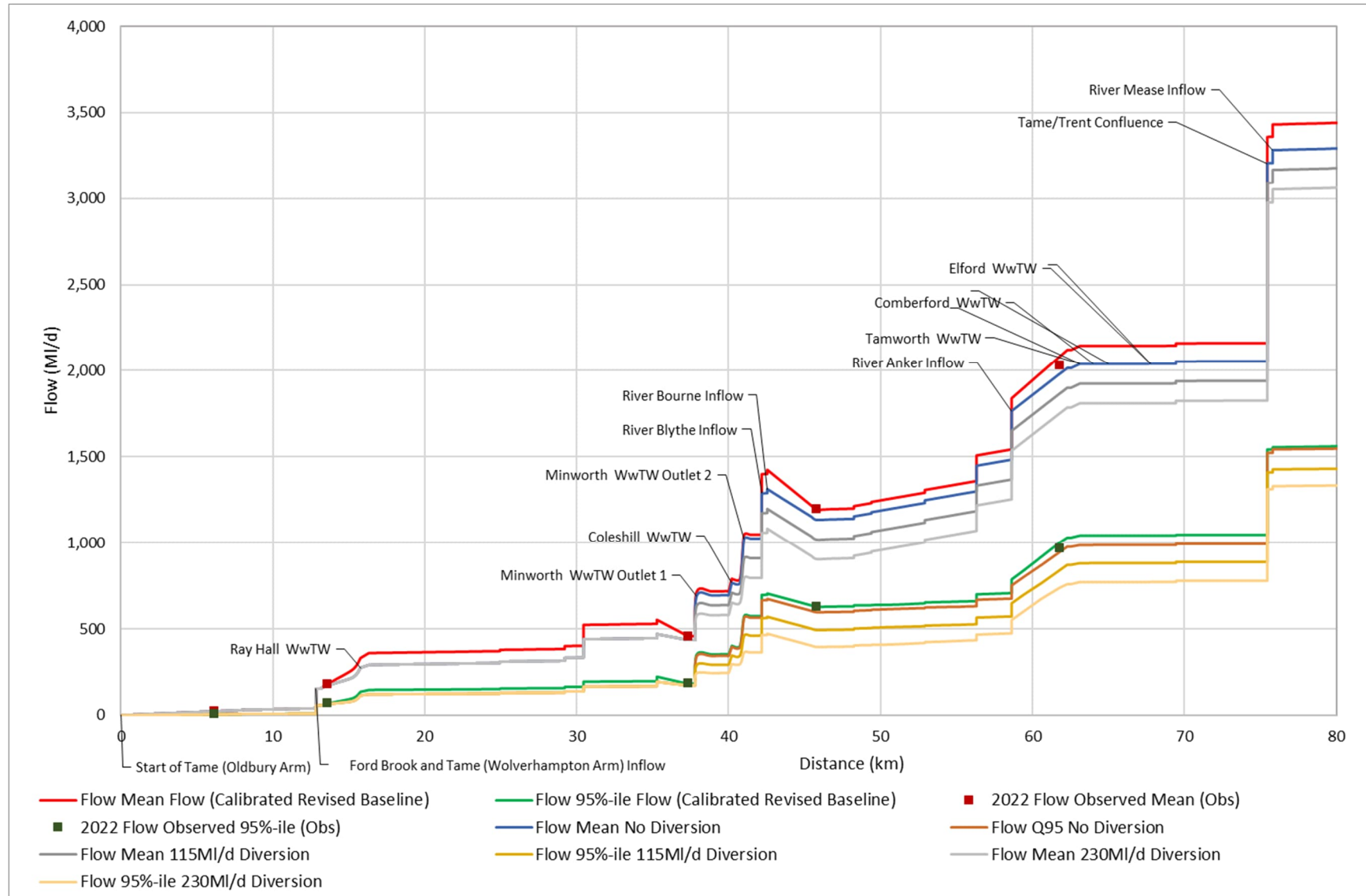


Figure 3-2: Change in Mean and Q95 Flow in the River Tame under the Proposed Future Scenarios

- 3.3.8 Figure 3-3 shows the modelled mean orthophosphate concentrations along the River Tame under the potential future discharge scenarios. These scenarios are compared with the climate change baseline because the climate change model uses the Gate 2 water quality monitoring data which reflects the current WFD classification for both orthophosphate and ammonia in the receiving waters. The impacts on water quality for orthophosphate and ammonia is assessed assuming ambient quality is similar to present day conditions but in the context of reduced river flows. Water quality data will be revised and updated for Gate 4 as discussed above.
- 3.3.9 The model results show that reduced discharges from Minworth Outlet 1 reduce orthophosphate concentrations locally under both flow diversion scenarios. Modelling a diversion of 115 Ml/d reduces the mean orthophosphate concentrations downstream of Minworth Outlet 1 from 0.27 mg/l (climate change baseline) to 0.25 mg/l and concentrations further decrease to 0.22 mg/l when modelling a diversion of 230 Ml/d.
- 3.3.10 Further downstream, the reduction in river flow results in slight increases in the orthophosphate concentration in the River Tame under both proposed scenarios. These increases are minor and occur where the additional inputs are diluted, e.g. downstream of the Comberford, Tamworth, and Elford WwRC discharges. The increases are sustained to the Tame-Trent confluence but there is no significant impact on modelled orthophosphate concentrations in the River Trent. The modelled increases in the River Tame are very small and are not sufficient to cause a change in WFD status classification at any location along the Rivers Tame or Trent compared to baseline conditions.
- 3.3.11 Figure 3-4 shows the modelled 90%ile ammonia concentrations in the River Tame under the baseline and future modelled scenarios. The impacts from both diversion scenarios do not significantly change ammonia concentrations from the modelled climate change baseline along the Rivers Tame and Trent. A slight decrease in ammonia concentrations is observed locally downstream of Minworth Outlet 2 and the River Bourne inflow, however, concentrations increase again further downstream.

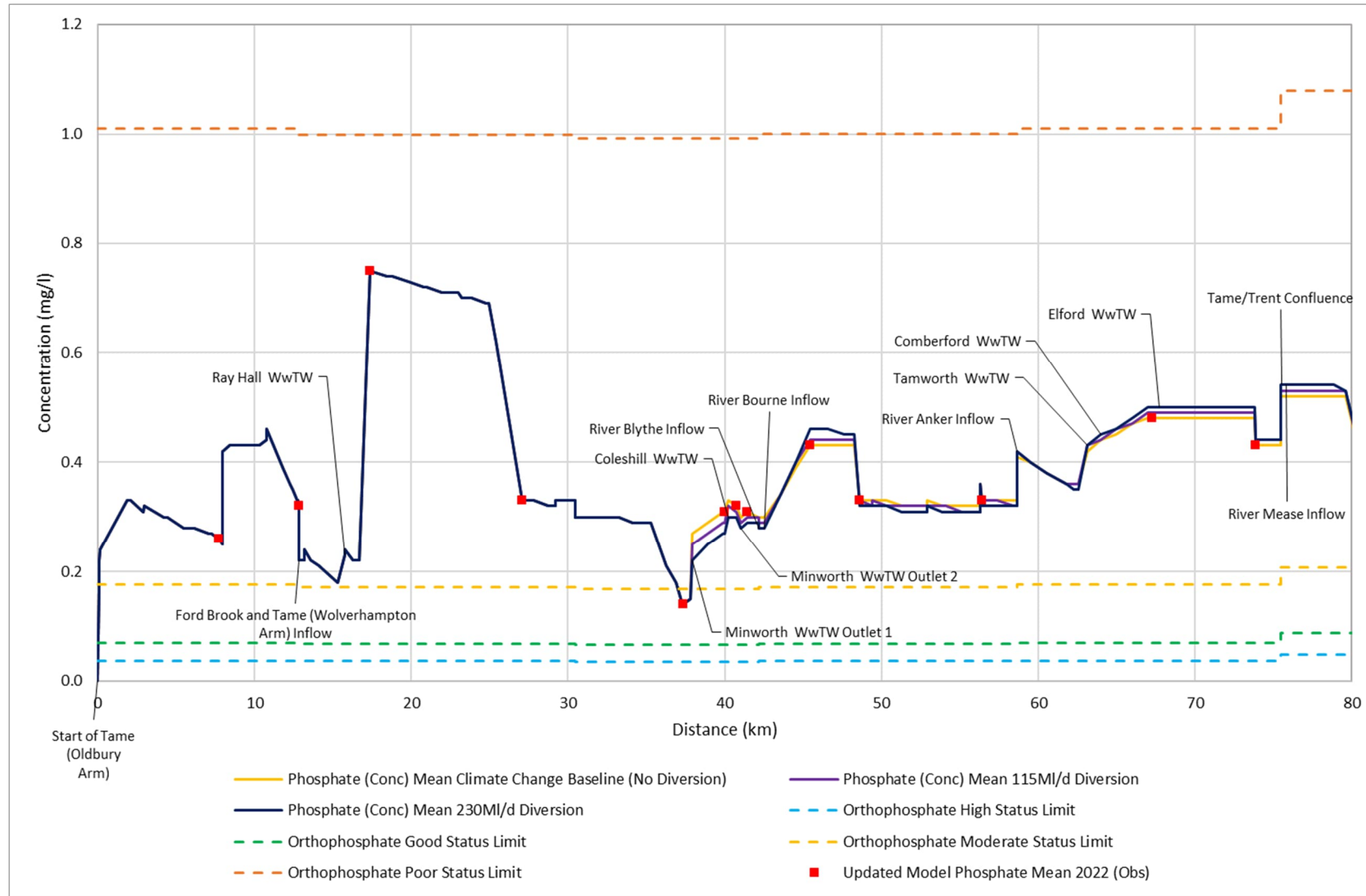


Figure 3-3: Modelled Mean Orthophosphate Concentrations in the River Tame (Climate Change Baseline and Future Scenarios)

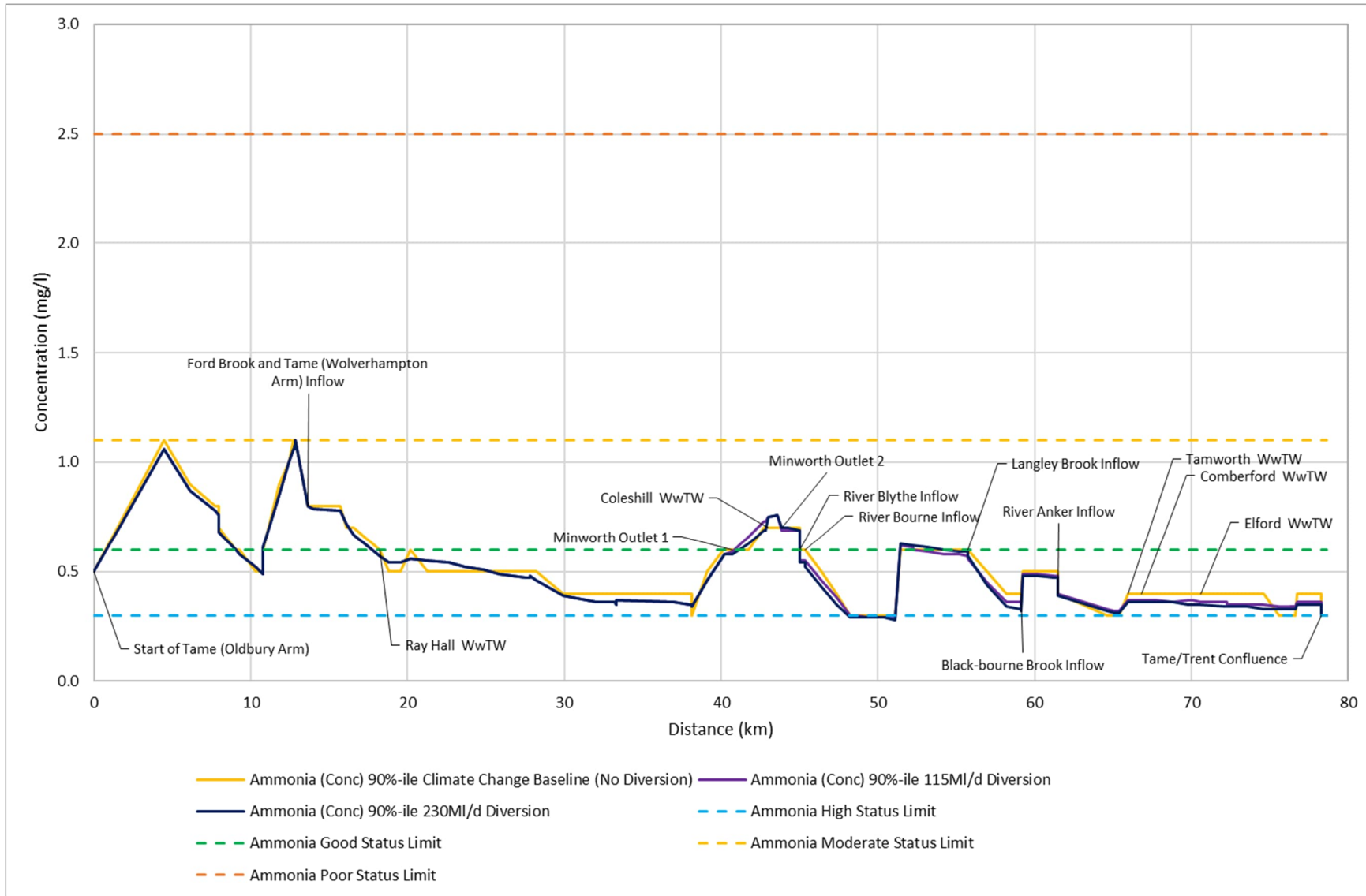


Figure 3-4: Modelled 90%ile Ammonia Concentrations in the River Tame (Climate Change Baseline and Future Scenarios)

## SIMCAT Modelling Summary

- 3.3.12 SIMCAT catchment modelling has been used to assess the impacts of reducing flows of treated recycled water from Minworth WwRC to the River Tame and the River Trent downstream in the context of reduced river flows based on the projected impacts of climate change. The results are compared with an updated baseline model developed at Gate 2 which uses using up to date river flow data and WwRC recycled water flow and quality data. This data reflected recent changes in wastewater treatment at WwRC within the Tame and Trent catchment, however the impact of the improvements had not yet been evidenced in the receiving ambient water quality statistics. It is therefore proposed to further update and improve the baseline SIMCAT model at Gate 4 to fully represent recent and anticipated future improvements in wastewater treatment. The aim of the modelling at Gate 3 is to determine whether the combined impacts of climate change and flow diversion from Minworth WwRC would have significant impacts on ammonia and orthophosphate concentrations in the Rivers Tame and Trent, and the Gate 2 baseline model is sufficient for this purpose.
- 3.3.13 Two future discharge scenarios for Minworth WwRC recycled water have been tested as well as the impacts of a 5% reduction in mean and Q95 river flows due to climate change. The results have been used to assess the impacts of potential future water management strategies on mean orthophosphate concentrations and 90%ile ammonia concentrations which are used to set status limits under WFD.
- 3.3.14 The SIMCAT modelling shows that the impact of reducing discharges from Minworth WwRC on orthophosphate and ammonia concentrations is generally minor and localised. Orthophosphate concentrations in the River Tame were slightly reduced at Minworth WwRC outfall locations but slightly increased downstream due to reduced dilution capacity in the River Tame. There were no impacts in terms of WFD compliance and no significant impacts on orthophosphate concentrations in the River Tame. Variations in ammonia concentrations were small, with slightly reducing ammonia concentrations in response to reduced discharges from Minworth WwRC. There were no impacts on the River Trent and no change in WFD status classification.
- 3.3.15 The SIMCAT modelling has therefore demonstrated the removal of recycled water flows from Minworth WwRC from the River Tame, of up to 230 MI/d, will not have significant impacts on water quality in terms of orthophosphate and ammonia concentrations and WFD compliance. The significance of the flow reductions on the ecological communities in the Rivers Tame and Trent has been assessed in parallel Gate 3 studies.

## Other Pollutant Assessment

- 3.3.16 Reduction of discharges from Minworth WwRC could potentially reduce River Tame water quality downstream if concentrations of pollutants are elevated above the EQS in the River Tame upstream and the addition of Minworth WwRC recycled water acts to dilute pollutants under current discharge conditions.
- 3.3.17 A total of 149 substances (not inclusive of nutrient substances) have EQS values set for rivers, of this total 102 substances have been monitored as part of the Gate 3 water quality monitoring assessment. A total of 58 substances were not detected during the monitoring of samples from the River Tame (at Water Orton, upstream of Minworth Outlet 1) and therefore are not considered to be at risk of reducing water quality in the River Tame as a result of reduced recycled water discharges from Minworth WwRC. An additional nine substances were also not detected; however, the limit of detection exceeded the EQS value, and these substances will be taken forward for further monitoring at Gate 4. It should be noted that the list of substances with EQS values in rivers is anticipated to be updated in the near future as part of the Environment Agency's 'Approach to Hazardous Substances Including Substances of Emerging Concern for Water Recycling Strategic Resource Options' which is currently under development. This document will be used to inform monitoring at Gate 4, at which time this assessment will be repeated to account for any changes in the list of substances of concern.
- 3.3.18 A total of 35 substances with EQS limits were detected in samples collected from the River Tame at Water Orton. Five of these substances (chloride, mecoprop, propyzamide, terbutryn, and nonylphenol) were detected in greater average and maximum concentrations within the Minworth recycled water compared to samples taken from the River Tame. Therefore, a reduction in recycled water discharges

- from Minworth WwRC will always result in reduced concentrations of these substances in the River Tame and mass balance calculations are not required. The remaining 30 substances were detected at greater average or maximum concentrations within the River Tame compared to Minworth recycled water and are therefore at risk of decreasing water quality downstream due to reductions in dilution from reduced recycled water discharges from Minworth WwRC.
- 3.3.19 Mass balance calculations were used to assess the impact of reduced Minworth WwRC discharges on downstream concentrations of these 30 substances. Average river flows and recycled water flows were assumed in all calculations, but maximum recycled water and river concentrations were used to assess impacts on Maximum Allowable Concentration (MAC) EQS values. Average recycled water and river concentrations were used to assess impacts on average annual (AA) EQS values. A total of 24 substances are limited using AA EQS and 20 are limited using MAC EQS values (14 have both).
- 3.3.20 Mass balance calculations were completed for pollutants which are limited by WFD AA EQS values, and which were found to be present in the recycled water from Minworth WwRC at concentrations greater than the River Tame. Most pollutants are present in the River Tame and Minworth recycled water at concentrations significantly below the AA EQS and the result of reducing river flows by 5% to account for climate change impact is a slight reduction in pollutant concentrations. Reducing the Minworth recycled water flows results in a slight increase in concentrations above the present-day baseline, however the downstream concentration does not approach the EQS for any substance currently present in the River Tame at concentrations below the EQS. Average concentrations of diuron in the recycled water exceed average river concentrations such that reducing river flows slightly increases downstream concentrations and reducing recycled water flows slightly reduces downstream concentrations. However, this has no impact on compliance with EQS values.
- 3.3.21 A total of five pollutants (fluoranthene, naphthalene, PFOS, PAHs, and zinc) are currently detected in the River Tame at Water Orton at concentrations above the AA EQS. Concentrations of these substances are further increased as a result of reduced flows from Minworth WwRC, but the increase is generally a small proportion of the extent to which the EQS value is breached upstream. Compliance with EQS values cannot be achieved by dilution of River Tame water with Minworth WwRC recycled water for these substances. Pollutants that currently exceed AA EQS values continue to breach limits under the climate change scenario.
- 3.3.22 Mass balance calculations were also completed for pollutants which are limited by WFD MAC EQS values, and which were found to be present in the recycled water from Minworth WwRC at concentrations greater than the River Tame. Most pollutants are present in the River Tame at concentrations significantly below the MAC EQS except for benzo(b)-fluor-anthene and benzo(g,h,i)-perylene.
- 3.3.23 Seven substances (2,4-D, benzo(k)-fluoranthene, chromium (III), isoproturon, mancozeb, nickel, and PFOS) are present at slightly higher maximum concentrations in Minworth WwRC recycled water than in the River Tame so reducing River Tame flows by 5% results in a slight increase in downstream concentrations, and reducing flows from Minworth WwRC reduces downstream maximum concentrations. However, the change from baseline is small for all substances. Maximum concentrations of MCPA are equal in both the River Tame and the recycled water so changing flows from either source has no impact on downstream concentrations.
- 3.3.24 The remaining substances (atrazine, benzo(a)-pyrene, benzo(b)-fluoranthene, benzo(g,h,i)perylene, diuron, fluoranthene, glyphosate, lead, naphthalene, simazine, and toluene) are present at higher maximum concentrations in the River Tame than in the Minworth WwRC recycled water so reducing recycled water flows does result in a slight increase in downstream maximum concentrations. However, downstream concentrations do not approach the EQS for any substance which is present in the River Tame below the MAC EQS value. For the two substances which breach the MAC EQS upstream of Minworth WwRC, reducing the recycled water flow results in a small percentage change above baseline.

## Other Pollutant Assessment Summary

- 3.3.25 The calculations described above assess the impact of Minworth WwRC discharges on water quality in the River Tame through addition of pollutants other than orthophosphate and ammonia. A total of 30 substances with AA and/or MAC EQS limits are present in the River Tame and the impacts of reducing Minworth WwRC flows on these substances has been assessed using mass balance calculations.
- 3.3.26 For all but one substance (diuron) limited by AA EQS, reducing the Minworth recycled water flows results in a slight increase in concentrations above the present-day baseline, however the downstream concentration does not approach the EQS for any substance. Average recycled water diuron concentrations exceeds average river concentrations such that reducing river flows slightly reduces downstream concentrations and reducing recycled water flows slightly increases downstream concentrations. However, this has no impacts on compliance with EQS values.
- 3.3.27 Five pollutants with AA EQS limits are currently detected in the River Tame at Water Orton at concentrations above the EQS. Concentrations of these substances are further increased as a result of reduced flows from Minworth WwRC, but the increase above baseline concentrations is generally small (1% to 20%). Compliance with EQS values cannot be achieved by dilution of River Tame water with Minworth WwRC recycled water for these substances.
- 3.3.28 Eight substances with MAC EQS limits are present at equal or slightly higher maximum concentrations in Minworth WwRC recycled water than in the River Tame, so reducing flows from Minworth WwRC reduces downstream maximum concentrations. A further seven substances with MAC EQS limits are present at higher maximum concentrations in the River Tame than in the Minworth WwRC recycled water so reducing recycled water flows does result in a slight increase in downstream maximum concentrations. However, downstream concentrations do not approach the EQS for any substance which is present in the River Tame below the MAC EQS value. For the two substances which breach the MAC EQS upstream of Minworth WwRC, reducing the recycled water flow results in a small (up to 4.6%) percentage change above baseline.
- 3.3.29 Changes in Minworth WwRC recycled water discharge rates will therefore have a minor impact on downstream water quality for the above assessed substances and there will be no breaches in EQS values above those which already occur upstream of the Minworth outfalls. Substances currently exceeding EQS limits upstream will continue to breach compliance but the additional impact due to reduced flows from Minworth WwRC will be small.

## Recommendations

- 3.3.30 Based on the findings of the baseline water quality monitoring undertaken to date, and the water quality modelling, the following recommendations are made in respect of further water quality monitoring.
- 3.3.31 Monitoring should be continued beyond Gate 3 to ensure that the baseline developed over Gate 2 and Gate 3 remains largely unchanged and is sufficiently robust to inform the impact assessment for the Minworth SRO scheme. This should be reported within the Development Consent Order application. It is recommended that monitoring should remain at a monthly frequency at the same locations and should continue for 12-months, with any further monitoring strategy to be agreed in consultation with the Environment Agency. However, a large number of determinands have been identified as being consistently below LoD (i.e. not detectable), and as such it is recommended that subject to Environment Agency agreement, that those below LoD (where LoDs are sufficiently low to measure against EQS) are reduced in monitoring frequency. We would recommend reducing monitoring for these substances to once per quarter over 12-months rather than monthly.
- 3.3.32 There are a number of determinands, listed below, for which the appointed laboratories used in this monitoring period have not been able to achieve LoDs sufficiently low to allow compliance with EQS to be determined. The Environment Agency are aware of the analytical difficulties that have prevented some of these LoDs being achieved. Nonetheless, we are aware of some laboratories having recently developed increased capability to achieve more of these LoDs, and where possible Gate 4 monitoring should aim to have LoDs that meet 10% of the EQS for all determinands.
- 3.3.33 The affected parameters with LoDs above EQS at Gate 3 are as follows:

- Azinphos-methyl (EQS 0.01 µg/l);
- Benzo(b)fluoranthene (EQS 0.00017 µg/l);
- Benzo(ghi)perylene (EQS 0.00017 µg/l);
- Benzo(k)fluoranthene (EQS 0.00017 µg/l);
- Total Cyanide (EQS 0.001 mg/l);
- Cybutryne (Irgarol) (0.0025 (EQS 0.00017 µg/l);
- Total cypermethrin (EQS 0.00008 µg/l);
- Dichlorvos (EQS 0.0006 µg/l);
- Diflubenzuron (EQS 0.001 µg/l);
- Heptachlor epoxide (EQS 0.0000002 µg/l) – EQS known to be technically unachievable at present;
- Indeno(123cd)pyrene (EQS 0.00017 µg/l);
- o,p'-DDT (EQS 0.01 µg/l);
- p,p'-DDT (EQS 0.01 µg/l);
- Pentachlorobenzene (EQS 0.007 µg/l);
- Total permethrin (EQS 0.001 µg/l); and
- Triazophos (EQS 0.005 µg/l)

- 3.3.34 The Environment Agency is in the process of developing an 'Approach to Hazardous Substances Including Substances of Emerging Concern for Water Recycling Strategic Resource Options'. As part of this a final list of substances of emerging concern is being developed, and this will require review once published to determine any data gaps in the current monitoring suite that would need to be incorporated at Gate 4. Furthermore, the Environment Agency have stated that a pragmatic approach to LOD is under development, to enable screening of those substances with LOD above the EQS or Predicted No Effect Concentration without the need to devise further analytical methods to resample down to a lower LOD. The outcome of this new approach will need to be reviewed, and the Gate 4 monitoring approach adapted accordingly to ensure that Environment Agency requirements are incorporated.
- 3.3.2 At Gate 4, further consideration should be given to the source and potential mitigation for certain determinands where dilution may increase their concentrations, where relevant.
- 3.3.35 The physicochemical parameters currently specified should continue to be monitored in the field as part of the future monitoring strategy. The three sondes should also be maintained in order to provide continuous, long-term turbidity, DO, temperature and conductivity data to support the future assessments at Gate 4.
- 3.3.36 An update of the water quality modelling should be undertaken at Gate 4 as further data becomes available, particularly where improvements are achieved in LoDs, and this will feed through to any revised WFD and environmental assessment, in relation to the proposed flow reductions and modelled utilisation and seasonality of the Minworth and associated SROs.
- 3.3.37 In terms of turbidity, sonde monitoring and spot sampling is currently set to continue until February 2025, and further assessments will be required of more comprehensive datasets to be able to identify temporal and spatial trends with more confidence.
- 3.3.38 Ideally, sondes would be installed in closer proximity upstream and downstream of the Minworth discharge, to isolate the impacts of the Minworth discharge on the River Tame, but this has already proved not feasible due to damage to the sondes (thought to be due to vandalism) and a shortage of safely accessible locations. Similarly, more sondes throughout the study area such as in the River Bourne and River Blythe would directly measure the role of those sub-catchments and other sediment inputs more directly, although this may not add significant value to the assessments.

- 3.3.39 Coupling depth loggers / pressure transducers with the sondes would yield continuous data for both flows and turbidity, which would enable much more detailed analysis of intra-storm sediment dynamics such as hysteresis effects. For example, high temporal resolution data that reveals spikes in turbidity as flow rates increase would indicate mobilisation of local bed sediment, whereas turbidity peaks lagging behind the hydrograph would imply more contributions of sediment from the catchment surface (due to time taken to run off the catchment into the river). This in turn would inform appropriate sediment management strategies.
- 3.3.40 Auto-samplers programmed to sample at high flows would enable more detailed turbidity – TSS rating curves to be developed. Most sediment transport takes place during peak flow events, but it is typically not safe to sample these manually.

## 3.4 Fisheries Assessments

### Fish Passage

#### Discussion

- 3.4.1 A summary of conclusions for the River Tame and River Trent fish passage assessment is provided in Table 3-1 below. Weirs are listed in order from upstream (River Tame – highlighted yellow) to downstream (River Trent), the most upstream being Lea Marston Weir.
- 3.4.2 Note: Where it is stated that the weir or fish pass is assessed as a ‘complete barrier’ for all flows and species for the baseline scenario, it is therefore the case that the operation of the SRO would not have a worsening impact on fish passability. However, the weir and fish pass likely remain passable under higher flow conditions. For example, where species such as Atlantic salmon and river/sea lamprey are recorded upstream, the intervening weirs are passable under certain flow scenarios; therefore, passability in these cases will be unaffected by the operation of the Scheme.
- 3.4.3 Overall, there are predicted negative impacts at Sites (Weirs) 7 and 8, though neither would have an impact on river/sea lamprey passability. There are no predicted negative impacts on fish passability at any site on the River Trent.
- 3.4.4 The operation of the SRO schemes is predicted to have a positive impact at Sites (Weirs) 3 and 12, with the latter improving lamprey passability.

**Table 3-1 Summary of impacts at weirs on the Tame and Trent as a result of the Minworth SRO**

Site (Yellow = River Tame; Unshaded = Trent)      SRO effect (Green = Positive; Red = Negative; Unshaded = Neutral)

Site 3 – Lea Marston Weir	The SRO would have a positive impact
Site 4 - Coton Weir (E)	Assessed together. The SRO would not have an impact on the overall passability
Site 5 – Coton Weir (Central)	
Site 6 - Coton Weir (W)	Overall, the SRO would not have an impact on the overall passability on any species at Coton Weir West, with it already being considered a ‘complete barrier’ for all flows and species for the baseline situation
Site 7 - A4097 Weir	Eels, lamprey and cyprinids - the SRO would not have an impact Salmon - SRO would have a negative impact for salmon passability at $Q_{mean}$ flow conditions due to the reduction in depths Trout - the SRO would have a negative impact for trout passability at $Q_{mean}$ flow conditions due to the reduction in depths
Site 8 - Nether Whitacre Weir	the SRO would have a negative impact on fish passability, in particular for salmon and trout, under $Q_{0.5}$ and $Q_{mean}$ , due to the reduction in depths and increase in hydraulic head associated with the reduction on flows
Site 9 - Broad Meadow LNR Upstream Weir	The SRO would not have an impact on the overall passability on any species at Broad Meadow LNR Downstream Weir, with it already being considered a ‘complete barrier’ for all flows and species for the baseline situation, limited by depths.

Site (Yellow = River Tame; Unshaded = Trent) SRO effect (Green = Positive; Red = Negative; Unshaded = Neutral)

Site 10 - Broad Meadow LNR Downstream Weir	The SRO would not have an impact on the overall passability on any species at Broad Meadow LNR Downstream Weir, with it already being considered a 'complete barrier' for all flows and species for the baseline situation, limited by depths.
Site 11 - Meadow Weir	The SRO would not have an impact on the overall passability for any species at Meadow Weir, with it already being considered a 'complete barrier' for all flows and species for the baseline situation, limited by depths (passage through the fish pass unimpacted).
Site 12 - Newton Weir	The SRO would have a positive impact on salmon, trout and lamprey passability
Site 13 - Sawley Weir	The SRO would not have an impact on the overall passability of any of the species
Site 14 - Thrumpton Weir	The SRO would not have an impact on the overall passability of any of the species
Site 15 - Beeston Weir	The SRO would not have an impact on the species passability along the weir or fish pass, with both already being considered 'complete barriers' for all flows and species for the baseline situation.
Site 16 - Holme Sluices Colwick	The SRO would not have an impact on passability for any of the species. At the fish pass, the results from the assessment indicated that the scheme would decrease the amount of time that the fish pass is operational by on average a reduction of 2-3 days per year.
Site 17 - Stoke (Bardolph) Weir	The SRO would not have an impact on passability for any of the species
Site 18 - Gunthorpe Weir	The SRO would not have an impact on passability for any of the species
Site 19 - Hazelford Weir (South)	The SRO would not have an impact on passability for any of the species.
Site 20 - Hazelford Weir (North)	The SRO would not have an impact on passability for any of the species.
Site 21 - Averham Weir	The SRO would not have an impact on passability for any of the species.
Site 22 - Newark Weir	The SRO would not have an impact on passability for any of the species.
Site 23 - Nether Lock Weir	The SRO would not have an impact on passability for any of the species.
Site 24 - Cromwell Weir	The SRO would not have an impact on the species passability along the weir or fish pass, with both already being considered 'complete barriers' for all flows and species for the baseline situation.

3.4.5 The fish passage assessment is made in the context of the seasonality of fish migration for the species present in the Rivers Tame and Trent. Key fish records and locations are as follows, in relation to the weirs which provide barriers to the passage of migratory species under assessment in this report:

- eDNA analysis has identified European eel at all sites except Broad Meadow downstream and both up and downstream of Lea Marston and Water Orton.
- Brown trout was detected by eDNA survey downstream of Hazelford (ID 19/20) and Gunthorpe (ID 18) and upstream of Broad Meadow (ID 9/10), the latter being considered a record of resident, non-migratory brown trout.
- Atlantic salmon was detected downstream of Cromwell (ID 24) only but is recorded significantly farther upstream (see Table 3-2).
- No lamprey species were detected in any eDNA samples, or in any fish surveys.

3.4.6 The most upstream records of the key migratory species, established at Gate 1 and Gate 2, are shown in Table 3-2 below.

Table 3-2 Migratory fish records

Species	Location of most upstream record	Location of furthest downstream record	Year of most recent record	Designation (refer to Gate 2 Annex B3.1.2)
Atlantic salmon <i>Salmo salar</i>	██████████ River Dove upstream of Trent confluence, downstream of Newton Weir	██████████ >44 km downstream of Minworth WwRC	2010	Bern Conv.-A3 HDir2, Hdir5, HabRegs4, S41, UKBAP, IUCN LC
Brown/Sea Trout <i>Salmo trutta</i>	██████████ Lea Marston lake, downstream of Coton Weir (E)	██████████ 9 km downstream of Minworth, but represents resident brown trout (non-migratory)	2016	S41, UKBAP, IUCN LC
Brook lamprey / ammocoete <i>Lampetra planeri</i>	██████████ River Dove upstream of Trent confluence, downstream of Newton Weir	██████████ >44 km downstream of Minworth WwRC	2013	Bern Conv., HDir2, IUCN LC
European eel <i>Anguilla anguilla</i>	██████████ River Tame between Water Orton and Lea Marston	██████████ ~5 km downstream of Minworth	2019	Bonn Conv., S41, UKBAP, IUCN CR
European eel (glass eels) <i>Anguilla anguilla</i>	██████████ River Blythe upstream of Tame confluence, Whitacre Heath	██████████ ~5 km downstream of Minworth	2019	Bonn Conv., S41, UKBAP, IUCN CR
Petromyzontidae Lamprey sp.	██████████ River Trent, Willington, downstream of Newton Weir	██████████ >44 km downstream of Minworth WwRC	2011	Depends on species, incl. Bern Conv., HDir2, HDir5, S41, UKBAP, IUCN LC

3.4.2 The following observations are made in terms of the fish passage assessment:

- The most upstream record of river/sea lamprey (re Humber SAC – refer to the Gate 3 HRA report) is in the River Trent downstream of Newton Weir, where there is a positive impact. Therefore, river/Sea lamprey may be able to migrate farther upstream as a result of the operation of the SRO.
- There are no river/sea lamprey recorded in the River Tame, and it is currently considered that there are no migratory species, apart from adult European eel, routinely present in the River Tame. However, there are aspirations to facilitate the return of migratory fish to the River Tame, including through river restoration initiatives, for example at Lea Marston.
- Modelled impacts on fish passage are in the River Tame at Site 7 - A4097 Weir, and Site 8 - Nether Whitacre Weir. There are no predicted negative impacts on fish passability at any site on the River Trent.
  - At Site 7 – A4097 Weir, there would be a negative impact on Atlantic salmon and brown/sea trout at  $Q_{mean}$  flow conditions due to the reduction in depths.
  - At Site 8 – Nether Whitacre Weir, the SRO would have a negative impact on fish passability, in particular for Atlantic salmon and trout, under  $Q_{95}$  and  $Q_{mean}$ , due to the reduction in depths and increase in hydraulic head associated with the reduction in flows.
- Although there is an impact on fish passability at certain flows at the two weirs named above, there will remain higher flows when the weirs remain passable, and fish passage is likely already limited at those weirs under low flow conditions.
- This assessment is made on a 'worst-case' scenario based on the maximum operation of the schemes under Scenario A (115 Ml/d flow reduction in the River Tame and Trent) and scenario B (230 Ml/d reduction). Therefore, the likely operation of the SRO schemes would have a reduced impact on fish passage than that predicted here.

- 3.4.3 The likely impacts of the scheme are assessed in the context of the current and future distribution of migratory fish in the catchment, current Water Framework Directive (WFD) status (for fish), and the location of predicted impacts. Refer also to the Gate 3 WFD Assessment report, and the Gate 3 Habitats Regulations Assessment (HRA) report.

## Recommendations

- 3.4.4 The following recommendations for further assessment or mitigation are made as a result of the fish passage assessment:
- Develop the assessment through Environmental Impact Assessment (EIA) at Gate 4 to support Development Consent Order (DCO) submission. This assessment will feed into the EIA Scoping report prior to Gate 3 submission, and the impact assessment will be refined further through the EIA to inform detailed mitigation requirements.
  - Incorporate the assessment of potential changes in river temperature and dissolved oxygen (DO) into the fisheries assessment for the Rivers Tame and Trent, supported by detailed modelling of these parameters in the River Tame, which will be reported early in Gate 4 and support the on-going environmental assessments.
  - Mitigation options at weirs 7 and 8 should be investigated to improve fish passability for the species predicted to be impacted by the operation of the SRO schemes. Such options may include remediation works to the weirs, the installation of appropriately designed fish passes, or ultimately the partial or complete removal of weirs. This should be further discussed with the Environment Agency in the context of the on-going restoration scheme at Lea Marston. This would benefit the following species:
    - At Site 7 – A4097 Weir, Atlantic salmon and brown/sea trout.
    - At Site 8 – Nether Whitacre Weir, Atlantic salmon and brown/sea trout.
  - Continue to liaise with Regulators and stakeholders to maximise opportunities for river restoration and the reinstatement or improvement of fish passage, including through current and proposed restoration initiatives, for example at Lea Marston.
  - Future-proof the design of proposed fish passes to ensure there is no potential for impacts to fish passage through the future operation of the SRO schemes.
  - Seek further benefits of the SRO schemes, for example through the Biodiversity Net Gain (BNG) assessment and recommendations of other environmental assessments at Gate 3 or Gate 4 (EIA). For example, improvements to water quality through the reduced discharge of treated recycled water from Minworth; enhancements to river and riparian habitats through BNG assessment and targeted mitigation or enhancement of wetland and water dependent habitats.
  - Explore the potential for partnership funding to facilitate aspirational schemes and seek wider environmental benefits.

## Fish Olfaction

### Results in Context

- 3.4.7 Atlantic salmon return to their home rivers via a combination of geomagnetic, sun-orientation, and olfactory cues, the latter as a result of temperature, water chemistry, and river geology (e.g., Hansen and Jonsson, 1994; Stabell, 1984). Geological differences between home catchments are key at resulting in genetic differentiation between salmon populations, for example between the chalk rivers of Southern England and other catchments (Griffiths et al, 2010). Because salmon generally stick to their home geographical / geological catchment, this results in divergent evolution and populations becoming genetically distinct from those in other catchments. The resulting olfactory signature of a river is not dependent upon individual chemicals, but on the overall make-up of water chemistry, which may change naturally or artificially over time.
- 3.4.8 In contrast to salmonids, sea lamprey do not exhibit natal homing behaviours (Bergstedt and Seelye, 1995; Waldman et al., 2008). Instead, sea lamprey evaluate the suitability of a stream based on the presence of larval populations (Teeter, 1980; Moore and Schleen 1980). Migratory sea lamprey are

acutely tuned to the larval odour (migratory cue); putative components are detected at low concentrations (Li et al., 1995) and larval odour elicits behavioural responses at the concentrations produced by a single larvae diluted several thousandfold (Vrieze and Sorensen, 2001). Once sea lamprey arrive at the spawning grounds, final sexual maturation is partially triggered by conspecific odours (Chung-Davidson, 2013a,b). Upon complete sexual maturation, mate search and spawning are guided by the odours of the opposite sex (Teeter, 1980). The male odour appears multi-functional, mediating upstream movement behaviours (Johnson et al., 2009) and proximate nest construction and spawning synchronization behaviours (Johnson et al., 2012).

- 3.4.9 Overall, there are relatively few studies on the olfactory effects of the chemicals of interest in the River Tame on the species of interest identified by this literature search. Peer-reviewed studies were found relating to the olfactory effects of the chemicals of interest described below, both on the fish species of interest, and similar species, for example rainbow trout, coho salmon, chinook salmon, and pink salmon. The relevant studies have been interpreted in relation to the potential olfactory impacts of the chemicals described below on Atlantic salmon and brown/sea trout. These studies are described in the context of the modelled changes in these determinands in the River Tame.

### Cypermethrin

- 3.4.10 Modelled concentrations of cypermethrin in the River Tame under the proposed reduced Minworth WWRC recycled water scenarios range from 0.000235-0.000243  $\mu\text{g L}^{-1}$ . These concentrations are potentially within the range of concentrations at which olfactory effects were observed in Atlantic salmon and trout respectively. Moore and Waring (2001) reported effects of cypermethrin at concentrations  $<0.004 \mu\text{g/l}$ ; however, this finding was limited by the LoD of cypermethrin of  $0.004 \mu\text{g/l}$ , and potential effects were reported as low as  $0.0001 \mu\text{g/l}$  ( $0.1 \text{ ng/l}$ ).
- 3.4.11 Further results for cypermethrin from the literature are as follows:
- Sahota et al (2021) reported decreases in olfactory responsiveness at lower concentrations with longer exposure periods: down to  $100 \text{ ng/l}$  at 7-day exposure.
  - Typical 1 – 4-day LC50 values for trout exposed to cypermethrin fall within the range  $1\text{-}11 \mu\text{g/l}$  (Davies and Cook, 1993).
  - Volz et al (2020) found no statistical difference between the effects of permethrin and cypermethrin on the embryonic development of zebrafish; however, the in-combination effects of the two chemicals together were found to be greater.
  - Stengel et al. (2018) showed that both vision and olfaction proved quite resistant to concentrations  $\leq \text{EC}10$  of all of the model neurotoxicants tested. For cypermethrin, no effects were detectable within solubility limits, demonstrating the difficulty of assessing effects at such low concentrations, at which for example cypermethrin may have an adverse effect on olfaction in fish.
- 3.4.12 Current concentrations of cypermethrin in the River Tame are uncertain as results from Gate 3 monthly sampling are limited by the higher LoD ( $0.004 \mu\text{g/l}$ ). However, further water quality data is available showing an upstream background concentration of  $0.1 \text{ ng/l}$ , compared to a concentration in the Minworth recycled water of  $0.2 \text{ ng/l}$  (Gate 2 results). As a result of the diversion of Minworth recycled water away from the River Tame, there is therefore a slight modelled reduction in the downstream concentration of cypermethrin (up to a  $-0.4\%$  reduction).
- 3.4.13 Further monitoring of cypermethrin in the River Tame is proposed utilising a lower LoD. When the results of on-going monitoring are available, the mass balance calculations for cypermethrin will be updated accordingly.

### Mancozeb

- 3.4.14 Few studies on the effects of mancozeb on fish olfaction are available for the target or similar species, and this is a developing area of research for the fungicide mancozeb. In coho salmon, the EC50 was higher at  $2.05 \text{ mg/l}$  (Jarrard et al., 2004); mancozeb exposure caused significant increases in AChE activity in the brain. The EOG EC50 for mancozeb in this study was very close to the reported 48-h LC50 for this compound in rainbow trout ( $2.2 \text{ mg/l}$ ).
- 3.4.15 Costa-Silva et al. (2018) investigated concentrations of mancozeb ranging around  $10 \text{ mg/L}$ ; significant changes in cell viability and apoptosis parameters in carp exposed to mancozeb were not observed. Concentrations of MZ tested ( $5$  and  $10 \text{ mg/L}$ ) were in the range of  $10\%$  or less the LC50 in fish (EPA

2005), suggesting the MZ concentrations tested triggered adaptive responses that may have ameliorated MZ-induced toxicity; i.e., an avoidance response.

- 3.4.16 Both Jarrard et al. (2004) and Costa-Silva et al. (2018) described that mancozeb is believed to break down rapidly in the environment. Costa-Silva et al found an approximately 50% drop in MZ concentrations in water at 48 h, which either indicates significant degradation or elimination of the fungicide in solution.
- 3.4.17 Concentrations of mancozeb in the River Tame are currently 1.47 µg/l (upstream background), and 1.439 µg/l (downstream). Reduction in the discharge of Minworth recycled water (1.411 µg/l) is modelled to cause a small increase in mancozeb concentrations downstream, up to a 0.6% increase. Given the evidence that mancozeb rapidly breaks down in the environment, this is not considered to represent a significant potential impact on fish olfaction downstream of Minworth. Concentrations of mancozeb in the River Tame are far below those presented in the literature as having an effect (2.2 mg/l being the lowest).

### Glyphosate

- 3.4.18 Modelled concentrations of glyphosate in the River Tame under the proposed reduced Minworth WWRC recycled water scenarios range from 0.491-0.502 µg L<sup>-1</sup>. These concentrations are significantly lower than those concentrations at which olfactory effects were observed in Atlantic salmon (150 µg L<sup>-1</sup>). No clear olfactory effects from glyphosate exposure were observed in trout at the concentrations tested (150 µg L<sup>-1</sup>).

### Metals

- 3.4.19 The effects of copper, zinc, and nickel on fish from the literature are presented below.

#### Copper

- 3.4.20 Baldwin et al. (2003) demonstrated effects on the neurophysiological response to all odorants within 10 min of exposure in coho salmon, with inhibitory effects as low as 1.0 mg/l copper. Concluding that copper is broadly toxic to the salmon olfactory nervous system. Toxicity thresholds for the different receptor pathways were determined by using the benchmark dose method and found to be similar (a 2.3–3.0 mg/L increase in total dissolved copper over background).
- 3.4.21 Sandahl et al. (2007) reported altered response in Coho salmon when exposed to 2 µg/l copper; 20 µg/l copper essentially abolished responses.
- 3.4.22 Sprague (1965) gave a lowest observed effect concentration (LOEC) of 2.3 µg/l for Atlantic salmon.
- 3.4.23 Olfactory responses from rainbow trout (*Oncorhynchus mykiss*) exposed to 25 – 100 µg/l copper were reduced between 50 and 65%. Rainbow trout exposed to concentrations <25 µg/l did not exhibit olfactory responses. Rainbow trout avoided copper at 4.4 µg/l. The calculated LOEC was 6.4 µg/l (Scannell, 2009).
- 3.4.24 The upstream concentration of copper in the River Tame is 0.23 µg/l, and this is modelled to increase downstream as a result of reduced dilution from Minworth (up to a +23.16% increase). However, concentrations remain well below those shown to have an effect on olfaction in salmonid species – down to 2 µg/l in the case of coho salmon. Therefore, this is not considered to represent a significant effect on fish olfaction in the Rivers Tame and Trent.

#### Zinc

- 3.4.25 Sprague (1965) demonstrated avoidance in Atlantic salmon parr exposed to 53 µg/l zinc in the laboratory. Adult Atlantic salmon migrating upstream avoided areas contaminated with a mixture of copper and zinc. The threshold for avoidance was approx. 17 – 21 µg/l Cu and 210 – 258 µg/l Zn. Concentrations of 38 µg/l Cu and 480 µg/l Zn could completely block spawning runs.
- 3.4.26 Concentrations of zinc in the River Tame are 31.66 µg/l upstream, 12.158 µg/l in the Minworth recycled water, and 21.189 µg/l downstream. This is modelled to increase by up to 13.09% to 23.68 µg/l in the worst-case scenario 230 MI/d reduction. However, this remains well below the concentration demonstrated to result in an avoidance reaction in Atlantic salmon parr (53 µg/l minimum), and Minworth will continue to provide a benefit in diluting the zinc emanating from upstream in the River Tame.

## Nickel

- 3.4.27 Scannell (2009) found that rainbow trout were attracted to low nickel concentrations (about 6 µg/l) but avoided higher levels (> 19 µg/l). Best estimate of the avoidance threshold was 23.9 µg/l total nickel.
- 3.4.28 Nickel is present in the River Tame at 3.62 µg/l (upstream), and at 3.597 µg/l in the Minworth recycled water. This is modelled to increase to a maximum of 3.610 µg/l in the worst-case scenario, which remains well below the avoidance threshold of 23.9 µg/l total nickel. Similarly to zinc, Minworth will continue to provide a benefit in diluting the nickel emanating from upstream in the River Tame.

## Conclusions

- 3.4.29 It is considered unlikely that there would be significant adverse effects upon olfaction in migratory fish as a result of changes in the concentrations of these chemicals in the River Tame, although further investigation of cypermethrin is required at the reduced LoD. However, salmon or sea trout are not currently present in the River Tame (refer to fish records presented from previous reports at Gate 1 and Gate 2). There are minimal changes in concentrations of the chemicals in question, as demonstrated by water quality modelling and mass balance calculations. Furthermore, dilution after the confluence with the Trent will likely mean no risk to migratory species in the Trent and associated lower reaches.
- 3.4.30 As described above, Minworth will continue to provide a benefit to the River Tame in diluting several chemicals emanating from upstream in the river, notably glyphosate, lead, mancozeb, manganese, and zinc.
- 3.4.31 This review does not consider possible future changes in abstraction or discharge in the River Tame, for example due to future Sustainability Reductions or discharge permits surrendered/revoked. The impacts of such changes may require further consideration of effects on the olfactory signature of the River Tame specific to the changes they result in, independent of this assessment and the current Minworth scheme.
- 3.4.32 A previous literature review on 'Olfactory Toxicity in Fishes by Tierney et al., (2010) did not include any additional relevant references on the effects of the parameters of interest on the fish species of interest, or similar species.
- 3.4.33 A review of the STT olfaction review has been undertaken and the following points are noted:
- During the varying operation of the Minworth transfer, the attracting flows and natal homing cues are unlikely to be affected by the quantity of water entering the Humber Estuary, via the Rivers Tame and Trent.
  - Gate 3 assessments for Minworth are considering the effects of reduced discharge from Minworth on temperature and dissolved oxygen. Modelling of changes to temperature and dissolved oxygen in the River Tame, in combination with climate change effects, will inform the fisheries assessment for the River Tame, at which point potential effects on olfactory cues can also be assessed.
  - The small number of chemicals modelled to increase in the River Tame is considered relatively insignificant in relation to those considered in the STT review for the River Avon and Severn Estuary.
  - There is a comprehensive suite of water quality monitoring underway for the River Tame, agreed with the Environment Agency at Gate 2, to inform the updated water quality model at Gate 3. This will subsequently inform the WFD assessment, as well as the update of the olfaction and overall fisheries assessment. Water quality data will also be available from other monitoring programmes, including further downstream the Tame and Trent, and this will also be fed into the water quality model.
  - Water quality monitoring and modelling is underway for the River Tame at Gate 3, the outcomes of which will inform an update of this olfactory assessment.
  - The majority of the olfactory inhibitors in the River Tame are already present in the baseline, and corresponding effects are largely independent of the Minworth SRO. However, this report assesses those chemicals modelled to increase in concentration as a result of reduced dilution at Minworth.
- 3.4.34 In conclusion, it is considered that the relatively minor changes in the olfactory signature of the Rivers Tame and Trent as a result of changes in discharge from Minworth WWRC, in the context of the fish community currently present in the catchment, would likely represent a negligible effect upon the migratory success of resident or migratory fish species. Any such effect would be fully quantified and

assessed as part of the Environmental Impact Assessment (EIA) utilising the updated olfaction report based on on-going monitoring of cypermethrin at the reduced LoD, and updated water quality modelling.

## 3.5 River surveys

### Connectivity of local environmental features

#### Ladywalk LWS

- 3.5.1 Ladywalk LWS nature reserve mainly comprises wet woodland, reedbed and open water, with areas of swamp and wet grassland. Ladywalk LWS is situated within a wide meander on the west side of the River Tame. Of the four connections to Ladywalk LWS assessed, only two were shown to be connected to the River Tame, these were Ladywalk LWS 2 and Ladywalk LWS 4.
- 3.5.2 The Ladywalk LWS 1 channel was present but formed a dry channel that would only be connected to the River Tame at high flows above Q10. It is therefore considered that this channel was designed, or has formed naturally, to accommodate flood flows over-topping the Tame and entering the LWS. Therefore, this channel would not be impacted by reduced low flows in the Tame.
- 3.5.3 The Ladywalk LWS 3 channel was dry at the time of the topographical survey, and it has been confirmed by hydrological modelling that this channel is disconnected from the River Tame, as the channel bed level is higher than any modelled water levels in the River Tame.
- 3.5.4 From the site visit it was determined that Ladywalk LWS 2 is a small channel that connects Main Lake to Rudd Lake, which then connects to the River Tame to the southeast of the reserve. It was difficult to see where Ladywalk LWS 2 entered the River Tame due to dense vegetation, but wardens at the reserve confirmed that the channel does connect to the river. Modelled water levels in the ELF, Q95 and Q99 scenarios show that Ladywalk LWS 2 is disconnected from the River Tame for the BL, Scenario A (SA) and Scenario B (SB). However, a 10 cm reduction in water levels has been recorded between the mean BL and mean SB and a 5 cm reduction in water levels between the mean BL and mean SA.
- 3.5.5 Ladywalk LWS 2 and Ladywalk LWS 3 are effectively overflows from the standing water bodies within the LWS, allowing water levels within them to be controlled. It is considered unlikely that water supply from the River Tame through these pipes/culverts is a significant occurrence, especially as Ladywalk LWS 2 appeared to be blocked or obscured. Therefore, they would remain unaffected by reduced low flows.
- 3.5.6 Ladywalk LWS 4 is the most northerly site surveyed, at the downstream end of the site. The channel runs the length of the reserve from north to south and connects to Ladywalk LWS 1, where it would receive flow in flood events. There was a clear connection between Ladywalk LWS 4 and the River Tame to the north of the reserve. Modelled water levels show that Ladywalk LWS 4 is connected to Ladywalk LWS in all baseline scenarios modelled but becomes disconnected in ELF for SA and SB and Q95 and Q99 for SB; however, it is likely that it would continue to receive flow from the standing water bodies on the LWS. As this site is at the downstream end of the reserve, it is not thought that this channel is a significant feed to Ladywalk LWS and based on modelling results and site walkovers to date, it is more likely that the site is dependent on flood events, groundwater recharge, and/or rainfall to keep the site wet.
- 3.5.7 Ladywalk LWS 4 is the main outflow from the LWS to the River Tame, serving to control levels in the large water bodies within the LWS. Therefore, it is considered unlikely that water would flow from the River Tame through this channel to the LWS.
- 3.5.8 Ladywalk LWS is a private reserve, with land owned by E.ON and leased to and managed by West Midlands Bird Club. Any suggested mitigation measures would need to be agreed in collaboration with the reserve wardens and volunteers; however, no mitigation is currently considered necessary.

## Whitacre Heath SSSI

- 3.5.9 Two connections sites were assessed for Whitacre Heath Site of Special Scientific Interest (SSSI), which consists of 44 hectares of pools, woodland, and wet grassland. During the site visit no channel was evident for Whitacre Heath 1 but topographical readings were taken at the nearest point to aerial imagery. Water modelling results showed that Whitacre Heath 1 was situated above modelled water levels in the River Tame and therefore does not support wetland features within this SSSI. Although Whitacre Heath 2 was shown to be connected to the River Tame based on modelling results, the site visit via boat confirmed that this site is not directly connected to the River Tame but will become inundated in high flow events. Another site/channel was located just upstream of Whitacre Heath 2, which was shown to have a bed level perched above the River Tame.
- 3.5.10 The results of this assessment support the conclusions of the SSSI Interaction report<sup>21</sup> which states that surface water features at Whitacre Heath SSSI are not connected to the superficial deposits and so are hydraulically disconnected from the River Tame. It is therefore understood that the ponds are dependent on rainfall ponding on the low permeability ground. The ponds are anticipated to also be supported by flooding of the site due to the good connection to the banks of the River Tame, it is likely the site frequently receives flood flow. Therefore, the reduction in water levels due to the Minworth SRO is not anticipated to reduce connectivity to Whitacre Heath SSSI.
- 3.5.11 Water supply to the SSSI from the Tame is not a significant occurrence, as established at Gate 2. The SSSI is purely dependent on supply from the river during flood events.

## Kingsbury Wetlands LWS

- 3.5.12 Kingsbury Wetlands (Water Park) LWS supports a mosaic of wetland habitats on the west side of the River Tame in Warwickshire. Wet woodland surrounds much of the water-filled gravel pits some of which support swamp. Six sites were assessed for connectivity to Kingsbury Wetland LWS. It is considered likely that the Water Park is fed by groundwater and flood events from the River Tame, and by minor tributaries from the west.
- 3.5.13 Kingsbury Wetlands 1 was the most southerly and upstream site investigated. The site visit to Kingsbury Wetlands 1 confirmed that there was a channel, which flowed from Mill Pool and out to the River Tame. The channel was full of lots of deadwood/debris and some tree branches growing across it. The channel was well vegetated on both sides. Hydrological modelling has shown that this channel is only connected in the mean base and Q10 flow events with depths being as shallow as 4 mm in the mean baseline and a maximum of 39 cm in the Q10 baseline scenario. This channel is shown to be disconnected from the River Tame in all other flow events modelled. However, the site visit confirmed that this channel is connected and does have flowing water. Kingsbury Wetlands 1 acts as an outflow to control the level of Mill Pool and would therefore not be affected by reduced low flows in the River Tame.
- 3.5.14 Kingsbury Wetlands 3 was shown to be a significant channel connected to the River Tame. Readings taken on site showed a depth of a minimum of 1.7 m before hitting a silt layer with a channel width of 2.5 – 3 m. Mapping shows that this channel heads south, connecting to Mitchell's Pool, Bodymoor Heath Water and Hemlingford Water. Modelling results show that Kingsbury Wetlands 3 is connected to the River Tame in all flow events. Mean base flows would reduce by a maximum of 11 cm when comparing the mean base line with SB and 6 cm when comparing the mean baseline with SA. The maximum reduction in water depth was recorded in the ELF for Scenario B, with a reduction of 23 cm. However, even with this reduction in water depth, the channel would remain connected with a depth of 13 cm in the baseline ELF compared to a baseline of 36 cm in the SB ELF event. As a substantial tributary to the River Tame, results show that even in the ELF event for the worst-case scenario (SB 62.38 mAOD), Kingsbury Wetlands 3 would still be connected to the River Tame at the lowest bed elevation and would not be impacted by reduced low flows in the Tame.
- 3.5.15 Kingsbury Wetlands 6 is an installed pipe connecting Grebe Pool to the River Tame as a 'fish refuge.' A site visit and statutory consultation with the Environment Agency has confirmed that there is a fish pass here connecting the River Tame to Grebe Pool. This fish pass constitutes two black corrugated PVC pipes, which were only just visible on the site visit as water levels were high and turbid. Photos

<sup>21</sup> Gate 2 Annex B3.1.1 Environmental Assessment: Minworth and South Lincolnshire Reservoir (SLR). Appendix A: SSSI Interaction.

and correspondence with Kingsbury Wetlands park rangers confirmed that this fish pass may be in need of some maintenance due to silt accumulation, and it was observed to have rubble in the entrance with potential damage to the pipe. Hydrological modelling shows that this site is connected to the River Tame at all but the lowest modelled flows (ELF SB). There is a difference of only 2 cm between channel bed level and ELF scenario B, and therefore it is considered that mitigation is not required for this connection, as it remains connected under all but the very lowest modelled flows.

- 3.5.16 Kingsbury Wetlands 5 is the most northerly and downstream connection site investigated at this site. Hydrological modelling results showed that the site is connected to the River Tame in all scenarios modelled other than ELF SB. With a maximum reduction in water levels of 8 cm for ELF SA and 18 cm for ELF SB. During the site visit to Kingsbury Wetlands 5 there was an obvious channel forming a substantial tributary to the River Tame, which was very silty from point of entry but became less silty moving away from the River Tame. This channel leads to an unnamed standing water body where water was seen actively flowing from the pool to the River Tame. Due to the downstream location of Kingsbury Wetlands 5 and the minimal reductions in water levels recorded, there is not thought to be any significant loss of connectivity to the River Tame at this location and no further mitigation is required.

## RSPB Middleton Lakes LWS

- 3.5.17 RSPB Middleton Lakes Nature Reserve supports a mosaic of wetland habitats on both sides of the River Tame and across the Warwickshire/Staffordshire boundary. In total approximately 12 ha of reedbed is located in three locations at Fisher's Pool (on the north side of Fisher's Mill Meadow LWS), the south-west corner of Jubilee Wetlands (within Middleton Hall Pit LWS) and north-east side of Dosthill Pit LWS.
- 3.5.18 Five sites were investigated for connectivity to RSPB Middleton Lakes LWS. Middleton Lakes 1 was visited in June 2023 and is only slightly downstream of Kingsbury Wetlands 6, but unfortunately the channel could not be located due to dense vegetation. The site was revisited in March 2024 when the vegetation had died back, and the site was accessed by boat. There was an obvious channel connected to the River Tame. Hydrological modelling shows that this channel remains connected to the RSPB Middleton Lakes LWS in all scenarios.
- 3.5.19 Middleton Lakes 2 is Langley Brook, a substantial tributary of the River Tame, and was easily identified. The channel was approximately 2 – 2.5 m wide and 0.5 m deep and flows from west to east passing through Middleton Pool and flowing into the River Tame. The source of Langley Brook is located to the west of the A38 and therefore is understood to be groundwater fed. As such any connection to the River Tame should not significantly influence levels within Langley Brook. Hydrological modelling shows that Middleton Lakes 2 remains connected in all scenarios other than the ELF for SB. The greatest reduction in levels is 20 cm; however, Langley Brook would continue to flow into the River Tame at low flows.
- 3.5.20 Middleton Lakes 4 was difficult to identify on the site walkover due to dense vegetation. A potential channel was surveyed for topographical levels but was dry at the time of survey in June 2023. A boat survey was undertaken at Middleton Lakes 4 in March 2024, but the channel could not be found. However, based on the levels recorded, it is understood that the area would become regularly inundated by the River Tame in all scenarios modelled hydrologically. The greatest reduction in levels recorded was 15 cm in the ELF, but the area would still be connected, with a depth of 5 mm. It is worth noting that the baseline depth for the ELF would only be 20 mm.
- 3.5.21 Middleton Lakes 5 was an obvious channel with two outlets around an island that flow into the River Tame. The channel connects to several pools within the reserve. Outlets 1 and 2 remain connected in all flow scenarios modelled other than the ELF for SB at outlet 1. Water levels reduce by a maximum of 18 cm.
- 3.5.22 All connecting channels at Middleton Lakes represent substantial tributaries of the River Tame, and the site itself is unlikely to be dependent upon flows from the River Tame, certainly during low flows. Langley Brook feeds the upstream end of Middleton Lakes, and it is considered likely that the site is also groundwater-dependent and therefore would not be impacted by small decreases in flow in the Tame at times of low flow. It is not considered that any mitigation is required for Middleton Lakes.

## Tameside LNR

- 3.5.23 Tameside LNR is located both sides of the River Tame south of Tamworth, Staffordshire and mainly supports rough grassland, with scattered trees, swamp vegetation around the lake fringes and ditch to the north.
- 3.5.24 Three potential connection sites were investigated for Tameside LNR. Site visits and hydrological modelling have confirmed that Tameside LNR 1 and 3 are not channels and are not connected to the River Tame. No visible channels were located on the site visits and where topographical survey levels were taken at potential channel sites; bed levels were shown to be elevated above water levels in the River Tame for all scenarios modelled.
- 3.5.25 Tameside LNR 2 was a significant channel, with an estimated depth of 1.5 m at the time of the site visit. The site was flooded at the time of the site visit due to heavy rain fall and therefore, topographical survey points were taken within the channel and not at the actual connection point with the River Tame. This feature represents a connecting pipe and channel to Smiley Face Pool within the LNR, as observed with the Environment Agency on site in April 2022. For all other scenarios the River Tame is not connected to Tameside LNR via this feature, meaning that it becomes disconnected from the River Tame at flows of Q95 and below. The maximum potential reduction in water levels has been recorded in the mean scenario with a difference of 20 cm between the ELF BL (57.98 mAOD) and ELF SB (57.78 mAOD).
- 3.5.26 It is possible that the connecting pipe/feature at Tameside LNR 2 has been set at such a level as to allow fish passage between the Tame and Smiley Face Pool. Therefore, the level of this connecting feature may need to be re-assessed to allow continued connectivity under the with-scheme scenarios. The difference at Extreme Low Flow between base level and scenario B (worst-case) is 20 cm, meaning the channel/pipe would need to be lowered by this amount to maintain connectivity under all scenarios. However, this would need to be weighed up against the requirement to maintain water levels in Smiley Face Pool by ascertaining the level of the other end of the connection, to avoid water flowing out of the pool at low flows.
- 3.5.27 The Tameside LNR is managed by Tameside Wildlife Conservation Group, a joint initiative between Staffordshire Wildlife Trust and Tamworth Borough Council. Any mitigation measures suggested should be in collaboration with these organisations, and with the Environment Agency.

## Summary of Recommendations

### Ladywalk LWS

- 3.5.28 Ladywalk LWS is considered to be fed by flood events from the River Tame via Ladywalk LWS 1, the high flow channel at the upstream end of the site. It is likely also groundwater-fed. Ladywalk LWS 2 and Ladywalk LWS 3 are effectively overflows from the standing water bodies within the LWS, allowing water levels within them to be controlled. Ladywalk LWS 4 is the main outflow from the LWS to the River Tame, serving to control levels in the large water bodies within the LWS. Therefore, it is considered unlikely that water would flow from the River Tame through these channels to the LWS, and no mitigation is required.

### Whitacre Heath SSSI

- 3.5.29 Water supply to the SSSI from the Tame is not a significant occurrence, as established at Gate 2. The SSSI is purely dependent on supply from the river during flood events. Therefore, no mitigation is required.

### Kingsbury Wetlands LWS

- 3.5.30 Kingsbury Wetlands 1 acts as an outflow to control the level of Mill Pool and would therefore not be affected by reduced low flows in the River Tame.
- 3.5.31 As a substantial tributary to the River Tame, results show that even in the ELF event for the worst-case scenario (SB 62.38 mAOD), Kingsbury Wetlands 3 would still be connected to the River Tame at the lowest bed elevation and would not be impacted by reduced low flows in the Tame.
- 3.5.32 Kingsbury Wetlands 6 is an installed pipe connecting Grebe Pool to the River Tame as a 'fish refuge.' Hydrological modelling shows that this site is connected to the River Tame at all but the lowest modelled flows (ELF SB). There is a difference of only 2 cm between channel bed level and ELF

scenario B, and therefore it is considered that mitigation is not required for this connection, as it remains connected under all but the very lowest modelled flows.

- 3.5.33 Due to the downstream location of Kingsbury Wetlands 5 and the minimal reductions in water levels recorded, there is not considered to be any significant loss of connectivity to the River Tame at this location.
- 3.5.34 No mitigation is required for any of the connecting features in Kingsbury Wetlands.

### **RSPB Middleton Lakes**

- 3.5.35 All connecting channels at Middleton Lakes represent substantial tributaries of the River Tame, and the site itself is unlikely to be dependent upon flows from the River Tame, certainly during low flows. Langley Brook feeds the upstream end of Middleton Lakes, and it is considered likely that the site is also groundwater-dependent and therefore would not be impacted by small decreases in flow in the Tame at times of low flow. It is not considered that any mitigation is required for Middleton Lakes.

### **Tameside LNR**

- 3.5.36 Tameside LNR 1 and 3 are not channels and are not connected to the River Tame.
- 3.5.37 Tameside LNR 2 represents a connecting pipe and channel to Smiley Face Pool within the LNR, as observed with the Environment Agency on site in April 2022. For all other scenarios the River Tame is not connected to Tameside LNR via this feature, meaning that it becomes disconnected from the River Tame at flows of Q95 and below. Therefore, the level of this connecting feature may need to be re-assessed to allow continued connectivity under the with-scheme scenarios. The difference at Extreme Low Flow between base level and scenario B (worst-case) is 20 cm, meaning the channel/pipe would need to be lowered by this amount to maintain connectivity under all scenarios. However, this would need to be weighed up against the requirement to maintain water levels in Smiley Face Pool by ascertaining the level of the other end of the connection, to avoid water flowing out of the pool at low flows.

## **River Habitat Surveys and macrophyte surveys**

### **River Habitat Survey**

- 3.5.38 The results for the 2023 RHS of TA1 compared with that undertaken in 2021 demonstrated that whilst the survey reach remained in the same HMS and RHQ categories, the 2023 survey attained a lower HMS score and a greater HQA score. The same observations were present when comparing the 2023 RHS of TA2 with the results of the 2021 RHS at the same location, except that the RHQ category improved from 'V – Extremely poor, restore' in 2021 to 'IV – Poor, Rehabilitate' in the 2023 survey – the 2023 surveys, completed under optimal conditions, are considered a more accurate indication of river character and condition.
- 3.5.39 The change in the HMS and HQA scores for both sites, and resultant increase in RHQ category at TA2, result from the increased visibility of channel features and channel substrate, alongside increased flow variety recorded within the survey reach under typical flow conditions.
- 3.5.40 As both survey sites are upstream of the Minworth discharge, any reduction in flows will not affect the habitat or water quality of either location.
- 3.5.41 Should mitigation be required or necessary at either location, the following actions are suggested:
- Management to eradicate the riparian INNS present (Himalayan balsam, giant hogweed, Japanese knotweed and Nuttall's Waterweed). Ideally this should be part of a catchment wide INNS management plan agreed between relevant stakeholders to prevent recolonisation from upstream;
  - Selective planting of bankside trees to stabilise the banks, enhance marginal habitats by the presence of submerged roots and woody material input into the channel, and diversify the bank vegetation structure;
  - Selective planting of native marginal vegetation to stabilise the banks, enhance marginal habitat, and diversify the bank face and in-channel vegetation structure;
  - Remediation of resectioned and/or artificial bank features, such as the gabions recorded at TA2, and remediation of the historic channel re-sectioning would greatly benefit both locations; and,

- Whilst no barriers to fish passage were recorded within either survey reach, a substantial weir was noticed upstream of TA2, and as such improvements to longitudinal connectivity, including for passage of migratory fish species may also benefit the river as a whole.

### Aquatic Macrophytes

- 3.5.42 Survey reaches TA1 and TA2 improved from Bad status in 2021 to Poor status in 2023. Over the same time period, TA4 maintained Poor status whereas TA6 decreased from Good status to Moderate status.
- 3.5.43 The changes in macrophyte WFD classification at TA1, TA2 and TA6 can be attributed to increased detection and abundance estimation of submerged macrophyte species, the observation of which was likely impeded by the high turbidity and high flows observed during the 2021 surveys. Therefore, the 2023 surveys, completed under optimal conditions, are considered a more accurate indication of river character and condition.
- 3.5.44 The 2023 aquatic macrophyte survey determined that TA1, TA2 and TA4 attained Poor WFD macrophyte status, suggesting excessive nutrient enrichment and effects due anthropogenic pressures such as changes in flow dynamics and modified channel morphology are adversely influencing the macrophyte community at each location. These conclusions are consistent with those reported following the 2021 surveys. The Moderate WFD macrophyte status attained at TA6 indicates the location is subject to the same pressures, albeit to a lesser extent.
- 3.5.45 The River Tame is a heavily modified river flowing through highly urbanised and industrialised areas of Birmingham. The observed RMNI at all reaches were greater than their predicted RMNI, suggesting adverse influence due to nutrient enrichment. The physical habitat was also of poor quality with reaches being resectioned and lacking natural features. These characteristics likely drive the Poor WFD macrophyte classification at TA1, TA2 and TA4. Furthermore, the water quality pressure is also likely driving the Moderate WFD macrophyte classification at TA6.
- 3.5.46 Reasons for not achieving good (RNAG) as reported by the EA through the Catchment Data Explorer website<sup>22</sup> following 2021 surveys detailed urbanisation of the watercourse resulting in diffuse pollution and point source intermittent and continuous sewage discharge resulting from wastewater treatment, and diffuse pollution from transport drainage. These RNAG remain valid contributors to the WFD macrophyte classifications resulting from the surveys completed in 2023.

### Invasive Non-Native Species

- 3.5.47 Nuttall's waterweed, Himalayan balsam, giant hogweed, and Japanese knotweed were all identified during macrophyte and RHS surveys, as summarised in Table 3-3. These species are listed in Schedule 9 of the Wildlife and Countryside Act 1981 (as amended)<sup>23</sup> and/or the Invasive Alien Species (Enforcement and Permitting) Order 2019<sup>24</sup>. Taken together, the legislation referenced makes it an offence to plant, or otherwise cause to grow (including allowing to spread), listed plant species in the wild. If transported off site, there is a duty of care with regards to the disposal of any part of the plant that may facilitate establishment in the wild and cause environmental harm (as per the Environmental Protection Act 1990). The legislation also makes it an offense to release, or allow to escape, listed species (or species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

**Table 3-3 Summary of Invasive Non-Native macrophyte species recorded during RHS and macrophyte surveys**

Scientific name	Common name	WCA 1981 <sup>23</sup>	IAS 2019 <sup>24</sup>	TA1	TA2	TA4	TA6
<i>Elodea nuttallii</i>	Nuttall's waterweed		Y		✓		✓
<i>Impatiens glandulifera</i>	Himalayan balsam	Y	Y	✓	✓	✓	✓
<i>Reynoutria japonica</i>	Japanese knotweed	Y			✓		
<i>Heracleum mantegazzianum</i>	Giant hogweed	Y	Y		✓		

<sup>22</sup> <https://environment.data.gov.uk/catchment-planning>, accessed 21 December 2023

<sup>23</sup> Wildlife and Countryside Act 1981 (England and Wales) (as amended) c.69. Available at: <https://www.legislation.gov.uk/ukpga/1981/69/introduction>

<sup>24</sup> Invasive Alien Species (Enforcement and Permitting) Order 2019 (SI 2019/527). Available at: <https://www.legislation.gov.uk/uksi/2019/527/introduction/made>

## Recommendations

- 3.5.48 Results from the aquatic ecology baseline assessment have informed the overall environmental assessment of the River Trent in relation to the SRO schemes Gate 3.
- 3.5.49 Conclusions drawn from the 2023 survey results are consistent with those from the 2021/22 surveys (Gate 2 Minworth Annex B1: Aquatic Ecology Monitoring ), therefore, recommendations made previously remain valid.

## 3.6 ERS Invertebrates

- 3.6.1 Exposed riverine sediment is not a common habitat on the River Tame and River Trent, as established through ecological assessments at Gate 2, and ERS can host a unique and specialist invertebrate fauna.
- 3.6.2 The surveys of ERS habitats of the River Tame and River Trent undertaken in 2023 resulted in particularly low number of specimens and were not fully representative of the invertebrate communities of ERS, due to the limitations reported. Losing pitfall traps is not an uncommon issue when surveying this habitat type. Previous surveys on the River Tame also reported a low catch size due to a combination of heavy rainfall and the 'flashy' nature of the watercourse (Bell & Sadler, 2001) – refer to earlier detail of diurnal flow fluctuations on the River Tame.
- 3.6.3 Bell & Sadler (2001) highlighted the advantage that pitfall trapping gives when determining the beetle assemblage on ERS with considerably more species captured with this method, and the current study illustrates the importance of having such data. With considerably more Coleoptera species being captured using pitfall trapping in comparison to hand searching and excavation, the total loss of pitfall traps leads to difficulties in the interpretation of current data. A combination of fidelity scores and species notability are used to infer conclusions and recommendations, and the inclusion of literature review and desk study has added species records to enhance the assessment.
- 3.6.4 Bell and Sadler (2001) reported similar limitations in terms of the difficulty of surveying in the River Tame and survey completeness; however, they concluded that the Tame ERS habitats compared 'reasonably well' with ERS in other rivers with similar environmental parameters, although the Tame 'will not rank among the UK's most valuable ERS invertebrate sites.' They noted that the connectivity of riverine ERS to adjacent and nearby wetland habitats may be an important factor in supporting their functionality by providing refuge during periods of high flow. Therefore, Biodiversity Net Gain (BNG) objectives to enhance riparian and nearby wetland habitats could also contribute to the development of riverine ERS.
- 3.6.5 It is clear that conditions in 2023 were not conducive to surveying ERS, with regular extreme weather and high river levels resulting in the inundation of ERS habitats. These surveys require a week of dry weather and low flows between survey visits to permit pitfall trapping, the most effective survey technique, which was a rare occurrence during the survey season in 2023.
- 3.6.6 Irrespective of the low catch size, each of the three sites with some survey success had at least one species with total fidelity to ERS or a nationally notable species. The ground beetle *Trechus rubens* is Nationally Scarce (Telfer, 2016) and was recorded at the Middleton Lakes / Tamworth Shooting Ground and Thrumpton Weir sites. The ground beetle *Bembidion punctulatum* has an ERS fidelity score of 1 and was found at Sawley Weir and Middleton Lakes / Tamworth Shooting Ground sites. These findings illustrate that the ERS habitat on both the River Tame and River Trent can host a specialist invertebrate community and the habitats surveyed provide good habitat for a diverse Coleopteran community in particular.
- 3.6.7 Previous studies on the River Tame reported by Bell & Sadler (2001) noted seven Coleoptera species that were Nationally Scarce and four that had an ERS fidelity score of 1. Ground and rove beetles are known to dominate the invertebrate fauna (Eyre & Lott, 1997; Bell & Sadler, 2001) and more than half of the Coleoptera observed in the current surveys were from these two groups. The predominant method of capturing these two groups is pitfall trapping and so to observe notable species from minimum results indicates the importance of ERS on the River Tame to the insect communities.
- 3.6.8 There are several pathways of impacts to ERS habitats that could be considered a risk from the operation of the SRO scheme:

- The INNS Himalayan balsam *Impatiens glandulifera* is widespread in the riparian habitat of both the River Tame and the River Trent and is known to homogenise plant communities by becoming dominant and shading out other plant growth. This in turn destabilises ERS, increasing erosion and resulting in the loss of ERS (Farrow *et al.*, 2022). However, the corresponding effects of a reduction in flow in the River Tame, which could otherwise facilitate the establishment of Himalayan balsam on ERS habitats, is considered negated as higher flows will remain unaffected and will continue to prevent such establishment;
- Flow reduction or changes in flow regime may alter sediment transport, thereby impacting the erosion/deposition balance of ERS (O'Callaghan, 2011) – sedimentation assessment for the Rivers Tame and Trent at Gate 2 and Gate 3 has demonstrated that there will be no significant changes to sediment regime in the rivers as a result of the Minworth scheme, and therefore this risk can be discounted; and
- Construction projects may result in an increased sediment load which replaces, smothers and fills the interstitial spaces of the coarser sediments on ERS (O'Callaghan *et al.*, 2013). The Minworth scheme would not present this type of impact as any construction works, e.g., the AWTP at Minworth, will be located a significant distance from the River Tame.

3.6.9 As such, the above impact pathways are not considered a risk for the Minworth scheme.

3.6.10 Conversely, there are potential benefits as a result of the proposed scheme with the diversion of recycled water away from the River Tame:

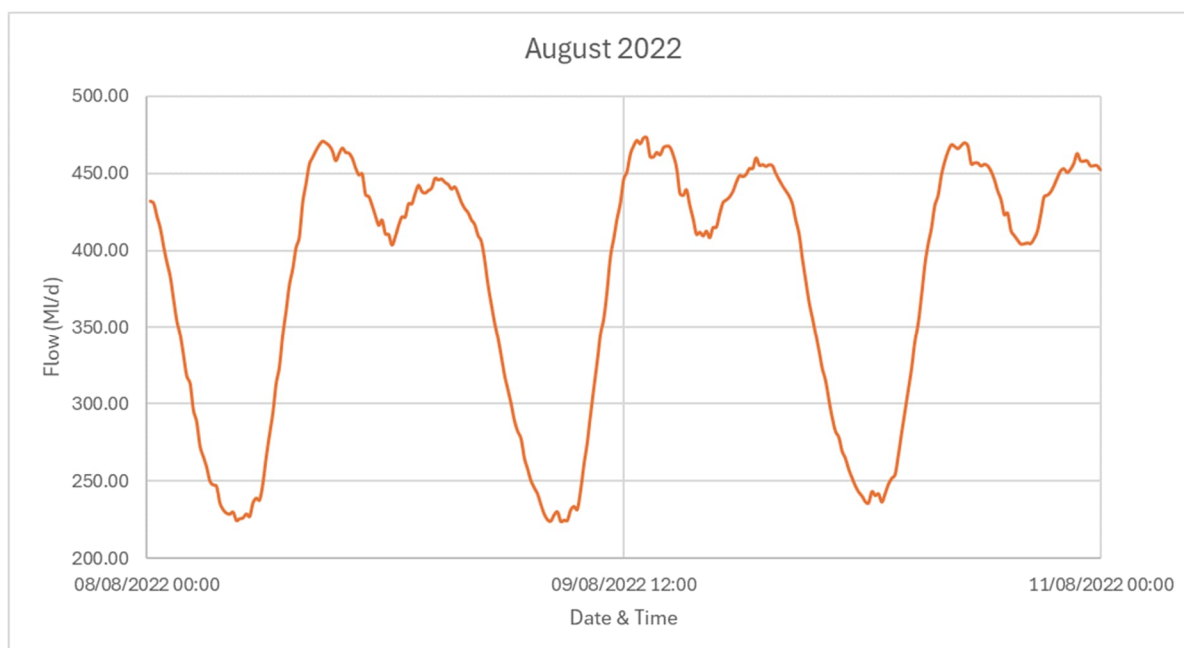
- Reduced flows in the River Tame (at times of low flow only – high flows will remain unaffected) may result in ERS habitats being exposed for longer, and the establishment of additional areas of ERS, allowing the invertebrate communities within them to become more established (see below for further details from Gate 3 hydrological modelling). This may provide additional areas of this otherwise uncommon habitat in the Tame and Trent catchment.
- A decrease in nutrients such as phosphates as a result of the reduction in volume of recycled water may influence ERS by decreasing vegetation cover, thereby positively affecting the unique ERS invertebrate community (Eyre & Lott, 1997). Gate 3 water quality modelling indicates a 'minor and localised' reduction in orthophosphate and ammonia concentrations in the River Tame; however, this may contribute into eventual benefits in combination with other future improvements in the catchment. Similarly, any improvement in water quality may support the development of a wider community of ERS invertebrates, although few studies have attempted to provide evidence for this (Bell and Sadler, 2001).

## Hydrological Modelling Results

3.6.11 Gate 3 hydraulic and hydrological modelling has refined the assessment of changes to flows, levels, and wetted perimeter in the Rivers Tame and Trent as a result of the operation of the SRO. Refer to the Gate 3 Annex B1.6 Hydraulic and Hydrological Modelling Report for full results. The diurnal flow analysis was completed for the River Tame only as it is considered to result in a negligible effect on the Trent.

3.6.12 Modelling indicates the diurnal output for all the model nodes on the River Tame. The modelling report gives the node locations in the appendices. The daily range of water levels the River Tame experiences currently (due to the daily variation in Minworth flow) is similar in magnitude to the change demonstrated in the worst case with the SRO transfer operating up to 230 Ml/d. This is an important conclusion in the context of the variation the river is already likely to be experiencing during low flow periods.

3.6.13 Flow data was analysed to isolate a 24-hour pattern which had close to a 20-day period of antecedent dry conditions (to represent a dry weather flow condition) and which could be repeated in a time-series simulation in the River Tame. The chosen discharge pattern was taken from the 2022 summer flows (which had a 20-day preceding dry period) for a 24-hour discharge pattern over three days (08/08/2022) with an average daily flow of 376.30 Ml/d. This pattern is shown in Figure 3-5 below, which illustrates the diurnal flow variation as a result of the Minworth discharge (and other WwRC).



**Figure 3-5 Chosen discharge pattern (08/08/2022 – 11/08/2022) for diurnal analysis**

- 3.6.14 Minimum and maximum water levels for each scenario are presented in the modelling report for selected locations (Whitacre Heath, Tameside and Kingsbury Water Park). These results show the range in water level that occurs due to the diurnal variability of Minworth WwRC discharges both with and without the SRO operating during low flows (Q95 and Q99).
- 3.6.15 The results demonstrate that, when considering Q95 low flows in the river, the influence of the current variation in diurnal flow from Minworth WwRC is approximately 50% to 35% greater than the difference in water level likely to be made by operating either one of the SROs (GUC or STT transfer) at the maximum level (Scenario A – 115 ML/d). Both SROs operating at maximum (Scenario B – 230 ML/d, which is likely to happen less than 0.5% of the time) would result in a water level reduction which is comparable (sometimes slightly greater) than the daily range in water level currently caused by the Minworth WwRC discharge profile.
- 3.6.16 During Q99 flows, the change during Scenario A is broadly similar to the diurnal fluctuation effect, and for Scenario B there is a slightly larger drop in water level caused by the SROs operating at their maximum compared to the diurnal effect.
- 3.6.17 This analysis demonstrates that, during lower river flows, the River Tame already experiences a variation in water level throughout the day which is of a similar (and in some cases greater) magnitude than would be expected to be caused for the majority of the time the SROs would be operating. This suggests that impact of the SROs on river hydraulics will be of a similar order to that which the river experiences daily under present conditions and helps to put into context the scale of change the SROs could be expected to result in.
- 3.6.18 The modelled effects on ERS habitats are illustrated by the predicted change in wetted perimeter as a result of the operation of the SRO. Wetted perimeter being the proportion of river channel that is inundated with water under a given scenario.
- 3.6.19 As described above, the changes to wetted perimeter as a result of the operation of the SRO transfer are similar to the change caused by diurnal flow fluctuations under current conditions during lower river flows (Q95 and Q99). These are summarised as follows:
- The maximum modelled reduction in max. wetted perimeter is -51.08% between Cliff Pool (Kingsbury Water Park) and Dosthill Lake (cross-section TM044515) (Q95; Scenario B).
  - The change in max. wetted perimeter for Q95 at Scenario A (115 ML/d reduction) ranges from – (minus) 0.43% (Lea Marston upstream lake: cross-section TM053379) to -48.20% (Cliff Pool location above).

- The change in max. wetted perimeter for Q99 at Scenario A ranges from -0.33% (Lea Marston upstream lake) to -46.58% (Cliff Pool location above).
- The change in max. wetted perimeter for Q95 at Scenario B (230 Ml/d reduction) ranges from – (minus) 0.78% (Lea Marston upstream lake) to -51.08% (Cliff Pool location above).
- The change in max. wetted perimeter for Q99 at Scenario A ranges from -0.70% (Lea Marston upstream lake) to -49.75% (Cliff Pool location above).

3.6.20 Specifically in relation to the ERS survey locations, where the location of modelled cross-sections allows, the following are noted:

- At cross-section TM041901, immediately upstream of the Tamworth Shooting Ground braided channels, there is a -20.09% (Scenario A) and -23.53% (Scenario B) (Q95), and a -3.96% (Scenario A) and -7.97 (Scenario B) (Q99) reduction in max. wetted perimeter from baseline.

3.6.21 While modelling does not show a marked change in the variation in wetted perimeter as a result of the SRO transfer, it is likely that in combination with climate change (which is built into the model as the RCP6.0 climate change scenario) may result in ERS habitats being exposed for longer. Therefore, there is likely to be a demonstrable increase in the availability of these important habitats and the notable assemblage of invertebrate species they support, and the fauna and flora that depend on them.

## Recommendations

3.6.22 Based on the survey results and interpretation of previous ERS studies, the following recommendations are made:

- Further surveys are not considered necessary to inform the assessment of invertebrate communities in ERS habitats – surveys at the locations detailed in this report, due to the limitations described, have been bolstered with detailed desk study and literature review, which has demonstrated the importance of these uncommon habitats in the Tame and Trent catchments.
- It is unlikely to be feasible to control or eradicate INNS at a catchment scale given the prevalence of these species along the Rivers Tame and Trent – notably Himalayan balsam, Japanese knotweed, and giant hogweed. However, ERS habitats on the local scale could be monitored for establishment by INNS, and steps taken to safeguard the integrity of ERS by localised control of INNS, should there be a risk of them becoming established (in particular, Himalayan balsam). This would also contribute to Biodiversity Net Gain (BNG) objectives by maintaining and enhancing these habitats. There are developing options for the control of INNS, for example a rust fungus for the control of Himalayan balsam<sup>25</sup>. Such options could be explored as part of mitigation for the scheme.
- To further increase BNG, work with stakeholders at a catchment scale to identify suitable areas along the River Tame and River Trent to enhance and protect ERS habitats, for example in combination with other restoration schemes such as that at Lea Marston. Previous studies have indicated that colonisation of ERS can happen within a short period (within 2-3 years), and therefore the creation and management of these habitats may bring rapid benefits for biodiversity.
- Riparian and nearby (<30 m stated by Bell and Sadler, 2001) wetland habitats provide essential refuge for invertebrates during high flows and as overwintering sites. Ecological assessment of water dependent habitats and designated sites adjacent to the River Tame has been undertaken at Gate 2 and Gate 3, and there may be the potential to enhance riparian habitats locally through the BNG aspirations of the scheme and provide corresponding benefits to adjacent or nearby ERS habitats – such enhancements could be targeted to also benefit adjacent ERS habitats.
- There are no risks of the proposed scheme to sediment mobilisation or transport in the Rivers Tame or Trent. However, catchment-wide measures could be explored to minimise fine sediment inputs from land drainage, which may currently have an adverse effect on ERS habitats. Such measures could include:
  - Working with stakeholders to facilitate effective land management practices to reduce sediment runoff from agriculture, for example riparian fencing and the installation of cattle drinkers, and the maintenance of vegetated buffer strips along watercourses;

<sup>25</sup> <https://www.cabi.org/projects/biological-control-of-himalayan-balsam/#:~:text=The%20rust%2C%20a%20Puccinia%20species,balsam%20throughout%20the%20growing%20season.>

- Seek opportunities for habitat creation, in particular wetland habitat in the riparian zone, to contribute to the network of sites for biodiversity benefit.
- Irregular flow patterns in the River Tame serve to support the continued presence of ERS habitats and the associated specialised invertebrate communities that depend on them. It is considered likely that such flow variations will remain in the River Tame due to its 'flashy' nature and observed diurnal fluctuations, which have been modelled to remain largely unchanged by the operation of the SRO scheme.
- Monitoring of ERS habitats for their continued provision of suitable habitats for the invertebrate communities that depend upon them. Look to demonstrate benefits of the SRO scheme through continued monitoring post-construction and implementation of the scheme.

## 3.7 Water Framework Directive Assessment

### Level 2 WFD Assessment

#### Assessment Basis

- 3.7.1 Level 2 screening was undertaken for both of the two flow scenarios for the Minworth SRO: the 115 MI/d flow reduction and the 230 MI/d flow reduction.
- 3.7.2 Only one activity assessed at Level 1 screening, the cessation of an existing discharge, was considered to be a great enough risk to carry water bodies through to Level 2 WFD assessment. This activity posed a risk to the following five water bodies:
- Tame – R Rea to R Blythe (GB104028046841)
  - Tame from R Blythe to River Anker (GB104028046440)
  - Tame from River Anker to River Trent (GB104028047050)
  - Trent – R Tame to R Dove (GB104028047180)
  - Trent from Dove to Derwent (GB104028047420)
- 3.7.3 There is potential that changes caused by the transfer will cause deterioration of water bodies.

### Level 2 WFD Assessment Summary

- 3.7.4 The Gate 3 WFD assessment report details the Level 2 WFD assessment for the 115 MI/d and 230 MI/d flow reduction scenarios respectively.
- 3.7.5 There are five potential impacts which apply to all water bodies carried through to Level 2 assessment and both flow reduction scenarios.
- 3.7.6 The results of the Minworth Gate 2 Annex B2 Hydrological and Hydraulic Modelling: Tame and Trent modelling show only small changes in flow depths and velocities within the Rivers Tame and Trent which are not anticipated to result in a deterioration of WFD status of any of the five water bodies. For full results see Appendix A of the Gate 2 Annex B2 report. As such there should be no impact on the River Blythe SSSI, a tributary of the Tame.
- 3.7.7 Changes in flow are particularly small during annual flood events, which are the flows generally responsible for controlling channel footprint and morphology, and so there will be no significant change in these elements as a result of the scheme (which is likely to be operating at the minimum 23 MI/d 'tick-over' flow during those conditions).
- 3.7.8 Furthermore, the current discharge of recycled water from Minworth WwRC into the River Tame causes baseline flows to be artificially elevated above natural conditions. A reduction in the volume of recycled water discharged from Minworth is therefore a return to more natural hydrological conditions.
- 3.7.9 A return to more natural hydrological conditions may be of some benefit to aquatic ecology within the water bodies. For example, reduced flows in the River Tame at times of low flow may result in the establishment of greater macroinvertebrate habitat. For a full assessment of the impact on macroinvertebrates, refer to Gate 3 Annex B3.3 Invertebrates of Exposed Riverine Sediments (ERS).

For impacts to macrophytes, refer to Gate 3 Annex B3.2 River Habitat Surveys and Aquatic Macrophyte Surveys.

- 3.7.10 Results from Gate 3 Annex B3.6 Water Quality Monitoring and Modelling also show there to be no significant impact on water quality in any of the five water bodies. Modelling of dissolved oxygen and temperature in the River Tame will be reported early in Gate 4 and will feed into the on-going environmental assessments.
- 3.7.11 The Fish Passage Assessment undertaken at Gate 3 (Gate 3 Annex B3.4) concluded that there are two weirs at Lea Marston where fish passage may be reduced as a result of both the 115 MI/d and 230 MI/d flow reduction scenarios within the Tame and Trent system. These weirs, and the water body they are in, are:
- A4097 Weir: Tame from R Blythe to River Anker (GB104028046440); and
  - Nether Whitacre Weir: Tame from R Blythe to River Anker (GB104028046440).
- As such there may be potential impacts to fish passage within this water body. There may also be impacts to water bodies upstream of the weirs, namely Tame from River Anker to River Trent (GB104028047050) and Tame – River Rea to River Blythe (GB104028046841). It is therefore recommended that improvements to fish passability are investigated at Gate 4 such that there is no significant impact. Should adequate measures be put in place, then there should be no significant impact to fish within these water bodies and therefore there should be no significant impact to their WFD classification. It is noted that further assessment at Gate 4 will consider the in-combination effects with independent schemes, for example restoration of the River Tame at Lea Marston.

## Conclusions and Recommendations

- 3.7.12 Five water bodies were identified for inclusion in the Gate 3 Level 1 assessment for both the 115 MI/d and 230 MI/d flow reduction scenarios, with all five water bodies being carried forward to Level 2 of the WFD assessment. This was because one activity assessed at Level 1 screening, the cessation of an existing discharge, was considered to be a great enough risk to carry the five water bodies through to Level 2 WFD assessment, based on the ACWG scoring system.
- 3.7.13 No significant impacts are predicted in terms of changes to channel footprint, changes in sediment deposition, changes in hydromorphology, or changes in water quality in any of the five water bodies. The conclusion that impacts on hydromorphology and sediment transport processes are likely to be minimal is based on the fact that changes in water depth and flow velocity are predicted to be small, particularly during high flows that control geomorphological processes and conditions.
- 3.7.14 The conclusion that there will be no significant impact to water quality is based on the results of Gate 3 Annex B3.6, which shows that there are no significant impacts to WFD components.
- 3.7.15 However, there is a potential impact relating to the change in flow velocity and volumes. Reduced water depths over two weirs may impact fish passage, based on the findings of Gate 3 Annex B3.4. This impact is considered limited upstream of Minworth due to the current assemblage of fish present in the River Tame; however, the fish passage assessment also considers future scenarios should migratory fish species return to the river.
- 3.7.16 Gate 3 Annex B3.6 has concluded that any changes to water quality in the Rivers Tame and Trent as a result of the reduced discharge from Minworth will not be significant. The modelled change in phosphate and ammonia through the SIMCAT model is insignificant and does not lead to a change in WFD status. Temperature and dissolved oxygen have been modelled and results will be reported early in Gate 4, but early indications are that again any changes will not be significant.
- 3.7.17 At Gate 4, it is recommended that improving fish passage at the two weirs potentially impacted is investigated further, with the aim of establishing an understanding of what measures are required to maintain fish passage at current levels as a minimum (such as design of a fish pass), in combination with other proposed schemes such as restoration of the River Tame at Lea Marston. Should adequate measures be put in place, then there should be no significant impact to fish within these water bodies and therefore should be no significant impact to their WFD classification.

- 3.7.18 Modelling of temperature and dissolved oxygen at Gate 3 will be reported early in Gate 4 - the WFD assessment will be updated with these results when they are available. The water quality assessment makes further recommendations for continued monitoring, including reducing the limit of detection (LoD) for some determinands to allow more accurate assessment against the Environmental Quality Standard (EQS), and likewise, the WFD assessment will be updated accordingly at Gate 4.
- 3.7.19 This WFD assessment should be reviewed at a later design stage to provide assurance that the developed scheme complies with the WFD.

## 3.8 Habitats Regulations Assessment

### Habitats (European) Sites

#### Humber Estuary SAC, SPA and Ramsar

- 3.8.1 The Humber Estuary is a large macro-tidal estuary with high suspended sediment loads, leading to the rapid accreting and eroding of intertidal mudflats, sandflats, saltmarsh and reedbeds. With declining salinity upstream, tidal reedbeds and brackish saltmarsh lie on the fringes of the estuary. Notable fish species include river and sea lamprey, which migrate up the estuary to breed in upstream freshwater bodies. The south bank of the estuary (Donna Nook) provides habitat for breeding grey seal colonies from September to December.

#### River Mease SAC

- 3.8.2 The Natural England standing advice for the River Mease SAC describes the river as a relatively natural lowland river which contains a diverse range of physical in-channel features including riffles, pools, slacks, vegetated channel margins and bankside tree cover, providing the conditions necessary to sustain populations of spined loach and bullhead. The river is also considered to support a significant presence of water-crowfoot *Ranunculus fluitans* and water starwort *Callitriche sp.*

#### Ensor's Pool SAC

- 3.8.3 Ensor's Pool lies on the western edge of Nuneaton in the north of Warwickshire and formed in an abandoned clay pit. It is about 220 metres long, 50 metres wide with an average depth of eight metres and is fed by groundwater. The pool overlies Etruria Marl which was extracted for brickmaking earlier this century. Ensor's Pool is associated with an exceptionally large population of native white-clawed crayfish *Austropotamobius pallipes* estimated at 50,000 individuals.

## Screening for Likely Significant Effects

### Initial HRA Scoping Carried Over From Gate 2.

- 3.8.4 Due to the iterative nature of the project development process, the Gate 1 and Gate 2 stages (which have been informally consulted on by Natural England and the Environment Agency) have narrowed down the key relevant impact pathways that require consideration.
- 3.8.2 The Gate 2 HRA<sup>26</sup> identified that the **Humber Estuary SAC, SPA and Ramsar sites** could potentially be affected by **changes in water flow** resulting from the SRO. Impacts identified are:
- Reduced water flows restricting the ability of designated migratory fish species (river lamprey and sea lamprey) to migrate within the River Trent (NB Gate 1 investigations identified that migratory fish species are not present within the River Tame); and
  - Changes to macroinvertebrate and macrophyte populations upon which the designated bird species feed upon within the Humber Estuary (as a result of decreased freshwater outputs).
- 3.8.5 Detail from Gate 3 technical assessments has been used to assess these potential impact pathways further.
- 3.8.3 Potential for effects on the **River Mease SAC** is considered limited but needs to be proven beyond reasonable scientific doubt. The preliminary Gate 1 assessment did not identify any significant transmission pathways by which a Likely Significant Effect could reasonably occur. However informal liaison at this time with the Environment Agency, Natural England and other relevant stakeholders

<sup>26</sup> Gate 2 Minworth Annex B3.1.3 Appendix C River Mease SAC; and Gate 2 Minworth Annex B4 EAR

before commencing Gate 2 identified concerns regarding potential effects the River Mease SAC depending on **hydrological connectivity** with the Minworth SRO. This has been determined and verified for Gate 2. Detail provided to inform Gate 3 will be used to assess this impact pathway further. It is noted that the Gate 2 in combination assessment considered in combination impacts of the proposed Packington Scheme.

- 3.8.4 **Ensor's Pool SAC** is located 13km from the Minworth – Atherstone pipeline. The Gate 2 Environmental Assessment Report identified that Ensor's Pool SAC could be screened out. The Environment Agency has confirmed Ensor's Pool is groundwater fed and is not hydraulically linked to nearby ordinary watercourses. The Environment Agency's Groundwater Team highlighted that any development within 2-3km of Ensor's Pool SAC could have a hydrogeological connection to Ensor's Pool. At 13km distant, the nearest part of the scheme is therefore well beyond any area for effects on SAC groundwater, and as such there is **no potential for likely significant effects. Ensor's Pool SAC is not discussed further within this report.**

## Water Quantity, Level and Flow

- 3.8.6 The unique nature of wetlands combines shallow water, high levels of nutrients and high primary productivity. These conditions are ideal for the growth of organisms at the basal level of food webs, which feed many species of birds, mammals, fish and amphibians. Overwintering and migrating wetland bird species are particularly reliant on these food sources, as they need to build up enough nutritional reserves to sustain their long migration routes.
- 3.8.7 Maintaining a steady water supply is of critical importance for many hydrologically dependent SPAs, SACs and Ramsar sites. For example, in many wetlands winter flooding is essential for sustaining a variety of foraging habitats for SPA / Ramsar wader and waterbird species. However, different species vary in their requirements for specific water levels. Splash and / or shallow flooding is required to provide suitable feeding areas and roosting sites for ducks and waders. In contrast, deeper flooding is essential to provide foraging habitats for Bewick's swans and other ducks.
- 3.8.8 Wetland habitats rely on hydrological connections with other surface waters, such as rivers, streams and lakes. A constant supply of water is fundamental to maintaining the ecological integrity of sites. However, while the natural fluctuation of water levels within narrow limits is desirable, excess or too little water supply might cause the water level to be outside of the required range of qualifying birds, invertebrate or plant species. This might lead to the loss of the structure and functioning of wetland habitats. Direct changes to the hydrology of water bodies connected to the Minworth SRO have the potential to impact habitats Sites where there is hydrological connectivity.
- 3.8.9 Overall, the following Habitats Sites are considered potentially sensitive to water quantity, level and flow and are taken forward into screening:
- Humber Estuary SPA, SAC and Ramsar site; and,
  - River Mease SAC.

### Humber Estuaries Habitats Sites

- 3.8.10 The following potential impacts are screened for likely significant effects as a result of changes to water levels and flows through the hydrological connectivity:
- Changes in the bird population
  - Fish Passage
- 3.8.11 Localised changes in the potential invertebrate assemblage of the Humber Estuary SPA/Ramsar site could arise at the confluence between the River Trent and River Humber if the diversion of water is sufficiently great to affect overall flows and thus salinity, depending on the tolerance of the invertebrates present to changes in salinity. This has been informed by a flow impact analysis.
- 3.8.12 Both the River Tame and the River Trent are tributaries of the River Humber. However, fish studies and a desktop data search conducted to inform Gate 1 identified that no migratory fish (i.e. the designated river lamprey and sea lamprey) are present within the River Tame. Due to the presence of existing weirs on the River Trent, it is likely that the river lamprey and sea lamprey are not present far up the River Trent due to these obstacles. However, the scheme needs to be future proof and it is understood that

there are plans to provide fish passes within the River Trent to enable the migration of the river lamprey and sea lamprey further within the river. As such the impact of potential changes to water flows on existing fish passes within the River Trent has also been undertaken.

### Flow Impact Analysis and Effect on SPA Bird Populations

- 3.8.13 The operation of the SROs will reduce river flow in the River Tame and River Trent. Hydrological and hydraulic modelling studies have been undertaken at Gate 2 and Gate 3 to quantify the potential impact on river flows, levels, velocity, and wetted perimeter across the two rivers to support hydro-ecological impact assessment.
- 3.8.14 In agreement with the Environment Agency, the models used are limited to the non-tidal section of the River Trent at Cromwell. The models do not include for approximately 77km of the River Trent (and its contributing catchment); therefore, the models cannot be used to estimate impact on total River Trent flow into the Humber estuary.
- 3.8.15 For the purposes of estimating total flow into the estuary, a combination of simulations from the non-tidal models used at Gate 3, and gauging stations on tributaries draining into the tidal Trent have therefore been used to estimate total flow to the estuary. However, the limited coverage of gauging stations means a large proportion of the catchment below Cromwell weir is not represented in the calculations and the resultant outputs will underestimate total flow and will be a conservative representation of flow into the estuary.
- 3.8.5 Estimated flow statistics for total flow to the estuary (from the Trent catchment) were derived for the present day and for a climate change scenario consistent with the single scenario used in the hydraulic modelling for Gate 3 and ST's WRMP24: this was RCP6.0-RCM08 (2040s).
- 3.8.6 Utilisation profiles of the Minworth SRO (supporting both GUC and STT SROs) were modelled at Gate 3, and using these hydrological model outputs, it was possible to estimate an average flow reduction due to operation of Minworth SRO in the present day and in the climate change future selected. Utilisation profiles for Lincolnshire Reservoir were not simulated for the Minworth SRO Gate 3 studies as the abstraction location is to be downstream of Cromwell Weir and hence outside of the spatial scope of the Gate 3 models. However, a maximum flow reduction is available for the SRO (300 MI/d) based on hydrological modelling being undertaken by Anglian Water; maximum reductions for Minworth SRO are also available based on the utilisation profiles (115 MI/d for the GUC component and 115 MI/d for the STT component). Moreover, since the Lincolnshire Reservoir abstraction location is now to be located in the tidal part of the Humber Estuary SPA/Ramsar site, it will not operate in combination with the Minworth SRO on freshwater flows into the estuary.
- 3.8.16 The analysis indicates the following when considering the likely average SRO utilisation:
- The average use of the GUC SRO component of Minworth SRO could result in a reduction in mean flow to the Humber of approximately 0.5% in the present day and 0.6% in the climate change future.
  - The average use of the Minworth SRO (GUC and STT SROs combined) could result in a reduction in mean flow to the Humber of approximately 1% in the climate change future<sup>27</sup>.
- 3.8.17 Looking at worst case SRO usage i.e. the SROs all being used at their maximum:
- The GUC SRO component of the Minworth SRO could result in a reduction in mean flow to the Humber of approximately 1.4% in the present day and 1.5% in the climate change future.
  - The Minworth SRO (GUC and STT SROs combined) could result in a reduction in mean flow to the Humber of approximately 2.8% in the present day and 3% in the climate change future.
  - The combination of Minworth SRO (GUC & STT) with LR used at maximum could result in a reduction in mean flow to the Humber of approximately 6.4% in the present day and 6.8% in the climate change future.
- 3.8.18 However, the maximum utilisation of all SROs needs to be considered in context. For example, the GUC SRO component of Minworth will only operate at its maximum for 1% of years simulated in the

<sup>27</sup> Note, the Gate 3 modelling did not represent detailed utilisation of the STT SRO for the present day and focused on climate change only; therefore, average use of the STT is not available for the present day, only the known maximum use.

modelling<sup>28</sup> and for those years, only during the months of June, July and August which is the period when SPA/Ramsar bird presence will be lowest, as the SPA/Ramsar is of greatest importance for non-breeding birds which are only present in large concentrations during the winter and passage periods (i.e. September to March) when freshwater flows are naturally greatest. The STT SRO component of Minworth is only one of several support sources to the STT scheme as a whole, and hence its use is variable, and the LR scheme would draw on River Trent flows supplementary to abstractions from the River Witham catchment. Therefore, all three SRO schemes operating at their maximum is extremely rare and hence the analysis focuses on calculating average SRO use impacts on mean river flows. For the purposes of this assessment, it is the approximate <1% average reduction in flows that is considered most useful.

- 3.8.19 A reduction in water levels due to the abstraction has the potential to impact upon the aquatic invertebrates upon which the designated bird populations in the Humber Estuary SPA and Ramsar rely. However, a likely significant effect would only be possible if the reduction in freshwater inputs (thus resulting in a change of salinity) at the confluence of the Trent and Humber were to affect the invertebrates and plants on which the SPA and Ramsar designated bird species feed.
- 3.8.20 Given the modelled mean reduction in freshwater inputs of 0.56%-1% from the Trent, a minimal (if any) effect on the resident macroinvertebrate and macrophyte communities of the Humber estuary SPA would result. Typical estuarine taxa acting as a food source for birds would include *Hydrobiidae* snails such as spire snail *Ecobia ventrosa* and lave spire snail *Peringia ulvae*, oligochaete worms including *Baltidrilus costatus* (formerly *Heterochaeta costata*), and *polychaete* worms (ragworms) such as the common ragworm *Nereis (Hediste) diversicolor*. Numerous shrimp/prawn species (e.g. *Crangon crangon*, *Palaemonetes varians*, *Neomysis integer*) may also be present in shallow margins or estuarine pools. Macrophytes providing cover in the Humber estuary for birds are typically dominated by very large beds of the common reed *Phragmites australis*. These macroinvertebrates and macrophyte organisms occupying the Humber Estuary have wide salinity tolerances in order to survive tidal-mediated fluctuations in water chemistry so the modelled reduction in flow from the River Trent is unlikely to have any influence.
- 3.8.7 It is considered likely based on Gate 3 modelling that Likely Significant Effects (LSEs) will not result in-combination or in isolation, regarding the impact of Water Quantity, Level and Flow on bird populations. However, this conclusion will be revisited at Gate 4 with the results of updated hydrological and hydraulic modelling.

### Fish Passage

- 3.8.8 A reduction in water levels due to the abstraction has the potential to affect fish passage along the River Trent potentially impacting migratory fish which are qualifying features of the Humber Estuary SAC or Ramsar site, specifically sea lamprey and river lamprey.
- 3.8.9 Fish can only migrate upstream if water velocity is equal to or less than the fish's swimming ability. Therefore, fish passage should ensure the water velocity is not greater than the natural stream velocity. It is probable that a reduction in flow would reduce velocities and so the magnitude of this is not considered to pose further passage issues. Changes in depth may, however, potentially affect lamprey passage upstream at the Holme Sluices fish pass (refer to Gate 3 Annex B3.4 River Tame and Trent Fisheries Assessment) and thus the Humber Estuary SAC and Ramsar site.
- 3.8.10 Given the separation between the WwRC outfall locations and the Humber Estuary Habitat sites (>120 km) the only potential impact pathway is whether the Minworth SRO, either alone or in-combination with other projects, would result in a reduction in water levels in the Humber Estuary SAC or Ramsar site, or upstream of the site, sufficient to disrupt the ability of sea lamprey and river lamprey to travel to and from the SAC/Ramsar site, given that the Humber Estuary SAC and Ramsar site includes approximately 15 km of the River Trent in its tidal reaches between Keadby and the Humber Estuary itself.
- 3.8.11 There are no records of river/sea lamprey in the River Tame. River/sea lamprey are recorded in the River Trent to a point downstream of Newton Weir<sup>29</sup>. Table 3-4 summarises the impact of the SRO (GUC and STT SROs combined) on weirs in the Rivers Tame and Trent<sup>30</sup>.

<sup>28</sup> Using 19,200 years of stochastic data.

<sup>29</sup> Gate 3 Minworth Annex B3.5 Fish Olfaction Assessment (River Tame)

<sup>30</sup> Gate 3 Minworth Annex B3.4 River Tame and Trent Fisheries Assessment

**Table 3-4 SRO impact on weirs in the Rivers Tame and Trent**

<b>Site (Upstream to Downstream)</b>	<b>SRO Impact</b>
Site 3 – Lea Marston Weir (River Tame)	The SRO would have a positive impact
Site 4 - Coton Weir (E) (River Tame)	The SRO would not have an impact on the overall passability
Site 5 – Coton Weir (Central) (River Tame)	The SRO would not have an impact on the overall passability
Site 6 – Coton Weir (W) (River Tame)	Overall, the SRO would not have an impact on the overall passability on any species at Coton Weir West, with it already being considered a 'complete barrier' for all flows and species for the baseline situation
Site 7 - A4097 Weir (River Tame)	Eels, lamprey and cyprinids - the SRO would not have an impact Salmon - SRO would have a negative impact for salmon passability at Qmean flow conditions due to the reduction in depths Trout - the SRO would have a negative impact for trout passability at Qmean flow conditions due to the reduction in depths
Site 8 - Nether Whitacre Weir (River Tame)	The SRO would have a negative impact on fish passability, in particular for salmon and trout, under Q95 and Qmean, due to the reduction in depths and increase in hydraulic head associated with the reduction on flows
Site 9 - Broad Meadow LNR Upstream Weir (River Tame)	The SRO would not have an impact on the overall passability on any species at Broad Meadow LNR Downstream Weir, with it already being considered a 'complete barrier' for all flows and species for the baseline situation, limited by depths.
Site 10 - Broad Meadow LNR Downstream Weir (River Tame)	The SRO would not have an impact on the overall passability on any species at Broad Meadow LNR Downstream Weir, with it already being considered a 'complete barrier' for all flows and species for the baseline situation, limited by depths.
Site 11 - Meadow Weir (River Tame)	The SRO would have a negative impact only on trout passability at Qmean flows.
Site 12 - Newton Weir (River Trent)	The SRO would have a positive impact on salmon, trout and lamprey passability
Site 13 - Sawley Weir (River Trent)	The SRO would not have an impact on the overall passability of any of the species
Site 14 - Thrumpton Weir (River Trent)	The SRO would not have an impact on the overall passability of any of the species
Site 15 - Beeston Weir (River Trent)	The SRO would not have an impact on the species passability along the weir or fish pass, with both already being considered 'complete barriers' for all flows and species for the baseline situation.
Site 16 - Holme Sluices Colwick (River Trent) and associated fish pass	The scheme would decrease the amount of time that the fish pass is operational by on average a reduction of 2-3 days per year. This effect is considered of minor significance. Velocity conditions through the sluices are unsuitable for all species at all flows, under baseline and SRO scenarios. Given conditions are similar under baseline and SRO scenarios, the SRO would not have an impact on the species passability through the sluices (with passage not deemed possible under the existing or with SRO scenarios).
Site 17 - Stoke (Bardolph) Weir (River Trent)	The SRO would not have an impact on passability for any of the species
Site 18 - Gunthorpe Weir (River Trent)	The SRO would not have an impact on passability for any of the species
Site 19 - Hazelford Weir (South) (River Trent)	The SRO would not have an impact on passability for any of the species.
Site 20 - Hazelford Weir (North) (River Trent)	The SRO would not have an impact on passability for any of the species.
Site 21 - Averham Weir (River Trent)	The SRO would not have an impact on passability for any of the species.
Site 22 - Newark Weir (River Trent)	The SRO would not have an impact on passability for any of the species.
Site 23 - Nether Lock Weir (River Trent)	The SRO would not have an impact on passability for any of the species.
Site 24 - Cromwell Weir (River Trent)	The SRO would not have an impact on the species passability along the weir or fish pass, with both already being considered 'complete barriers' for all flows and species for the baseline situation. However, the weir and fish pass remain passable under higher flow conditions and river/sea lamprey are recorded upstream; therefore, passability will be unaffected by the operation of the Scheme.

- 3.8.12 The only locations where passability would be affected due to the SROs (GUC and STT SROs in combination) are Site 6 (Coton Weir), Site 7 (A4097 Weir) and Site 8 (Nether Whitacre Weir). These are all on the River Tame where there are no records of qualifying sea or river lamprey. Moreover, passability on Sites 7 and 8 would only be affected for salmon and trout rather than eels, lamprey, and cyprinids, while Site 6 is already a 'complete barrier' to fish passage for all flows and species in the baseline. Furthermore, the SRO has a positive impact on the passability of Site 12 Newton Weir potentially allowing for the potential for river/sea lamprey to pass further upstream.
- 3.8.13 The Holme Sluices and fish pass assessment has concluded that the operation of the Minworth SRO may on average result in a reduction of 2-3 days per year when the fish pass is operational. The significance of this in relation to the Humber Estuary SAC will be assessed further at Gate 4 in consultation with the Environment Agency and Natural England, supported by on-going hydraulic modelling.
- 3.8.14 In summary, further assessment is required at Gate 4 to assess the significance of the predicted impacts to the Holme Sluices fish pass, supported by updated hydrological and hydraulic modelling. Updated modelling will include the updated Aquator model to assess the in-combination effects of AMP8 and AMP9 schemes. The Lincolnshire Reservoir SRO will now abstract from the tidal reach of the Humber Estuary SAC/SPA/Ramsar site and will therefore not affect fish passage along the River Trent or Tame in combination with the GUC and STT SROs.

## River Mease SAC

- 3.8.21 For the Gate 2 study, an investigation was undertaken into potential hydrological linkages between the River Tame and the River Mease SAC<sup>31</sup>. This identified that the underlying geology for the River Mease consists of superficial river terrace deposits overlying the Gunthorpe Member (comprising mudstone). The river terrace deposits allow for more groundwater movement and infiltration of surface water due to their high permeability, whereas the Gunthorpe Member has very low permeability. It therefore allows limited amounts of groundwater movement and there is limited infiltration from surface water. Due to the high permeability of the river terrace deposits, it is expected that these deposits will have relatively high hydraulic conductivity and interact with the River Mease, providing baseflow.
- 3.8.22 The accretion data indicate that the Mease does not gain additional baseflow from the superficial aquifer in the Tame surface water catchment at the expense of the River Tame but continues to accrete from baseflow from the superficial aquifer within the Mease surface water catchment. The flows and levels in the lower River Mease will therefore not be influenced by changes in River Tame levels via hydraulic continuity with the river terrace gravels secondary aquifer and are therefore not expected to be affected by reduction in discharge at Minworth. Rather river flows are dependent on local recharge to the superficial aquifer and the sandstone principal aquifer in its upper reaches, and upstream discharges.
- 3.8.23 Moreover, even under the scenario with a 230 Ml/d flow reduction at Minworth (equivalent to both GUC and STT operating at their maximum) the predicted fall in River Trent levels (8.2cm at Q95 and 5.2cm at Q50) is not considered likely to lower groundwater levels in the lower Mease area sufficiently to result in loss of flow to the superficial secondary aquifer, compared to seasonal variation in river levels, aquifer recharge, and the influence of discharges and evaporative losses from former quarry lakes on river levels. Water levels are recorded on the River Trent near the confluence with the River Mease at Croxall. Water levels show a seasonal variation in excess of 1m. Water levels are recorded on the River Tame at Tamworth, upstream of where River Tame water levels may interact with the superficial aquifer considered to be in hydraulic continuity with the lower River Mease. The gauge shows a typical seasonal variation of approximately 0.3m, with occasional brief peaks in excess of 1m higher than the typical range.
- 3.8.24 Abstractions and discharges local to the site may influence flow and river levels. The Gate 1 assessment identified that there are no significant surface water abstractions near the mouth of the River Mease as it flows into the River Trent. There are five discharge points close to the mouth of the River Mease which are associated with Barton quarry and Alrewas quarry, discharging to the River Tame and River Trent. However, these locally augment flow near the River Mease and may support local groundwater levels in the superficial aquifer and are therefore not expected to reduce flows in the Mease in combination with the Minworth SRO. Since changes in levels and flows in the River Tame will not affect levels and flows in the River Mease SAC, and even the maximum reduction in flow at Minworth would not result in

<sup>31</sup> Minworth Gate 2 Annex B3.1 Environmental Assessment: Minworth and SLR Overall Report

a sufficient fall in River Trent levels to materially affect the superficial aquifer linked to the lower River Mease, it can be concluded that the Minworth SRO will not result in a likely [adverse] significant effect on the River Mease SAC or its qualifying interest features either alone or in combination with other plans and projects.

- 3.8.25 Moreover, since both white-clawed crayfish and bullhead are species preferring relatively shallow water (as identified in the Supplementary Advice on the Conservation Objectives for River Mease SAC) it is understood that Natural England have an aspiration to reduce flow levels in the River Mease SAC to restore them to a more natural level compatible with its international interest features. This is reflected in the SAC target (associated with the Supplementary Advice on the Conservation Objectives) to '*Restore the natural flow regime of the river, with daily flows as close to what would be expected in the absence of abstractions and discharges (the naturalised flow)*'. As such, it is possible that the planned reduction in flows in the River Mease that will arise from the relocation of the discharge from Packington WTW on the Gilwiskaw Brook out of the River Mease SAC catchment could make a positive contribution to this objective. In the unlikely event that the Minworth SRO contributes to the reduction in flow in the Mease, it would also contribute to this benefit, although any beneficial in-combination effect would be very minor.
- 3.8.15 Likely Significant Effects (LSEs) can be discounted, and it is considered likely that the site will be screened out for appropriate assessment regarding the impact of Water Quantity, Level and Flow. However, this conclusion will be revisited at Gate 4 with the results of updated hydrological and hydraulic modelling.

## HRA Conclusions and Recommendations

- 3.8.16 This HRA was undertaken at Gate 3, and the assessment undertaken within this report builds upon the Gate 2 HRA.
- 3.8.17 At Gate 2 impacts on **Ensor's Pool SAC** were screened out from resulting in a likely significant effect due to the lack of a realistic linking impact pathway between the SRO and the SAC. It was screened out based on the lack hydrological connectivity between the SRO and the SAC and the distance from the SRO to the SAC.
- 3.8.18 The Gate 2 HRA<sup>32</sup> discussed potential impacts on the **River Mease SAC**. Modelling to inform the Gate 2 HRA concluded that any changes in levels and flows in the River Tame will not affect levels and flows in the River Mease SAC. Even the maximum reduction in flow at Minworth would not result in a sufficient fall in River Trent levels to materially affect the superficial aquifer linked to the lower River Mease. It was concluded that the Minworth SRO would not result in a likely [adverse] significant effect on the River Mease SAC or its qualifying interest features either alone or in combination with other plans and projects. This conclusion will be revisited at Gate 4 with the results of updated hydrological and hydraulic modelling.
- 3.8.19 The Gate 2 HRA identified that the **Humber Estuary SPA and Ramsar sites** could potentially be affected by changes in water flow resulting from the operation of the Minworth SRO. Potential impacts identified and assessed are:
- Reduced water flows restricting the ability of designated migratory fish species (river lamprey and sea lamprey) to migrate within the River Trent, including potential effects at Holme Sluices and the associated fish pass; and
  - Changes to macroinvertebrate and macrophyte populations upon which the designated bird species feed upon within the Humber Estuary (as a result of decreased freshwater outputs and corresponding changes in salinity).
- 3.8.20 It was concluded that because the macroinvertebrate and macrophyte organisms occupying the Humber Estuary, that designated bird species feed upon, have wide salinity tolerances in order to survive tidal-mediated fluctuations in water chemistry, a 1% reduction in flow from the River Trent would not have a significant influence. **No likely significant effect in isolation or in combination with other projects and plan was concluded.** However, this conclusion will be revisited at Gate 4

<sup>32</sup> Gate 2 Minworth Annex B3.1.3 Appendix C River Mease SAC; and Gate 2 Minworth Annex B4 EAR

with the results of updated hydrological and hydraulic modelling and the further assessment recommendations detailed in Section 5.

- 3.8.21 An assessment of the ability of qualifying migratory fish (sea lamprey / river lamprey) for the **Humber Estuary SAC** has been undertaken using the modelled water flows over weirs in the Rivers Tame and Trent (refer to Gate 3 Annex B1.6 Tame & Trent Hydrological and Hydraulic Modelling Report; and Annex B3.4 River Tame and Trent Fisheries Assessment) and concluded that there is **no likely effect in isolation or in combination with other projects and plans**. However, given the uncertainty regarding potential effects on fish passage at Holme Sluices, and on-going modelling, this conclusion will be revisited at Gate 4 with the results of updated hydrological and hydraulic modelling.
- 3.8.22 Update to the HRA at Gate 4 will be supported by on-going hydraulic modelling and in consultation with the Environment Agency and Natural England, and also informed by on-going discussion with Anglian Water regarding potential in-combination effects with the Lincolnshire Reservoir SRO (refer also to the Gate 3 HRA for that scheme).
- 3.8.23 As a result of other environmental assessments at Gate 3 and their conclusions and recommendations, the following considerations for the Humber Estuary Habitats Sites will also be incorporated into the updated HRA at Gate 4:
- Updated hydraulic and hydrological modelling at Gate 4 utilising the latest Aquator model, which incorporates the proposed AMP8 and AMP9 schemes for ST.
  - On-going discussions with Anglian Water regarding potential in-combination effects with the Lincs Reservoir SRO, considering predicted utilisation of the scheme, abstraction location in the Trent (currently expected to be downstream of Cromwell Weir), and any future changes to the scheme. Including on-going engagement with Natural England and the Environment Agency to confirm the scope of in-combination assessment.
  - Refined modelling of reduced flows and resulting potential changes in salinity into the Humber Estuary SAC/SPA and the tidal Trent downstream of Cromwell Weir. Seeking additional (existing and available) flow data for freshwater inputs to the Humber Estuary, in order to quantify the potential effects on flows and salinity in the Estuary and tidal Trent.
  - Extended literature review of species' tolerances to potential changes in salinity in the tidal Trent and Humber Estuary, including macroinvertebrates, macrophytes, and fish, to establish whether they may be affected by predicted minor changes in salinity.
  - Potential impacts of olfactory disrupting chemicals on migratory fish (Cypermethrin and Mancozeb in particular – refer to Gate 3 Annex B3.5 Water Quality Monitoring and Modelling Report; and Annex B3.5 Fish Olfaction Assessment), as a result of reduced dilution of the River Tame due to the diversion of recycled water from Minworth WwRC, supported by on-going water quality monitoring and modelling at Gate 4.
  - Consideration of temperature and dissolved oxygen modelling of the River Tame, and whether there is a likelihood of impacts propagating along the River Trent to the Humber Estuary SAC.
  - Consideration of the likelihood of other water quality impacts, informed by on-going water quality monitoring and modelling for the Rivers Tame and Trent at Gate 4.
  - All previous assessments will be revisited (Gate 1, Gate 2, Gate 3) to present a holistic assessment of all potential effects and provide robust justification as to why some impacts have been screened out, if that remains the case. This will include, for example, previous assessments of potential impacts to the River Mease SAC and the confluence of the River Mease with the Trent.

## 3.9 INNS Risk Assessment

### Risk of INNS propagule transfer to GUC

- 3.9.1 Based on the detailed INNS risk assessment, it is clear that no INNS propagules could survive, or move through, the entire treatment process (i.e. existing WwRC + AWTP) and be subsequently transferred to the Coventry Canal for the GUC transfer. However, it is noted that several treatment stages are open to the environment. As such, it is possible that INNS propagules could 'bypass' various stages of the treatment process. However, a closed system is present from AWTP-Floc-Sed

onwards. Accordingly, it is important to understand if INNS propagules could survive this part of the treatment process in isolation (i.e. excluding all preceding treatment stages). This specific part of the treatment process is risk assessed separately in Table 3-5.

- 3.9.2 It is worth noting, realistically, the only propagules that could be introduced where a treatment stage is 'open to the environment' are plant seeds, either wind-borne seeds (such as those belonging to rhododendron), or due to 'seed rain' from plants growing adjacent to water treatment structure (with Himalayan balsam being the most likely culprit), or introduced by birds perching on the edges of tanks and other structures (e.g. in mud on their feet or in their faeces). Regardless, Table 3-5 considers all types of INNS.

**Table 3-5 Potential for INNS propagules to pass through or survive key AWTP treatment steps**

Treatment Step	Description	Risk of movement to next stage
Flocculation and sedimentation	The vast majority of INNS material or propagules would be removed from the process at this point and be passed into the sludge treatment stream. However, smaller particles could conceivably avoid coagulation and settlement.	No risk for most INNS material. Low risk for small plant propagules such as spores and seeds, and potentially animal larvae or veligers (although it's unlikely such animal propagules would survive the chemical environment created (i.e. due to the ferric sulphate coagulant used), even if they do pass through it).
Ozonation	The ozonation process works by breaking chemical bonds, which also has disinfectant properties. Small animals that make it this far would be destroyed at this point, as would plant spores (which lack the same protective coat as seeds).	No risk for most INNS material. Low risk for plant seeds.
Biologically activated carbon and sand filtration	The minimum INNS propagule sizes identified for relevant species (Table 3-6) are greater than those that can pass RGF sand filters. As only plant seeds could realistically reach this point, and the smallest plant seed assessed was more than 10 times too big to pass through, this is the end point for INNS propagules in the system.	No risk.
Granular activated carbon and enhanced media absorption	INNS would not reach this stage.	No risk.

### INNS propagule size

- 3.9.3 An important variable in this assessment is the minimum propagule size for various INNS species, as a key step in the treatment process (Biological Activated Carbon BAC filtration) filters out particles down to a size of <10 µm. This is particularly relevant to seeds, as these are the only propagule types that could realistically reach the BAC filtration step. No INNS seeds were sufficiently small to make it through the BAC filtration stage (Table 3-6). It is worth noting that even rhododendron seeds, which are some of the smallest in the plant kingdom, would still be far too large to pass through the BAC filtration stage.

**Table 3-6 INNS propagule size for key representative species**

Species	Propagule type	Size of propagule (1mm = 1000µm)
<b>Plants</b>		
Himalayan Balsam	Seed	3.5 mm (3,500 µm)
Water Fern	Spore mass	50 micrometres (µm)
Giant Hogweed	Seed	5 mm (5,000 µm)
New Zealand Pigmyweed	Viable fragment	2 mm (2,000 µm)
Rhododendron	Seed	Length: 1.5 mm (1,500 µm) Width: 500 micrometres (µm)

Species	Propagule type	Size of propagule (1mm = 1000µm)
<b>Animals</b>		
Zebra Mussel	Veliger	70 micrometres (µm)
Asian Clam	Larvae	200 micrometres (µm)
Signal Crayfish	Eggs	2.5 mm (2,500 µm)
	Juveniles	> 5 mm (> 5,000 µm)
Killer Shrimp	Eggs	200 micrometres (µm)
	Larvae	1.8 mm (1,800 µm)
Zander	Eggs	1 mm (1,000 µm)
	Fry	4 mm (4,000 µm)

## Discussion

3.9.4 Broadly speaking, INNS risk associated with the Minworth SRO can be usefully divided into three topics, which cover the potential that:

- INNS are spread during the construction of the AWTP and associated wetlands, e.g. propagules are brought onto the Site, or spread around the Site, in soil of dirty tyres and excavator buckets.
- INNS survive the treatment process (and get transferred to the GUC), which can be further sub-divided into two sub-topics:
  - INNS enter the WwRC in wastewater, from where propagules would need to persist and survive through all treatment steps; and
  - INNS enter the treatment process downstream of the influent point by bypassing one or more treatment steps (for this to happen, a treatment step needs to be open to the environment and there needs to be a mechanism by which the INNS could enter at that point.
- INNS are accidentally spread in byproducts of water treatment, e.g. sludge or backwash.

3.9.5 These three topics are summarised in Table 3-7 below.

**Table 3-7 Potential impacts of the Minworth SRO on INNS**

Potential impact/pathway	Risk Overview	Recommendations
Construction of the AWTP, and associated wetlands, facilitating the spread of INNS, due to construction activity overlapping areas with INNS.	INNS risk associated with the development of the AWTP at Minworth WwRC is low, as no INNS were observed within the proposed Working Area.  However, two INNS were observed in close proximity to the south boundary, and some areas within the proposed Working Area could not be viewed (due to the presence of very dense vegetation).	A Biosecurity Management Plan should be produced for the construction phase, which includes steps to prevent INNS arriving on construction equipment, defines suitable exclusion zones for the INNS identified near the south boundary of the proposed AWTP, and ensures INNS are searched for when vegetation clearance is carried out in the area of the Site that was inaccessible.
Spread of INNS to the GUC, from where they become widely dispersed across the canal network, due to INNS propagules making it though the treatment process.	If INNS were introduced in wastewater/sewage into Minworth WwRC, no INNS propagules could survive or pass through all treatment stages. As such, there is no risk associated with this sub-topic.	No INNS specific mitigation is required relating to the potential that INNS could be transferred via this pathway to the GUC.
	INNS could conceivably enter the system 'downstream' of the primary influent point, effectively bypassing part of the treatment process. However, as the system is closed to the environment from AWTP-Floc-Sed onwards (Figure 3-1), and since INNS propagules would still not survive, or pass through, all treatment stages downstream of this	No INNS specific mitigation is required relating to the potential that INNS could be transferred via this pathway to the GUC.

Potential impact/pathway	Risk Overview	Recommendations
	step, there is no risk associated with this sub-topic.	
Spread of INNS in byproducts of water treatment, i.e. sludge, to, for example, farmland.	<p>Solids are removed from water as part of the treatment process, ultimately creating sludge, some of which can be re-used away from Site (e.g. being spread on farmland). In the context of the WwRC, this risk is mitigated by the BMP in place for the Site.</p> <p>However, while this pathway presents no risk regarding INNS transfer to the GUC, it is possible that additional INNS propagules could be introduced into the sludge treatment process, or the proposed wetland, from the proposed AWTP.</p>	<p>In order to maintain the current 'status quo' with respect to INNS risk associated with the sludge treatment pathway, the BMP in place for the Site should be expanded to cover the AWTP and the associated wetland (following construction). As observed as part of this assessment, the BMP in place, due to the quality of its implementation, is sufficient to prevent the establishment of INNS around water treatment infrastructure open to the environment. Preventing INNS establishment in the proposed wetland will be more challenging. This area should be specifically monitored for INNS and a rapid response protocol developed.</p> <p>It is also important that INNS establishment on the north bank of the recycled water channel continues to be prevented, as if INNS were to establish in this area, spread into the AWTP would be sure to follow (complicating land management in this area). Given how widespread Himalayan balsam is to the south of the recycled water channel, and along the River Tame beyond, wider long-term eradication of the species would not be realistically feasible. As such, the recycled water channel represents a pragmatic 'defensive line' that should be maintained.</p>

## INNS Conclusions and recommendations

3.9.6 The Biosecurity Management Plan in place for Minworth WwRC was being followed to a high standard. Mown buffer zones around settlement tanks, filter beds, and separating the recycled water channel to the south from the rest of the Site, were well maintained and sufficient to stop INNS (plants) from establishing in such locations.

### Recommendations:

- The BMP should be updated to cover the AWTP and associated wetland (following their construction), with the land around the AWTP intake and settlement tanks, the proposed wetland, and the recycled water channel being a particular focus. A specific monitoring programme, and a rapid response protocol, should be developed for the proposed wetland.
- A strict biosecurity protocol for the construction of the AWTP and wetland should be established and agreed with all stakeholders to ensure that no INNS are inadvertently brought onto the Site.
- Open tanks should either be covered over (which is considered disproportionate in relation to INNS risk) or fitted with anti-bird spikes to prevent roosting on the edges of open tanks. If bird spikes were added, coupled with the existing vegetation management (which prevents INNS plants establishing beside open tanks etc.), it is considered that all pathways that would allow INNS propagules to bypass treatment would be cut off.

3.9.7 No INNS were observed within the development boundary of the AWTP. As such, the risk that AWTP construction could facilitate INNS spread is low. A BMP should be produced for the construction phase, with a focus on preventing introduction during the works and avoiding the INNS risks present close to the south boundary of the proposed development (i.e. the Japanese knotweed and Himalayan balsam located along the recycled water channel).

3.9.8 It was concluded that no INNS propagules could make it through all treatment stages (WwRC + AWTP). However, it was noted that INNS (realistically only plant seeds) could bypass several treatment stages. Regardless, it was also concluded that no INNS could survive, or pass through, the

treatment stages downstream of the last treatment stage (i.e. AFTW-Floc-Sed) that is open to the environment. As such, **there is a negligible INNS risk associated with the transfer of recycled water from Minworth AWTP to the Coventry Canal for the GUC Transfer**, and no INNS-specific mitigation is required in that regard. This finding does not apply to pathogens, which will be assessed in the appropriate chapter in the Environmental Impact Assessment at Gate 4.

# 4. Scoping Checklist

4.1.1 This section summarises the requirements for further assessment and mitigation beyond Gate 3. EIA Scoping is underway at Gate 3 and will incorporate the findings of the assessments presented here, while in addition considering all disciplines screened in for EIA. Table 4-1 summarises the outcome of each topic assessment, including recommendations for further assessment and appropriate mitigation options, further context and detail of which is presented in each Gate 3 technical report.

**Table 4-1 Scoping checklist – preliminary assessment of impacts and mitigation recommendations for Gate 4**

Receptor or Feature under Assessment	Significance	Impact Pathway and Source (Minworth)	Scale of Impact (Positive / Neutral / Negative)	Red/Amber/Green Risk of SRO affecting the receptor (High / Medium / Low)	Recommendations for Further Assessment	Mitigation Options
<b>Water quality monitoring and modelling, including sediment and turbidity</b>						
Water quality in the Rivers Tame and Trent; WFD compliance	Regional (WFD water body scale)	Reduced discharge of recycled water from Minworth WwRC, and corresponding changes in water quality in the River Tame/Trent – changes in dilution regime.	Neutral	Low	<p>Update water quality assessments upon completion of 12-month monitoring period. Continue water quality monitoring beyond Gate 3 to inform EIA at Gate 4. Monitoring to remain at monthly frequency at the same locations and should continue for 12-months, including in-situ sondes. Remove from monitoring, or reduce to quarterly, determinands that are consistently below LoD, where sufficiently low to measure against EQS. Reduce LoD for determinands where current LoD is not sufficiently low to allow compliance with EQS to be determined. Review monitoring suite against the EA 'Approach to Hazardous Substances Including Substances of Emerging Concern for Water Recycling Strategic Resource Options' and approach to LoD (when published). Update of water quality modelling at Gate 4.</p> <p>At Gate 4, further consideration of the source and potential mitigation for certain</p>	<p>None required – no impacts on WFD compliance and no significant impacts on phosphate or ammonia.</p> <p>Proposed improvements to the Minworth WwRC are in the pipeline independent of the Minworth SRO scheme.</p>

Receptor or Feature under Assessment	Significance	Impact Pathway and Source (Minworth)	Scale of Impact (Positive / Neutral / Negative)	Red/Amber/Green Risk of SRO affecting the receptor (High / Medium / Low)	Recommendations for Further Assessment	Mitigation Options
					determinands where dilution may increase their concentrations, where relevant.	
Water quality in the Rivers Tame and Trent: fish olfaction	Up to National	Changing concentrations of chemicals in the River Tame as a result of operation of the Minworth SRO – diversion of recycled water away from the River Tame and resulting changes in dilution or chemical inputs	Negative	Low (pending further assessment)	Further monitoring of cypermethrin at the reduced LoD. Other recommendations as above, after which the olfaction assessment should be updated.	None required (pending further assessment)
Water quality in the Rivers Tame and Trent: sediment and turbidity	Regional (WFD water body scale)	Reduced discharge of recycled water from Minworth WwRC, and corresponding changes in water quality (TSS) and sediment transport in the River Tame/Trent.	Neutral	Low (no risk)	None required	None required (Minworth discharge is not important for diluting baseflow turbidity in the River Tame)
<b>Fisheries assessment</b>						
<b>Fish Passage</b>						
Predicted negative impacts at Sites (Weirs) 7 and 8, though neither has an impact on river/sea lamprey passability: Site 7 – A4097 Weir (Tame) Site 8 – Nether Whitacre Weir (Tame) Operation of the Holme Sluices fish pass may be reduced by an average of 2-3 days per year.	Up to National	Reduction in recycled water discharge from Minworth WwRC results in reduced flows in the River Tame and subsequent impacts to fish passage at weirs and existing fish passes on the Tame and Trent.	Negative	High	Update the fish passage assessment at Gate 4 with the results of updated hydraulic and hydrological modelling. Environmental Impact Assessment (EIA) at Gate 4 to support Development Consent Order (DCO) submission. Incorporate the assessment of potential changes in river temperature and dissolved oxygen (DO) (modelled at Gate 3 and to be reported early in Gate 4) into the fisheries assessment.	Investigate mitigation options at weirs 7 and 8 to improve fish passability for the species predicted to be impacted by the operation of the SRO schemes. Liaise with Regulators and stakeholders to maximise opportunities for river restoration and the reinstatement or improvement of fish passage, for example via partnership funding. Seek further benefits of the SRO schemes, for example through Biodiversity Net Gain (BNG) assessment.
The operation of the SRO schemes is	Up to National	Modelling and fish passage analysis shows that reduced	Positive	N/A – Positive Impact	None required	None required

Receptor or Feature under Assessment	Significance	Impact Pathway and Source (Minworth)	Scale of Impact (Positive / Neutral / Negative)	Red/Amber/Green Risk of SRO affecting the receptor (High / Medium / Low)	Recommendations for Further Assessment	Mitigation Options
predicted to have a positive impact at Sites (Weirs) 3 and 12, with the latter improving lamprey passability.		flows from Minworth WwRC would improve passability at these two weirs.				
All other weirs and fish passes along the River Tame and River Trent	Up to National	No impacts on fish passage as a result of reduced recycled water discharge from Minworth WwRC.	Neutral	N/A – No impact	None required	None required
<b>Fish Olfaction</b>						
Resident and migratory fish in the Rivers Tame and Trent	Up to National	Changing concentrations of chemicals in the River Tame as a result of operation of the Minworth SRO – diversion of recycled water away from the River Tame and resulting changes in dilution or chemical inputs	Negative	Low	On-going water quality monitoring to inform further update of water quality model – to be informed by the Olfactory Chemicals List provided by the Environment Agency. Further monitoring of cypermethrin in the River Tame utilising a lower LoD. When the results of on-going monitoring are available, the mass balance calculations for cypermethrin will be updated accordingly. Updated assessment in EIA (Gate 4).	Currently considered that no mitigation is required in relation to olfactory cues in the Rivers Tame and Trent.
<b>Connectivity of designated sites to the River Tame</b>						
Ladywalk Local Wildlife Site Whitacre Heath SSSI Kingsbury Wetlands LWS RSPB Middleton Lakes	County (LWS and RSPB Reserve) Regional (SSSI)	Reduced flows in the River Tame at low flows as a result of diverted recycled water from Minworth. Connectivity of sites to the Tame assessed against hydrological modelling results.	Neutral	Low	None required	Potential for enhancement of water dependent habitats in the designated sites to meet BNG aspirations for the scheme.
Tameside Local Nature Reserve	County	Reduced flows in the River Tame at low flows as a result of diverted recycled water from Minworth.	Negative	Medium	The level of this connecting feature may need to be re-assessed to allow continued connectivity under the with-scheme scenarios.	The difference at Extreme Low Flow between base level and scenario B (worst-case) is 20 cm, meaning the channel/pipe would need to be lowered by this

Receptor or Feature under Assessment	Significance	Impact Pathway and Source (Minworth)	Scale of Impact (Positive / Neutral / Negative)	Red/Amber/Green Risk of SRO affecting the receptor (High / Medium / Low)	Recommendations for Further Assessment	Mitigation Options
		Connectivity of sites to the Tame assessed against hydrological modelling results. Disconnection of fish pass pipe/channel from Smiley Face Pool at low flows (<=Q95).			Ascertaining the level of the other end of the connecting pipe/channel to Smiley Face Pool.	amount to maintain connectivity under all scenarios; weighed up against the requirement to maintain water levels in Smiley Face Pool. Consultation with the site owners/managers and the EA to inform mitigation requirements.
<b>River Habitat Survey and Aquatic Macrophytes</b>						
Minworth WwRC site	County	Spread of INNS from Minworth along the Rivers Tame and Trent, within the WwRC site, and to the canal network (refer to INNS Risk Assessment).	Negative	Medium (INNS are already prevalent along the Tame and Trent)	INNS Risk Assessment (completed for Gate 3). Biosecurity Management Plan – already in existence for Minworth WwRC. INNS monitoring surveys.	Design of Minworth AWTP to minimise risk of INNS transfer to the River Tame (and to the GUC). Continued implementation of BMP on the Minworth site through construction and operation.
River Tame	Regional	Reduced discharge from Minworth results in greater occurrence of exposed riverine sediment (ERS) habitats for invertebrate and other species	Positive	Low	ERS invertebrate surveys (completed for Gate 3). Hydraulic and hydrological modelling of the Rivers Tame and Trent (completed for Gate 3 and to be refined further at Gate 4).	
<b>ERS habitats and invertebrates</b>						
River Tame & River Trent – ERS habitats and invertebrate species	Up to County	Risks associated with altered flow regime in the River Tame – reduced flows during periods of low flow; high flows and flood events will remain unaffected. Risk of INNS spread and establishment on ERS. Erosion of ERS and deposition of fine sediment on them.	Negative	Medium (INNS are prevalent along the Tame and Trent)	INNS Risk Assessment (completed for Gate 2 and updated at Gate 3 [Minworth site only]) Biosecurity Management Plan – already in existence for Minworth WwRC. INNS monitoring surveys.	Design of Minworth AWTP to minimise risk of INNS transfer to the River Tame (and to the GUC). Consideration of INNS control measures. Continued implementation of BMP on the Minworth site through construction and operation.

Receptor or Feature under Assessment	Significance	Impact Pathway and Source (Minworth)	Scale of Impact (Positive / Neutral / Negative)	Red/Amber/Green Risk of SRO affecting the receptor (High / Medium / Low)	Recommendations for Further Assessment	Mitigation Options
River Tame & River Trent – ERS habitats and invertebrate species	Up to County	Engineering work related to Minworth SRO and modification of discharge from Minworth.	Negative	Low	Hydraulic and hydrological modelling of the Rivers Tame and Trent (completed for Gate 3 and to be refined further at Gate 4).	Catchment-scale measures to reduce fine sediment input from land management and drainage.
River Tame & River Trent – ERS habitats and invertebrate species	Up to County	Reduced flows in the River Tame at times of low flow, in combination with higher flows remaining unaffected, may result in the establishment of additional areas of ERS. Reduction in discharge of recycled water to River Tame provides improvements to water quality.	Positive	N/A – positive outcome	None	Monitor establishment and health of ERS habitats. Seek opportunities to enhance riparian habitats (wetlands and water dependent habitats), for example for BNG objectives.
<b>WFD Assessment</b>						
Five WFD water bodies at risk of potential deterioration as a result of the SRO Scheme: Tame – R Rea to R Blythe (GB104028046841) Tame from R Blythe to River Anker (GB104028046440) Tame from River Anker to River Trent (GB104028047050) Trent – R Tame to R Dove (GB104028047180) Trent from Dove to Derwent (GB104028047420)	Up to National	Changes to channel footprint. Changes in flow velocity and volume. Changes in sediment deposition. Changes to water body hydromorphology leading to changes in river processes and habitats upstream and downstream. Changes in water quality due to new or changed discharge of surface water into surface water body.	Negative	Low (Gate 3 WFD Assessment provides increased confidence in the assessment from Gate 2)	Update of WFD Assessment at Gate 4 to support EIA and DCO submission. Updated hydraulic and hydrological modelling at Gate 4 to inform the updated fish passage and other assessments. Modelling of temperature and dissolved oxygen has been completed at Gate 3 and will be reported early in Gate 4, when it will feed into the on-going environmental assessments. Continued water quality monitoring through Gate 3 and Gate 4, upon which the WFD Assessment will be updated. Monitoring of determinands at reduced LoD for better comparison to EQS for water quality assessment.	Investigation of opportunities to improve fish passability, and habitat mitigation / enhancements in the River Tame catchment informed by BNG assessment at Gate 4.
<b>Habitats Regulations Assessment</b>						

Receptor or Feature under Assessment	Significance	Impact Pathway and Source (Minworth)	Scale of Impact (Positive / Neutral / Negative)	Red/Amber/Green Risk of SRO affecting the receptor (High / Medium / Low)	Recommendations for Further Assessment	Mitigation Options
<p>Impacts on European Sites (SAC, SPA, Ramsar) as a result of reduced flows in the Rivers Tame and Trent:</p> <ul style="list-style-type: none"> <li>• Humber Estuary SAC, SPA, Ramsar</li> <li>• River Mease SAC</li> <li>• Ensor's Pool SAC</li> </ul>	International	Reduced recycled water discharge from Minworth WwRC results in reduced flows in the Rivers Tame and Trent, and corresponding effects on fish passage and other receptors relevant to the European Sites.	Neutral	Low (No I key significant effects)	<p>HRA is reviewed and updated as required in light of any additional information provided at Gate 4 prior to DCO submission.</p> <p>HRA informed by updated hydraulic and hydrological modelling, and water quality modelling, at Gate 4.</p> <p>In-combination assessments with Lincs Reservoir in consultation with Anglian Water, the Environment Agency, and Natural England.</p>	Refer to mitigation for fish passage assessment and other environmental assessments
<b>INNS Risk Assessment</b>						
Transfer of INNS from the Minworth site or WwRC to the Coventry Canal and GUC Transfer route	Up to National	Transfer of INNS via the pipeline from the Minworth AWTP to the Coventry Canal at Atherstone	Negative	Low (negligible)	<p>On-going assessment of INNS risks as the environmental baseline develops and Gate 4 through EIA.</p> <p>Continued monitoring of the Minworth site for INNS.</p> <p>Biosecurity Management Plan (BMP) updated to cover the AWTP and associated wetland.</p>	A specific monitoring programme, and a rapid response protocol, should be developed for the proposed wetland.
Transfer or spread of INNS either within the Minworth WwRC site, off-site, or to the River Tame	Up to National	Transfer or spread of INNS during construction and operation of the AWTP and wetlands	Negative	Low	<p>On-going assessment of INNS risks as the environmental baseline develops and Gate 4 through EIA.</p> <p>Continued monitoring of the Minworth site for INNS.</p> <p>Biosecurity Management Plan (BMP) updated to cover the AWTP and associated wetland.</p>	<p>A specific monitoring programme, and a rapid response protocol, should be developed for the proposed wetland.</p> <p>A strict biosecurity protocol for the construction of the AWTP and wetland should be established and agreed with all stakeholders to ensure that no INNS are inadvertently brought onto the Site.</p>

# References

- Affinity Water. (2024). Strategic Resource Options. Available at: <https://affinitywater.uk.engagementhq.com/strategic-resource-options> [Accessed: July 2024]
- APEM. (2019b). Hazelford Weir Hydropower Scheme: Fisheries and Geomorphology assessment.
- Baldwin, D. H., J. F. Sandahl, J. S. Labenia, and N. L. Scholz. (2003). Sublethal effects of copper on coho salmon: Impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. *Environmental Toxicology and Chemistry* 22: 2266–2274.
- Bell, D. and Sadler, J.P. (2001) A survey report on the invertebrate fauna (Coleoptera and Araneae) of recently created exposed riverine sediment along a short section of the River Tame, Warwickshire. Bristol: Environment Agency.
- Bergstedt R.A., Seelye J.G. (1995) Evidence for lack of homing by sea lampreys. *T Am Fish Soc.* 124:235–9.
- Chung-Davidson, Y.W., Wang, H., Siefkes, M.J., Bryan, M.B., Wu, H., Johnson, N.S. and Li, W. (2013a) Pheromonal bile acid 3-ketopetromyzonol sulfate primes the neuroendocrine system in sea lamprey. *BMC neuroscience*, 14, 1-13.
- Clean Rivers Trust. (2024). Available at: <https://www.cleanriverstrust.co.uk/purification-lakes-at-lea-marston-uk/>. [Accessed June 2024]
- Costa-Silva, D.G., Lopes, A.R., Martins, I.K., Leandro, L.P., Nunes, M.E.M., de Carvalho, N.R., Rodrigues, N.R., Macedo, G.E., Saidelles, A.P., Aguiar, C. and Doneda, M., (2018). Mancozeb exposure results in manganese accumulation and Nrf2-related antioxidant responses in the brain of common carp *Cyprinus carpio*. *Environmental Science and Pollution Research*, 25, pp.15529-15540.
- Davies, P. E., and L. S. J. Cook. (1993). Catastrophic macroinvertebrate drift and sublethal effects on brown trout, *Salmo trutta*, caused by cypermethrin spraying on a Tasmanian stream. *Aquatic Toxicology* 27: 201–224.
- Environment Agency (2003). River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual: 2003 Version. Environment Agency, Bristol.
- Environment Agency. (2009). River Tame Flood Risk Mapping Study, Halcrow.
- Environment Agency. (2010). Fish Pass Manual: guidance notes on the legislation, selection and approval of fish passes in England and Wales. Environment Agency, Bristol.
- Environment Agency (2021). Lea Marston Restoration Vision. Restoring the River Tame & Flood plain connection.
- Environment Agency. (2024). Colwick (Holme Sluices) Fish Pass Information Page. Available at: [Colwick \(Holme Sluices\) Fish Pass Information Page - Environment Agency - Citizen Space \(environment-agency.gov.uk\)](https://www.environment-agency.gov.uk/citizen-space/colwick-holme-sluices-fish-pass-information-page). [Accessed June 2023]
- Eyre, M.D. and Lott, D.A. (1997) *Invertebrate of Exposed Riverine Sediments*. Bristol: Environment Agency.
- Farrow, R.A.F., Roy, H.E. and Brown, P.M.J. (2022) The rare five-spot ladybird *Coccinella quinquepunctata* (Coleoptera: Coccinellidae) surviving in an unstable habitat. *Frontiers in Conservation Science*, 2, 759038
- Fishtek. (2017). Cromwell Weir Hydroelectric Scheme Fisheries Assessment. Fishtek, Totnes.
- Griffiths, A.M., Machado-Schiaffino, G., Dillane, E. et al. (2010). Genetic stock identification of Atlantic salmon (*Salmo salar*) populations in the southern part of the European range. *BMC genetics*, 11, 31.
- Hansen, L., Jonsson, B. (1994). Homing of Atlantic salmon: effects of juvenile learning on transplanted post-spawners. *Animal behaviour*, 47, 220–222.

- Jarrard, H.E., Delaney, K.R. and Kennedy, C.J., (2004). Impacts of carbamate pesticides on olfactory neurophysiology and cholinesterase activity in coho salmon (*Oncorhynchus kisutch*). *Aquatic Toxicology*, 69(2), pp.133-148.
- Moore, A. and Waring, C.P., (2001). The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (*Salmo salar* L.). *Aquatic toxicology*, 52(1), pp.1-12.
- JNCC (2016). Common Standards Monitoring Guidance for Rivers. Version September 2016. Joint Nature Conservation Committee, Peterborough.
- Johnson N.S., Yun S-S., Thompson H.T., Brant CO., Li W. (2009) A synthesized pheromone induces upstream movement in female sea lamprey and summons them into traps. *Proc Natl Acad Sci U S A*. 106:1021–6.
- Johnson, N. S., Muhammad, A., Thompson, H., Choi, J., & Li, W. (2012). Sea lamprey orient toward a source of a synthesized pheromone using odor-conditioned rheotaxis. *Behavioral Ecology and Sociobiology*, 66, 1557–1567.
- Li W.M., Sorensen P.W., Gallaher D.D. (1995) The olfactory system of migratory adult sea lamprey (*Petromyzon marinus*) is specifically and acutely sensitive to unique bile-acids released by conspecific larvae. *J Gen Physiol*. 105:569–87.
- Moore H.H., Schleen L.P. (1980) Changes in spawning runs of sea lamprey (*Petromyzon marinus*) in selected streams of Lake Superior after chemical control. *Can J Fish Aquat Sci*. 37:1851–60
- Naura, M. (2021). River Habitat Survey Input and Analysis Software: Riverdene Consultancy. Version 1.5: January 2021.
- NRFA. (2024). Tame at Lea Marston Lakes. Available at: [NRFA Station Data for 28080 - Tame at Lea Marston Lakes \(ceh.ac.uk\)](https://www.ceh.ac.uk/nrfa-station-data-for-28080-tame-at-lea-marston-lakes). [Accessed December 2021]
- O'Callaghan, M.J. (2011) Controls on the distribution of specialist invertebrates inhabiting exposed riverine sediments in England and Wales. PhD. University of Birmingham
- O'Callaghan, M.J., Hannah, D.M., Williams, M. and Sadler, J.P. (2013) Exposed riverine sediments (ERS) in England and Wales: distribution, controls and management. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 23, 924-938.
- OFWAT. (2023). The RAPID gated process and the proposed water resource solutions. Available at: <https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/> [Accessed: July 2024]
- Ricardo (2022). Technical Note: Severn Thames Transfer SRO – Impact of determinands on olfaction and fish populations in the Severn Estuary. United Utilities on behalf of the Severn Thames Transfer Programme.
- Riverdene Consultancy (2016a). Hydromorphology and geomorphology guidelines: Hydromorphological indices derivation: Instructions for calculating the Habitat Modification Score using River Habitat Survey data. (Based on Environment Agency guidelines for calculating HMS scores, 2003).
- Riverdene Consultancy (2016b). Instructions for calculating the River Habitat Quality Class using RHS. Based on Naura (2001) River Habitat Quality Assessment and Walker (2005) River Habitat Objectives (Environment Agency internal reports). Riverdene Consultancy.
- Sadler, J. and Bell, D. (2002). Invertebrates of Exposed Riverine Sediments. Phase 3 – Baseline faunas. Technical Report W1-034/TR. Environment Agency, Bristol.
- Sahota, C., Hayek, K., Surbey, B. and Kennedy, C.J., (2021). Lethal and sublethal effects in Pink salmon (*Oncorhynchus gorbuscha*) following exposure to five aquaculture chemotherapeutants. *Ecotoxicology*, pp.1-20.
- Sandahl JF, Baldwin DH, Jenkins JJ, Scholz NL. (2007). A sensory system at the interface between urban stormwater runoff and salmon survival. *Environ Sci Technol*. 2007 Apr 15;41(8):2998-3004.
- Scannell, P.W. (2009). Effects of copper on aquatic species: A review of the literature. Alaska Department of Fish and Game, Division of Habitat, Technical Report No. 09-04, Fairbanks.
- Scholz, A., Horrall, R., Cooper, J., Hasler, A., (1976). Imprinting to chemical cues: the basis for home stream selection in salmon. *Science* 192, 1247–1249.

SNIFFER. (2010). WFD111 (2a) Coarse resolution rapid-assessment methodology to assess obstacles to fish migration

Sprague, J.B., Elson, P.F., Saunders, R.L. (1965). Sublethal Copper-Zinc Pollution In A Salmon River—A Field And Laboratory Study. *Advances in Water Pollution Research*, Pergamon, Pages 61-82.

Stabell, O. (1984). Homing and olfaction in salmonids: a critical review with special reference to Atlantic salmon. *Biological Reviews*, 59, 333–388.

Stengel, D., Wahby, S. and Braunbeck, T., (2018). In search of a comprehensible set of endpoints for the routine monitoring of neurotoxicity in vertebrates: sensory perception and nerve transmission in zebrafish (*Danio rerio*) embryos. *Environmental Science and Pollution Research*, 25, pp.4066-4084.

Teeter J. (1980) Pheromone communication in sea lampreys (*Petromyzon marinus*): implications for population management. *Can J Fish Aquat Sci.* 37:2123–32.

Telfer, M.G. (2016) A review of the beetles of Great Britain: Ground Beetles (*Carabidae*): Species Status No. 25. Natural England Commissioned Reports, Number 189. York: Natural England.

Tierney, K.B., Baldwin, D.H., Hara, T.J., Ross, P.S., Scholz, N.L. and Kennedy, C.J., (2010). Olfactory toxicity in fishes. *Aquatic toxicology*, 96(1), pp.2-26.

Volz, S.N., Hausen, J., Smith, K., Ottermanns, R., Schaeffer, A., Schiwy, S. and Hollert, H., (2020). Do you smell the danger? Effects of three commonly used pesticides on the olfactory-mediated antipredator response of zebrafish (*Danio rerio*). *Chemosphere*, 241, p.124963.

Vrieze L.A., Sorensen P.W. (2001) Laboratory assessment of the role of a larval pheromone and natural stream odor in spawning stream localization by migratory sea lamprey (*Petromyzon marinus*) *Can J Fish Aquat Sci.* 58:2374–85.

Waldman J., Grunwald C., Wirgin I. (2008) Sea lamprey *Petromyzon marinus*: an exception to the rule of homing in anadromous fishes. *Biol Lett.* 4:659–62.

Walker, J. Diamond, M. & Naura, M. (2002) The development of physical quality objectives for rivers in England and Wales. *Aquatic Conservation: Marine and Freshwater Ecosystems* 12: 381-390.

WFD-UKTAG (Water Framework Directive – United Kingdom Advisory Group) (2014). UKTAG River Assessment Method Macrophytes and Phytobenthos: Macrophytes (River LEAFPACS2).

# Appendix A Tame water quality sampling locations

**Table A-1 Tame water quality sampling locations from Gate 2 which are being used at Gate 3**

Sample Location ID	Description	Approximate NGR	Comment
MIN-01	R Tame upstream of Water Orton Lane		Upstream of Minworth WwRC discharge
MIN-02A	R Tame Coleshill WwRC, u/s of discharge		Downstream of Minworth WwRC discharge, upstream of Coleshill WwRC discharge
MIN-02B	Coleshill WwRC discharge		
MIN-02C	R Tame Coleshill WwRC, d/s of discharge		Downstream of Coleshill WwRC discharge
MIN-03	R Tame Kingsbury Rd, Kingsbury Village		Downstream of River Blythe confluence with the River Tame
MIN-04	R Tame at Hopwas		Downstream of the River Anker confluence with the River Tame
MIN-05	Non-Tidal R. Trent Burton on Trent		Downstream of the River Trent confluence with the River Tame



# Appendix B Designated sites and wetland habitats for Gate 3 assessment

**Table B-1 Designated sites and wetland habitats for further assessment**

Receptor or Feature under Assessment	Significance	Impact Pathway due to Minworth	Scale of Impact (Positive / Neutral / Negative) <sup>33</sup>	Red/Amber/Green rating of Risk to SRO (High / Medium / Low)	Recommendations for Further Assessment	Opportunities
River Tame Local Wildlife Site (LWS)	County	Reductions in flow in River Tame, hydrological regime, sedimentation, fish passage, etc.	Negative	High	Refer to recommendations across the environmental assessments.	Wetland creation: river and riparian habitats; connectivity of River Tame to designated sites and habitats.
Ladywa k LWS	County	Impact on wetland habitats and the species they support, due to reduced baseflow in River Tame.	Neutral	Medium	No significant effects predicted. Further assessment recommended to assess connectivity of existing channels to the River Tame, and to inform potential mitigation options for BNG.	Site visit to assess the potential for wetland habitat creation and/or enhancement opportunities at this site.
Whitacre Heath SSSI	National	Impact on wetland habitats and species, due to reduced baseflow in River Tame.	Neutral	Medium	No significant effects predicted <sup>#</sup> , to be informed by further modelling of reduced summer flooding. Further assessment to assess connectivity of existing channels to River Tame and inform potential mitigation options.	Site visit to assess the potential for wetland habitat creation and/or enhancement opportunities at this site.
Kingsbury Wetlands (Water Park) LWS	County	Impact on wetland habitats and species, due to reduced baseflow in River Tame.	Neutral	Medium	No significant effects predicted <sup>#</sup> . Further assessment of connectivity of existing channels to the River Tame, and to inform potential mitigation options for BNG.	Site visit to assess the potential for wetland habitat creation and/or enhancement opportunities at this site.
RSPB Middleton Lakes (Fisher’s Mill Meadow LWS and Dosthill Pit & Middleton Hall Pit LWS)	County	Impact on wetland habitats and species due to reduced baseflow in Tame.	Neutral	Medium	No significant effects predicted <sup>#</sup> . Further assessment recommended to assess connectivity of existing channels to the River Tame.	Site visit to assess the potential for wetland habitat creation and/or enhancement opportunities at this site.
Tameside LNR	County	Impact on wetland habitats and species due to reduced	Neutral	Medium	No significant effects predicted <sup>#</sup> . Further assessment recommended to assess connectivity	Site visit to assess the potential for wetland habitat creation and/or enhancement

<sup>33</sup> To distinguish between positive (beneficial), neutral, and negative (detrimental) impacts, to inform future assessment for EIA, if required.

Receptor or Feature under Assessment	Significance	Impact Pathway due to Minworth	Scale of Impact (Positive / Neutral / Negative) <sup>33</sup>	Red/Amber/Green rating of Risk to SRO (High / Medium / Low)	Recommendations for Further Assessment	Opportunities
		baseflow in Tame.			of existing channels to the River Tame.	opportunities at this site.
Waterbirds	Up to international	Potential impact on wetland habitats that support waterbirds.	Neutral	Low	No significant effects predicted#. Requirement for further surveys dependent on assessment of connectivity of sites designated for wetland bird interest to Tame and Trent.	Site visits to assess the potential for wetland habitat creation and/or enhancement opportunities for waterbirds.

# Pending the outcome of on-going hydraulic and hydrological modelling and assessment of connectivity of designated sites and water dependent habitats

# Appendix C RHS and macrophyte surveys, and optimal survey season

**Table C-1 Proposed RHS and macrophyte surveys, and optimal survey season**

Watercourse	Site ID (refer to Gate 2 report)	Site Name	Central NGR	Optimal Survey Season	
<b>River Habitat Survey (RHS)</b>					
Tame	TA1	Castle Bromwich	[REDACTED]	April to September	
Tame	TA2	Water Orton			
<b>Macrophyte Survey</b>					
Tame	TA1	Castle Bromwich			
Tame	TA2	Water Orton			
Tame	TA4	Tamworth			June to September
Tame	TA6*	Alrewas Arboretum			

\* TA6 was not listed as a survey limitation, however turbidity was high, and it is considered that the survey would merit from being repeated concurrently with the other River Tame sites

# Appendix D Locations for ERS invertebrate surveys

**Table D-1 Locations for river shingle invertebrate surveys**

Location	Grid Reference	Description
River Tame, River Blythe confluence		Confluence of River Blythe with River Tame opposite Ladywalk Nature Reserve. Mid-channel gravel bar at confluence, where concerns were raised by stakeholders at Gate 2 regarding impacts of low flows in the Tame on the River Blythe (including the River Blythe SSSI upstream).
River Tame braided channels, opposite Tamworth Shooting Ground, Dosthill		Area of previous Environment Agency river restoration project resulting in geomorphologically active braided channels with notable areas of sediment, gravel, and shingle deposits. Previously accessed via Tamworth Shooting Ground for wa kover surveys with Environment Agency.
River Trent, River Tame confluence		Notable deposits of river gravels and sediments at the confluence of the River Tame with the Trent, upstream of the confluence with the River Mease. Previous concerns raised by Environment Agency regarding potential flow changes at the River Trent/Mease confluence.
Lower Trent at Willington		Mature island present, as was a vegetated point bar and discrete unvegetated silt deposits. Substrate consisted predominantly of gravel and pebbles, although silt and sand were also recorded. Right bank included a large natural berm, and a vegetated side bar. Water depth was 0.5 m, and the bed material was unconsolidated.
Lower Trent at Long Eaton (Sawley)		Unusually for a river of this size and character, a single riffle was present in association with two unvegetated point bars and a vegetated mid-channel bar, caused by deposition downstream of Sawley Weir. Such depositional features provide valuable habitat diversity.
River Trent, downstream Thrumpton Weir		Notable area of river gravel and sediment deposits downstream of Trentlock and Thrumpton Weir. River gravels deposit downstream of the weir providing spawning habitat for fish and exposed shingle habitats, especially during low flows.

# Appendix E Barriers to fish passage on the River Tame and River Trent

**Table E-1 Barriers to fish passage on the River Tame and River Trent**

<b>Barrier</b>	<b>Name / Location</b>
Site 1	Orton Weir
Site 2	Water Orton Lane Road Bridge
Site 3	Lea Marston Weir
Site 4	Coton Weir (E)
Site 5	Coton Weir (Central)
Site 6	Coton Weir (W)
Site 7	A4097 Weir
Site 8	Nether Whitacre Weir
Site 9	Broad Meadow LNR Upstream Weir
Site 10	Broad Meadow LNR Downstream Weir
Site 11	Meadow Weir
Site 12	Newton Weir
Site 13	Sawley Weir
Site 14	Thrumpton Weir
Site 15	Beeston Weir
Site 16	Holme Sluices Colwick
Site 17	Stoke (Bardolph) Weir
Site 18	Gunthorpe Weir
Site 19	Hazelford Weir (South)
Site 20	Hazelford Weir (North)
Site 21	Averham Weir
Site 22	Newark Weir
Site 23	Nether Lock Weir
Site 24	Cromwell Weir
Site 25	River Blythe submerged weir

From Gate 2 report: Minworth Gate 2 Annex B3.1.2 Appendix B(ii) Aquatic Ecology

