Strategic Regional Water Resource Solutions: Annex C: Strategic Water Quality Risk Assessment (SWQRA)

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

Date: November 2022

Severn to Thames Transfer

Strategic Water Quality Risk Assessment (SWQRA)

STT-G2-S3-354

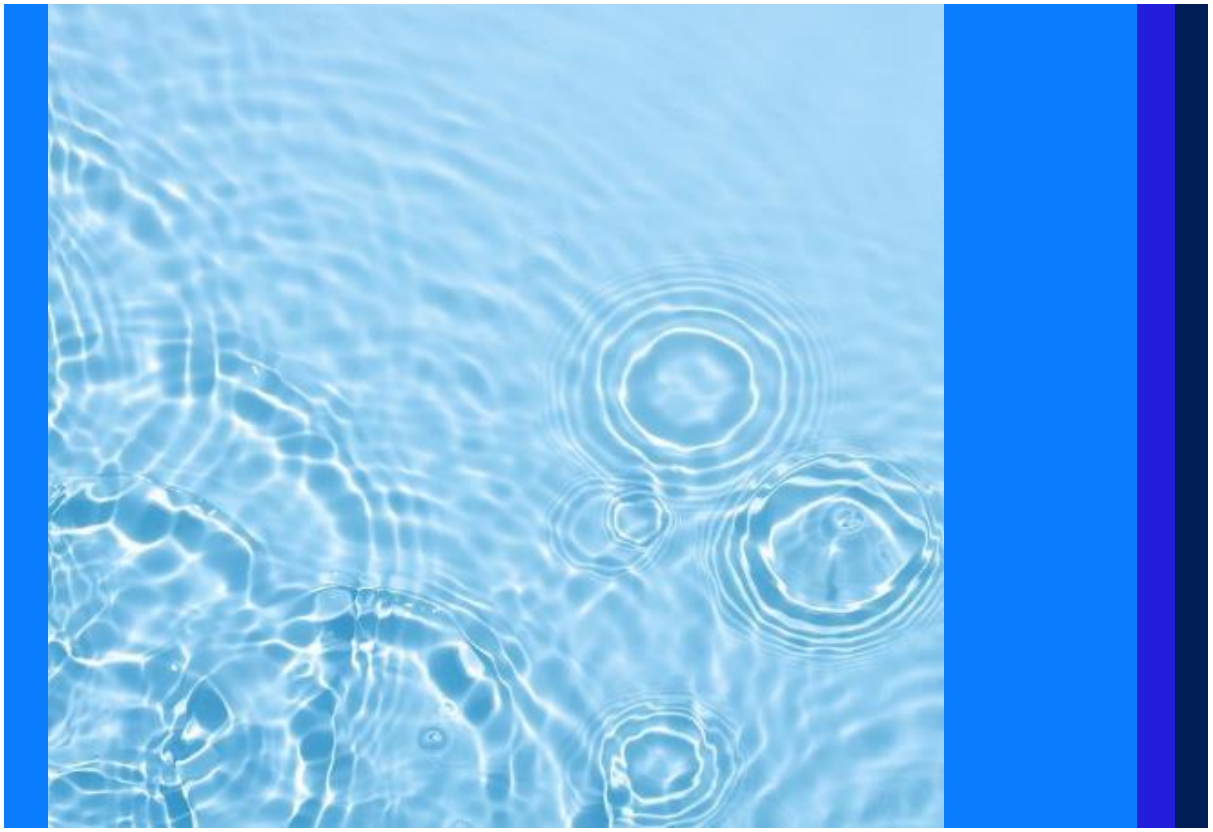
November 2022

Disclaimer

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

Strategic Water Quality Risk Assessment (SWQRA) for Severn to Thames Transfer

Document no: STT-G2-S3-354
Revision no: B



Executive summary

This document provides a summary of the strategic water quality risk assessment undertaken for the Severn to Thames Transfer (STT) Strategic Resource Option (SRO).

The Strategic Water Quality Risk Assessment (SWQRA) provides a high-level risk assessment based on a drinking water safety approach to identify limiting hazards and assessing their risks across the water supply system for Strategic Resource Options (SROs). At each stage from catchment to consumer (i.e catchment, abstraction, conveyance, treatment, storage, distribution and consumer) pre-mitigated risks are assessed using a 5x5 risk matrix, mitigation measures proposed, and resultant post mitigated residual risks assessed.

The framework methodology for this was developed and this report provides a summary of the outcome from the risk assessment framework approach.

This document summarises the changes to the SQWRA for Severn to Thames Transfer SRO (STT) between Gate 1 and Gate 2 which are as follows:

1. Review of new and updated information since Gate 1
2. Additional Limiting Hazards at Gate 2
3. SWQRA risk scoring methodology
4. Completion of the SWQRA
5. Gate 2 Risk Assessment outcome

Risk assessment Scenarios

The following risk assessment (RA) scenarios have been undertaken considering a catchment through to consumer's tap approach, described above, aligned with the Drinking Water Safety Planning methodology:

A. Pipeline Conveyance (Full Support)
B. Pipeline Conveyance (Without Minworth)
C. Canal Conveyance (Full Support)
D. Canal Conveyance (Without Minworth)
E. Bristol Water's Intake on the Gloucester and Sharpness Canal

These RAs were undertaken in Gate 1 and are updated in this Gate 2 work.

Limiting Hazards at Gate 2

The following Gate 1 limiting hazards were reassessed at Gate 2:

- RA scenarios A&B

  E. coli, *Cryptosporidium*, Iron, Manganese, Bromide, Pesticides – total, Metaldehyde, Benzo(a)pyrene, Corrosivity (change of water chemistry), Change in source type, Alkalinity, Pathogens – other bacteria, viruses, protozoa, Total Organic Carbon, Conductivity, Turbidity, Algae.

- RA scenarios C&D

  E. coli, *Cryptosporidium*, Iron, Manganese, Bromide, Pesticides – total, Metaldehyde, Benzo(a)pyrene, Corrosivity (change of water chemistry), Change in source type, Alkalinity, Pathogens – other bacteria, viruses, protozoa, Total Organic Carbon, Conductivity, Turbidity, Algae.

- RA scenarios E

Enterococci, *E. coli*, *Cryptosporidium*, Coliform bacteria, Iron, Manganese, Nitrate, Nitrite, Pesticides – total, Metaldehyde, Odour, Taste, Geosmin/2-Methylisoborneol(2-MIB), Pathogens – other bacteria, viruses, protozoa, Ammonium, Conductivity, Turbidity, Clostridium Perfringens, Pharmaceuticals, Aluminium, Glyphosate.

The following additional limiting hazards included in the Gate 2 SQWRA on the basis of the new or updated information (Water Quality (WQ) data, DWSPs, reg 28 reports and process flow diagrams):

- Contaminants of Emerging Concern (CEC) - PFOS, PFOA,1,4-Dioxane, NDMA
- Nitrite
- PAH
- Temperature
- Invasive non-native species (INNS) as they have the potential to affect water supply.

Conclusions

Key conclusions from the Gate 2 assessment are:

- New limiting hazards have been included at Gate 2. These include the CECs PFOS, PFOA, NDMA and1,4-Dioxane.
- The pre-mitigated risk scores at catchment for all but one of the limiting hazards are high (red) or medium (amber). The exception is conductivity with a low (green) risk score at catchment. Details are included in the main report and the SWQRA spreadsheet.
- Most of the hazards are mitigated at the treatment stage although there are some catchment, abstraction, and distribution stage mitigations.
- For most of the limiting hazards the residual risks posed to the consumer are low (green). There are, however, some limiting hazards which will require further review and assessment. These are:
    - Limiting hazards which pose a risk that consumers could experience a change in perception of their water. These are generally related to change in source and include change in source type, taste, odour, and alkalinity. The mitigation for these is early customer engagement. This needs to continue throughout the project to keep the consumers informed with the developments and changes in the project that may impact on their water quality and to address their concerns. Further details on customer engagement are contained in Chapter 9 of the Gate 2 report.
    - Corrosivity (change in water chemistry) will need further assessment regarding its impact on network corrosion for which the mitigation is treatment/blending.
    - Limiting hazards related to CECs - PFOS, PFOA, 1,4-Dioxane and NDMA. The current drinking water risk from these is deemed to be low; however, it is also possible that this may change in future. The SWQRA states that these are monitored going forward and the risks reassessed in light of the new water quality data.
- The collaborative "catchment to consumer" approach of the SWQRA process is also aligned with the objectives of the Drinking Water Protected Areas. These objectives are:
    - meeting the requirements of the Water Supply (Water Quality) Regulations 2016,
    - the protection of the supply by avoiding deterioration in water quality to reduce the level of purification treatment required and for groundwater,
    - the achievement of good chemical status and reversing upward trends in pollution, and
    - the reduction of pollution at source as this is more cost-effective than removing pollutants or blending with clean water.

- Overall, the SWQRA shows that the risks to drinking water quality from the limiting hazards identified can be mitigated by the measures proposed. However, for CECs and in particular PFAS, if in future the UK water quality regulations were to be tightened in line with recent USEPA guidance, compliance will be very challenging for most of UK new and existing water treatment works.

Contents

Acronyms and abbreviations

AWTP	Advanced Water Treatment Plant
CEC	Contaminants of Emerging Concern
CRI	Compliance Risk Index
DWSP	Drinking Water Safety Plans
FE	Final Effluent
INNS	Invasive non-native species
NDMA	N-Nitrosodimethylamine
PAH	Polycyclic Aromatic Hydrocarbons
PFD	Process Flow Diagram
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
RA	Risk Assessment
SRO	Strategic Resource Option
STT	Severn to Thames Transfer
STW	Sewage Treatment Works
SWQRA	Strategic Water Quality Risk Assessment
TOC	Total Organic Carbon
WQ	Water Quality
WwTW	Wastewater Treatment Works
2-MIB	2-Methylisoborneol

1. Introduction

The Strategic Water Quality Risk Assessment (SWQRA) provides a high-level risk assessment (RA) based on a drinking water safety approach to identify limiting hazards and assess their risks across the water supply system for Strategic Resource Options (SROs).

The framework methodology for this was developed and the key SWQRA outputs are a workshop providing overview and agreement on the RA which are completed in excel form and used to provide summary information to Gate 2 reports and associated documents.

This document summarises the changes to the SQWRA for Severn to Thames Transfer SRO (STT) between Gate 1 and Gate 2 which are as follows:

1. Review of new and updated information
2. Additional Limiting Hazards at Gate 2
4. SWQRA risk scoring methodology
3. Completion of the SWQRA template
5. Revised Risk Scores

2. Risk assessment scenarios

Five SWQRAs have been undertaken to cover the STT:

A. Pipeline Conveyance (Full Support)

B. Pipeline Conveyance (Without Minworth)

C. Canal Conveyance (Full Support)

D. Canal Conveyance (Without Minworth)

E. Bristol Water's Intake on the Gloucester and Sharpness Canal

These RAs were undertaken in Gate 1 and are updated in this Gate 2 work.

3. Limiting Hazards at Gate 2

The limiting hazards at Gate 2 included all the Gate 1 hazards plus additional hazards included on the basis of new water quality data from the bespoke SRO monitoring programme being carried which became available at Gate 2. It was however considered that the number of data points available at Gate 2 were not sufficient to exclude any of the Gate 1 limiting hazards although these could be reviewed at Gate 3 as more water quality data becomes available.

3.1 Limiting Hazards for Thames Water and Affinity Water's lower Thames intakes' catchments

3.1.1 Gate 1 hazards reconsidered at Gate 2

Table 3-1 shows all Gate 1 hazards which were then reassessed at Gate 2.

Table 3-1 - Gate 1 Hazards reconsidered at Gate 2.

Limiting Hazard	Pipeline Conveyance Full Support	Pipeline Conveyance Without Minworth	Canal Conveyance Full Support	Canal Conveyance Without Minworth
E. coli	Yes	Yes	Yes	Yes
Cryptosporidium	Yes	Yes	Yes	Yes
Iron	Yes	Yes	Yes	Yes
Manganese	Yes	Yes	Yes	Yes
Bromide	X	X	Yes	Yes
Pesticides Total	Yes	Yes	Yes	Yes
Metaldehyde	Yes	Yes	Yes	Yes
Benzo(a)pyrene	Yes	Yes	Yes	Yes
Corrosivity (change of water chemistry)	Yes	Yes	Yes	Yes
Change in source type	Yes	Yes	Yes	Yes
Alkalinity	Yes	Yes	Yes	Yes
Pathogens – other bacteria, viruses, protozoa	Yes	Yes	Yes	Yes
Total Organic Carbon (TOC)	Yes	Yes	Yes	Yes
Conductivity	Yes	Yes	Yes	Yes
Turbidity	Yes	Yes	Yes	Yes
Algae	X	X	Yes	Yes

3.1.2 Additional limiting hazards included at Gate 2

The following limiting hazards were included in the Gate 2 SQWRA on the basis of the above new or updated information. In particular, the new water quality monitoring data, which was not available at Gate 1, and literature and global best practice on contaminants of emerging concern (CEC) in water reuse projects. At Gate 2 there was no data available for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) other than Minworth Sewage Treatment Works (STW) Final Effluent (FE) (Site 28) or some sites monitoring for 'perfluorooctane sulfonic acid and its derivatives'. Additionally there was no data available for 1,4-Dioxane and N-Nitrosodimethylamine (NDMA) apart from at Site 28. This gap has been identified and these contaminants will be monitored at the relevant sites for this assessment going forward with data requiring assessment at Gate 3.

Additional limiting hazards added in at Gate 2:

- Nitrite – Based on new water quality data.
- Polycyclic Aromatic Hydrocarbons (PAH) – Based on new water quality data.
- PFOS – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation.
- PFOA – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation.
- 1,4-Dioxane – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation. This is challenging to treat in advanced water recycling facilities and drinking water treatment etc.
- NDMA – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation. This is challenging to treat in advanced water recycling facilities and drinking water treatment etc.
- Temperature – Temperature in pipeline conveyance is likely to be higher than the receiving water in the River Thames.
- Invasive non-native species (INNS) – Based on evidence from the Gate 1 Environmental assessment report for INNS (May 2021).

Temperature and INNS are mainly environmental hazards however have been included in the SWQRA on the grounds that they have the potential to prevent the scheme from progressing and thereby constitute a water supply risk.

3.2 Limiting Hazards for Bristol Water's intake

3.2.1 Gate 1 hazards reconsidered at Gate 2

Enterococci, *E. coli*, *Cryptosporidium*, Coliform bacteria, Iron, Manganese, Nitrate, Nitrite, Pesticides – total, Metaldehyde, Odour, Taste, Geosmin/2-MIB, Pathogens – other bacteria, viruses, protozoa, Ammonium, Conductivity, Turbidity, Clostridium Perfringens, Pharmaceuticals, Aluminium, Glyphosate.

3.2.2 Additional limiting hazards included at Gate 2

Additional limiting hazards included at Gate 2 based on new information, as above, were:

- Bromide – Based on WQ data and the possibility of bromate formation.
- PAH – Based on new water quality data.
- PFOS – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation.

- PFOA – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation.
- 1,4-Dioxane – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation. This is challenging to treat in advanced water recycling facilities and drinking water treatment etc.
- NDMA – Likely to be present in wastewater effluent discharges and may be of risk at time of scheme operation. This is challenging to treat in advanced water recycling facilities and drinking water treatment etc.
- Temperature – Temperature in pipeline conveyance is likely to be higher than the receiving water in the River Thames.
- INNS – Based on evidence from the Gate 1 Environmental assessment report for INNS (May 2021).

4. Review of new and updated information for Gate 2

4.1 New Water quality Sampling Data

Water quality data from the bespoke SRO monitoring programme[1], not available at Gate 1, was obtained to reassess the risks identified in the Gate 1 SWQRA. The data covers the sampling period from December 2020 to December 2021. Data until round 16 of the monthly spot sampling, dated 06.01.22 and from continuous sampling was included in the assessment.

Sites reviewed include:

- Site 24 – River Vyrnwy
- Site 28 – Minworth STW FE
- Site 29 – River Severn (lower) at Deerhurst
- Site 30 – Netheridge STW FE
- Site 32 – River Severn (lower) upstream Gloucester Docks
- Site 33 – Gloucester & Sharpness Canal d/s Gloucester Docks
- Site 34 – Gloucester & Sharpness Canal u/s Saul Junction
- Site 35 – Stroudwater Navigation d/s Saul Junction

4.2 Drinking Water Safety Plans (DWSP)

DWSPs relevant to the STT were obtained and reviewed:

Affinity Water – Blackford, Chertsey, Egham, Iver, Walton.

Severn Trent – Mythe Catchment, Shelton Catchment, Strensham Catchment, Trimpley Catchment.

Thames Water – Datchet, Farmoor, Hythe End, Laleham, Lockwood Shaft Thames Inlet, Surbiton, Walton-on-Thames.

4.3 Regulation 28 Reports

Regulation 28 reports were also reviewed to understand the outcome of the risk assessments carried out in the DWSPs and the mitigation measures undertaken to address risks to water quality highlighted.

Bristol Water – Purton Intake.

United Utilities – Vyrnwy Catchment.

4.4 Process Flow Diagrams (PFD)

PFDs of the Thames Water, Affinity Water and Bristol Water's water treatment works, which would abstract water transferred under the STT, were reviewed to understand if the existing treatment processes at these works are suitable to address the risks posed by the limiting hazards identified in the SWQRA.

Affinity Water – Chertsey WTW, Egham WTW, Iver WTW, Walton WTW.

Bristol Water – Purton WTW.

Thames Water – Ashford Common WTW, Hampton WTW, Kempton Park WTW, Walton-on-Thames WTW.

[1] Thames Water Strategic Resource Options – Water Quality Monitoring 2020, 2020.

5. SWQRA Gate 2 Risk Scoring Methodology

5.1 General Approach

The general approach used for Gate 2 SWQRA risk scoring was as follows.

An independent assessment of the risks was carried out by using a methodology developed for STT Gate 2 SQWRA (see below). These scores were then compared with the risk scores in the water company's DWSPs, and the highest risk score adopted as the Gate 2 risk score. This procedure allowed for consistency with the water companies DWSP risk scores (Gate1 approach) while allowing for these to be increased (a conservative approach) where the independent assessment considered the risk to be higher.

5.2 Gate 2 SWQRA Risk Scoring Methodology

ACWG methodology on SQWRA provides on overall framework of risk scores based on a 5X5 risk matrix using likelihood and consequence of risks as shown below in Figure 1.

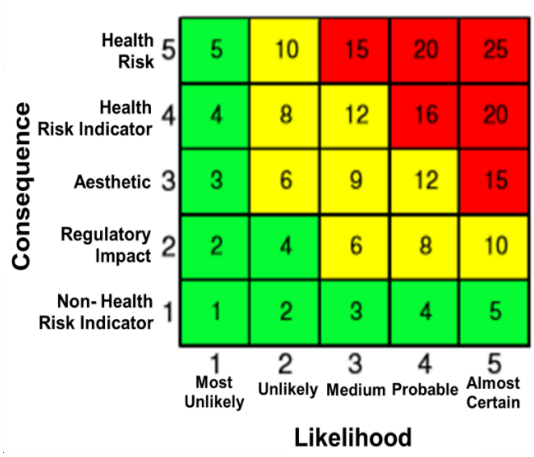


Figure 1: 5x5 Risk Matrix.

Different companies and consultants use varying definitions for consequence and likelihood. At Gate 2 the following definitions for the likelihood and consequence scores were applied, seen in Table 5-1 and Table 5-2.

Table 5-1: Likelihood scores definitions.

Score	Likelihood	Occurrence	Probability range (Failures in 5 years)
1	Most unlikely	< Once in 10 years	0,1
2	Unlikely	Once in 10 years	2,3,4
3	Medium	Annually	5-14
4	Probable	Monthly	15-59
5	Almost Certain	Daily	≥60

The consequence scores were defined based on *parameter scores* for contaminants included in the DWI's Compliance Risk Index methodology. It is noted that the full CRI methodology, which is used to assess the impact of water quality compliance failures, is **not** applied here and only the parameter scores are used to assign a consequence score as seen in Table 5-2.

Table 5-2: Consequence scores definitions.

Score	Consequence	CRI Parameter Score
5	Health Risk	5
4	Health Risk Indicator	4
3	Aesthetic	3
2	Regulatory Impact	2
1	Non-Health Risk Indicator	1

6. SWQRA Gate 2 Pre-Mitigated Catchment Risk Scores and Changes from Gate 1

The following section provides a summary of Gate 2 SWQRA scores and also shows changes in these from Gate 1. It also includes scores for new limiting hazards introduced at Gate 2 stage.

6.1 Interconnector pipeline option with full support

Table 6-1, Table 6-2 and Table 6-3 list the changes to pre-mitigated catchment risk scores between Gate 1 and Gate 2. Table 6-4 lists the scores for new limiting hazards included at Gate 2. Risk scores are broken down and shown as likelihood x consequence = overall.

Table 6-1: Limiting hazards for which the risk scores have increased.

Limiting Hazard	Gate 1 Risk Score	Gate 2 Risk Score	Risk Score Change	Reason for Change
E. coli	4 x 5 = 20	5 x 5 = 25	Increased	Likelihood increased based on WQ data.
Cryptosporidium	4 x 5 = 20	5 x 5 = 25	Increased	Likelihood increased based on DWSPs.
Metaldehyde	2 x 5 = 10	5 x 4= 20	Increased	Higher risk score taken from DWSPs.
Benzo(a)pyrene	4 x 5 = 20	5 x 5 = 25	Increased	Likelihood increased based on DWSPs.
Corrosivity	4 x 2 =8	4 x 3 = 12	Increased	Consequence increased based on scoring definitions applied.
Change in Source	1 x 3 = 3	5 x 3 = 15	Increased	Likelihood increased as necessary for scheme implementation.
Turbidity	5 x 4 = 20	5 x 5 = 25	Increased	Consequence increased based on scoring definitions applied.

Table 6-2: Limiting hazards for which the risk scores have reduced.

Limiting Hazard	Gate 1 Risk Score	Gate 2 Risk Score	Risk Score Change	Reason for Change
Iron	5 x 5 = 25	5 x 4 = 20	Reduced	Consequence reduced based on scoring definitions applied.
TOC	5 x 5 = 25	4 x 5 = 20	Reduced	Likelihood decreased.

Table 6-3: Limiting hazards for which the risk scores have not changed.

Limiting Hazard	Gate 1 Risk Score	Gate 2 Risk Score	Risk Score Change
Manganese	5 x 4 = 20	5 x 4 = 20	no change
Pesticides: Total	5 x 4 = 20	5 x 4 = 20	no change
Alkalinity	3 x 5 = 15	3 x 5 = 15	no change
Pathogens - Bacteria, Viruses, Protozoa	5 x 5 = 25	5 x 5 = 25	no change
Conductivity	3 x 1 = 3	3 x 1 = 3	no change

Table 6-4: New limiting hazards included in Gate 2 SWQRA.

Limiting Hazard	Gate 1 Risk Score	Gate 2 Risk Score	Risk Score Change	Reason for Change
Nitrite	N/A	5 x 5 = 25	New	WQ assessment
PAH	N/A	3 x 4 = 12	New	WQ assessment
PFOS	N/A	2 x 5 = 10	New	CEC
PFOA	N/A	2 x 5 = 10	New	CEC
1,4-Dioxane	N/A	2 x 5 = 10	New	CEC
NDMA	N/A	2 x 5 = 10	New	CEC
Temperature	N/A	3 x 2 = 6	New	May prevent scheme from progressing and so constitute a supply risk.
INNS	N/A	3 x 4 = 12	New	May prevent scheme from progressing and so constitute a supply risk.

It is noted that PFOS, PFOA, 1,4-Dioxane and NDMA are CECs which are typically associated with wastewater. PFOS and PFOA were only monitored individually at Site 28. 1,4-dioxane and NDMA were only monitored at Site 28. The risk scores assigned reflect this uncertainty. It is recommended to sample for these parameters at the relevant sites ahead of Gate 3. Water companies currently sample for PFOS and PFOA however this data was unavailable at the time of the assessment. This data should be reviewed at Gate 3.

6.2 Interconnector pipeline option without Minworth

This option and other risk assessments options assessed in the following sections of this report are very similar to the interconnector pipeline with full support option above. Therefore, only the differences in the options are presented in the following sections.

6.2.1 Differences from Pipeline Conveyance With Full Support

The main difference in the two options is that no wastewater effluent from AWTP will be in the water supplied by the STT. However, it is noted that existing wastewater treatment works already discharge in final effluent in River Avon, River Severn and tributaries upstream of Deerhurst. These include Finham, Longbridge and Stratford WwTWs and other smaller works. There are also a number of WwTWs that discharge into the River Thames catchment (approx. 339 WwTW) above the most downstream abstraction point. Consequently, water in both the River Severn at Deerhurst and the River Thames at Culham already have existing wastewater discharges.

It is therefore considered that the limiting hazards are likely to be the same for both full support and without Minworth.

6.3 Canal conveyance with Full Support

6.3.1 Differences from Pipeline Conveyance With Full Support

The main differences in the two options are:

- Water quality in River Severn and the canals.
- Additional limiting hazards – Bromide and Algae both with a pre-mitigated catchment risk score of 2x5=10.
- Increased risk of INNS (INNS risk assessment) with a pre-mitigated catchment risk score of 3x4=12.

It is therefore considered that the limiting hazards are likely to be the same as for pipeline with full support, with the exceptions of Bromide and Algae, retained from Gate 1, and INNS added at Gate 2, as additional hazards.

6.4 Canal conveyance with without Minworth

6.4.1 Differences from Pipeline Conveyance With Full Support

The main differences in the two options are:

- Water quality in River Severn and the canals.
- Additional limiting hazards – Bromide and Algae both with a pre-mitigated catchment risk score of 2x5=10.
- No wastewater effluent from AWTP - However it is noted that existing WwTWs (Finham, Longbridge and Stratford) already discharge in final effluent in River Avon.
- Increased risk of INNS (INNS risk assessment) with a pre-mitigated catchment risk score of 3x4=12.

It is therefore considered that the limiting hazards are likely to be the same as for pipeline with full support, with Bromide, Algae and INNS as additional hazards.

6.5 Bristol Water's intake on the canal

6.5.1 Differences from Pipeline Conveyance With Full Support

The main differences in the two options are:

- Pipeline conveyance with full support is likely to represent the greatest water quality risks to Bristol Water's intake as it allows both Minworth and Netheridge effluent to enter the canal.
- Water quality in River Severn and the canals.
- Additional limiting hazards are: Enterococci (5x5=25), Coliform bacteria (5x4=20), Odour (5x3=15), Taste (5x3=15), Geosmin/2-MIB (5x3=15), Ammonium (3x4=12), Pharmaceuticals (5x4=20), Aluminium (4x4=16), Glyphosate (3x4=12).
- Increased risk of INNS (INNS risk assessment) with a pre-mitigated catchment risk score of 3x4=12.

It is therefore considered that the limiting hazards are likely to be the same as for pipeline with full support, with additional hazards listed above.

7. Post Mitigated Residual Risks in Water Supplied to the Consumers

The SQWRA process considers the risks to drinking water quality at all stages from catchment to the consumer. The risks are assessed at each stage of the process and mitigated where appropriate as detailed in the SWQRA spreadsheet.

In the case of STT the majority of risks are mitigated at the treatment stage, although there are some catchment, abstraction, and distribution stage mitigations. For most of the limiting hazards the residual risks posed to consumer are low (green). There are, however, some limiting hazards which will require further review and assessment. These are:

- Limiting hazards which pose a risk that consumers could experience a change in perception of their water. These are generally related to change in source and include change in source type which is assessed as a high risk (red) due to its high likelihood. Also included are taste, odour, Geosmin/2-MIB and alkalinity assessed as medium risks (amber). The mitigation proposed for all these is early customer engagement. This needs to continue throughout the project to keep the consumers informed with the developments and changes in the project that may impact on their water quality and to address their concerns. Further details on customer engagement are contained in Chapter 9 of the Gate 2 report.

- Corrosivity (change in water chemistry) will need further assessment regarding its impact on network corrosion for which the mitigation is treatment/blending.

- Limiting hazards related to CECs - PFOS, PFOA, 1,4-Dioxane and NDMA. These are mainly found in wastewater effluent and generally are difficult to treat. Monitoring of final effluent at Minworth suggests that the current drinking water risk from these is low however it is also possible that the presence of CECs may change in future. At Minworth advanced water treatment is to be provided to remove these. There are however other wastewater discharges into the Severn where these CECs are not being monitored, where they are just as likely to be present, and where there is no advanced treatment proposed. Due to limited monitoring for theses CECs at the relevant sites for the SRO monitoring programmes, CEC's have been assessed as a medium risk (amber) to reflect this uncertainty. The SWQRA states that these are monitored going forward and the risks reassessed at Gate 3 in light on the water quality data. Additionally, PFOS and PFOA monitoring data from water companies, which was not available at the time of the Gate 2 assessment, should be reviewed at Gate 3.

8. Conclusions

Key conclusions from the Gate 2 assessment are:

- New limiting hazards have been included at Gate 2. These include the CECs PFOS, PFOA, NDMA and1,4-Dioxane.
- The pre-mitigated risk scores at catchment for all but one of the limiting hazards are high (red) or medium (amber). The exception is conductivity with a low (green) risk score at catchment. Details are included in the main report and the SWQRA spreadsheet.
- Most of the hazards are mitigated at the treatment stage although there are some catchment, abstraction, and distribution stage mitigations.
- For most of the limiting hazards the residual risks posed to the consumer are low (green). There are, however, some limiting hazards which will require further review and assessment. These are:
    - Limiting hazards which pose a risk that consumers could experience a change in perception of their water. These are generally related to change in source and include change in source type, taste, odour, and alkalinity. The mitigation for these is early customer engagement. This needs to continue throughout the project to keep the consumers informed with the developments and changes in the project that may impact on their water quality and to address their concerns. Further details on customer engagement are contained in Chapter 9 of the Gate 2 report.
    - Corrosivity (change in water chemistry) will need further assessment regarding its impact on network corrosion for which the mitigation is treatment/blending.
    - Limiting hazards related to CECs - PFOS, PFOA, 1,4-Dioxane and NDMA. The current drinking water risk from these is deemed to be low; however, it is also possible that this may change in future. The SWQRA states that these are monitored going forward and the risks reassessed in light of the new water quality data.
- The collaborative "catchment to consumer" approach of the SWQRA process is also aligned with the objectives of the Drinking Water Protected Areas. These objectives are:
    - meeting the requirements of the Water Supply (Water Quality) Regulations 2016,
    - the protection of the supply by avoiding deterioration in water quality to reduce the level of purification treatment required and for groundwater,
    - the achievement of good chemical status and reversing upward trends in pollution, and
    - the reduction of pollution at source as this is more cost-effective than removing pollutants or blending with clean water.

Overall, the SWQRA shows that the risks to drinking water quality from the limiting hazards identified can be mitigated by the measures proposed. However, for CECs and in particular PFAS, if in future the UK water quality regulations were to be tightened in line with recent USEPA guidance, compliance will be very challenging for most of UK new and existing water treatment works.