ANNEX A1

Netheridge Conceptual Design Report

This document has been written in line with the requirements of the RAPID gate two guidance and to comply with the regulatory process pursuant to Severn Trent Water's 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, Severn Trent Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

Severn Trent Water

SEVERN TRENT SOURCES STRATEGIC RESOURCE OPTION

Netheridge Concept Design Report

70088464-WSP-NETHSRO-RP-GT-2001
OCTOBER 2022

PUBLIC

Severn Trent Water

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Netheridge Concept Design Report

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CONTENTS

APPENDICES

APPENDIX B

ACWG DESIGN PRINCIPLES

EXECUTIVE SUMMARY

INTRODUCTION

This Concept Design Report supports Severn Trent Water's (STW) Gate 2 submission to the Regulator's Alliance for Progressing Infrastructure Development (RAPID) for the Severn Trent Sources Strategic Resource Option (STS SRO). The STS SRO comprises two elements: the diversion of treated effluent from Netheridge wastewater treatment works (WwTW) and the reallocation of the Mythe water treatment works (WTW) River Severn abstraction licence.

This report covers the concept design for the Netheridge element of the STS SRO and will be referred to as the Netheridge SRO. The reallocation of the Mythe WTW abstraction licence is primarily an administrative process and is not covered in the scope of this report.

The intent of the Netheridge SRO is to divert up to 35 Ml/day of treated effluent from the Netheridge WwTW to augment the STT SRO at the point of abstraction. This report details the development of treatment and transfer options in support of STW's Gate 2 STS SRO submission.

During the development of the Gate 2 reports, discussions have taken place with the Environment Agency in relation to the issues and benefits associated with the different options. Through discussions with EA during Gate 2 it become apparent that reduced flows in the River Severn would be considered (between Deerhurst and Haw Bridge). Environmental modelling and WFD assessments have shown Option 2 to be acceptable, however it is anticipated that further work will be necessary in Gate 3 to enable agreement to be reached with the EA. Option 2 (Haw Bridge) is the preferred option and will be progressed to the next stage. Ongoing discussion with the EA and further environmental work will be required at Gate 3 to refine Option 2, especially with regards to the treatment process, which is currently designed for a 'worst case' scenario.

Alternative 'no treatment' options were put forward by the project team as a result which significantly reduce the increases in carbon and cost resulting from the additional treatment when compared to the Gate 1 solution. The 'no treatment' options are discussed in Section 5.1 of the CDR report and there will be an opportunity to pursue these further in Gate 3.

The approach at Gate 2 has been to continue and enhance work carried out in the development of the scheme at Gate 1. In establishing more detail of how the scheme may operate, and as the likely discharge quality standards are better understood, a number of opportunities have been identified around treatment process and the opportunity for different end use of the Netheridge effluent. These have been addressed in the process basis of design report and the alternative options addendum.

GATE 2 OPTION SUMMARY

The Netheridge SRO will comprise two main elements:

- Additional treatment of the diverted flows to meet the higher required water quality standards at the new discharge location. Flow will be diverted from the Netheridge WwTW final effluent outfall, though additional treatment processes and onto a transfer pumping station adjacent to the WwTW site.

- Transfer of flows to the discharge point via a pumped pipeline. A new [redacted] mm diameter pipeline will be constructed and will terminate at a submerged outfall structure at the discharge location in the River Severn.

A summary of the Gate 2 options is provided below:

OPTION 1 – RIVER SEVERN - DEERHURST

A pipeline from Netheridge WwTW to the River Severn just downstream of the new STT SRO Deerhurst Water Treatment Works. Treatment at Netheridge comprises iron based coagulant dosing into the existing activated sludge plant (ASP) – nitrification (moving bed bioreactor (MBBR)) – phosphorus removal (CoMag^{TM}) – metals and organics removal (ozonation, biologically active filtration (BAF) and granular activated carbon (GAC)). Pipeline approximately 18 km in length.

OPTION 2 – RIVER SEVERN - HAW GAUGING STATION

A pipeline from Netheridge WwTW to the River Severn just upstream of the EA Gauging Station at Haw. Treatment comprises iron based coagulant dosing into the existing ASP – nitrification (MBBR) – phosphorus removal (CoMag^{TM}) – metals and organics removal (ozonation, BAF and GAC). Pipeline approximately 15.5 km in length.

OPTION 3 – RIVER SEVERN - EAST CHANNEL

A pipeline from Netheridge WwTW to the east channel of the River Severn downstream of the existing Canal & River Trust (CRT) pumping station to Gloucester Docks. Treatment to comprise iron based coagulant dosing into the existing ASP – nitrification (MBBR) – phosphorus removal (CoMag^{TM}) – metals and organics removal (ozonation, BAF and GAC and Ion Exchange). Pipeline approximately 5 km in length.

OPTION 4 – GLOUCESTER AND SHARPNESS CANAL

A pipeline from Netheridge WwTW to the Gloucester and Sharpness (G&S) Canal. Treatment to comprise iron based coagulant dosing into the existing ASP – nitrification (MBBR) – phosphorus removal (CoMag^{TM}) – metals and organics removal (ozonation, BAF and GAC and Ion Exchange) and disinfection (ultraviolet (UV) treatment). Pipeline approximately 400 m in length.

OPTION 5 – SOUTHWEST REGION BRANCH PIPELINE

Additional pipeline for diversion of flows from the Netheridge to Deerhurst (or Haw Bridge) pipeline for discharge to the East Channel of the River Severn downstream of the intake for Gloucester Docks. This branch will follow the same route as Option 3.

STT SRO INTEGRATION

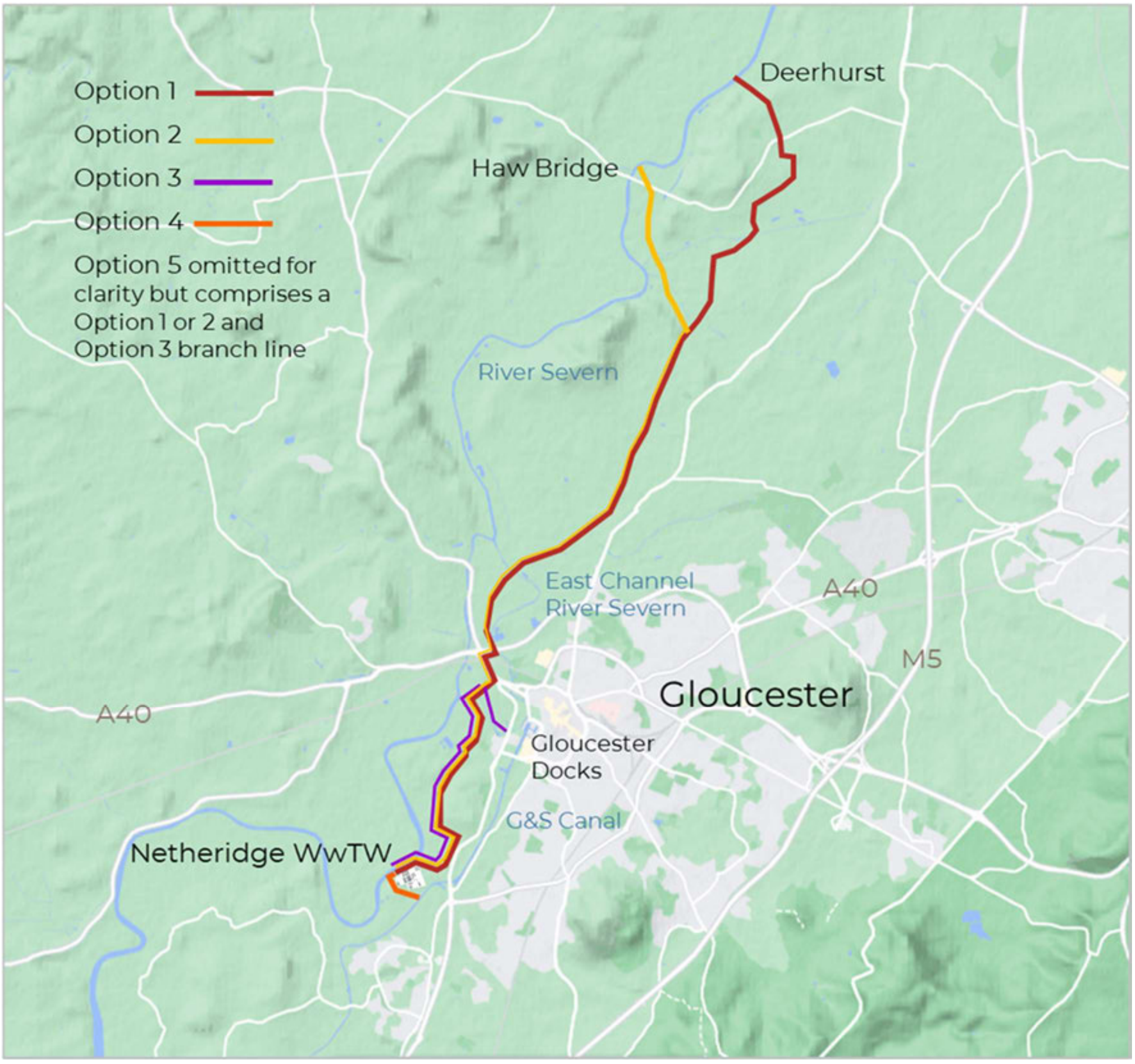
The Netheridge SRO will be designed to operate in conjunction with the STT SRO with the transfer of treated effluent being on an ‘on demand’ basis as determined by the STT SRO. The following STT SRO defined operational parameters were used for the development of the Netheridge SRO concept design:

- When operational the STT SRO will 'call' for 35 Ml/d from Netheridge. This is the total volume required over a 24-hour period and does not need to be provided at a constant flow rate.
- When flow in the River Severn drops below 'hands off flow' (where the river level is too low to undertake abstraction without augmentation from other sources), Netheridge flows will be utilised to provide the 'sweetening' flow in the STT SRO pipeline. The STT SRO will 'call' for 20 Ml/d from the Netheridge SRO as the sweetening flow.
- The STT SRO will provide 17 days' notice of the requirement before commencing operation. This is understood to include the requirement for sweetening flows.
- The STT SRO will remain operational for at least 20 days. This is understood to include the requirement for sweetening flows.
- For the purpose of producing operational cost estimates it is assumed that the STT SRO will be operational for 35 days per annum (circa 10% of the year).
- When not in use the transfer pipeline will be drained and left empty to avoid risk of septicity. Some elements of the Netheridge SRO treatment process will operate on a continual basis to ensure viability of the biological processes.
- The SRO schemes are assumed to operate for an 80 year period.

The Netheridge SRO must be completed and be operating before the STT SRO can become fully operational. The STT SRO will not be able to abstract the full volumes of water from the abstraction point if Netheridge SRO is not available to provide the 35 Ml/d to augment the water source.

The size and complexity of the Netheridge SRO should allow for the scheme to be constructed in less time than the STT SRO and so it should not fall on the 'critical path' for delivery and implementation of the wider SRO schemes.

Figure 1 - Location and Pipeline Routes Overview



TREATMENT PROCESS DESIGN

The Netheridge WwTW currently discharges treated effluent to the tidal zone of the River Severn. The tidal nature of the receiving water allows for a less stringent discharge consent permit than a freshwater river or less dynamic water body. The effluent quality required for future effluent discharge to the non-tidal stretches of the River Severn (i.e. Deerhurst or Haw Bridge) or the G&S Canal will be more onerous than those in place for the existing Netheridge WwTW discharge. Therefore, additional treatment processes are required for the Netheridge SRO.

The approach taken for the Concept Design has been to develop the proposed Gate 1 technologies as a standalone treatment plant that can be operated independently of Netheridge WwTW. As the concept design has progressed the effluent quality standards for the River Severn and River Severn East Channel have increased with the new requirement for removal of trace organics. This has led to the inclusion of additional treatment steps to those proposed at Gate 1.

The proposed treatment process is based on the following criteria:

- Provision of treatment equipment that can handle flows between 200 l/s and 550 l/s to match the recorded diurnal dry weather flow pattern at Netheridge WwTW.
- An assumed requirement to achieve a BOD consent of 5 mg/l (mean)
- An assumed requirement to achieve a mean ammonia concentration of 1 mg/l, 95th percentile of 2 mg/l.
- An assumed requirement to meet a mean 0.2 mg/l total phosphorus permit.
- An assumed requirement to remove the listed pesticides and herbicides that have not been detected in the receiving water course to non-detectable concentrations to meet likely permitting conditions.
- An assumed requirement to remove PFOS to non-detectable concentrations to meet likely permitting conditions to prevent impediment towards achieving target water framework directive (WFD) status.

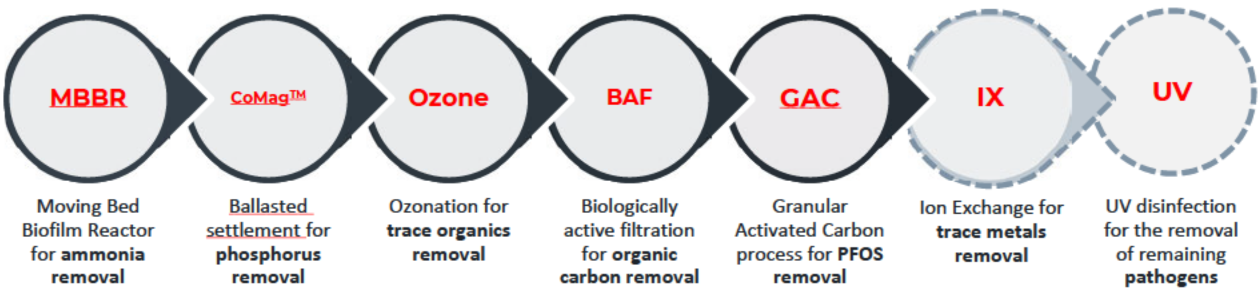
In addition to the above, an assumed requirement to remove metals to non-detectable concentrations to meet likely permitting requirements (for Options 3, 4 and 5 only)

- An assumed requirement to provide disinfection to permit discharge into the drinking water protected area (For Option 4 only).
- It is assumed in all cases any total suspended solids (TSS) permit requirement will be met through the provision of a multi-barrier treatment process.

Treatment plant layouts were initially developed within the Netheridge WwTW boundary, but it became apparent that there was inadequate space to locate all the treatment units satisfactorily. Hybrid layouts were considered, with some plant within the existing boundary and some outside the boundary, but this created inefficiencies in transfer of flows between treatment units. The solution chosen locates all the treatment process to the west of Netheridge WwTW on STW owned land. The existing sludge cake handling area has been utilised to limit the need to remove a wooded area to the southwest.

An overview of the proposed treatment process is summarised in Figure 2.

Figure 2 - Treatment Process Overview



The treatment processes shown in black are common throughout all proposed options. Ion exchange applies to the options that require trace metals removal (option 3, 4 and 5 only) and UV for option 4 to provide a disinfection stage.

The construction of a new treatment plant at Netheridge will require upgrades to the existing electrical supply and a new motor control centre (MCC) and control building. Control and monitoring of the both the treatment process and transfer pump station will be largely automated and could be achieved by interfacing with the existing Netheridge WwTW control room or as standalone system.

TRANSFER PUMP STATION DESIGN

The transfer pump station will be located at Netheridge WwTW. It could potentially be a dry or wet-well arrangement. The flowrate basis for the transfer pumping station must align with the upstream treatment stages and so variable speed control is expected to be necessary to allow the conveyance flowrate to approximately match the treatment flowrate which will follow the diurnal flow pattern.

PIPELINE DESIGN

The pipeline design developed one route to each of the four discrete discharge locations. Other sub-options for route and discharge locations were discounted as the opportunity for alternative pipe routes is limited and are within the margin of error of the cost estimates.

The initial pipeline route corridors were selected based on aerial photographs. These corridors were then assessed using digital terrain modelling incorporating utilities information and landownership information. The routes underwent iterations to ensure that the route was optimised for ease of construction and operational performance.

The pipeline is mostly routed through agricultural land. Options 1,2 and 3 pass through Alney Nature Reserve but construction impact can be minimised which presents an opportunity for biodiversity net gain during reinstatement. Options 1 and 2 require the pipeline to pass under the railway and all options pass under the East Channel of the River Severn and a number of other small water courses.

For the pipeline for Options 1 and 2, where the pipeline passes the high point, it is proposed to construct a break pressure tank to allow the last section of the pipeline to flow by gravity to the discharge point.

Across all options, the flows will be discharged to the receiving waters via a submerged outfall structure. This structure has a minimal bank side presence and incorporates eel protection.

The pipeline will be operated on an intermittent basis and drained to be left empty when not in use. Drain points are proposed at each of the tunnel crossings and low points along the pipe route. The pipeline will be drained by pumping at an appropriate rate into the local water course. Given the effluent has undergone additional treatment it should be possible to achieve adequate dilution to mitigate any environmental concerns.

SCHEME DELIVERY

The Netheridge SRO must be completed and be operating before the STT SRO can become fully operational. The STT SRO will not be able to abstract the full volumes of water from the abstraction point if Netheridge SRO is not available to provide the 35 Ml/d to augment the water source.

The size and complexity of the Netheridge SRO should allow for the scheme to be constructed in less time than the STT SRO and so it should not fall on the 'critical path' for delivery and implementation of the wider SRO schemes. There is no direct connection to the STT SRO as the Netheridge SRO effluent is discharged to the receiving water independently of STT SRO abstraction

It is anticipated that the Netheridge SRO would be constructed in two parts: the treatment plant upgrade and the pipeline and both will take less than 24 months to complete once all permissions are in place and design is complete.

DEPLOYABLE OUTPUT

The deployable output (DO) from the Netheridge SRO will benefit the London water resource zones via the STT SRO. The DO for the Netheridge SRO is 35 Ml/d based on available outflows from the Netheridge WwTW. This value has been predetermined and agreed as part of the wider STT SRO. The 35 Ml/day value was re-assessed as part of the Gate 2 concept design, and it has been identified that outflows from Netheridge during dry periods may lead to short periods (around 1% of the time or 3-4 days a year) where 35 Ml/day may not be achievable even when future growth in the catchment is taken into consideration.

It was also identified that provision of 35 Ml/day would not be a constant flow rate but would need to vary over a 24 hour period in line with the recorded diurnal inflows into Netheridge WwTW. Transfer flows are therefore assumed to vary between 200 l/s overnight and 550 l/s at peak times.

FUTURE SCHEME DEVELOPMENT

As the Netheridge SRO concept design has progressed a number of developments in the anticipated discharge quality standards and the resulting level of additional treatment required has led to identification of other potential opportunities for the Netheridge SRO. The development of these opportunities will be a critical next step in the development of the Netheridge SRO and may alter the overall premise of the scheme. These will be pursued separately by STW and will be discussed and agreed with RAPID as part of the Gate 2 process.

Southwest Region Supply: the opportunity to provide flows to the southwest, in particular Bristol Water at Purton, by transferring flows to the G&S Canal.

No Treatment Options: the opportunity to develop options that do not require any form of additional treatment but instead rely on multistage pumping or transfer of flows within river quality zones. This will have a significant impact on the total carbon of the Netheridge SRO project as well as reducing the capital and operational cost.

Development of the current Netheridge SRO will require further development of the concept design including:

- Development of the treatment process design based on confirmed water quality standards
- Further analysis of inflow to Netheridge WwTW to ensure delivery of required DO
- Development of the treatment plant layout in conjunction with future asset management period 8 (AMP8) upgrades
- Construction of a pilot plant to test and refine the proposed treatment processes
- Engagement with landowners and stakeholders to gain easements, discharge consents and planning permissions.
- Survey work for geology, topography, utilities and environmental impact.

ECONOMICS AND CARBON COST

The cost estimates of the five options considered as part of the concept design are summarised in Table 1-1.

Table 1-1 – Summary of Costs

Option No.	Option Name	Total Capex Cost (incl, Risk and Optimism Bias)	Net Present Value (NPV) Finance	NPV Opex	AIC (p/m^3)
Option 1	Deerhurst	£153,664,600	£168,185,540	£76,874,965	93.08
Option 2	Haw Bridge	£147,644,600	£163,915,721	£73,460,388	90.17
Option 3	East Channel	£128,500,700	£154,520,009	£70,083,464	85.31
Option 4	G&S Canal	£116,190,800	£146,993,167	£71,329,031	82.93
Option 5	Southwest Branch	£13,478,400	£15,146,408	£15,016,144	11.46

The carbon estimates of the five options considered as part of the concept design are summarised in Table 1-2. The carbon for option 5 is in addition to options 1 or option 2 to accommodate the branch into the East Channel of the River Severn downstream of the intake for Gloucester Docks.

Table 1-2 – Summary of Whole Life Carbon Emissions (tCO_2e) by category - 80 year period

Option	Pipeline Capital Carbon	Treatment Capital Carbon	Pipeline Operational (Power) Carbon	Treatment Operational (Power) Carbon	Treatment Operational (Chemical) Carbon	Total Whole Life Carbon
Option 1	26,159	10,266	15,838	45,781	47,428	145,473
Option 2	23,997	10,266	12,347	45,781	47,428	139,819
Option 3	7,646	13,276	6,455	48,051	47,428	122,856
Option 4	1,710	17,796	6,618	49,117	47,428	122,669
Option 5	1,122	1,462	1,746	2,270	-	6,599

There is a balance between the embodied carbon of the four main options with higher pipeline carbon for options 1 and 2 and higher treatment carbon for options 3 and 4 which require additional treatment steps. Overall the total embodied carbon is highest for option 1 which is due to the long pipe length which also leads to high operational carbon over the 80 year assessment period.

A number of steps have been taken in the concept design for Gate 2 to reduce the overall carbon:

- Reduce the length of the pipelines and maximise hydraulic efficiency
- Remove the need to continually pump 10% of the flow to prevent septicity by draining the pipeline when not is use
- Reduce flows through each treatment process to the minimum required to keep the process viable
- Selection of lower carbon treatment processes and equipment where appropriate

RISK AND OPPORTUNITIES

The key risks identified for the Netheridge SRO are:

- Uncertainty regarding the quality standards required for the effluent discharge to the River Severn, East Channel for the River Severn or the G&S Canal.
- Uncertainty regarding the inflows to Netheridge WwTW and the ability of the Netheridge SRO to provide 35 Ml/day Deployable Output to the STT SRO during periods of dry weather.
- Uncertainty regarding the ownership of land, wayleaves and easements and permissions needed for construction of the pipeline

Alongside the opportunities identified under the future scheme development, number of opportunities for enhancement of the Netheridge SRO concept design have been identified for investigation in subsequent stages of the project:

- Biodiversity net gain along the pipeline route and at the WwTW
- Alternative treatment process based on confirmed discharge standards and pilot plant trials
- Further carbon reduction or offsetting including:
  - Netheridge WwTW holistic upgrade
  - Nature based solution (wetlands for phosphorous removal)
  - PV Array for local power generation at the Netheridge site

1 INTRODUCTION

1.1 CONTEXT

As water resources come under increasing pressure from population growth, economic development and climate change it has been recognised that significant investment is required to help prevent water shortages, protect the environment and provide resilience required to meet societal needs.

In 2019 Ofwat formed the Regulators' Alliance for Progressing Infrastructure Development[1] (RAPID) to help facilitate the development of large-scale strategic solutions to these water supply issues. The strategic solutions will pass through a gated process where decisions will be made on the solution progression.

Nine Water Companies have collaborated to create 17 Strategic Resource Options (SROs) which were submitted to RAPID for appraisal at Gate 1 in July 2021. All SROs were approved and are undergoing further development for submission to Ofwat at Gate 2 in November 2022.

This Concept Design Report supports Severn Trent Water's (STW) Gate 2 submission to RAPID for the Severn Trent Sources SRO (STS SRO). The STS SRO comprises two elements: the diversion of treated effluent from Netheridge wastewater treatment works (WwTW) and the reallocation of the Mythe water treatment works (WTW) River Severn abstraction licence.

This report covers the concept design for the Netheridge element of the STS SRO and will be referred to as the Netheridge SRO. The reallocation of the Mythe WTW abstraction licence is primarily an administrative process and is not covered in the scope of this report.

1.2 LINKS AND DEPENDENCIES WITH OTHER SRO SCHEMES

The STS SRO is closely linked to the Severn to Thames Transfer SRO (STT SRO) as flows diverted from Mythe WTW and Netheridge WwTW will be used to augment flow transfers south to the Thames Water regions.

Also linked to the STT SRO are the Vyrnwy Aqueduct, Minworth and United Utilities Sources SROs which all form part of the wider solution to transfer water from the northwest to the southeast of England by redistributing water supply sources in the northwest and enabling augmentation of flows in the River Severn.

- Severn Trent Sources: Mythe abstraction licence (15 Ml/d) and Netheridge WwTW (35 Ml/d) – up to 50 Ml/d
- Vyrnwy Aqueduct and United Utilities sources (these facilitate the release from Lake Vyrnwy) – up to 180 Ml/d
- Minworth reuse – up to 115 Ml/d

[1] Comprising Ofwat, Drinking Water Inspectorate and the Environment Agency

Figure 1-1 and Figure 1-2 show the RAPID schematic for the SROs that form part of a wider scheme to redistribute water supply sources in the northwest to enable transfer of flows to the southeast.

Figure 1-1 - Severn to Thames Transfer Schematic (RAPID Gate 1 submission)

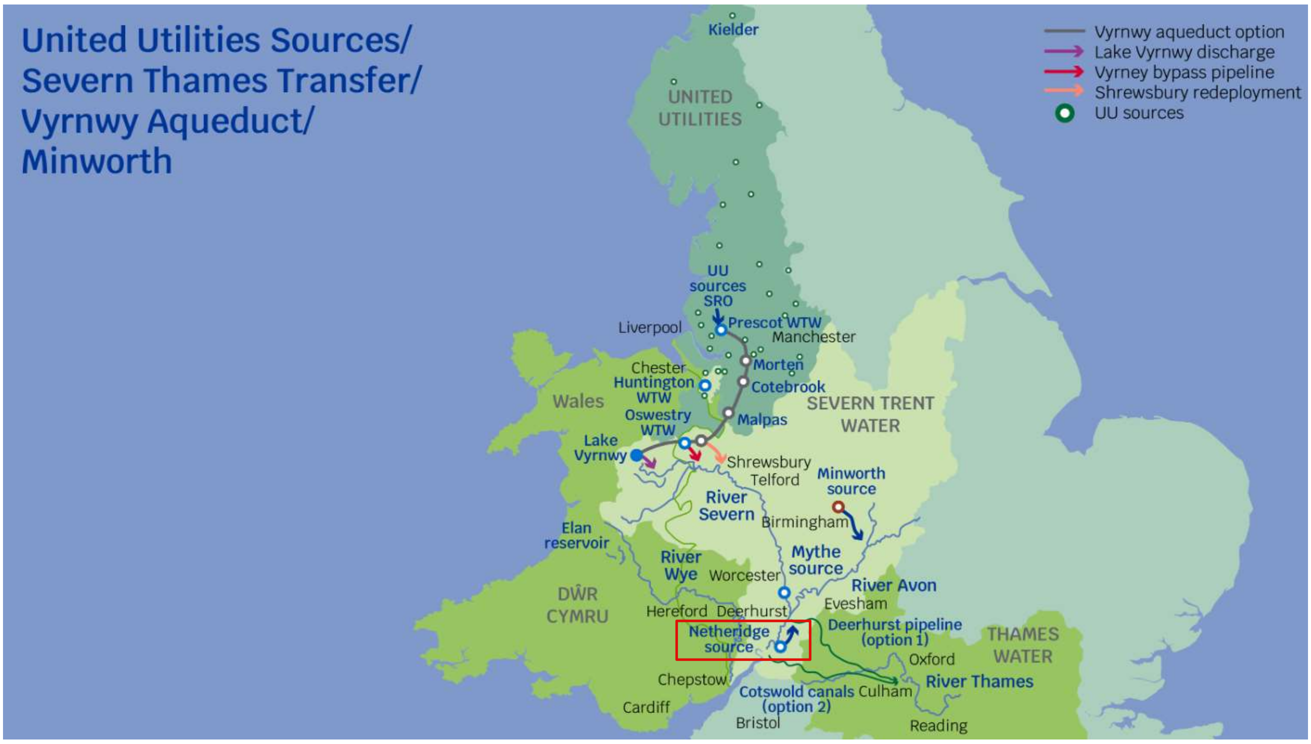
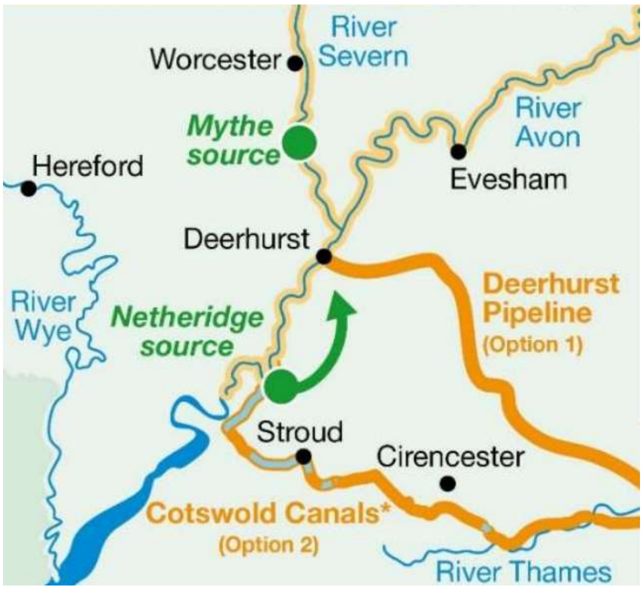


Figure 1-2 - STT SRO Schematic (Gate 1 submission for Severn Trent Sources Strategic Resource Option)



The intent of STT SRO is to transfer up to 500 Ml/day from the River Severn to the Thames region. At Gate 1 there were two options being considered:

1. Abstraction from the River Severn with treatment at Deerhurst before transfer via pipeline to Culham for onward distribution.
2. Abstraction via the Gloucester docks, transfer along the Cotswolds canals, treatment and then pumped from Lechlade to Culham for onwards distribution.

The option choice for the STT SRO will dictate the discharge location for the Netheridge SRO, with flows being transferred to Deerhurst for option 1 or to the canal for option 2.

The Netheridge SRO requirements are primarily determined by the STT SRO operational regime. The scheme will only transfer flows when called for by the STT SRO. The key operational parameters of the STT SRO are as follows:

- The STT SRO will provide at least 17 days' advance notice of the intent to begin transfer of flow to the Thames region
- The STT SRO will operate for a minimum of 20 days once fully operational
- The Netheridge SRO will provide 35 Ml/day for River Severn flow augmentation when the STT SRO scheme is operational
- The Netheridge SRO will provide 20 Ml/day when the STT SRO is NOT operational but when levels in the River Severn are below 'hands off' flow'(HOF) and cannot abstract 'sweetening' flows from the River Severn without augmentation from other sources

1.3 SCHEME OVERVIEW AND LOCATION

The intent of the Netheridge SRO is to divert up to 35 Ml/day of treated effluent from the Netheridge WwTW to augment the STT SRO at the point of abstraction. This report details the development of treatment and transfer options in support of STW's Gate 2 STS SRO submission.

Netheridge WwTW is located just south of Gloucester and is bounded by the River Severn on the west and the G&S Canal on the east. The WwTW can treat up to 42.8 Ml of wastewater (dry weather flow) a day with flows coming from Gloucester and the surrounding catchments. The existing treatment process comprises screening, preliminary settlement, biological treatment via Activated Sludge Process (ASP) lanes and final settlement. The WwTW currently discharges treated effluent to the tidal zone of the River Severn. Figure 1-3 shows the layout and location of the main treatment components.

Figure 1-3 – Netheridge WwTW

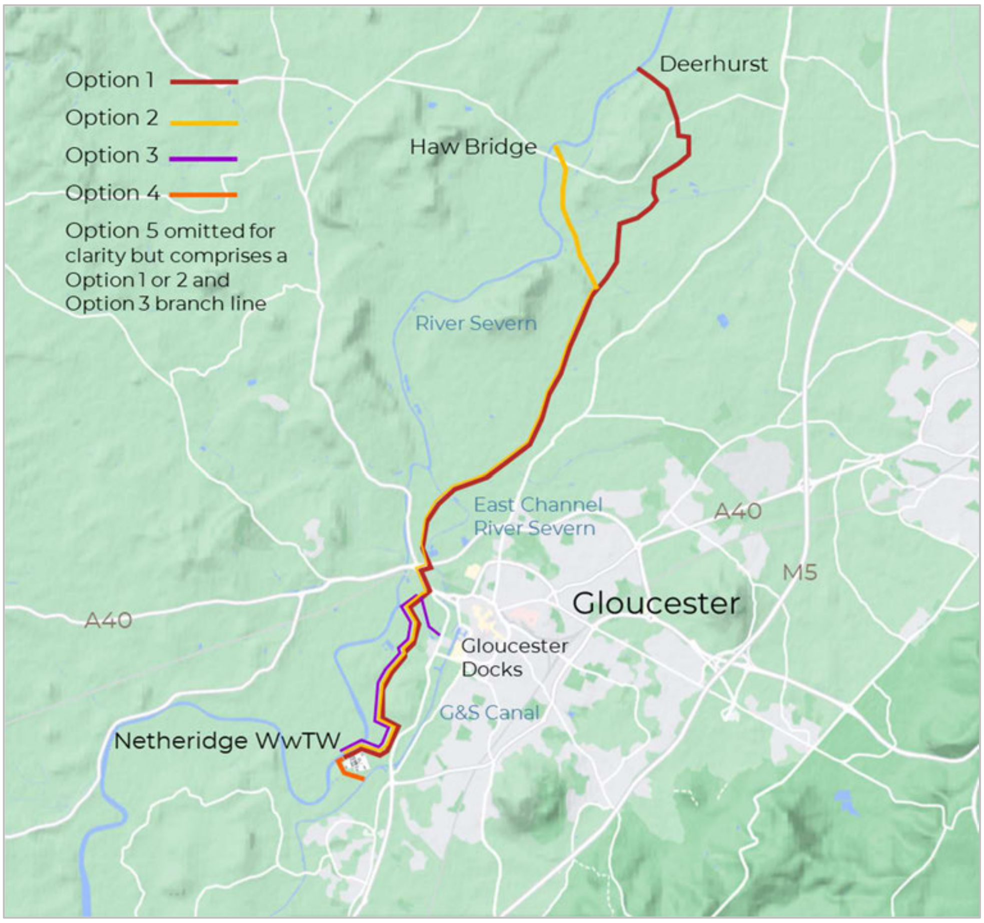
[redacted]

The Netheridge SRO will comprise two main elements:

- Additional treatment of the diverted flows to meet the higher water quality standards at the new discharge location
- Transfer of flows to the discharge point via a pumped pipeline

Figure 1-4 shows the location of Netheridge WwTW and the transfer pipeline route options to the STT SRO abstractions points at Deerhurst and the G&S Canal.

Figure 1-4 – Netheridge SRO Overview



The additional treatment required for the Netheridge WwTW effluent before transfer is dependent on the discharge location. The current discharge location for Netheridge WwTW effluent is in the tidal zone of the River Severn. This allows for an effluent quality standard that is less stringent than that required for discharge to a freshwater river environment. Therefore, any discharge further north on the River Severn, including the East Channel of the River Severn, will need additional treatment to meet the required quality standards. Similarly, discharge to the G&S Canal has more stringent quality standards that are further impacted by the potential need to meet drinking water abstraction standards. Treatment upgrades for each discharge location are proposed.

The transfer options and pipeline routes have been developed based on the STT SRO potential abstraction points:

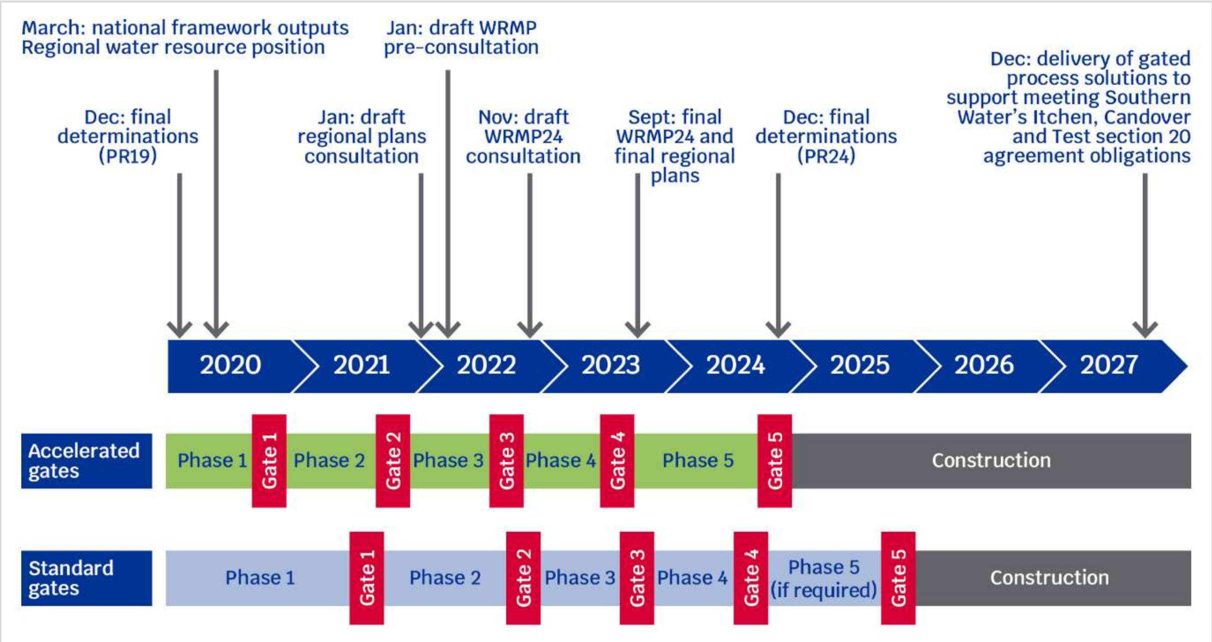
- **Deerhurst.** The STT SRO is proposing to construct a new water treatment works at Deerhurst that will abstract water from the River Severn. If this abstraction point is utilised, then options to discharge Netheridge SRO effluent at Deerhurst or 3 km downstream at Haw Bridge are proposed.
- **G&S Canal.** The STT SRO is proposing to abstract water from the G&S Canal south of Gloucester. If this abstraction point is utilised, then options to discharge Netheridge SRO effluent directly to the G&S Canal at Netheridge and to the East Channel for the River Severn at Gloucester Docks are proposed.

1.4 RAPID GATE 2 REQUIREMENTS

1.4.1 RAPID GATE 2 SCOPE

In order to ensure water companies are progressing their SROs in a timely and efficient manner, and that solutions and options merit further development, RAPID use a gated approval process. This process aligns with the Regional Water Resource Plan development and comprises four Gates designed to take the SRO from initial concept solutions through to a robust recommended option.

Figure 1-5 - RAPID Gated Process for SRO Solutions



The high level outcome for Gate 2 is described as 'Detailed feasibility, concept design and multi-solution decision making'. This stage builds on Gate 1 activities to improve detail and reduce uncertainty with the aim of reducing the number of options under consideration.

The purpose of this Concept Design Report is to support the STW submission to RAPID at Gate 2 for the STS SRO scheme. The Concept Design Report will inform a number of sections of the submission including:

- 3 – Solution Design, Options and Sub-options
- 7 - Programme and Planning
- 8 - Solution Costs and Benefits

1.4.2 CONCEPT DESIGN REPORT SCOPE

The particular scope of work for the Netheridge SRO Concept Design Report commission includes:

- Gate 1 Options appraisal
- Options Development including:
  - Detailed development of the pipeline route options
  - Hydraulic analysis
  - Detailed development of treatment options
  - WwTW site layouts

- Power requirements
- Development of an operation strategy
- Carbon cost estimation
- Biodiversity Net Gain opportunities
- Requirements for investigations and studies in the next phase of the project
- Incorporation of feedback from the environmental teams and the land planning teams

- Capital and operational cost estimation, including net present value (NPV), optimism bias and costed risk assessment

Excluded from the Concept Design Report Scope are all environmental studies and stakeholder engagement. These aspects of the Netheridge SRO are being carried out by a separate consultants engaged as part of the wider STT SRO.

1.4.3 CONCEPT DESIGN APPROACH AND METHODOLOGY

The Netheridge Concept Design Report does not attempt to make direct comparisons or recommendations as to the best option for the Netheridge SRO scheme. The drivers for option choice are wider than the Netheridge SRO project with external factors, such as Environment Agency (EA) decisions regarding exact discharge location, ultimately deciding the option choice. To that end this report collates the key design outputs, cost and carbon estimates, and identified risks and presents them to allow for broader understanding of the opportunities that the Netheridge SRO may present.

The approach at Gate 2 has been to continue and enhance work carried out in the development of the scheme at Gate 1. In establishing more detail of how the scheme may operate, and as the likely discharge quality standards are better understood, a number of opportunities have been identified around treatment process and the opportunity for different end use of the Netheridge effluent. Due to the constraints of the RAPID gated process these will be pursued separately by STW.

In the absence of actual discharge quality standards, the development of the treatment process has been based on the most onerous discharge quality standards anticipated by the environmental consultant.

There are a number of potential pipeline route options for each of the discharge locations, but preliminary assessment determined that the routes are materially the same with variations in length, obstacle crossings, land ownership and hydraulic characteristics very similar in terms of cost, risk and level of disruption. The cost variations were within the overall margin of error and therefore there was little value in presenting each variation at this stage of the design.

1.4.4 REPORTS ISSUED AT GATE 2

The Concept Design Report has been split into a number of separate reports to align with other STW SRO reports and to facilitate third line assurance.

The following reports comprise the Severn Trent Source SRO - Netheridge Concept Design Report:

- Severn Trent Source SRO - Netheridge Concept Design Report
  (Annex A1) (this report)
- Severn Trent Sources (Netheridge SRO) – CDR Addendum – Alternative (No Treatment) Options
  (Annex A1.1
- Severn Trent Source SRO - Netheridge Pipeline Route Appraisal Report
  (Annex A2)
- Severn Trent Source SRO - Netheridge Process Basis of Design
  (Annex A3)
- Severn Trent Source SRO - Netheridge Carbon Report
  (Annex A4)
- Severn Trent Source SRO - Netheridge Cost Report
  (Annex A5)

2 CONCEPTUAL DESIGN

2.1 GATE 1 OPTIONS APPRAISAL

2.1.1 GATE 1 DISCHARGE LOCATION APPRAISAL

For RAPID Gate 1 three options were developed for the Netheridge SRO based on the potential discharge location. For Gate 2 these options have been refined based on subsequent environmental assessments and engagement with the EA and developments in the STT SRO.

OPTION 1

Option 1 comprised treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge to the River Severn at a new STT SRO Deerhurst WTW, with option 1A being downstream and option 1B being upstream of the proposed new WTW intake.

Discussion with the EA, and modelling work by the environmental consultants, subsequently ruled out option 1B. For Gate 2 the option to discharge downstream of the new WTW intake has been developed.

In addition, discussion with the EA indicated that the discharge point could potentially be downstream of the new WTW intake so long as it was upstream of the next flow gauging station located at Haw Bridge. This could reduce the length and hydraulic head of the transfer pipeline saving both capital and operational costs. A new option to discharge treated effluent upstream of Haw Bridge gauging station has been developed to allow further discussion with EA as to the feasibility of this as a discharge location.

OPTION 2

Option 2 comprised treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge directly to a new STT SRO Deerhurst WTW, with option 2A being at the outlet of the new WTW and option 2B being at the head of the new WTW.

Subsequent development of the STT SRO scheme did not indicate any benefit from this option with the preference being to discharge the Netheridge SRO flows into the River Severn which allowed for more flexible flow balancing through river abstraction.

OPTION 3

Option 3 comprised treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge to the G&S Canal for abstraction. Three sub options were considered:

- Option 3A1 direct discharge to the G&S Canal adjacent to Netheridge WwTW
- Option 3A2 discharge to the East Channel of the River Severn upstream of Gloucester Docks (and onwards into the G&S Canal)
- Option 3B discharge to the East Channel of the River downstream of Gloucester Docks (and onwards into the River Severn)

Discussions with the EA and preliminary modelling work by the environmental consultants subsequently ruled out option 3A2 as discharge upstream of the docks would not provide additional natural treatment or dispersion and so would need to meet the same more stringent water quality requirement as the direct discharge option 3A1 with the disadvantage of 5km of pipeline required to transfer flows.

2.1.2 INITIAL GATE 2 DISCHARGE LOCATION OPTIONS

At the beginning of Gate 2, four options were selected for further analysis. These were renamed as follows:

Option 1 (was option 1A) - Treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge to the River Severn downstream of the new STT SRO Deerhurst WTW.

Option 2 (variation of 1A) - Treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge to the River Severn upstream of the gauging station at Haw Bridge.

Option 3 (was 3B) – Treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge to the East Channel of the River Severn downstream of the Canal & River Trust (CRT) intake for Gloucester Docks.

Option 4 (was 3A1) - Treatment of effluent at Netheridge WwTW with transfer via [redacted] mm diameter pipeline and discharge to direct to the G&S Canal adjacent to the Netheridge WwTW.

2.1.3 REVISED GATE 2 DISCHARGE LOCATION OPTIONS

It had been anticipated that the Netheridge SRO would progress to Gate 2 with options in support of the STT SRO chosen conveyance route, which is likely to be via pipeline from Deerhurst. However, as Gate 2 progressed STW became aware of a potential need for additional water resources in the Wessex Water and Bristol Water regions. This presented an opportunity to utilise work done to date on discharge to the G&S Canal to develop options for supply to the southwest, in particular the Bristol Water Purton WTW which lies to the south of Netheridge and abstracts water from the G&S Canal.

Therefore, options 3 and 4, which discharge to the G&S Canal, have been continued through to the Gate 2 submission. The details of these options remain the same regardless of whether the end user is the STT SRO scheme or Bristol Water.

An additional option, which would allow provision of water to the STT SRO at Deerhurst and/or Bristol Water via the G&S Canal, has also been presented. This option is a combination of Options 1 or 2 and Option 3 and is presented as the additional cost of a branch line from the Netheridge SRO pipeline to the East Channel of the River Severn downstream of Gloucester Docks.

Option 5 – Additional pipeline for diversion of flows from the main Netheridge SRO pipeline for discharge to the East Channel of the River Severn downstream of the CRT intake for Gloucester Docks.

2.1.4 GATE 1 TREATMENT PROCESS APPRAISAL

Initial appraisal of the treatment process upgrades proposed at Gate 1 determined that the selected treatment technologies were appropriate. Treatment upgrades were proposed based on the anticipated effluent quality required at the discharge location.

OPTION 1 and 2

Options 1 and 2 would see effluent discharged to the River Severn. The proposed treatment upgrade was for ferrous dosing only. This was on the basis that there would be a requirement to treat phosphorus to 1 mg/l. No treatment was required for ammonia, trace organics or disinfection.

OPTION 3A

Option 3A1 would see effluent discharged directly to the G&S Canal, and option 3A2 indirectly to the G&S Canal via the River Severn East Channel (via CRT pump at Gloucester Docks). The proposed treatment process was for:

- CoMag™ - on the basis that there would be a requirement to remove phosphorus to less than 0.2 mg/l.
- Ozone – on the basis that would be a requirement to remove trace organics and provide disinfection

Noting that there was no specific requirement for ammonia or nitrate removal as the levels in the G&S Canal had not been classified.

OPTION 3B

Option 3B would see effluent discharge to the River Severn via the River Severn East Channel. The proposed treatment upgrades were for ferrous dosing only. This was on the same basis as options 1 and 2 assuming that there would be a requirement to treat phosphorus to 1 mg/l. No treatment was required for ammonia, trace organics or disinfection.

2.1.5 GATE 2 TREATMENT OPTIONS

Following Gate 1 completion in summer of 2021 comprehensive sampling of water quality of existing Netheridge WwTW final effluent and River Severn at the proposed discharge locations have increased the understanding of the likely discharge standard requirements. Provisional screening has been undertaken on discharge into the River Severn at Deerhurst to further improve the understanding. Screening of discharge into the River Severn East Channel and Gloucester and Sharpness Canal has not been undertaken. For these options, the chemicals that require removal have been determined according to water quality data where the concentration in the Netheridge WwTW final effluent is greater than the environmental quality standard (EQS) of the receiving water course. STW have engaged with the EA, and whilst no firm conclusions have been drawn, it is clear that the anticipated Gate 1 effluent quality standards were not appropriate. Significantly more stringent quality standards are likely to be required for discharge into the River Severn including the need to reduce the levels of ammonia, phosphorus to below 0.2 mg/l and to remove selected trace organics and metals prior to discharge.

Given the work completed to date on the Gate 1 treatment technologies these have been retained for Gate 2 concept design. The ongoing development in effluent quality standards left inadequate time to reconsider alternative technologies and the baseline Gate 1 assessment remains valid. It should be noted that there would be benefit for revisiting the treatment selection process carried out at Gate 1 to ensure that the most effective and efficient treatment processes are ultimately carried forward to the Netheridge SRO construction.

The increase in effluent quality standards has meant that Gate 2 treatment options are now largely based on Gate 1 Option 3A with further enhancements to remove ammonia and additional technologies to remove trace organics.

2.1.6 TREATMENT PLANT LAYOUT APPRAISAL

At Gate 1 it was anticipated that the new treatment process units and equipment as well as the transfer pump station, could be located within the boundary of the existing Netheridge WwTW site. Subsequent review of the treatment process requirement, and a more detailed assessment with STW Operations staff of the existing underground services within the site boundary, has determined that the Gate 1 treatment layouts are no longer feasible.

For Gate 2 concept design areas outside the exiting WwTW boundary have been considered. STW own land adjacent to Netheridge WwTW and this has been utilised to provide a preliminary site layout that establishes the basic land requirement and sequencing and connectivity of the proposed process units.

2.2 GATE 2 OPTION SUMMARY

A summary of the Gate 2 options is provided below:

OPTION 1 – RIVER SEVERN - DEERHURST

A pipeline from Netheridge WwTW to the River Severn just downstream of the new STT SRO Deerhurst Water Treatment Works. Treatment comprised iron based coagulant dosing into the existing ASP – nitrification (moving bed biofilm reactor (MBBR)) – phosphorus removal (CoMag™) – metals and organics removal (ozonation, biologicallyactive filtration (BAF) and granular activated carbon (GAC)). Pipeline approximately 18 km in length.

OPTION 2 – RIVER SEVERN - HAW GAUGING STATION

A pipeline from Netheridge WwTW to the River Severn just upstream of the EA gauging Station at Haw. Treatment comprised iron based coagulant dosing into the existing ASP – nitrification (MBBR) – phosphorus removal (CoMag™) – metals and organics removal (ozonation, BAF and GAC). Pipeline approximately 15.5 km in length.

OPTION 3 – RIVER SEVERN - EAST CHANNEL

A pipeline from Netheridge WwTW to the east channel of the River Severn downstream of the existing Canal and River Trust (CRT) pumping station to Gloucester Docks. Treatment to comprised iron based coagulant dosing into the existing ASP – nitrification (MBBR) – phosphorus removal (CoMag™) – metals and organics removal (ozonation, BAF and GAC and Ion Exchange). Pipeline approximately 5 km in length.

OPTION 4 – GLOUCESTER AND SHARPNESS CANAL

A pipeline from Netheridge WwTW to the G&S Canal. Treatment to comprised iron based coagulant dosing into the existing ASP – nitrification (MBBR) – phosphorus removal (CoMag™) – metals and organics removal (ozonation, BAF and GAC and Ion Exchange) and disinfection (ultraviolet (UV) treatment). Pipeline approximately 400 m in length.

OPTION 5 – SOUTHWEST REGION BRANCH PIPELINE

Additional pipeline for diversion of flows from the Netheridge to Deerhurst (or Haw Bridge) pipeline for discharge to the East Channel of the River Severn downstream of the intake for Gloucester Docks. This branch will follow the same route as Option 3.

2.3 DESIGN PRINCIPLES

The Netheridge SRO scheme has been carried out following WSP core design processes that ensure that our designs are:

- Safe, through application of construction (design and management) (CDM) principles
- Inclusive for all our communities
- Provide social and economic value, evaluated via value workshops
- Environmentally sustainable, evaluated though the WSP 'Future Ready' methodology

In addition, the Netheridge SRO concept design has been considered against the all company working group (ACWG) overarching Design Principles[2] that have been developed to ensure that all opportunity to enhance the design and achieve the best possible outcomes. A full list of design principles annotated with comments for the Netheridge SRO is included in Appendix B.

The design solution for the Netheridge SRO established at Gate 1 has been continued and enhanced for Gate 2, noting that the development of the concept design is dependent on the outcomes from a number of studies being undertaken separately from the Netheridge SRO project, in particular:

- The operational parameters of the STT SRO
- The environmental assessments and outcomes from EA engagement for the wider SRO schemes (quality sampling, river abstraction/discharge modelling and discharge quality requirements)
- The environmental assessments for the Netheridge SRO (WwTW site and pipeline route)
- Landowner engagement for the pipeline route

The following sections capture the key design parameters assumed by, or provided to, WSP by external parties at the time of writing the concept design report.

2.3.1 STT SRO OPERATIONAL PARAMETERS

The following STT SRO defined operational parameters were used for the development of the Netheridge SRO concept design

- When operational the STT SRO will 'call' for 35 Ml/d from Netheridge. This is the total volume required over a 24-hour period and does not need to be provided at a constant flow rate.
- When flow in the River Severn drops below HOF, Netheridge flows will be utilised to provide the 'sweetening' flow in the STT SRO pipeline. The STT SRO will 'call' for 20 Ml/d from the Netheridge SRO as the sweetening flow. This is the total volume over a 24-hour period and does not need to be provided at a constant flow rate.
- The STT SRO will provide 17 days' notice of the requirement before commencing operation. This is understood to include the requirement for sweetening flows.
- The STT SRO will remain operational for at least 20 days. This is understood to include the requirement for sweetening flows.

[2] All Company Working Group (ACWG) Design Principles, Process and Gate 2 Interim Guidance, dated 21st December 2021

- For the purpose of producing operational cost estimates it is assumed that the STT SRO will be operational for 35 days per annum (circa 10% of the year).
- The SRO schemes are assumed to operate for 71 years of the 80 year assessment period. The first 9 years of the project have been allocated for development and construction.

2.3.2 NETHERIDGE SRO OPERATIONAL ASSUMPTIONS

Due to the number of external dependencies and key design criteria that will remain unresolved in the short term, it has been necessary to make a number of assumptions regarding the way in which the Netheridge SRO will be operated to enable the concept design to progress:

- Upgrades to Netheridge WwTW will assume that there are no other new or additional works proposed at the site and the existing operational parameters and consent conditions will not change in the short term.
- All flows for transfer will be diverted downstream of the existing treatment processes.
- The transfer pipeline will only operate when the STT SRO is operational or utilising ‘sweetening flows’ and will be drained by direct discharge to local water course or sewers when not in use.
- There is no capacity to store any meaningful volume of treated effluent at Netheridge WwTW and therefore treatment and transfer pumping will be synchronised.
- The system will be designed to vary flow over a 24-hour period to ensure that 35 Ml/day is achievable at all times (min. flow 200 l/s max. flow 550 l/s based on diurnal in flow pattern).

2.3.3 DISCHARGE POINT AND PIPELINE ASSUMPTIONS

The transfer pipeline routes were developed around the following principles:

- Four discrete discharge locations were developed with other sub-options discounted (as discussed in section 2.1.
- Only one pipe route to each discharge location was developed as opportunity for alternative pipe routes are limited and within the margin of error of the cost estimates.
- The route was chosen to:
  - Achieve the shortest and most direct route between the Netheridge WwTW and the proposed discharge point.
  - Minimise construction within the existing road networks to minimise disruption to the local area, maximise construction productivity and reduce construction financial and carbon costs.
  - Avoid areas of population (towns and villages, farms and private gardens), where possible.
  - Avoid areas of woodland, ponds and other environmentally sensitive areas where possible.
  - Minimise the maximum elevation of the pipeline to reduce static pumping head requirements.
  - Minimise the total amount of rise and fall on the pipeline as much as possible.
  - Consider the crossing points for major infrastructure and ensure that there is sufficient space available for the construction of the crossing

2.3.4 EFFLUENT QUALITY STANDARDS AND TREATMENT PROCESS ASSUMPTIONS

The effluent quality standards for the Netheridge and wider SRO projects are being determined by a separate consultant. A number of discussions have taken place with the EA and other SRO partners, but the exact permit and discharge parameters will not be determined until after the concept design is completed. WSP have therefore made assumptions, largely based on a worst-case scenario, that enable a robust concept design to be progressed:

- New biological treatment and tertiary solids removal processes, comprising part of the tertiary treatment, will require continuous flow
- The range (minimum, average and maximum) of ammonia concentrations in the existing final effluent will be used to size the biological treatment stage required for tertiary ammonia removal
- Nitrification will be provided to achieve a 95th percentile ammonia concentration of 5 mg/l for all discharge locations
- Two-point iron based coagulant dosing is required to achieve an assumed 0.2 mg/l total phosphorus consent all discharge locations
- The tertiary solids removal process will require potable water for polymer make up which will be available from the existing supply on site (no upgrade required)
- BOD, TSS and Total Iron permit requirements are achievable through the provision of a tertiary solid's removal process
- Advanced treatment processes will be used to remove organics and perfluorooctanesulfonic acid (PFOS) for discharges to the River Severn. Discharges to the River Severn East Channel and G&S Canal will require metals removal in addition to organics and micropollutants.
- UV disinfection will be required for discharge to the G&S Canal in order to comply with drinking water abstraction standards
- The existing SAS thickening plant can accommodate the additional sludge produced as part of ferrous sulphate dosing into the ASPs.
- A new sludge thickening plant will be provided to thicken sludges from new treatment processes installed as part of the Netheridge SRO.
- There will be adequate storage of final effluent to enable stable and consistent flow particularly when the final effluent flow falls below 200 l/s.

2.4 SCHEME COMPONENTS

The Netheridge SRO comprises the following elements:

- Flow splitting to divert final effluent from existing Netheridge WwTW into the new treatment plant.
- New treatment plant based on discharge location effluent quality requirements
- Pump station to transfer between 200 and 550 l/s of treated effluent based on diurnal in flow pattern and demand from STT SRO.
- Pipeline to transfer treated effluent from Netheridge to the discharge location, including air valves, washout chambers and flow monitoring.
- Discharge to the River Severn via a short outfall
- Power supply and instrumentation, control and automation (ICA) for the treatment process and transfer pumping

The diagrams below show the main scheme components for each or the five design options.

Figure 2-1 - Options 1 and 2 – River Severn at Deerhurst or Haw Bridge

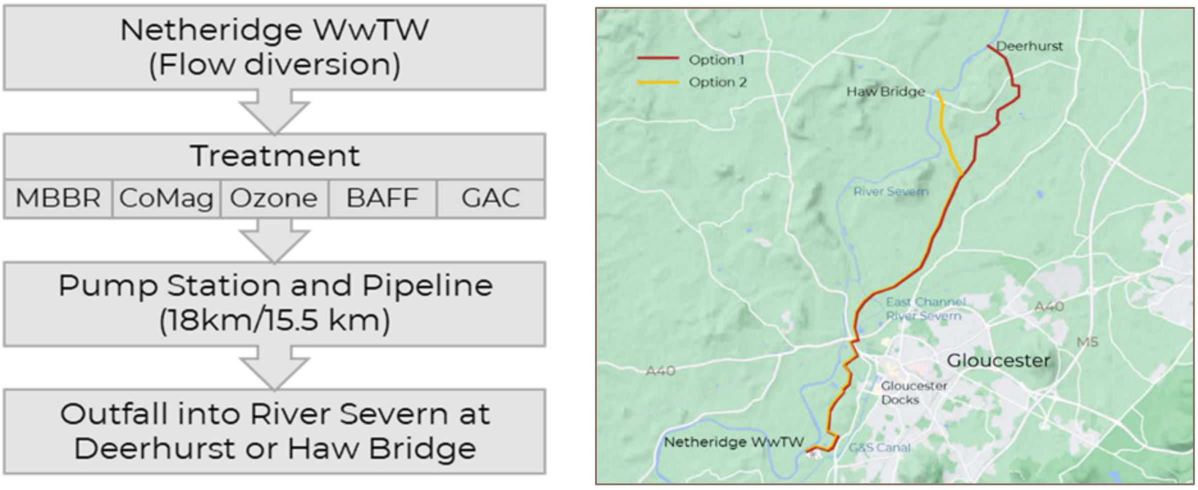


Figure 2-2 - Option 3 - East Channel River Severn at Gloucester Docks

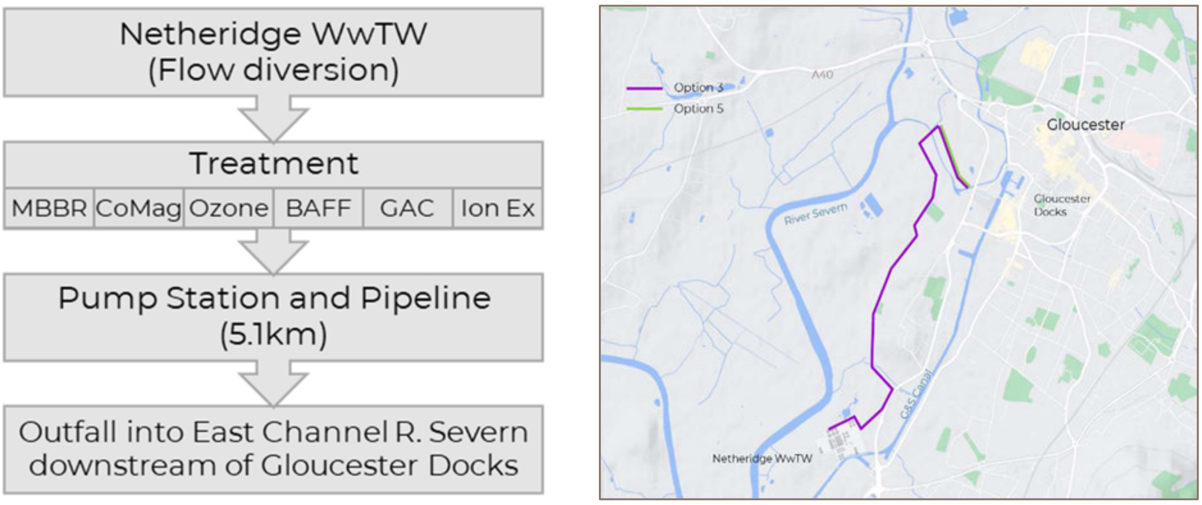


Figure 2-3 - Option 4 - G&S Canal at Netheridge

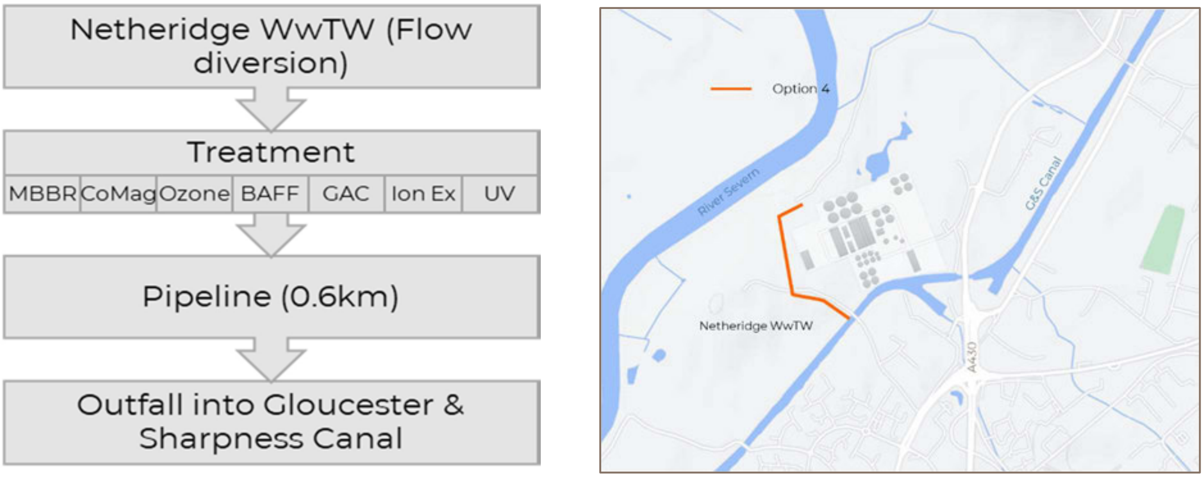
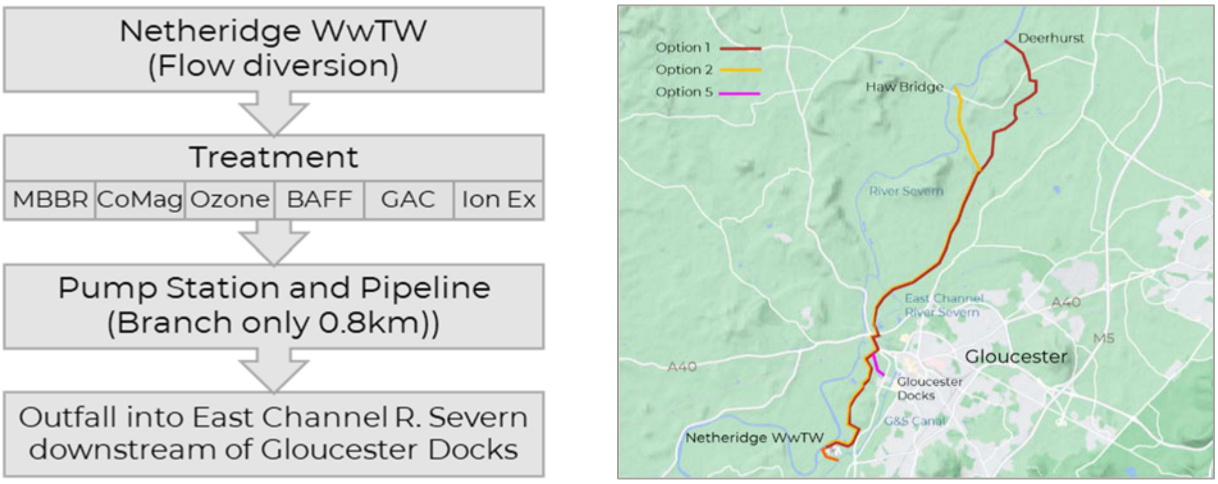


Figure 2-4 - Option 5 – Southwest Region Branch Line to Gloucester Docks



2.5 OPERATIONAL PHILOSOPHY

The Netheridge SRO will be designed to operate in conjunction with the STT SRO with the transfer of treated effluent being on an 'on demand' basis determined by the STT SRO.

When not in use the transfer pipeline will be drained and left empty to avoid risk of septicity. Some elements of the Netheridge SRO treatment process will operate on a continual basis to ensure viability of the biological processes. The remaining treatment processes will be decommissioned when not in use. When not transferred to the STT SRO, treated effluent will be discharged to the River Severn via the existing WwTW outfall.

The STT SRO will provide notice at least 17 days of the requirements for 'sweetening' flows (20 Ml/day) or full operational flows (35 Ml/day). This period will allow for the recommissioning and testing of the full treatment process, priming of the pipeline and testing of the pump system.

The Netheridge SRO will operate for at least 20 days at any one time. When treated effluent is no longer required by the STT SRO, flow diverted to the Netheridge SRO treatment processes will be reduced to a minimum to ensure viability or decommissioned and left ready for recommissioning when next required. The pipeline will be drained manually to a local watercourse, or the sewer system, as determined by the topography and pipe hydraulics. Draining of the pipeline will be carried out over a period that will allow adequate dilution in the water course or the sewer system.

The Netheridge SRO will operate independently of the existing WwTW with separate control systems with interfaces to Netheridge WwTW and the STT SRO. The Netheridge SRO treatment processes will be fully automated with end to end 'master control' that encompasses treatment flow control, level protection (dry flow and overtopping), MBBR, GAC backwash control, sludge storage management, return of waste streams to the main works, and transfer of treated final effluent to the River Severn via the WwTW outfall, or transfer to the STT SRO via the transfer pipeline.

2.6 TREATMENT PROCESS DESIGN

This section of the concept design report should be read in conjunction with the STS SRO Netheridge Treatment basis of Design Report which contains detailed analysis of the treatment requirement. The following sections highlight the key information used in developing the Gate 2 concept design.

2.6.1 EFFLUENT QUALITY STANDARDS

2.6.1.1 Existing Effluent Quality Standards (Netheridge WwTW)

The Netheridge WwTW currently discharges treated effluent to the tidal zone of the River Severn. The tidal nature of the receiving water allows for a less stringent discharge consent permit than a freshwater river or less dynamic water body.

The key current effluent quality parameters are shown in the Table 2-1 along with selected average and maximum values derived from recent sample data (December 2020 to October 2021).

Table 2-1 – Existing Netheridge WwTW Effluent Quality Parameters

Condition	Permit Value	Average Value	Maximum Value
Dry Weather Flow (DWF)	42.8 Ml/day	-	-
Full Flow to Treatment (FFT)	1,215 l/s	-	-
Biological Oxygen Demand (BOD)	25 mg/l	5.7 mg/l	13 mg/l
Suspended Solids (SS)	45 mg/l	10 mg/l	65 mg/l
Ammonia	15 mg/l	0.9 mg/l	4.6 mg/l

It should be noted that the effluent quality from Netheridge WwTW is consistently below the quality standards with ammonia not exceeding 5 mg/l and BOD not exceeding 13 mg/l. This project assumes no changes to the existing consent licence which would otherwise influence the final effluent quality used for the basis of design.

2.6.1.2 Anticipated Effluent Quality Standards

The effluent quality required for Netheridge SRO effluent discharge to the non-tidal stretches of the River Severn, or the G&S Canal will be more onerous than those in place for the existing Netheridge WwTW discharge. The actual effluent quality standards have not been confirmed but based on the modelling carried out by the environmental consultants, and ongoing dialogue with the EA, the standards used for development of the Netheridge SRO concept design are shown in Table 2-2.

Table 2-2 – Anticipated Effluent Quality Parameters

Condition	Options 1 and 2	Options 3 and 5	Option 4
Full Flow to Treatment (FFT)	550 l/s	550 l/s	550 l/s
Biological Oxygen Demand (BOD)	5 mg/l	5 mg/l	5 mg/l
Suspended Solids (SS)[1]	-	-	-
Ammonia	1 mg/l	1 mg/l	1 mg/l
Phosphorus	0.2 mg/l	0.2 mg/l	0.2 mg/l
Trace Organics and Metals[2]	5 named substances to limit of detection (LoD) concentrations	<15 named substances to the EQS of the receiving water course	<15 named substances.
Disinfection	Not required	Not required	Required

[1] A value for SS removals has not been stated as the proposed treatment technologies will significantly reduce the levels of SS in the final effluent and therefore it will meet any imposed quality standards

[2] The full list of trace organic and metal substances identified for removal can be found the STS SRO Netheridge Treatment Basis of Design Report

There has been no specific modelling work carried out the River Severn East Channel and so due to the potential reduction in dilution compared to the main channel of the River Severn, it has been assumed that all named micropollutants will need to be removed.

The G&S Canal is a Drinking Water Protected Area (DWPA) as water is abstracted by Bristol Water for treatment at Purton WTW approximately 19.5 km downstream of Netheridge WwTW. STW have engaged with the Drinking Water Inspectorate (DWI) and the EA, but there has been no confirmed water quality requirement. Therefore, it is assumed that the same ammonia and total phosphorus permit requirements will apply, as will a robust treatment process to remove micropollutants, similar to the River Severn East Channel treatment proposal. A requirement to provide disinfection is also assumed (but must be confirmed) to comply with DWPA discharge requirements.

2.6.2 EFFLUENT VOLUMES AND FLOW DIVERSION

2.6.2.1 35 Ml/d Transfer Volume

The premise of the Netheridge SRO is to transfer 35 Ml/d of treated effluent from Netheridge WwTW to the abstraction point of the STT SRO. This flow will be diverted to the new tertiary treatment process via a set of variable speed pumps that intercepts effluent from the existing final settlement tanks to the existing outfall into the River Severn just north of site. This value was determined based on the capacity of the WwTW process and the DWF discharge permit being 42.8 Ml/d. However, the WwTW does not currently operate at full capacity and preliminary analysis of the inflow to the works over a four-year period indicates that flow was below 42.8 Ml/day for approximately one third of the time. Flow was below 35 Ml/day for 2% of the time. When diurnal flow patterns and treatment process losses are factored in, flow available for transfer to the STT SRO could be below 35 Ml/day for around 7% of the time. However, when factoring in the anticipated growth within the Netheridge

WwTW catchment area, the 7% drops to just over 1% greatly reducing the risk of the Netheridge SRO not being able to transfer the required 35 Ml/day. The shortcoming in the Netheridge SRO ability to supply 35 Ml/day during dry periods is not addressed directly as part of the concept design as the outcome may be that Netheridge SRO does not transfer full volumes to the STT SRO. However, a cost to provide buffer storage is included in the costed risk assessment.

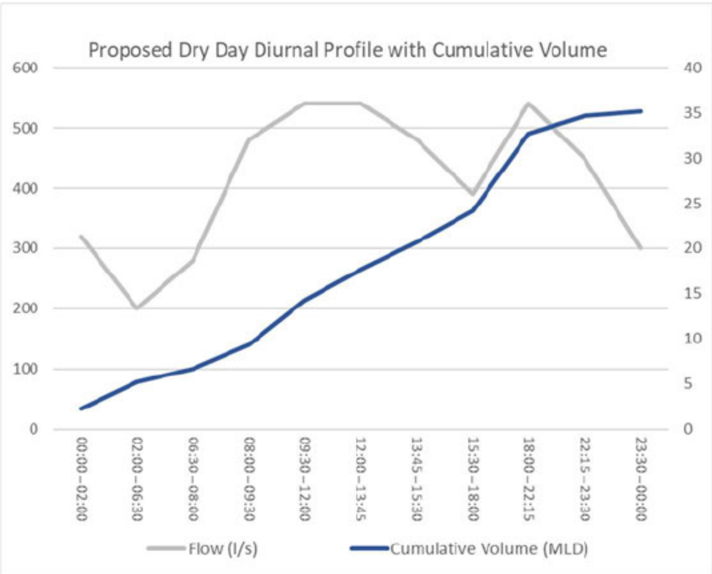
2.6.2.2 Diurnal Flow Patterns

During dry weather the flow into the works varies based on a diurnal pattern. Analysis of dry weather periods indicate that flows vary from as low as 100 l/s overnight, to over 800 l/s at the daytime peak. In order to meet the 35 Ml/d requirement it will be necessary to either buffer flows to allow a constant flow of 405 l/s or vary the flow over a 24-hour period. The most practical solution is to vary flows though the treatment process as not only does this remove the need for a large storage tank on site, but it also provides greater resilience and an opportunity for provision of additional transfer flows in the future. Discussions with the environmental modelling consultants and the EA indicated that variation of flow discharging to the River Severn over a 24-hour period would be acceptable so long as the total volume discharged was in line with the total volume abstracted.

Analysis of the dry weather flow into Netheridge WwTW over a three-year period from 2019 to 2021 allowed a dry day diurnal profile to be created that could be used for treatment process and pump selection and design. Table 2-3 shows the flow profile used for development of the concept design.

Table 2-3 – Proposed Dry Day Diurnal Profile with Cumulative Volume

Time	Flow (l/s)	Cum Vol (M/l/d)
00:00 – 02:00	320	2.3
02:00 – 06:30	200	5.2
06:30 – 08:00	280	6.7
08:00 – 09:30	480	9.3
09:30 – 12:00	540	14.2
12:00 – 13:45	540	17.7
13:45 – 15:30	480	20.7
15:30 – 18:00	390	24.2
18:00 – 22:15	540	32.7
22:15 – 23:30	450	34.7
23:30 – 00:00	300	35.2



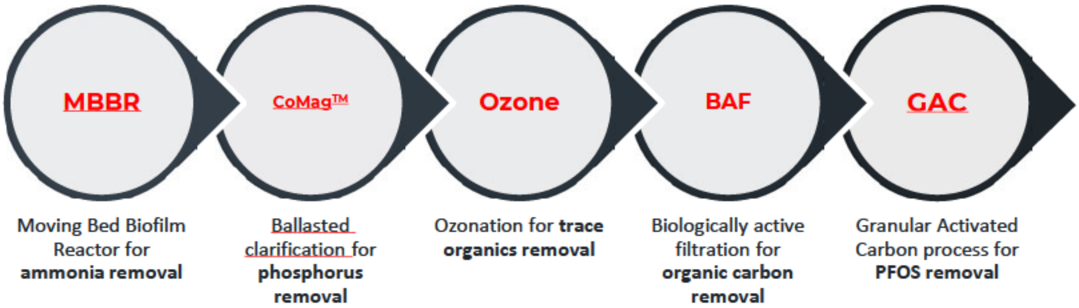
2.6.3 TREATMENT APPROACH AND TECHNOLOGIES

Full details of the proposed treatment technologies including the risk, opportunity and potential alternatives are included in the STS SRO Netheridge Process Basis of Design Report. Here a summary of the proposed treatment process stream for each option is outlined along with the key design criteria.

2.6.3.1 Approach 1 (Options 1 and 2 to River Severn)

For discharges to the River Severn, it is proposed to have five step treatment process as outlined in Figure 2-5.

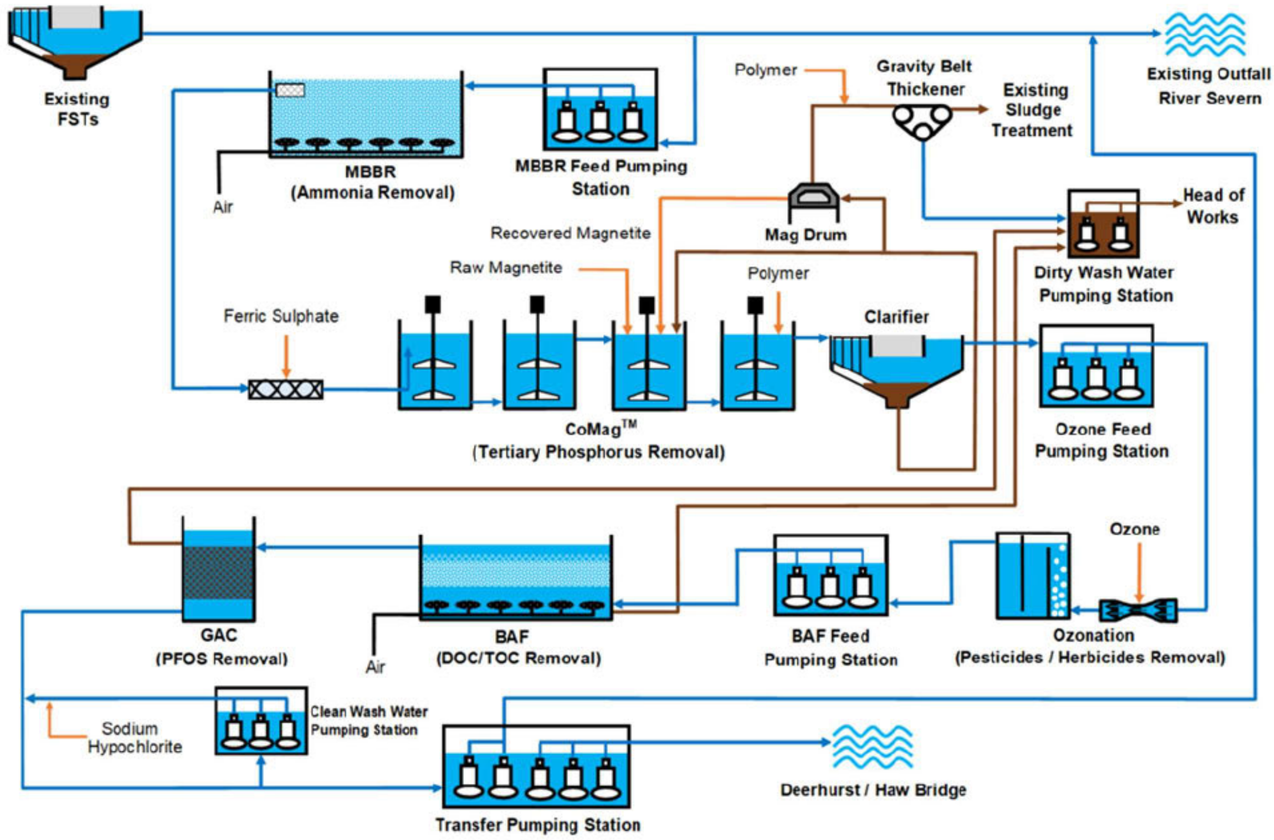
Figure 2-5 - Treatment Process Approach 1 (Options 1 and 2)



This proposed treatment train is based on the following criteria:

- Provision of treatment equipment that can handle flows between 200 l/s and 550 l/s to match the diurnal dry weather flow pattern at Netheridge WwTW. An assumed requirement to achieve an ammonia consent of 1 mg/l (mean).
- An assumed requirement to meet a 0.2 mg/l total phosphorus permit.
- An assumed requirement to remove the listed pesticides and herbicides to non-detectable concentrations to prevent the introduction of new substances at the point of discharge.
- An assumed requirement to remove PFOS to non-detectable concentrations to prevent impediment towards achieving target WFD status.

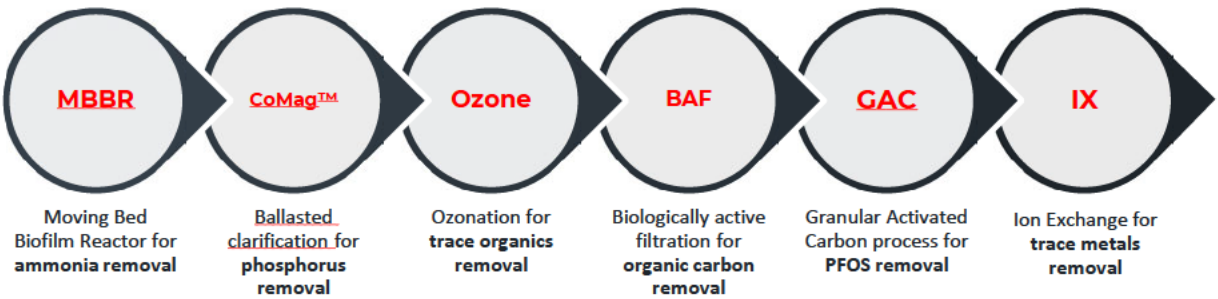
Figure 2-6 - Treatment Process Schematic Approach 1 (Options 1 and 2)



2.6.3.2 Approach 2 (Options 3 and 5 to River Severn East Channel)

For discharges to the River Severn East Channel, it is proposed to have six step treatment process as outlined in Figure 2-7.

Figure 2-7 - Treatment Process Approach 2 (Options 3 and 5)

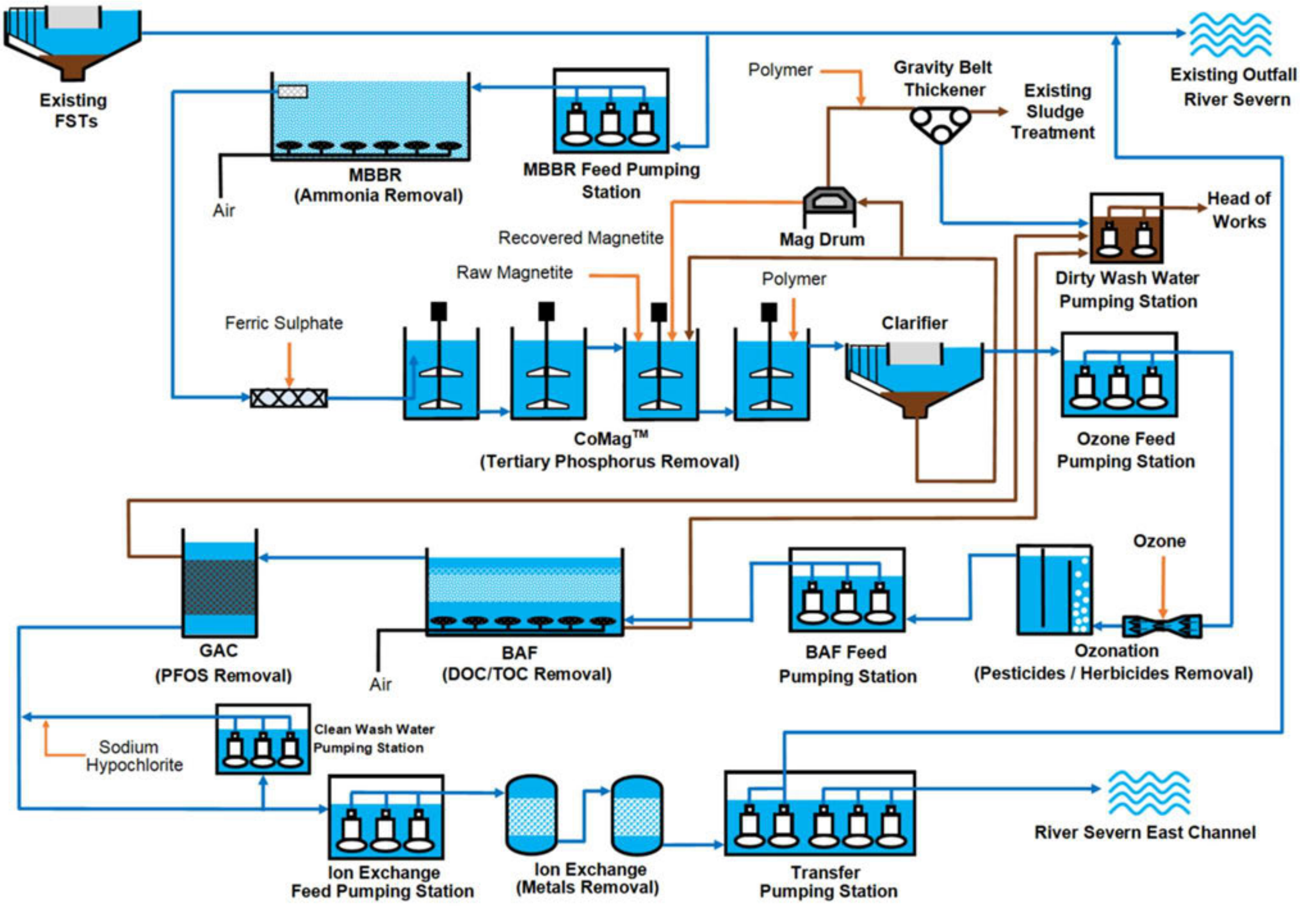


This proposed treatment train for Option 3 is based on the following criteria:

- Provision of treatment equipment that can handle flows between 200 l/s and 550 l/s to match the diurnal dry weather flow pattern at Netheridge WwTW.
- An assumed requirement to achieve an ammonia consent of 5 mg/l.
- An assumed requirement to meet a 0.2 mg/l total phosphorus permit. Primary chemical phosphorus removal will be provided by ferrous sulphate dosing into the ASP.

- An assumed requirement to remove the listed pesticides and herbicides to non-detectable concentrations to meet likely permitting conditions.
- An assumed requirement to remove PFOS to non-detectable concentrations to meet likely permitting conditions.
- An assumed requirement to remove metals to non-detectable concentrations to meet likely permitting requirements.

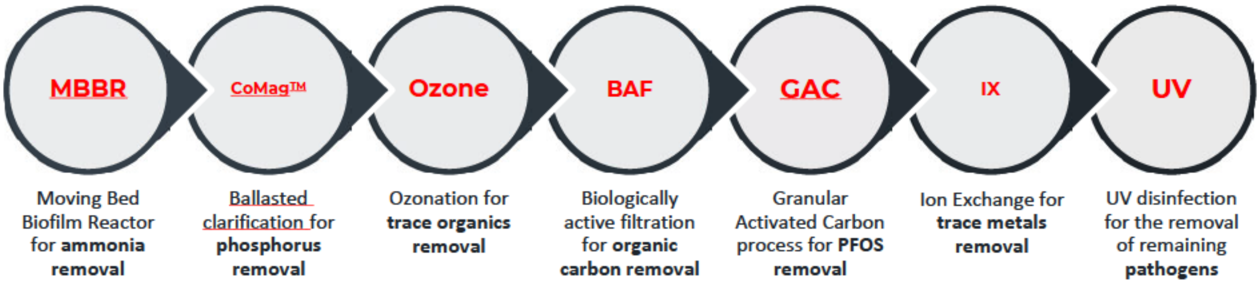
Figure 2-8 - Treatment Process Schematic Approach 2 (Options 3 and 5)



2.6.3.3 Approach 3 (Option 4 to G&S Canal)

For discharges to the G&S Canal it is proposed to have seven step treatment process as outlined in Figure 2-9.

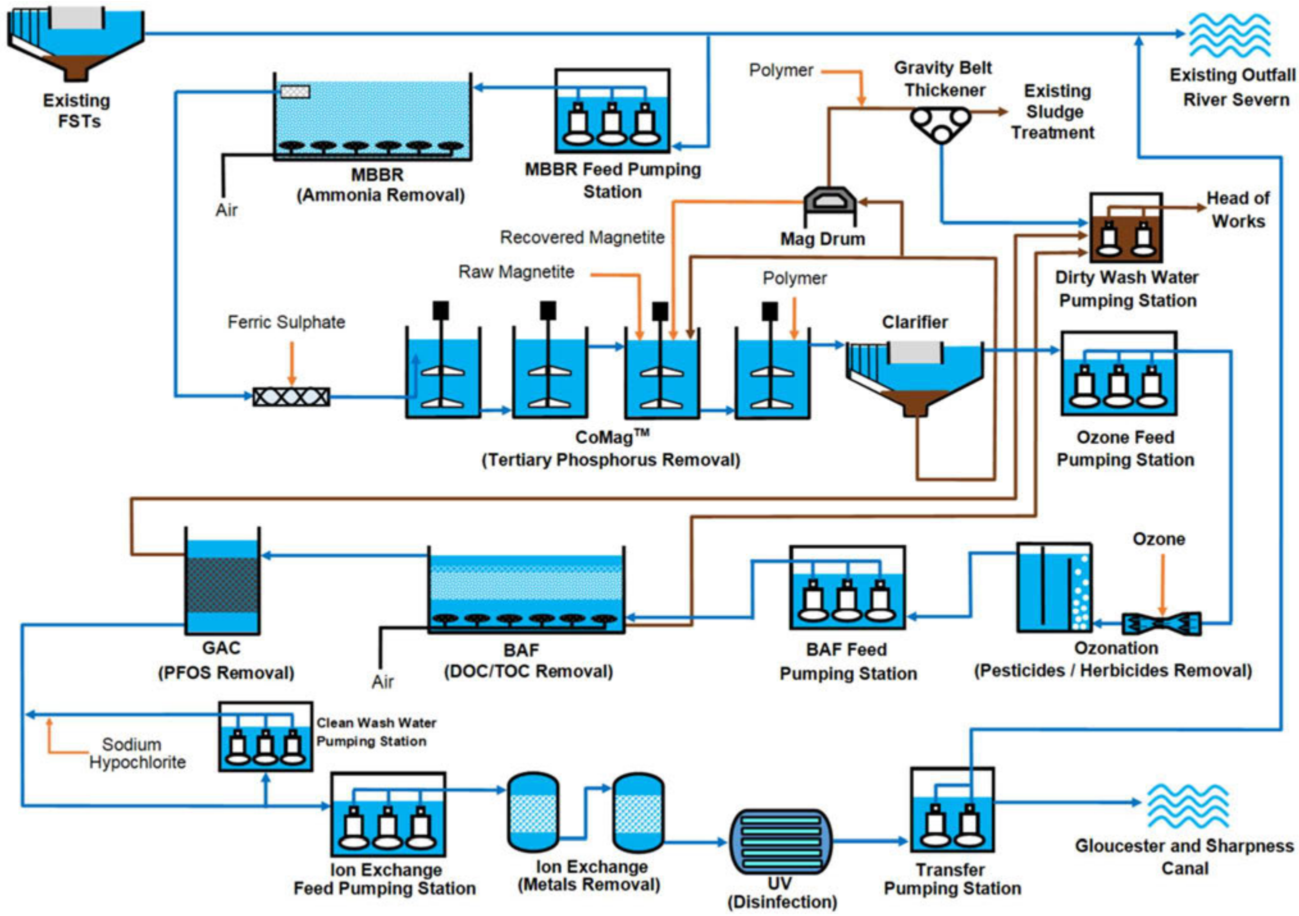
Figure 2-9 - Treatment Process Approach 3 (Option 4)



This proposed treatment train for Option 4 is based on the following criteria:

- Provision of treatment equipment that can handle flows between 200 l/s and 550 l/s to match the diurnal dry weather flow pattern at Netheridge WwTW.
- An assumed requirement to achieve an ammonia consent of 5 mg/l.
- An assumed requirement to meet a 0.2 mg/l total phosphorus permit. Primary chemical phosphorus removal will be provided by ferrous sulphate dosing into the ASP.
- An assumed requirement to remove the listed pesticides and herbicides to non-detectable concentrations to meet likely permitting conditions.
- An assumed requirement to remove PFOS to non-detectable concentrations to meet likely permitting conditions.
- An assumed requirement to remove metals to non-detectable concentrations to meet likely permitting requirements.
- An assumed requirement to provide disinfection to permit discharge into the DWPA.

Figure 2-10 - Treatment Process Schematic Approach 3 (Option 4)



2.6.4 ANCILLARY TREATMENT PLANT REQUIREMENTS

2.6.4.1 Sludge Treatment

Initial analysis of existing sludge thickening facilities at Netheridge WwTW identified that there is limited capacity to treat additional sludge produced by the new treatment process units. It is likely that additional sludge thickening facilities will be required as part of the new treatment plant. The thickened sludge will be processed in the existing Netheridge WwTW sludge handling area and so the new thickener could be located either adjacent to the new treatment units or adjacent to the existing sludge handling area.

2.6.4.2 Interstage Pumping

Due to the topography of the Netheridge WwTW site and surrounding area it is likely that interstage pumping will be required between each process unit. These will comprise a wet-well and adjacent valve chamber. The final size and location of these will be determined at later stages of the design process.

2.6.4.3 Backwash and Returns Pumping

A number of the new treatment units require backwash pumping to supply water and return liquors to the head of the works. Backwash pumping is proposed to be based on wet-well pumping stations either integral or adjacent to the respective backwash tanks. These tanks will be fed by gravity from the relevant processes. The final size and location of the backwash systems will be determined at later stages of the design process.

2.6.4.4 Electrical Power Upgrades

The new treatment processes and transfer pump station will increase the electrical load at Netheridge WwTW. The capacity of the electrical system will be exceeded and upgrades to the existing system will be required.

An assessment of the electrical loads for each process unit, interstage pumping, sludge thickening, and backwash systems has been made along with the electrical load of the transfer pump station to enable the upgrade requirement to be determined. Initial assessments suggest that a new feeder cable from the distribution network operator to the switch board will be required.

The new treatment units will require a new motor control centre (MCC) which will be housed in a new building.

2.6.4.5 System Control and Monitoring

Control and monitoring of the both the treatment process and transfer pump station will be via operator interaction at a central human machine interface (HMI). Interfacing the treatment control network to the site supervisory control and data acquisition (SCADA) system would allow central monitoring and supervisory control by staff in the existing control room.

The control philosophy proposed would be for a master controller (programmable logic controller (PLC)) to manage the end-to-end treatment process and supervise process units which will have their own control systems. The new treatment plant will have over 100 directly controlled valves, pumps and treatment units. The concept design is based on these elements being centrally controlled via a single intelligent MCC housing the master controller (PLC) and directly controlled motor drives. This would utilise control equipment currently available to the market and follow STW standards, principally intelligent MCCs, PLC, networked motor drives and actuated valves and HMI.

2.6.5 TREATMENT PLANT LAYOUT

2.6.5.1 Land availability

In order to determine the land available for construction of the new treatment process footprint the existing site constraints were reviewed. There are a number of constraints that reduce the areas that are feasible for the construction of the new treatment process:

- Land ownership – STW water own land adjacent to Netheridge WwTW but in some areas the existing structures are tight to the boundary, limiting the ability to transfer effluent around the site.
- Residential property – There are a number of residential properties in the vicinity Netheridge WwTW
- Existing utilities – There are extensive underground utilities within the Netheridge WwTW site boundary which would be expensive and disruptive to relocate.
- Ground conditions – Netheridge WwTW lies close to the River Severn on alluvial deposits.
- Environmental – The areas adjacent to the WwTW are a combination of woodland, wetland and agricultural land. Woodland and wetland areas have been avoided to limit disruption to local habitat and biodiversity.

2.6.5.2 Layout Development

Treatment plant layouts were initially developed within the Netheridge WwTW boundary, but it became apparent that there was inadequate space to locate all the treatment units satisfactorily. Hybrid layouts were considered, with some plant within the existing boundary some out with the boundary, but this created inefficiencies in transfer of flows between treatment units.

The solution chosen locates all the treatment process to the west of Netheridge WwTW on STW owned land. The existing sludge cake handling area has been utilised to limit the need to remove a wooded area to the southwest. The proposed land size and location of the new treatment plant is shown in Figure 2-11. The units have been arranged to optimise the treatment process by reducing pipeline lengths and pumping whilst maintaining adequate person or vehicular access for operation and maintenance.

Figure 2-11 - New Treatment Plan Location

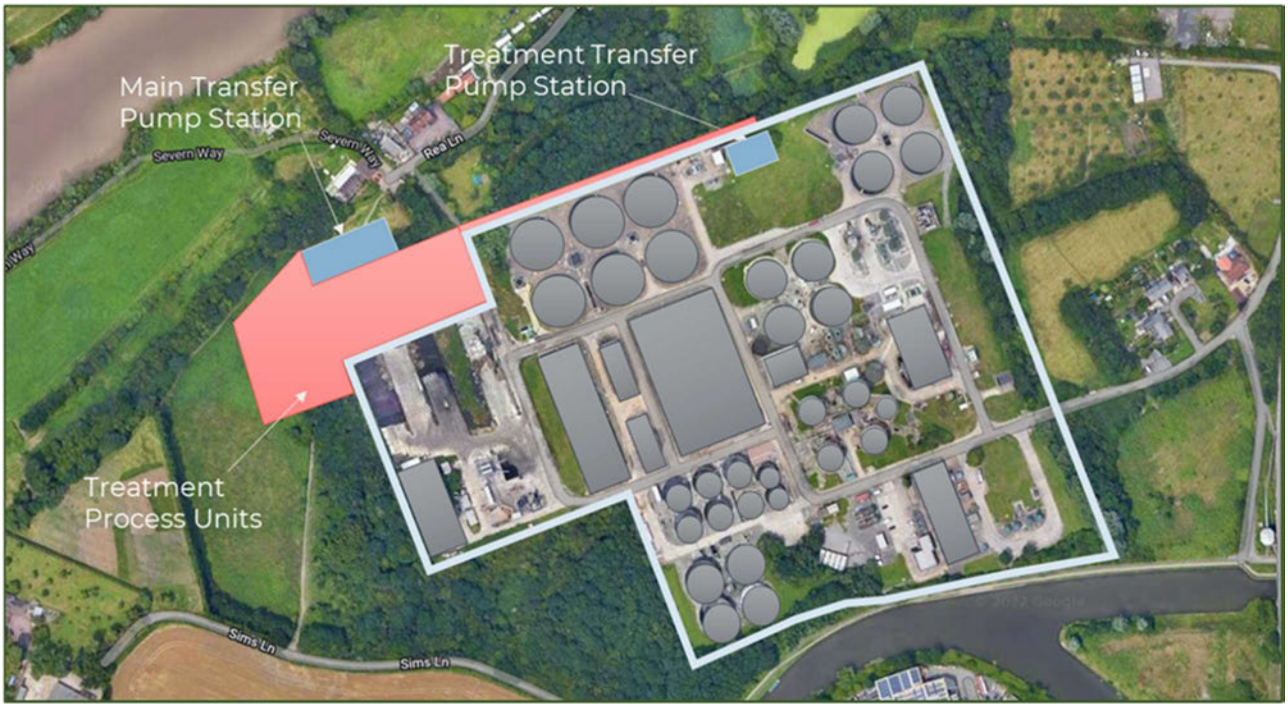
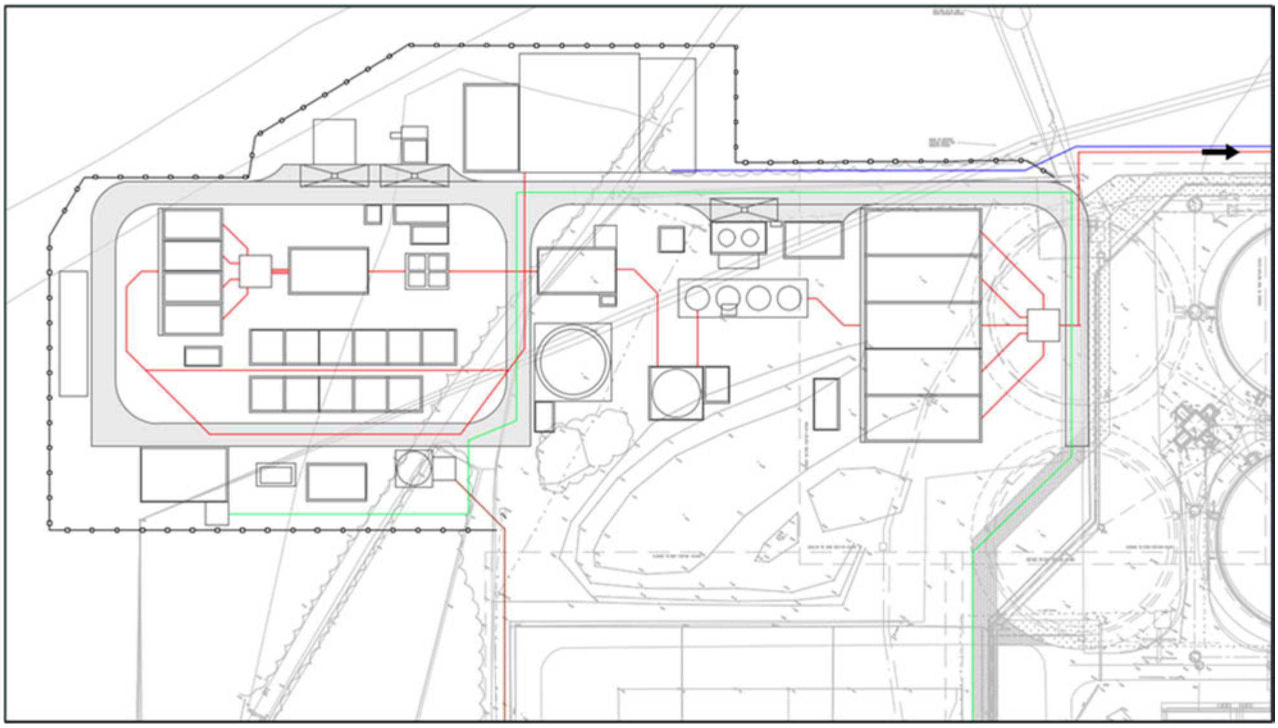


Figure 2-12 - New Treatment Plan Layout



2.6.5.3 Civils Works

The choice to locate the treatment plant outside the existing Netheridge WwTW boundary will mean that the existing site infrastructure cannot be used. New access roads, drainage, lighting, fencing and security will all be required as part of the Netheridge SRO. It is anticipated that control and telemetry systems will be housed in the existing Netheridge WwTW administration building which will also provide operations staff with welfare facilities on site.

2.7 TRANSFER PUMP STATION DESIGN

2.7.1 PUMP STATION

The transfer pump station will be sited at Netheridge WwTW. It could potentially be a dry or wet-well arrangement and the advantages and disadvantages of each are outlined in Table 2-4 below. A more detailed assessment of the pump station design can be completed once the chosen pipeline hydraulic characteristics and operating regime are confirmed. The size of the pumps (as dictated in this case by the discharge location) changes the balance of the factors given in Table 2-4 with the maintenance benefits of dry-well pumping stations outweighing the increase in station size and initial investment at a certain pump size.

Table 2-4 – Pumping station comparison (dry/wet-well)

Factor	Wet-well pumping station	Dry-well pumping station
Physical Footprint	Relatively smaller	Relatively larger
CAPEX	Relatively smaller	Relatively larger
Operability & Maintenance	Pumps require lifts for inspection and maintenance. Consideration is needed for how pumps are to be stored for periods of inactivity.	Pumps are accessible directly during operation. Pumps can be drained for long-term periods of inactivity.
Health & Safety	Greater need for lifting operations, but handled at ground level	Potential for deep dry-well structure requiring ventilation to mitigate risk to operators
Pumping Efficiency	Only submersible pumps are applicable, precludes higher efficiency pumps	Potential to use higher efficiency pumps depending on quality of treated effluent

2.7.2 PUMP SELECTION

The flowrate basis for the transfer pumping station must align with the upstream treatment stages and interstage pumping stations to avoid a flow imbalance. The flowrate design range for the conveyance pumping station is therefore 200 – 550 l/s, and this will follow the same diurnal profile as the treatment with some hysteresis. Variable speed control is expected to be necessary to allow the conveyance flowrate to approximately match the treatment flowrate.

Hydraulics of the options for transfer of treated effluent from Netheridge WwTW are given in Appendix A of the Netheridge Pipeline Route Appraisal Report (Annex A2).

2.8 PIPELINE DESIGN

This section of the Concept Design Report should be read in conjunction with the STS SRO Netheridge Pipeline Route Appraisal Report (Annex A2) which contains detailed analysis of the pipeline route appraisal and route selection. The following sections highlight the key information used in developing the Gate 2 concept design.

2.8.1 PIPELINE ROUTE

The initial pipeline route corridors were selected based on aerial photographs. These corridors were then assessed using digital terrain modelling incorporating utilities information and landownership information. The routes underwent iterations based on the design principles detail in section 2.3 to ensure that the route was optimised for ease of construction and operational performance.

2.8.1.1 Land Use and Ownership

Land use and ownership was considered to minimise disruption to the public and private landowners. Due to the length of the pipeline there will be multiple landowners, users and stakeholders, as well as multiple private landowners, whichever route is chosen. The following stakeholders have been identified:

- Environments Agency (river and water course crossings)
- Gloucestershire County Council

- Highways department
  - Local drainage department
  - Alney Island Nature Reserve
- Network Rail
- National Highways (formally Highways England)
- Representatives of the Coombe Hill Canal site of special scientific interest (SSSI)
- Owner/operator of Hempsted landfill site
- Owner/operator of Gloucester Green Energy and Eco Park

There was no land use or landownership identified that presented a risk or concern for the proposed routes. No stakeholder or landowners were approached at this stage of the project.

2.8.1.2 Planning and Rights of Access

It is not currently clear if the Netheridge SRO will be covered by the scope of the main STT SRO which is likely to be subject to government approval and covered by a Development Consent Order (DCO). If the Netheridge scheme does not fall within the wider DCO process, STW have powers under the Water Industry Act 1991 to enter land to construct water assets.

The pipeline and associated infrastructure will be constructed predominantly below ground and is unlikely to require specific planning permission over and above standard water industry permitted development rights.

Planning permission is likely to be required for any new site compounds and above ground features to be created to facilitate the draining of the main when not in use. As well as the creation of temporary entrances on to major roads and any temporary site compound establishments which are remote from the main construction easements.

Full assessment of planning permission and permitted development rights is outside the scope of the concept design report. Planning requirements should be confirmed early in subsequent phases of the project

2.8.1.3 Geology and Groundwater

Groundwater, geology and soil conditions were assessed to ensure that the pipeline route selected was not unduly impeded by difficult ground conditions. Geology in the Gloucester area generally comprises low strength variable alluvial deposits. The possibility of thin drift deposits and shallow rock head has been identified and geological mapping indicates that the underlying rocks generally comprise sedimentary deposits of a mixture of lithologies including mudstones, limestones and sandstones. Geology was not identified as a key factor in pipeline route choice

Water bearing alluvial deposits may be problematic in some areas of the pipeline route. Historic borehole records indicate water strikes at 3-4 m below ground level in the vicinity of the northern East Channel crossing. The presence of a significant number of land drainage ditches and surface water features also indicate the likelihood of shallow groundwater. This does not influence pipe route choice but is a risk to be mitigated during construction.

2.8.1.4 Ecology and Environment

Environmental consultants for the Netheridge SRO were not appointed until late in the pipeline route assessment process therefore limited formal input or environmental modelling results have been received to inform pipeline route selection. Gate1 environmental assessment information has been utilised where applicable along with public and open-source data relating to environmental classification of land areas within the pipe route corridor[3].

All pipeline routes, apart from Option 4, will require construction within the boundary of the Alney Island Local Nature Reserve. The nature reserve has been created in a post-industrial landscape comprising former electricity substations, railway sidings and goods yards. The route of the pipeline through the Nature Reserve has been selected to follow one of the main rail spurs running generally north – south through this area. This rail spur route appears to have been retained as an access path to the nature reserve area and so its use will minimise disruption and present an opportunity for enhanced reinstatement on completion.

The construction of the pipeline is a temporary activity and if properly planned and managed particularly with respect to the reinstatement has the potential to benefit the area through the deployment of biodiversity and offsetting scheme funds.

2.8.1.5 Rail, Road and River Crossings

All pipeline routes, apart from Option 4, will need to pass under a number of roads, the railway, the River Severn East Channel and a number of smaller water courses. Pipeline route selection was influenced by the need to cross this infrastructure the least number of times and in the least disruptive and cost-effective location.

The pipeline route to Deerhurst and Haw (Options 1 and 2) requires the crossing of the Gloucester to Lydney railway line. At Gate 1 it was proposed to cross the railway line using one of the existing arches in the viaduct over the River Severn East Channel. However, subsequent investigations and the findings of the utilities searches show that all viable routes under these arches are occupied with existing high voltage electricity cables. At the selected crossing point the railway line is elevated above the surrounding ground on an embankment to allow it to cross both the River Severn and the River Severn East Channel providing opportunity for a simpler tunnel construction. Network Rail have not been engaged to discuss the requirement for a pipe crossing.

The pipeline routes have been selected to minimise the impact on the existing road network. Where road crossings are required, the pipeline has been routed such that it will cross perpendicular to the road alignment to minimise the impact on the road.

It is anticipated that pipeline construction across minor roads including B class roads will be possible using traditional open cut trenching techniques under full road closures or where this is not possible the crossing will be constructed in two halves under single lane closures.

The pipeline routes to Deerhurst and Haw (Options 1 and 2) are required to cross both the A40 and the A417 on the approach to the Over Causeway roundabout. In both cases these roads are on elevated viaducts. A preliminary site inspection indicates that there is sufficient headroom below the viaducts to allow construction using traditional open cut trenching techniques, providing height restricted equipment is used to prevent bridge strikes.

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[3] DEFRA magic mapping site includes details of the recorded presence of protected species, SSSI and other sensitive areas. https://magic.defra.gov.uk The

All pipeline routes, apart from Option 4, will need to pass under the River Severn East Channel. The pipeline routes to Deerhurst and Haw Bridge (Options 1 and 2) need to pass under the East Channel of the River Severn a second time and also under the River Chelt. A 700NB pipe is too large for installation by directional drilling techniques. It is likely that the pipeline will be installed within an oversized tunnel sleeve, typically of 1000-1200 mm NB of steel or concrete construction, installed by micro-tunnelling or pipe jacking techniques. It is anticipated that minor watercourse crossings will be achieved through open cut techniques utilising sheet piles and over pumping.

2.8.2 HYDRAULIC DESIGN

A hydraulic analysis was carried out on all options to optimise the pipe size and determine the hydraulic characteristics for pump selection, pipe pressure rating and drainage options. The hydraulic analysis is detailed in Appendix A of the Netheridge Pipeline Route Appraisal Report (Annex A2).

2.8.2.1 Optimum Pipe Size

For concept design the optimum pipe size has been determined based on hydraulic performance of the pipe only. During detail design the pipe size may be refined by analysing operating costs against initial capital costs to determine the best net present value for different size pipe, pump and pipe material combinations.

The flow in the pipeline will vary between 200 l/s and 550 l/s depending on the diurnal flow into the treatment works. Table 2-5 shows the velocity of flows in a 600, 700 and 800NB pipe.

For a normal pumped sewage main the pipeline size must be selected to ensure that the velocity of the flow is between 0.75 m/s to minimise solids disposition and 3m/s to prevent scour. For the Netheridge system the effluent has undergone full treatment and so has a low solids content. In addition, the low flow value of 200l/s will be only for a short period with longer periods at 550l/s to flush any accumulated solids. Therefore, based on velocity a 600 or 700NB pipe would be acceptable.

In addition to flow velocity the friction head loss is also considered. Table 2-5 shows the friction head loss in a 600, 700 and 800NB pipe. There is no specific guidance to acceptable friction losses and much depends on the static head and total length of the pipeline. For Option 1 the static head is approximately 16 m so a 600NB pipe would have friction losses almost five times the static head. The friction loss for the 700NB pipe is approximately twice the static head and offers a good hydraulic performance for the range of flows proposed.

Table 2-5 – Hydraulic Characteristics for Different Pipe Size (For Option 1 to Deerhurst)

Diameter (NB)	600	700	800
Velocity at 200 l/s (m/s)	0.71	0.52	0.4
Velocity at 550 l/s (m/s)	1.95	1.44	1.09
Pipe friction loss at 200 l/s (m)	10.8	5.2	2.6
Pipe friction loss at 550 l/s (m)	73.2	34.3	17.4

Similar conclusions were drawn for analysis carried out for Options 2 and 3 with a 700NB pipe being selected for option development and costing.

For Option 4, due to the short length of pipe, a 600NB pipe was selected for option development. This increases the hydraulic losses in the short rising main (248 m), allowing easier control of the variable speed pumps.

2.8.2.2 Hydraulic Summary

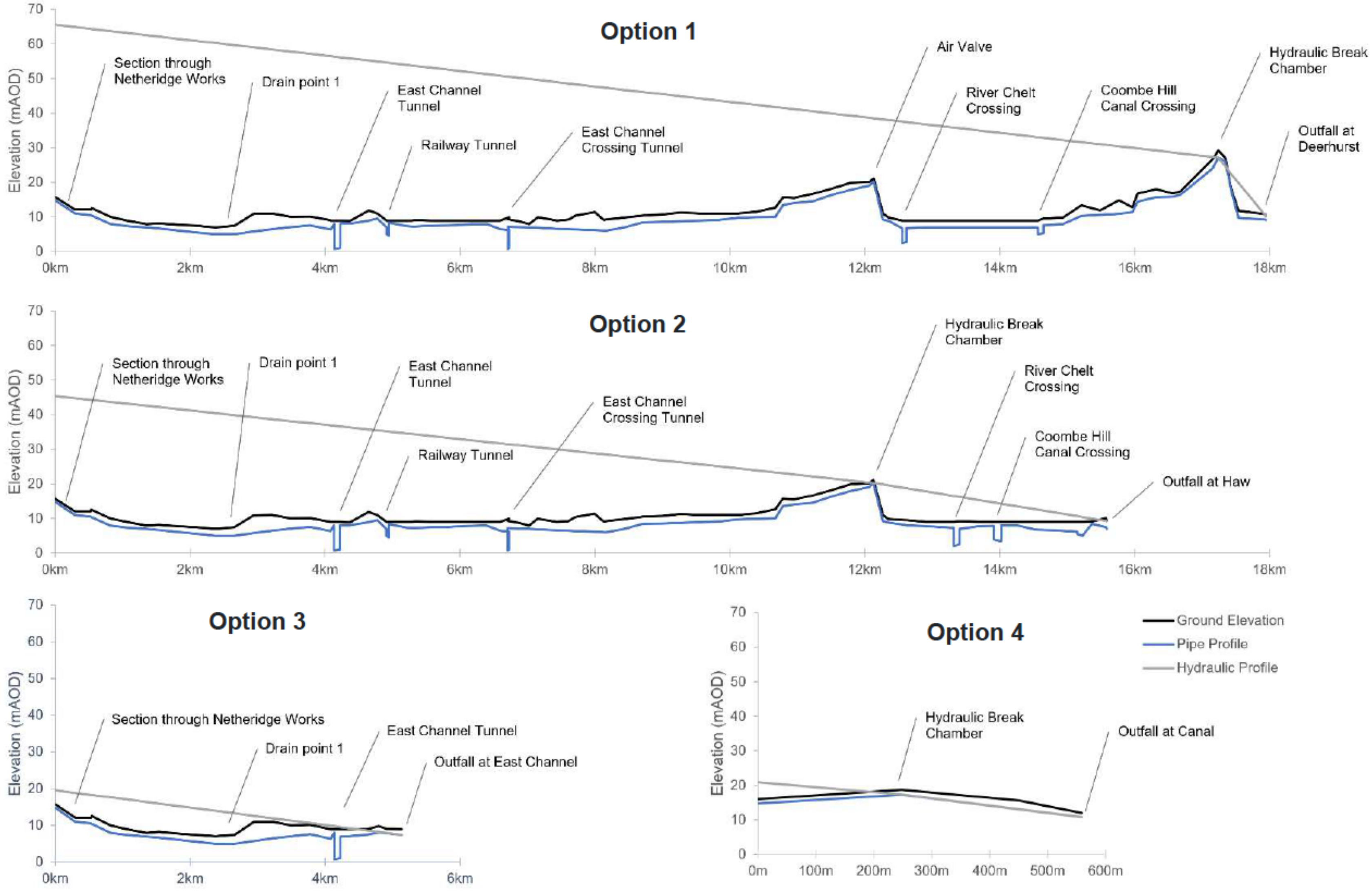
Table 2-6 summarises the key hydraulic parameters for options 1 to 4. Option 5 is not shown as the parameters will be the same as Option 3.

Table 2-6 - Hydraulic Characteristics for Options 1 to 4

Option	1	2	3	4
Design Flowrate Basis (l/s)	550	550	550	550
Total Pipeline Length (m)	17,943	15,587	5,133	559
Rising Main Length (m)	17,236	12,129	5,133	248
Rising Main Diameter (mm)	700	700	700	600
Velocity at Design Flowrate (m/s)	1.44	1.44	1.44	1.95
Roughness (mm)	0.06	0.06	0.06	0.06
Pipe Friction Losses (m)	35.5	24.95	10.6	1.1
Fittings Losses (m)	2	2	2	2.5
Suction Level (m)	12	12	12	12
Discharge Level (m)	28.2	20.3	7.4	17.4
Geodetic Head (m)	16.2	8.3	-4.6	5.4
Total Pump Head (m)	53.7	35.25	8	9
Gate 2 Sizing Basis THD (m)	55	36	8	9.5

A summary of the hydraulic profiles including key crossing points, drain points, main terrain type and hydraulic grade line for options 1 to 4 is shown in Figure 2-13.

Figure 2-13 - Hydraulic Profiles of Options 1 to 4



2.8.3 PIPE MATERIAL CHOICE

The hydraulic analysis shows that the steady state working pressure of the pipeline will be a maximum of 5.4 bar. This occurs at the transfer pumping station for Option 1 Deerhurst and comprises a combination of static and friction heads. All other route options result in a lower steady state working pressure. The initial concept design at Gate 1 anticipated that pipeline would be constructed of ductile iron. This pipe material has been carried forwards into the concept design. Standard ductile iron pipe has a maximum working pressure rating of 16 bar and is therefore well suited to this application. Ductile iron pipework has a number of advantages when compared to other materials such as high density polyethylene (HDPE) and steel, including:

- Speed of laying, ductile iron pipes can be readily pushed together without the need for complex and time-consuming welding. Typically, in open ground laying rates of >50 m per day can be achieved.
- Ductile iron pipes are classed as semi-rigid (BS9295) as such the structural performance is not as heavily reliant on the quality of pipeline bed and surround and the need of the bed and surround to act as a composite with the pipeline as with flexible pipe materials such as HDPE and steel. As a result, this allows the pipes to be installed and backfilled with selected excavated materials rather than imported granular materials which has many benefits including:
  - Less waste generated for disposal.
  - Less imported material required
  - Fewer vehicle movements for imports and exports.
  - Lower embedded carbon value.
- End-load resistant push fit joints can be used to create an anchorage system to provide restraint to thrust at changes of direction and testing points allowing it to mimic the performance advantages of welded jointing systems associated with HDPE and Steel joints.

For the Netheridge SRO scheme there are no overriding factors that dictate pipe material selection. The contractor preference in construction methods and the price of materials at the time of construction will inform a cost benefit analysis.

2.8.4 CIVILS STRUCTURES

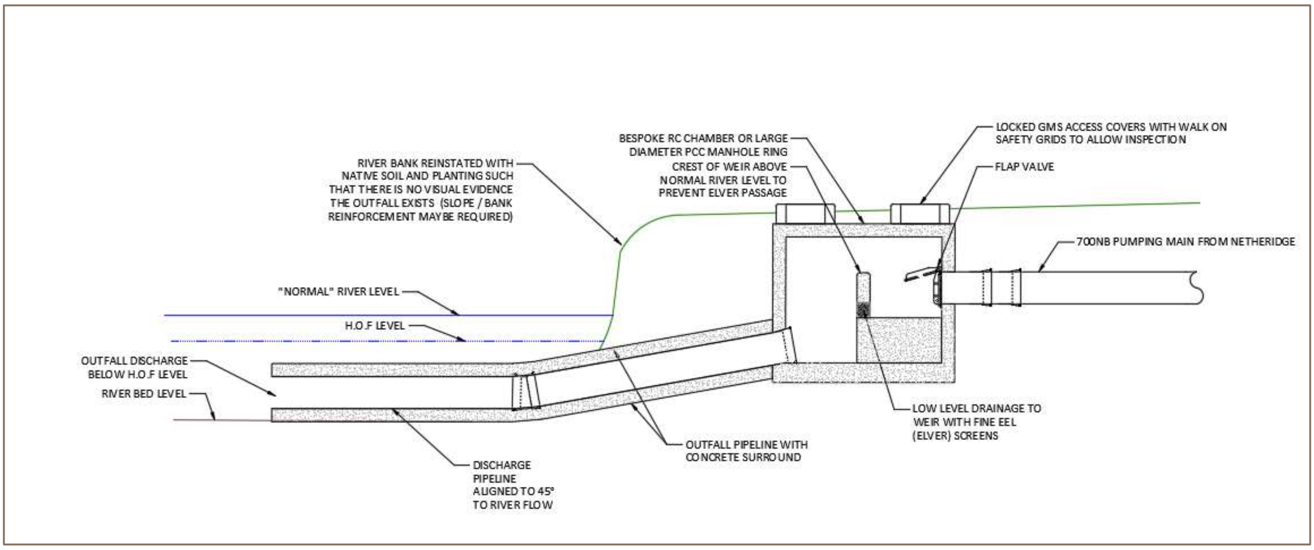
2.8.4.1 Outfall Structure

A new outfall structure will be required at the discharge location. It is proposed that the outfall structure for each of the options shall be a submerged type outfall as opposed to a bank side outfall. It is preferable and considered good practice to use submerged outfall structures where high volume and or high velocity discharges such as WwTW, industrial or Hydroelectric waters are to be discharged to the natural environments.

The River Severn is a known eel habitat and so some form of eel protection will be required on the outfall structure. For concept design a hydraulic break chamber has been proposed but other protection methods, including fine or electric screens, are also feasible.

A conceptual arrangement for the outfall arrangement is shown in Figure 2-14.

Figure 2-14 - Typical Outfall Design



Vehicle access will be required to the outfall structure on an annual basis to allow for inspection and maintenance. A new permanent access road and compound will be required at allow safe access. Planning permission will be required for the outfall compound and associated access tracks.

2.8.4.2 Drain Points

Due to intermittent operation of the transfer pipeline, it will be necessary to drain the effluent from the main to prevent the water stagnating. If the effluent is left in the pipeline when not is use it is possible that the quality of the effluent will not meet the required standards for discharge when the pipeline is returned to operation. To combat this, it is proposed to drain the pipeline at various locations along its length.

Drain points are located at each of the tunnel crossings for each option. At each tunnel one of the shafts will be used as a drain point. Effluent will discharge into a small wet well pumping station constructed within the tunnel shaft. Where tunnels are located near major water courses, it is proposed to discharge the drained effluent into the adjacent water course. At other locations such as at the railway line crossing it is proposed to lift effluent out of the tunnel shaft and discharge it back into the rising main to allow it to flow under gravity to a drain point with an appropriate water course discharge.

Where intermediate drain points are required, a small standalone pumping well will be connected to the main pipeline via a level invert tee with dual isolating valves. Where possible these additional drain points have been located close to large water courses to allow the treated effluent to be discharged locally without the need for long rising mains.

All drain points will be operated by mobile pumps which can be transported on or towed by the operations team normal transport vehicles. Adopting this approach removes the need for purchase and maintenance of pumps, MCC kiosks and provision of a new power supply at each of the drain point locations.

The rate of discharge for the drain points varies and will be determined by the size and flow rates of the receiving water course. The effluent to be discharged will have undergone additional treatment and so should be of a suitable quality for discharge to a freshwater environment but the rate of discharge may need to be slowed to ensure adequate dilution and avoid any detrimental effects on the local environment.

2.8.4.3 Hydraulic Break Chamber

For a pumped rising main, the idealised pipeline profile is continuously rising to its discharge. For the Options 1 (Deerhurst) and 2 (Haw Bridge), the pipeline profiles include a high point in the latter part of the route. Without a hydraulic break, these high points could lead to siphoning of flows with a corresponding negative pressure in the main. This condition is not preferred as it could exacerbate transient negative pressures and complicates the filling and draining of the pipeline. By providing a hydraulic break in the form of a chamber at the crest of the profile, the rising section is separated from the final falling section, simplifying hydraulic design and pump operation. The hydraulic break chamber will allow air into the pipeline at the head of the gravity system and prevent negative pressures being developed.

3 SCHEME DELIVERY

3.1 CONSTRUCTION

3.1.1 GENERAL

It is anticipated that the Netheridge SRO would be constructed in two parts: the treatment plant upgrade and the pipeline.

The treatment plant upgrade contract would include the transfer pump station and potentially the first section of the transfer pipeline located within the WwTW boundary. The pipeline contract would include the outfall construction and all the crossings point.

There is no direct connection to the STT SRO as the Netheridge SRO effluent is discharged to the receiving water independently of STT SRO abstraction.

The proposed location of the new treatment units to the west of the WwTW site enables the construction to be completed largely without the need for disruption to existing WwTW operations, other than to create the flow diversion chambers and link to the site power and control systems.

3.1.2 PIPELINE CONSTRUCTION

It is anticipated that the pipeline throughout its length will be constructed using open cut trenching techniques, except at specific strategic crossing points where trenchless, jacked micro-tunnelling techniques will be employed. Due to the proximity to the River Severn and location in the flood plain, ground water control will be required for a large part of the pipeline length.

Options 1,2, 3 and 5 pass under the East Channel of the River Severn and several smaller water courses. At 700 mm diameter the pipeline is too large for installation by directional drilling techniques, therefore it is likely that the pipeline will be installed within an oversized tunnel sleeve typically of 1000 – 1200 mm NB of steel or concrete construction installed by micro-tunnelling / pipe jacking techniques for the larger crossing. Smaller crossings may be feasible using open trench and cofferdam methods.

Options 1 and 2 pass under the railway line. Options to pass under the railway via existing viaduct have been discounted due to congestion from existing services and utilities. Therefore, it is proposed to pass under the railway at a point where the railway is elevated above the surrounding ground level in an embankment.

Options 1 and 2 also pass under a number of major roads including the A40 and the A417 at the approach to the Over Causeway Roundabout. In both cases these roads are elevated above the surrounding ground level and there is sufficient elevation to allow open cut construction techniques provided that hight restricted equipment is used to prevent bridge strikes.

The linear nature of a pipeline means that construction programme is extremely variable as it is dependent upon the number of locations that are constructed simultaneously. For Option 1, which is 18km long with major river road and rail crossings, a contractor utilising two crews for crossings and two for pipe installation, a construction period of 18 months would be reasonable once all permits and permissions were in place.

3.1.3 TREATMENT PLANT UPGRADE CONSTRUCTION

The construction of the treatment plant upgrade should not present any particular issue and would follow typical construction techniques. Due to the anticipated alluvial ground conditions it is likely that foundations for the treatment units will need to be piled. There may be some groundwater due to the proximity to the river.

The majority of the works can be completed independently of the existing WwTW operations with potential for a separate access to reduce disruption to day-to-day activity on the site. Interface with the existing WwTW site will be required for:

- Construction of the flow diversion chambers, intermediate pump station and return pipe work.
- Construction of the sludge thickening pipework
- Upgrade/installation of the ferrous dosing system on the ASP lanes
- Linkages to the existing control system
- Connection to the potable water supply
- Connection to the power system

3.1.4 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

The purpose of a construction environmental management plan is to outline how a construction project will avoid, minimise or mitigate effects on the environment and surrounding area.

Construction environmental management plans include:

- Highlight stakeholder requirements.
- Ensure that the development is compliant with current environmental legislation.
- Outline Environmental Management System requirements (in accordance with ISO 14001).
- Detail the mitigation committed to within the Environmental Statement and how it will be implemented on site.
- Ensure that any adverse effects are minimised during construction.
- Describe any site-specific method statements required.

A construction environmental management plan will be required for the Netheridge SRO but is not within the scope of the concept design report.

3.1.5 HEALTH AND SAFETY AND THE CDM REGULATIONS

For the concept design phase of the project WSP has assumed the role of Principal Designer under the Construction Design Management (CDM) Regulations. As Principal Designer WSP has an obligation to manage H&S risks though the design process, eliminating or reducing risk where possible to ensure that the project is safe to construct, operate and maintain. Where risks cannot be eliminated the Principal Designer must ensure that others working on the project are aware of the risks associated with the project.

During the development of the concept design WSP maintain a risk register and complete periodic review of the risks to identify, mitigate and mange project health and safety-based risk.

The design process identified a number of risks specific to the Netheridge SRO scheme which are highlighted below:

Construction works:

- Near railway lines
- Near water
- Near major roads
- Through contaminated land
- In deep trenches (service strike, water ingress, collapse, noise)
- On operational WwTW

Operation & Maintenance

- Use of hazardous chemicals
- Confined space

The H&S Residual Risk Register is included at Appendix A.

3.2 DELIVERY PROGRAMME

3.2.1 PLANNING DEVELOPMENT AND ENABLING STAGES

The delivery of the Netheridge SRO will be subject to the RAPID gated process. The dates of these gates are fixed and so they dictate the pace and progress of the next stages of the Netheridge SRO delivery.

The outcome for Gate 3 is described as 'Developed design, finalised feasibility, pre-planning investigations and planning applications'. This Gate is due for completion in Q1 of 2025 (see Figure 3-1). In this stage will see:

- Finalisation of the recommended option for the Netheridge SRO and the concept design completed.
- If practical, a pilot plant for the treatment units constructed and operated to gain information to refine the chosen concept design.
- Engagement with landowners and stakeholders and pre-planning activity will be undertaken.
- Discussions will continue with EA, DWI and other regulatory bodies to refine and agree the water quality requirements for the discharge permits at the chosen discharge location.

Further detail of specific design activities is provided in section 5.2.

The outcome for Gate 4 is described as 'Planning applications, procurement and land purchase'. The Gate is due for completion in Q2 of 2028 (see Figure 3-1). This stage will see:

- Land agreements and easements finalised
- Planning applications for the new WwTW and pipeline structures
- Discharge consents applied for and issued

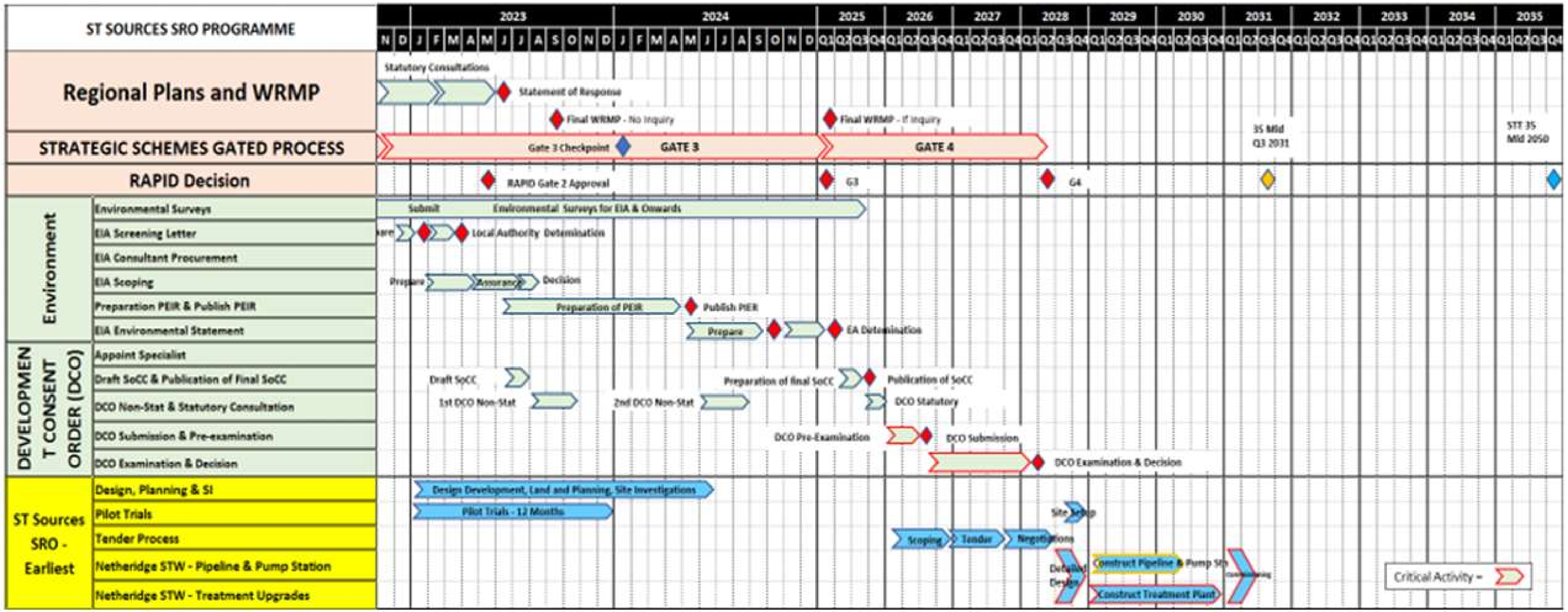
3.2.2 DETAIL DESIGN, CONSTRUCTION AND COMMISSIONING STAGES

Once the Netheridge SRO has passed Gate 4 the scheme will require detail design before construction and commissioning phases. Procurement strategies are not in the scope of this report, but the Netheridge SRO would be suitable for design and build delivery. Refer to section 3.1 for more details.

3.2.3 ST SOURCES SRO PROGRAMME

Figure 3-1 outlines the ST Sources SRO programme as of September 2022.

Figure 3-1 - ST Sources SRO Programme - September 2022



3.2.4 INTEGRATION WITH THE STT SRO SCHEME

The Netheridge SRO must be completed and be operating before the STT SRO can become fully operational.

The size and complexity of the Netheridge SRO should allow for the scheme to be constructed in less time than the STT SRO and so it should not fall on the ‘critical path’ for delivery and implementation of the wider SRO schemes.

4 WATER RESOURCES

4.1 DEPLOYABLE OUTPUT

Deployable Output (DO) is a key metric in water resources planning and is used as a measure of the supply capability of a water supply system. For SRO schemes an understanding of the DO is an important part of the scheme viability.

The DO from the Netheridge SRO will benefit the London water resource zones via the STT SRO. The DO for the Netheridge SRO is 35 Ml/d based on available outflows from the Netheridge WwTW. This value has been predetermined and agreed as part of the wider STT SRO. The 35 Ml/day value was re-assessed as part of the Gate 2 concept design, and it has been identified that outflows from Netheridge during dry periods may lead to short periods (around 1% of the time or 3-4 days a year) where 35 Ml/day may not be achievable even when future growth in the catchment is taken into consideration.

4.2 REGULATION AND LICENCING

A new discharge licence will be required for the Netheridge SRO to enable treated effluent to be discharged to the chosen STT SRO abstraction point. Assessment of this requirement is not within the scope of the concept design report and is being considered as part of the wider SRO schemes.

Planning permissions may be required for the new treatment plant and for chambers along the pipeline route. Assessment of this requirement is not within the scope of the concept design report and is being considered separately by STW.

5 FUTURE SCHEME DEVELOPMENT

5.1 ALTERNATIVE OPTIONS DEVELOPMENT

As the Netheridge SRO concept design has progressed a number of developments in the anticipated discharge quality standards and the level of additional treatment required has led to identification of other potential opportunities for the Netheridge SRO, as described in CDR Addendum – Alternative (No Treatment) Options (Annex A1.1). The development of these opportunities will be a critical next step in the development of the Netheridge SRO and may alter the overall premise of the scheme. These will be pursued separately by STW and will be discussed and agreed with RAPID as part of the Gate 2 process.

Southwest Region Supply

It is feasible that the Netheridge WwTW effluent could be used to supply the southwest regions (in particular Bristol Water at Purton) by transferring flows to the G&S Canal either at Gloucester Docks or directly to the Canal adjacent to the Netheridge WwTW site. This could be as an alternative to supplying the STT SRO or in addition to supplying the STT SRO by utilising surplus flows when they are not required by the STT SRO scheme.

There is significant benefit in developing an SRO that can provide additional flows to either the southeast, via the STT SRO or to the southwest via the G&S Canal. Option 5 in this report highlights the additional cost associated with providing a branch line to Gloucester Docks that would allow utilisation of surplus flows.

STW have initiated discussions with RAPID and southwest region water providers to discuss wider use of Netheridge water resources. Additional studies will be initiated post Gate 2 submission to further investigate the feasibility of utilisation of the deployable output from Netheridge SRO in other, potentially more cost-effective ways.

No Treatment Options

In establishing the feasibility of the STT and associated SROs it was assumed that the use of treated effluent from Netheridge WwTW would provide an efficient and reliable way of capturing flows from the Gloucester catchment and moving them northwards. In the early feasibility stages, it was anticipated that final effluent from the Netheridge WwTW would require minimal further treatment before being transferred to a location close to the STT SRO abstraction point at Deerhurst.

As the SRO studies have progressed it has become apparent that the quality of the Netheridge final effluent will need to be significantly improved before it can be discharged in the River Severn at Deerhurst. The effluent from Netheridge WwTW currently discharges to the tidal zone of the River Severn and the discharge quality standards at this location are set to maintain the quality of the brackish waters in the tidal zone. Deerhurst is some 18 km upstream of Netheridge at a point where the river is no longer under tidal influence. As such any water quality standard for effluent discharge will be set for a freshwater environment and which is now proving to be far more onerous than anticipated at the onset of the project.

Given the basic premise of minimal treatment requirements of the original project has changed, it is prudent to reconsider the options and the way in which water resources from the Gloucester catchment area are transferred north to augment the STT SRO scheme.

A number of options that do not require any form of additional treatment but instead rely on multistage pumping or transfer of flows within river quality zones have been identified by STW and these will be progressed further through consultation and agreement with the EA during Gate 3.

5.2 ENGINEERING DESIGN DEVELOPMENT

Based on the development of the concept deign for Gate 2 a number of further activities, studies and surveys have been identified for the progression of the scheme to Gate 3 and Gate 4.

5.2.1 TREATMENT PROCESS DESIGN

5.2.1.1 Water Quality Standards

The establishment of clear and defined effluent quality standards for the chosen discharge location are required. The scope of these activities largely sits with the environmental consultants engaged for the sampling and modelling work and is not discussed further in this report.

5.2.1.2 Netheridge WwTW Upgrades for AMP8

It is important that the short- and medium-term development plans for Netheridge WwTW are identified and taken into consideration when developing the treatment process in the next stages of design. Upgrades for growth or quality improvements may allow for a more holistic approach to provision of effluent as water resource.

As of July 2022, two upgrades for the Netheridge WwTW had been identified:

- Upgrades to improve ammonia and phosphorus removal in anticipation of increased water quality standards for the existing Netheridge WwTW discharge consent.
- Installation of a ‘gas to gird’ scheme to convert gaseous by-products for the WwTW to electricity.

5.2.1.3 Inflow to Netheridge WwTW

The ability for Netheridge WwTW to provide the required 35 Ml/d during periods of dry weather requires further assessment. A detailed analysis of the inflow and understanding of the causes of low flows to the WwTW are required to determine the extent to which 35Ml/d can be reliably achieved.

5.2.1.4 Treatment Pilot Plant

In order for the effectiveness and efficiency of the treatment processes be assessed it will be necessary to install a small pilot plant that will allow monitoring of the quality of the Netheridge WwTW effluent. The technologies suggested at concept design experience a large variability is effectiveness based on the actual effluent parameters. A pilot plant will allow the effectiveness to be assessed and the opportunities realised before full scale construction commences.

5.2.1.5 Operation and Control Systems

Further development of the proposed operational regime and control philosophy for the STT SRO and the required linkages to the Netheridge SRO is required.

5.2.2 TREATMENT PLANT DESIGN

5.2.2.1 Topographical Survey

Undertake detailed topographic survey of proposed construction and tie-in locations. This will facilitate cut/fill calculations to be undertaken as well as provide reliable elevations for further design work. This in turn will inform the system hydraulics and opportunities to reduce pumping requirements.

5.2.2.2 Utilities Surveys

Undertake a detailed utilities survey in the proposed areas of construction, identify roads that could be used for pipeline corridors and any tie-in locations. Statutory providers should be engaged early to commence discussions around the proposed utilities diversions and decommissioning of the unused gas main.

5.2.2.3 Potable Water Supply

An assessment of the current potable supply to site needs to be undertaken to determine if the existing supply can be improved or if a new supply to site needs to be provided. This can be carried out once the requirement for potable water in the treatment process units is confirmed.

5.2.2.4 Environmental Surveys

An appropriate environmental assessment should be undertaken, this will most likely include a Phase 1 Habitat Assessment as well as reptile surveys, badger surveys and bat surveys to confirm presence of these species already noted to be on the Netheridge WwTW site.

The EA flood risk maps show that the proposed location for the new treatment plant is in an area at very low risk of flooding from rivers or surface water. It should be considered whether further flood risk assessment is required.

The scope of these activities largely sits with the environmental consultants engaged for the environmental assessments and is not discussed further in this report.

5.2.3 PIPELINE DESIGN

5.2.3.1 Terrain Mapping

Terrestrial Topographical Surveys

Traditional terrestrial topographical surveys should be completed in specific areas to ensure the capture key details and features in strategically important areas such as:

- River and other major water course crossings to include both banks and areas with tunnel shaft construction works are to take place
- Rail crossing to include areas where tunnel shafts are to be constructed, access to railway property, the embankment, position and level of the running rails
- Road crossings to include road levels, presence of kerb line, surface water gullies and other street furniture, hedges and drainage ditches
- Pipeline permanent access points

LiDar – Improved Accuracy

Improved accuracy LiDar data typically obtained using a UAV (drone) for the proposed pipeline route including a buffer of typically 30-50m either side of the proposed centre line of the pipeline to allow local variations in route to be made.

Bathymetric Surveys

Bathymetric surveys at the crossing points on the River Severn East Channel, River Chelt and Coombe Hill Canal to include an area of approximately 30m upstream and downstream of the proposed crossing point. This information should be used in conjunction with a marine based geotechnical investigation to allow the design of the tunnel crossings of these elements.

5.2.3.2 Geotechnical Surveys

For subsequent phases of the Netheridge SRO it is recommended that ground investigation works are carried out at selected locations along the pipe routes namely:

- All micro-tunnelling locations to determine the local strata for tunnelling design
- Hempsted landfill site to determine the ground condition in this area
- Alney Nature Reserve to test for land contamination
- Selected locations on the pipe route for soil resistivity sampling and trial pits to confirm desk-based assumptions

5.2.3.3 Utilities

Additional utilities investigations to include engagement with utilities owners to determine exact line and level of utilities with potential trial pits where service diversions are required.

5.2.3.4 Environment And Ecology

An appropriate environmental assessment should be undertaken, this will most likely include a Phase 1 Habitat Assessment as well as reptile surveys, badger surveys and bat surveys to confirm presence of these species already noted to be on the pipeline route.

The EA flood risk maps show that the proposed location for the pipeline is in an area with risk of flooding from rivers or surface water. It should be considered whether further flood risk assessment is required.

The scope of these activities largely sits with the environmental consultants engaged for the environmental assessments and is not discussed further in this report. However, there two specific environmental investigations that are highlighted here:

Discharge from Drain Down Points

The operational philosophy of the Netheridge SRO is that the pipeline will be drained and left empty when not in use. Draining the pipeline will lead to the discharge of up to 6,500 m^3 of treated effluent to the local environment. This discharge needs to be carefully managed and engagement is required with the EA and regulatory bodies to agree the conditions for discharge.

Works in Alney Island Local Nature Reserve

Engagement with Gloucestershire County Council and the charities and organisations that own and maintain the Alney Island local nature reserve is required to discuss the pipeline construction as well as any environmental offsetting, improvements and mitigations that could be implemented as part of the construction reinstatement.

5.2.3.5 Planning Permissions

It is not currently clear if the Netheridge SRO will be covered by the scope of the STT SRO which may to be subject to government approval and covered by a Development Consent Order (DCO).

If the Netheridge SRO does not fall within the wider DCO process, STW have powers under the Water Industry Act 1991 to enter land to construct water assets. As such there are unlikely to be significant issues with accessing land for construction.

Engagement with planning authorities and key stakeholders is required for subsequent stages of the Netheridge SRO. The scope of these activities largely sits with STW, and the Land Agent engaged for this process and is not discussed further in this report.

5.2.3.6 Land Ownership and Rights of Access

Engagement with landowners and key stakeholders is required for subsequent stages of the Netheridge SRO. The scope of these activities largely sits with STW, and the Land Agent engaged for this process and is not discussed further in this report.

5.3 INTEGRATED PLANNING

The Netheridge SRO forms an integral part of the STT SRO and therefore design development activity should be coordinated with outcomes from this scheme. In particular:

- Activity relating to the water quality modelling at the STT SRO abstraction point should be integrated to ensure the best outcome for both the Netheridge SRO and the STT SRO schemes.
- The development of operational parameters for the STT SRO should also be an integrated activity as there are limitations and constraints on the Netheridge SRO that need to be accounted for when establishing the wider SRO scheme parameters.

5.4 RAPID GATE 3

Gate 3 is described as 'Developed design, finalised feasibility, pre-planning investigations and planning applications'. The following are listed as the key activities:

- Updated finalised feasibility, data collection and developed design
- Cross-comparison of updated solutions costs and benefits in regional and national models
- External assurance of data and approaches supported by Board statement
- Confirm procurement strategy including direct procurement for customers delivery decisions
- Pre-planning application submissions
- Start development consent orders pre-planning application investigations
- Planning permission-related stakeholder engagement completed
- Identify impacts of solution on current supply-demand balance delivery plan with simple comparison to current programme solutions.
- Identification of any changes in solution partner or solution substitutions
- Develop solution programme plan to determine the activities that need to be undertaken prior to each subsequent gate
- Proposals for gate four activity and outcomes, and penalty scale, assessment criteria and contributions

5.5 RAPID GATE 4

Gate 4 is described as 'Planning applications, procurement and land purchase'. The following are listed as the key activities:

- Designs updated where necessary
- Incorporation of pre-planning investigations
- Cross-comparison of updated solutions costs and benefits in regional and national models
- Implement procurement strategy including direct procurement for customers (where necessary)
- Continue planning applications (where relevant)
- Finalise development consent orders planning application investigations (where relevant)
- Planning permission-related stakeholder engagement completed
- External assurance of data and approaches supported by Board statement
- Identify impacts of solution on current supply-demand balance delivery plan with simple comparison to current programme solutions.
- Develop solution programme plan to determine the activities that need to be undertaken prior to each subsequent gate
- Proposals for gate five activity and outcomes, and penalty scale, assessment criteria and contributions (where necessary)

6 ECONOMICS AND CARBON COSTS

This section of the concept design report should be read in conjunction with the STS SRO Netheridge Cost Report (Annex A5) which contains detailed analysis of the approach, methodology and tools use for the economic analysis of the Netheridge SRO. The following sections highlight the output for each part of the economic analysis.

6.1 CAPITAL (CONSTRUCTION) COST

Table 6-1 – Capital Cost Summary (excluding Optimism Bias and Risk)

Option No.	Option Name	Treatment Capex	Pipeline Capex	Overall Capex Cost
Option 1	Deerhurst	£69,797,800	£32,625,300	£102,423,100
Option 2	Haw Bridge	£69,797,800	£28,595,700	£98,393,500
Option 3	East Channel	£78,240,000	£9,921,500	£88,161,500
Option 4	Canal	£79,535,400	£2,421,400	£81,956,800
Option 5	Southwest (SW) Branch	£8,442,200	£848,600	£9,290,800

6.2 QUALITATIVE COSTED RISK ASSESSMENT AND OPTIMISM BIAS

Table 6-2 – Optimism Bias Summary

Option No.	Option Name	STAGE 1	STAGE 2	STAGE 3
Option 1 Treatment	Deerhurst	58.96	37.10	30.49
Option 2 Treatment	Haw Bridge	59.62	37.47	30.62
Option 3	East Channel	63.58	39.65	31.41
Option 4	Canal	65.34	40.62	31.77
Option 5	SW Branch	64.02	39.89	31.50

The ACWG methodology outlines an OB process in three stages:

- Stage 1: The first stage defines the project type with regard to standard and non-standard engineering project to define the upper bound of OB
- Stage 2: The second stage scales back the OB based on the contributory factors outline in the Green Book methodology
- Stage 3: The third stage reassess the OB based on the output of the QCRA to ensure that the OB allowance considers the risks that have now been costed and included separately to avoid overestimation of the OB and Risk costs.

Table 6-3 – Risk Values

Option No.	Option Name	P10	P50	P90
Option 1	Deerhurst	£8,107,084	£20,012,656	£34,089,167
Option 2	Haw Bridge	£7,731,352	£19,122,965	£32,677,018
Option 3	East Channel	£3,965,783	£12,647,664	£23,032,876
Option 4	Canal	£597,119	£8,196,285	£16,917,954
Option 5	SW Branch	£348,124	£1,261,008	£2,338,111

6.3 OPERATIONAL COST ESTIMATES

Table 6-4 – Operational Cost Summary

Option No.	Option Name	Treatment Opex	Pipeline Opex	Annual Opex
Option 1	Deerhurst	£1,447,915	£217,745	£1,665,660
Option 2	Haw Bridge	£1,447,915	£171,422	£1,619,337
Option 3	East Channel	£1,485,967	£90,203	£1,576,170
Option 4	Canal	£1,504,087	£92,374	£1,596,462
Option 5	SW Branch	£38,052	£180,786	£218,838

6.4 NET PRESENT VALUE (NPV) AND AVERAGE INCREMENTAL COST (AIC)

Table 6-5 – NPV and AIC Template Output (Max Utilisation)

Option No.	Option Name	NPV Finance	NPV Opex	NPV WAFU (m^3)	AIC (p/m^3)
Option 1	Deerhurst	£168,185,540	£76,874,965	£263,267,297	£93.08
Option 2	Haw Bridge	£163,915,721	£73,460,388	£263,267,297	£90.17
Option 3	East Channel	£154,520,009	£70,083,464	£263,267,297	£85.31
Option 4	G&S Canal	£146,993,167	£71,329,031	£263,267,297	£82.93
Option 5	SW Branch	£15,146,408	£15,016,144	£263,267,297	£11.46

6.5 SUMMARY OF OPTION COSTS

Table 6-6 – Summary of Capital Costs

Option No.	Option Name	OB Value	Risk Value (P50)	Total Project Capex Cost
Option 1	Deerhurst	£31,228,800	£20,012,656	£153,664,600
Option 2	Haw Bridge	£30,128,100	£19,122,965	£147,644,600
Option 3	East Channel	£27,691,500	£12,647,664	£128,500,700
Option 4	Canal	£26,037,700	£8,196,285	£116,190,800
Option 5	SW Branch	£2,926,600	£1,261,008	£13,478,400

Table 6-7 – Summary of Operational Costs, NPV and AIC

Option No	Option Name	Annual Opex	NPV Finance	NPV Opex	AIC (p/m^3)
Option 1	Deerhurst	£1,665,660	£168,185,540	£76,874,965	93.08
Option 2	Haw Bridge	£1,619,337	£163,915,721	£73,460,388	90.17
Option 3	East Channel	£1,576,170	£154,520,009	£70,083,464	85.31
Option 4	Canal	£1,596,462	£146,993,167	£71,329,031	82.93
Option 5	SW Branch	£218,838	£15,146,408	£15,016,144	11.46

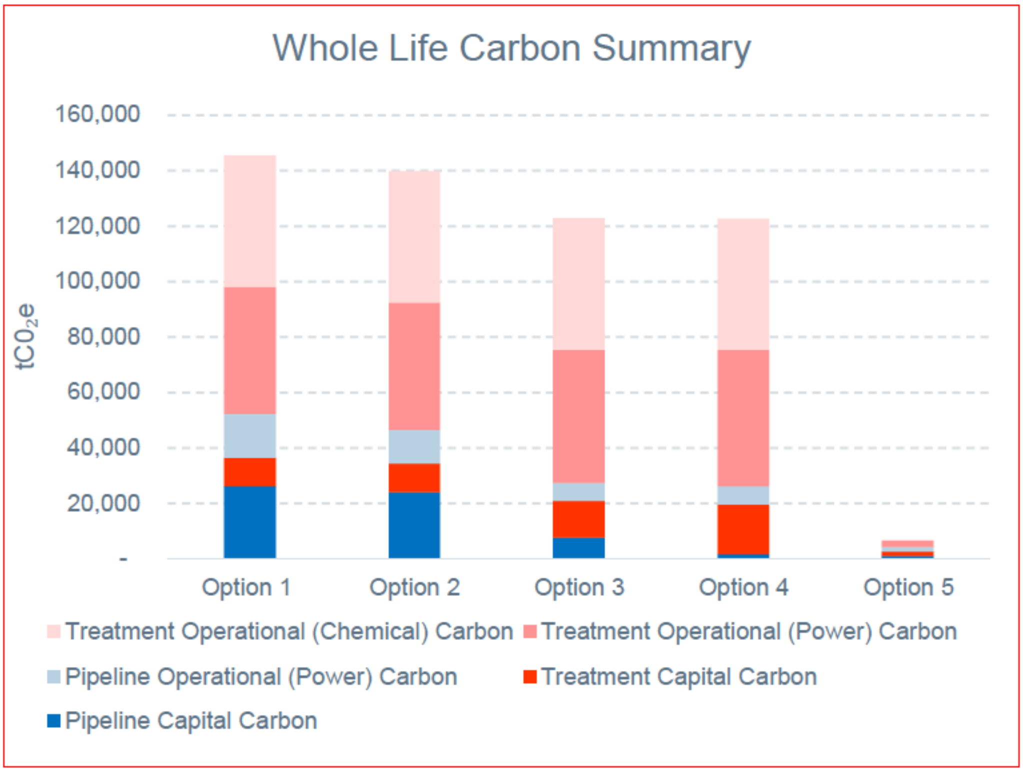
6.6 CARBON COSTS

This section of the concept design report should be read in conjunction with the STS SRO Netheridge Carbon Report (Annex A4). A summary of the carbon costs is provided in Table 6-8. This shows the embodied and operational carbon for each of the five options and allows comparison of the total whole life carbon over an 80 year assessment period, with the first 9 years allocated for development and construction, and the plant operational for the remaining 71 years.

Table 6-8 – Summary of Whole Life Carbon Emissions (tCO_2e) by category - 80 year period

Option	Pipeline Capital Carbon	Treatment Capital Carbon	Pipeline Operational (Power) Carbon	Treatment Operational (Power) Carbon	Treatment Operational (Chemical) Carbon	Total Whole Life Carbon
Option 1	26,159	10,266	15,838	45,781	47,428	145,473
Option 2	23,997	10,266	12,347	45,781	47,428	139,819
Option 3	7,646	13,276	6,455	48,051	47,428	122,856
Option 4	1,710	17,796	6,618	49,117	47,428	122,669
Option 5	1,122	1,462	1,746	2,270	-	6,599

Figure 6-1 - Whole Life Carbon Summary



The carbon associated with Option 5 considers the additional carbon associated with the pipework branch from the transfer pipework of option 1 and 2 into the East Channel of the River Severn downstream of the intake for Gloucester Docks

There is a balance between the embodied carbon of the four main options with higher pipeline carbon for options 1 and 2 and higher treatment carbon for options 3 and 4 which require additional treatment step, Overall the total embodied carbon is highest for option 1 which is due to the long pipe length which also leads to high operational carbon over the 80 year assessment period.

Overall there is around a 10% difference in total carbon for the four options which, given the margin of error and number of parameters which can only be determined at detail design stage, does not give a clear indication of one option being preferable over the others.

A number of steps have been taken in the concept design for Gate 2 to reduce the overall carbon:

- Reduce the length of the pipelines and maximise hydraulic efficiency
  - Option 2 is a direct output of the need to reduce carbon by reducing the length of the pipeline through a discharge at Haw Bridge rather than Deerhurst
- Remove the need to continually pump 10% of the flow to prevent septicity by draining the pipeline when not is use
  - An energy saving of 15-20% depending on the actual operation of the STT SRO scheme
- Reduce flows through each treatment process to the minimum required to keep the process viable
  - An energy saving in the order of 40%
- Selection of lower carbon treatment processes and equipment where appropriate

A more detailed discussion of carbon reduction opportunities is provided in section 7.3.3.

7 ASSUMPTIONS, RISKS AND BENEFITS

7.1 ASSUMPTIONS

Assumptions made for development of the concept design are stated in section 2.3 Design Principles including:

- Netheridge SRO Operational Assumptions
- Discharge Point and Pipeline Assumptions
- Effluent Quality Standards and Treatment Process Assumptions

Assumption relating to cost estimates are listed in the cost estimation report spreadsheets and the Netheridge SRO Cost Report.

7.2 PROJECT RISK

This section of the concept design report should be read in conjunction with the STS SRO Netheridge Cost Report (Annex A5) which contains the detailed risk register used for the qualitative costed risk assessment. The list below highlights the key risk identified for delivery of the Netheridge SRO project.

- Inadequate flow into Netheridge WwTW during dry weather flow to supply 35 Ml/d leading to STS SRO unable to supply required volume to STT SRO Scheme
- Quality of the influent into Netheridge WwTW changes/deteriorates leading to the new treatment process not meeting STS SRO discharge permit standards. Process upgrades required.
- Upgrades occur at Netheridge WwTW that utilise existing land, power, water, sludge resources assumed to be available for the SRO scheme leading to redesign of proposed new treatment layout. Additional power and water required to site.
- Water quality standards for the STS SRO discharge are higher than anticipated leading to the new treatment process not meeting STS SRO discharge permit standards. Process upgrades required.
- The new STS SRO treatment process does not produce effluent to the quality anticipated at design stage leading to new treatment process not meeting STS SRO discharge permit standards. Process upgrades required.
- Specified treatment process units do not fit with proposed WwTW layout requiring redesign leading to additional pipework and ancillaries required die to altered layout.
- Specific treatment process units required additional power requiring additional electrical upgrades leading to additional substation/electrical equipment required.
- Specific treatment process units required additional potable water requiring upgrade to incoming water supply leading to upgrade to incoming water supply to increase volume of water supplied
- Issues relating to landownership, wayleaves and access leading to alteration of pipe routes, delay to construction or different construction methods.
- Issues relating to obtaining planning permissions for WwTW or pipeline buildings and structures leading to alteration of building/structure size/location, different construction methods.
- Options 1,2 and 3 must pass through Alney Nature Reserve, under the railway, A40 and River Severn East Channel. Permissions have not been granted/ construction methods agreed leading to alternative location required for crossing increasing pipeline length. Alternative construction methods required. Additional mitigation and reinstatement required.

7.3 OPPORTUNITIES AND FUTURE BENEFITS REALISATION

During the development of the concept design for Gate 2 a number of opportunities were identified that would enhance the Netheridge SRO scheme. These are discussed briefly below:

7.3.1 BIODIVERSITY NET GAIN

Biodiversity net gain (BNG) is an approach which aims to leave the natural environment in a measurably better state than beforehand. BNG is not within the scope of the concept design report as environmental aspects of the project are being covered separately, however, it is worth highlighting the opportunity that construction of a pipeline presents. Whilst there is limited scope for enhanced reinstatement above the pipeline itself, open cut construction creates a 20-30m wide corridor over the length of the pipe route where local flora will be disturbed. There is opportunity to reinstate this corridor with a more diverse ecology and create extended wildlife corridors.

There is also potential to increase biodiversity through the augmentation of local water courses used as pipeline drainage points. Whilst at present the intent is to only discharge to these points when draining the pipeline when it is not in use, there may be scope in the future to continually discharge to some of these locations to augment flows in dry weather.

7.3.2 ALTERNATIVE TREATMENT PROCESSES

During the development of the concept design a number of alternative treatment technologies have been identified. The technologies suggested in the concept design are robust and demonstrate a feasible solution but as the required effluent quality standards are confirmed there may be opportunity to investigate other treatment options. The testing and refinement of the treatment technologies thought a pilot plant will potentially alter the treatment process, with better performance in some rendering others unnecessary. For example, coagulation and flocculation and GAC are potentially an effective metals removal process and so may remove the requirement for the ion exchange polishing stage.

Some of the opportunities identified include:

- Alternative primary phosphorus removal chemical and dosing location
- Biological phosphorus removal (rather than chemical)
- Optimisation of the existing ASP process allowing the construction of the MBBR to be deferred
- Filtration technologies for tertiary phosphorus removal which can be turned off when not required
- Reduction is sludge volumes removing the requirement for anew sludge thickening plant

There is also an opportunity to reduce the treatment scope and therefore whole life costs and carbon impact significantly by providing a phosphorus-removal- only treatment process. The feasibility of this opportunity will be pursued during gate 3 by performing a sensitivity analysis across all aspects of the option.

7.3.3 CARBON REDUCTION OR OFFSETTING

The Gate 2 concept design was a continuation of the Gate 1 concept of ‘bolt on’ treatment process at Netheridge and pumping to the discharge point of the STT SRO. There is limited scope to reduce carbon of that concept as the requirement for a pipeline and the predetermined nature of the treatment process units do not allow for a great deal of variation. However, a limited number of carbon reduction opportunities have been identified and are listed below.

- Improve the efficiency of the existing treatment process which may negate the need to apply secondary ferrous dosing and reduce ammonia load in subsequent process
- Replace the MBBR with biological trickling filters (subject to item above)
- Consider alternative to the CoMag™ process (or work with manufacturer to reduce carbon impact)
- Utilise a wetland process for phosphorus removal (see section below)
- Utilisation of high efficiency UV systems intended for potable water use
- Utilise powdered chemicals to reduce vehicle movements for delivery
- Utilise next generation high efficiency pumps and motors
- Shutting down the treatment process when not transferring flows to STT SRO and recommissioning when required
- Install a PV array for power generation

If a lower carbon alternative is required, then there will be a need to deviate from the existing concept design to consider other design solutions. There has been ongoing dialogue between STW and EA regarding this and STW have innated some early investigation into the following alternative solutions:

- A more holistic approach to improving effluent quality by upgrading the entire WwTW to improve the water quality of the Netheridge WwTW. This could provide significant efficiency over the 'bolt on' approach and have benefit of improved effluent quality at Netheridge.
- Nature based solutions such as wetland that have low embodied and operational carbon.
- No treatment solutions that transfer river water between similar water quality zones (i.e. tidal and non-tidal) and so remove the need for any additional treatment process.

7.3.3.1 Netheridge WwTW Holistic upgrade

During the initial concept design at Gate 1 the anticipated water quality standards for discharge to the River Severn led to the conclusion that a relatively basic level of additional treatment would be adequate. As development of the environmental modelling and engagement with the EA progressed, it became apparent that a higher water quality standard, and therefore an increased level of treatment, would be required. This, combined with developing knowledge of potential increase in water quality standards for the discharge at the existing Netheridge WwTW, may mean that a 'bolt on' approach to treatment may not be the most effective or efficient approach. It is possible that upgrades or replacement to the existing treatment process units would produce a more effective and holistic solution.

7.3.3.2 Nature Based Solutions: Wetlands Technology for Phosphorus Removal

There is good evidence to suggest that constructed wetland have a good success rate in removing phosphorus. Given the availability of land adjacent to the Netheridge WwTW there maybe scope to create a wetland that could contribute to the overall treatment process whilst improving the biodiversity and creating new habitat in the area.

Wetlands are a low carbon technology that can provide phosphorus removal. Tertiary solids removal processes will still be required for low phosphorus permits, however, if after discussion with regulatory bodies the assumed phosphorus permit is relaxed, wetlands may present themselves as an attractive low carbon and more environmentally sustainable option.

7.3.3.3 No Treatment Options

The opportunity for no treatment options is discussed in Section 5 Future Scheme Development and in particular 5.1.

7.4 BENEFITS SUMMARY

Environmental

The engineering design has been informed by the emerging environmental consenting requirements being led by the environmental consultants working on this scheme and Minworth SRO, in particular the process design. The impact on the local environment has been considered for the selection of both the new WwTW site and the pipeline route. For a statement on the SROs aspirations and capability to deliver embedded value including Social Value, BNG (Biodiversity Net Gain) and ENG (Environmental Net Gain) reference the Strategic Environmental Assessment. Natural capital assessment has been undertaken in line with ACWG design principles and recommendations are included within the report. Further work to address or mitigate environmental impacts will be undertaken at Gate 3.

Carbon

The design has considered the minimisation of new works and the reducing of embodied and operational carbon. The scheme ensures the maximum efficiency of the existing treatment process and identifies opportunities to reduce treatment scope before then proposing the new treatment works. Discharging at Haw Bridge rather than Deerhurst yields significant carbon, OPEX and CAPEX benefit. Non treatment options are outlined in the alternative options addendum and consultation with the EA has already commenced gaining valuable initial feedback. For further information on Carbon refer to the Netheridge Carbon report.

Resilience/Scalability/Adaptability

Resilience and adaptability will be assessed at Gate 3.

Flood Risk & Mitigation

The pipeline is known to be within a flood zone, however at this stage no flood assessment work has been undertaken, this will be addressed at Gate 3.

Stakeholder & Third-Party Impacts

Tier 1 stakeholders have been engaged and their feedback on the Gate 1 proposals has been used to develop this Gate 2 proposal. Stakeholder engagement will continue throughout the RAPID development process. Community engagement activities are planned to be undertaken to ensure adequate community consultation is taken into account in Gate 3.

Social Impacts

The pipeline routing was developed to minimise construction within existing road networks or populated areas to minimise disruption to the local area during construction.

Aspirations to contribute to the recovery of nature are contained within the Design Vision and Principles document, by WSP. Construction of Gloucester Green Energy and Eco Park is underway to the north of Netheridge and work during Gate 3 can establish if there is any way Netheridge could contribute to this - or any other nearby developments of this nature.

Value

Both the construction and operation of the scheme will create opportunities for work for the local community. Refer to the environmental statements (primarily BNG and Natural Capital) for details of the SROs aspirations and capability to deliver additional value. Design development will take place throughout Gate 3 to identify aspects which can be tailored/designed to consider the local context, insofar as location, layout, form, scale, appearance, landscape, materials and detailing.

Appendix A

H&S RISK REGISTER

BMS: ***Project Delivery***

T447a: Significant* Residual Design H&S Risks Relating to Construction/Installation

Project No	70088464	**Project Name**	STS SRO Netheridge Optionnering

The following information relates only to the **construction** of the building/facility and/or associated **installation** work

* **NB.** Significant in the context of this schedule does not mean those that involve the greatest risks but means those, including health risks, which are:

- § unusual in the context of this project/facility; or
- § not likely to be obvious to competent contractors, operators or other designers; or
- § particularly difficult to manage effectively; or
- § critical design assumptions apply in respect of erection/installation or demolition/dismantling sequences or the temporary works requirement

Hazard/Risk	**Further Information Source(s)** *[eg. drawings, statements of critical assumptions, other key reference documents, etc]*
Construction on operational wastewater site	Work is adjacent to the Netheridge WwTW and will require connection existing WwTW systems.
Construction in a confined space	WwTW enviroenment can pose a confined space risk.
Construction near railway lines	Pipeline crosses under the railway line.
Construction near water	Pipeline crosses the East Channel or the River Severn and several small water courses
Construction near roads	Pipeline crosses under A40 and A417
Construction through contaminated land	Pipeline passes through old landfill site and site of disused railway
Construction in deep trench (service strike, water ingress, collapse, noise)	Inherent risk in large dia pipeline opne cut trench construction. Pipe depth to be minimised during detail design.

Insert additional rows as necessary

Additional Comments/Notes

Prepared By	[redacted]	**Date**	20 May 2022	*Insert digital signature or hard copy sign and scan*

Issue 3.3

BMS: ***Project Delivery***

T447b: Significant* Residual Design H&S Risks Relating to Operational Risks

Project No	70088464	**Project Name**	STS SRO Netheridge Optionnering

The following information relates only to the operation of the building/facility

* NB. Significant in the context of this schedule does not mean those that involve the greatest risks but means those, including health risks, which are:

- § unusual in the context of this project/facility; or
- § not likely to be obvious to competent contractors, operators or other designers; or
- § particularly difficult to manage effectively; or
- § critical design assumptions apply in respect of erection/installation or demolition/dismantling sequences or the temporary works requirement

Hazard/Risk	**Further Information Source(s)** *[eg. drawings, statements of critical assumptions, other key reference documents, etc]*
Use of hazardous chemcials	Inhertent risk in treatment process adopted. Safe method of work required.
Work in confined space	Inhertent risk in treatment process adopted. Safe method of work required.

Insert additional rows as necessary

Additional Comments/Notes

Prepared By	[redacted]	**Date**	20 May 2022	*Insert digital signature or hard copy sign and scan*

Issue 3.3+B2A1:F33

Appendix B

ACWG DESIGN PRINCIPLES

	Principle	Target	G2 Indicator	Supporting comments
Climate	Nature knows no boundaries: Water is essential to all life and managing our response to climate change is a collective and urgent activity. Projects must be developed to work across companies and/or legislative boundaries to develop sustainable solutions and environmental enhancement for the wider benefit of society.	1.1. Collaborative working across companies and with stakeholders.	1. Evidence of collaborative working across companies.	The engineering design has been informed by the emerging environmental consenting requirements being led by the environmental consultants working on this scheme and Minworth SRO. In particular the process design has been informed from consultations with the permitting authority, the Environment Agency. The design vision and principles have been informed by this engagement.
		1.2. Timely - preparation of proposals ready to construct in 2025-2030 will involve early and rigorous development of design objectives followed by proposals.	2. Evidence of working with Regulatory, Statutory (and, where practicable, local) stakeholders including Catchment Partnerships where appropriate.	
		1.3. Alignment with other relevant environmental policy, plans and strategies such as Catchment Management and Local Nature Recovery Plans (see also Place 2).	3. Design Vision and Principles informed by this engagement (Stages 1-6 of design process).	
Climate	Resource and carbon efficient throughout: Projects shall seek to reuse existing assets, eliminate waste (including waste of water) and make efficient use of materials and transport across the whole of the project lifecycle.	2.1. Lifecycle Carbon: Projects shall support the water industry commitment to achieve Net-Zero in terms of operational carbon in accordance with the industry roadmap. Projects must be efficient in embodied carbon in both construction and operation.	1. Submissions to meet expectations of RAPID Gate 2 Guidance.	The design has considered the minimisation of new works and reducing carbon. The scheme ensures the maximum efficiency of the existing treatment process (e.g. ferrous dosing into the existing ASPs as part of the P removal process and seeks to use diurnal flow to achieve 35Ml/d output rather than construction of buffer storage) before then proposing the new treatment works. Discharging at Haw Bridge rather than Deerhurst yields significant carbon, OPEX and CAPEX benefit. Non treatment options are outlined in the alternative options addendum and consultation with the EA has already commenced gaining valuable initial feedback
		2.2. Projects should investigate if existing infrastructure assets could be repurposed and reused.	2. Narrative on the SRO approach to avoiding and reducing he use of carbon and other resources and Inclusion of the approach in the Design Vision and Principles.	
		2.3. Projects should look to avoid unnecessary construction and minimise use of materials		
		2.4. Projects should seek to minimise the use and waste of water		
Climate	Resilient and adaptable: Design for anticipated future demand at the appropriate scale. Build in the resilience to absorb and recover from the impacts of the extreme events and incremental stresses likely to arise from climate change.	3.1. Designs should be developed to include proportionate measures to anticipate future extreme events and stresses so that they can resist, absorb, recover and, where necessary, be adapted	1. Submissions to meet expectations of RAPID Gate 2 Guidance noting the climate change scenario(s) the schemes have been designed to cope with.	There is a risk that this concept design marginally fails to meet the requirements of up to 35 Ml/d flow identified. Further work in G3 required to assess this risk. The team have identified a potential future growth scheme in AMP8 and a bioresources scheme planned in AMP7. Ongoing coordination/collaboration with these project teams will ensure most efficient use of land and future proofing requirements The carbon impacts of the Scheme have been identified in the WSP Concept Design Report: Carbon. Mitigation opportunities are outlined in Section 4 of the Netheridge Carbon Report, which includes alternative (no treatment) options.
		3.2. Designs shall support the digitisation of the network at a catchment level using data to inform design, optimise solutions and improve operational efficiency in real time.	2. Review of local plans and strategies that may impact resilience. (G2 or G3 depending on scheme maturity)	
		3.3. Where proposals add to the resilience of the broader system this should be accounted for in its social value (see Value 3).		
		3.4. The layout and design of specific elements of infrastructure should be taken in cognisance of planned future development of the immediate area.		

	Principle	Target	G2 Indicator	Supporting comments
		3.5. Deploy nature-based approaches to resilience wherever poss ble (see also Place 2).		
People	Understand and respond to your Community's needs: Develop a full understanding of the social context that will be impacted by the project over its lifecycle. Design for how local communities will encounter the infrastructure in their everyday lives during both construction and operation.	1.1. Reliable supply of water to customers	1. Indicator for Target 1.1 to be decided by others	The concept design has been developed with resilience in mind with minimal single points of failure and the source of the water is the final effluent stream at Netheridge.
		1.2. Designs developed to maximise their social value.	2. Initial appraisal of the scheme and its potential to contribute to the UN's Sustainable Development Goals - or other Social Value evaluation process (see also Value 2 and 3).	
		1.3. Proposals reflect local community views as to how they interact with and experience the infrastructure as far as possible	3. Review of relevant regional/local policy and demographic information and narrative around how it has shaped the draft Vision and Principles for the option	
People	Engage widely, early and meaningfully: Work with stakeholders and local communities to develop their understanding of the importance of nature and water conservation. Develop co-design approaches to aspects of the design of infrastructure and associated landscape where practicable.	2.1. Stakeholders and communities understand the need for the scheme and the nature/appearance of the proposed solution(s).	1. Summary of feedback from stakeholders (either project specific or received to date through the WRMP/Regional Plan process) and narrative around how it has shaped the draft Vision and Principles for the option.	The feedback from Gate 1 has been used to develop this Gate 2 proposal. Our first tier engagement has focused on updating Environment Agency, Natural England and Historic England on the proposed scheme. We are now moving to tier two stakeholders to increase their understanding of the potential benefits of the SRO. We are working closely with Water Resources West and are also aware of interest from WCWR in potential to use Netheridge water in the regional planning process. We continue to have representation at the ACWG and River Severn Partnership. Engagement activities will be included within the design programme of the project plan for Gate 3 and beyond showing adequate time for community (public) consultation to inform both site selection (where possible) and developed design. The engagement activities will be supported by the development of tools that will enable successful engagement (e.g. digital models for visualisation/animation, GIS systems, precedent pictures of similar schemes/components.
		2.2. The views of local stakeholders have shaped the design, where possible.	2. Inclusion of engagement activities within the design programme of the project plan for Gate 3 and beyond showing adequate time for community (public) consultation to inform both site selection (where possible) and developed design.	
		2.3. Engagement and consultation with communities has influenced the design (including but not limited to site selection, layout, materials, detailing) making it more acceptable to them.	3. The development of tools that will enable successful engagement (e.g. digital models for visualisation/animation, GIS systems, precedent pictures of similar schemes/components) - activity may occur at G2 or G3.	
		2.4. The project provides the public with information on the importance of water and/or nature conservation (e.g. through information boards, artwork or digital information)).	4. Survey information on local needs and preferences in design	
People	Improve access and inclusion: Consider how people move around your works. Maximise opportunities to support active travel and improve recreational access to waterside and green spaces that can improve outcomes for wellbeing, health, local	3.1. Find opportunities to improve people's health, wel being and understanding of the natural environment, through access to waterside and green spaces for recreational and other purposes (see Note 1).	1. Mapping of interface with PRoW network*	The transfer pipeline routes were developed around the following principles: The route was chosen to:– Achieve the shortest and most direct route between the Netheridge WwTW and the proposed discharge point. –Minimise construction within the existing road networks to minimise disruption to the local area, maximise construction productivity and reduce construction financial and carbon costs. –Avoid areas of population (towns and villages, farms
		3.2. Maximise opportunities for workers to access sites via sustainable transport during construction and operation. Minimise disruption to travel routes in	2. Evidence of engagement with local access groups*	

	Principle	Target	G2 Indicator	Supporting comments
	economy, social inclusion and education	areas affected by a project during construction and operation.		and private gardens), where possible. –Avoid areas of woodland, ponds and other environmentally sensitive areas where possible. –Minimise the maximum elevation of the pipeline to reduce static pumping head requirements. –Minimise the total amount of rise and fall on the pipeline as much as possible. –Consider the crossing points for major infrastructure and ensure that there is sufficient space available for the construction of the crossing
		n/a	3. Review of Local Cycling and Wa king and Infrastructure Plans (LCWIPs) information or similar and note of how the project may impact/enhance it.*	
Place	Take care: Develop proposals in the spirit of stewardship looking to both the past and future of each context to understand and develop its landscape, cultural heritage, health and sustainability. Work with partners to secure the long-term success of all measures.	1.1. Achieve Environmental Net Gain (ENG)	2. Statement on SRO approach to achieving Environmental Net Gain within the Design Vision and Principles.	The pipeline routing options was carried out to minimise the impact on Place and an impacted footpath adjacent to the WTW will be reinstated to maintain the connectivity. Biodiversity Net Gain and Natural Capital Assessments have been undertaken to assess the impact of the scheme on Environmental Net Gain. Opportunities have been identified within the BNG and NCA assessments for activities that can take place to work toward overall net gain - although these will need developing further during Gate 3. Refer to environmental statements on the SRO approach to achieving Environmental Net Gain within the Design Vision and Principles.
		1.2. Adopt measures in the design that enhance the environment and help avoid future problems - e.g. adoption of SuDS solutions that improve cooling, attenuate surface water run-off and improve infiltration and biodiversity.	1. Evidence of place-based balanced, holistic and long-term decision making in the description of design considerations and development of design vision and principles.	
		1.3. Have clear and realistic long-term strategies for how operational and mitigation proposals will be managed and maintained. Develop partnerships with local communities where this has a mutual benefit.	3. Evidence of review of adopted (or emerging) spatial plans, strategies for the areas impacted by your works (May occur at G2 or G3 depending on scheme maturity).	
		1.4. Develop proposals in light of a clear understanding of the area's landscape and history.	4. Landscape/townscape character assessments and approach to design specific to context. (May occur at G2 or G3 depending on scheme maturity).	
Place	Protect and promote the recovery of nature: Focus on the role of landscape, its capacity to accommodate infrastructure and shape places. Work collaboratively and employ holistic, landscape-scale approaches that support and deliver biodiversity net gain as well as multiple other benefits.	2.1. Achieve at least 10% Biodiversity Net Gain(BNG)	1. Statements on your approach to achieving BNG and aspirations to contribute to the recovery of nature within Design Vision and Principles. May include specific reference to local Green-Blue Infrastructure Strategies/ (emerging) Local Nature Recovery Plans, catchment management plans and other measures to improve watercourse quality.	Scheme is currently showing a BNG loss, however the BNG assessment has identified the requirements to achieve a 10% net gain which STW will be required to fulfil. This includes identification of local sites where enhancements can be made. Nature-based approaches to mitigation are outlined in the BNG Report as well as the Natural Capital Assessment. Aspirations to contribute to the recovery of nature are contained within the Design Vision and Principles document, by WSP. Construction of Gloucester Green Energy and Eco Park is underway to the north of Netheridge and work during Gate 3 can establish if there
		2.2. Deploy nature-based approaches to integration and mitigation as the first-choice solution where poss ble.		
		2.3. When looking at options to provide compensation or enhancement prioritise measures that support achieving good ecological condition for affected watercourses and bodies as a whole. When making an intervention, mitigate infrequent impacts by developing proposals that keep them local and short lived.		

	Principle	Target	G2 Indicator	Supporting comments
		2.4. Work with landowners and land managers to develop mutually beneficial solutions where practicable.		is any way Netheridge could contribute to this - or any other nearby developments of this nature.
Place	Design all features beautifully, with honesty and creativity: Our utility infrastructure can be a source of pride and a positive contribution to its context. Develop proposals that reveal and celebrate its importance, provide visual delight and leave a positive legacy.	3.1. Develop a utilities architecture that speaks to its purpose and enhances its context. This applies to buildings, structures and landscape.	1. Set out with opportunities and aspirations for high quality design within Design Vision and Principles.	Design development will take place throughout Gate 3 to identify aspects which can be tailored/designed to consider the local context, insofar as location, layout, form, scale, appearance, landscape, materials and detailing. The purpose of Gate 2 was to develop feasibility of the SRO further and as such, this step is considered too early for delivery at Gate 2.
		3.2. Develop designs and, where appropriate, artworks that bring narrative (meaning), beauty and interest to the proposals.	2. Development of a project plan stating how these aspirations will be developed/achieved.	
		3.3. Consideration of context in every aspect of design including its location, layout, form, scale, appearance, landscape, materials and detailing.	3. Favourable independent design review outcomes.	
Value	Maximise embedded value: Work collaboratively across specialisms and with stakeholders to maximise the benefits of the scheme by being smart with the location and arrangement of elements and design of mitigation within the project scope and budget.	1.1. Early multidisciplinary input informing a design that solves multiple problems at once.	1. Evidence of multi-disciplinary input into site selection, this may include architects, ecologists, artists, planning professions etc.	The impact on the local environment has been considered for the selection of both the AWTP site and the pipeline route which were developed by a multi-disciplinary team. For a statement on the SROs aspirations and capability to deliver embedded value including Social Value, BNG and ENG reference the environmental statements. Natural capital assessment has been undertaken in line with ACWG design principles and recommendations included within this report. Need reference to these statements
		1.2. Design of infrastructure capable of adaptation to reasonable future demands (see also Climate 3).	2. Initial project and, where appropriate, site appraisals (including constraints and opportunities) undertaken by a multi-disciplinary team (steps 1-5 in design development process).	
		1.3. Site selection processes and layouts that assist (or as a minimum, do not prevent) local development except where absolutely necessary.	3. A statement within the Design Vision on the SRO's aspirations and capability to deliver embedded value which should include Social Value, BNG and ENG.	
		1.4. Reinstatement, landscape and mitigation proposals that improve the existing situation, - e.g. through better biodiversity, carbon sequestration, surface water infiltration and reduced run-off.		
		1.5. Deliver benefits efficiently by exploiting the two-way relationship between infrastructure and natural capital to enable multiple benefits to be delivered simultaneously.		
Value	Understand how you could provide additional value: Identify opportunities to contribute wider regional benefits outside of the project scope. In particular look for synergies with	2.1. Strategic project selection is informed by cross-sectoral engagement to maximise social benefit and reduce the use of customers money (this may be engagement with other utilities that may be able to share pipeline trenches or land for renewables).	1. A description of potential opportunities to work with other projects/partners to achieve wider benefits.	Both the construction and operation of the scheme will create opportunities for work for the local community – for example as construction workers or plant operators / maintainers. Refer to the environmental statements (primarily BNG and Natural Capital) for details of the SROs aspirations and capability to deliver additional value.

	Principle	Target	G2 Indicator	Supporting comments
	relevant catchment management plans and proposals that support the delivery and enjoyment of a healthy water environment.	2.2. Work closely with partners and focus on landscape scale schemes that improve hydrology, aquatic ecology and reduce/sequester carbon and provide opportunities for access to recreation and visual delight.	2. A statement within the Design Vision on the SRO's aspirations and capability to deliver additional value.	
		2.3. Be honest and realistic with partners as to what you might be able to offer as an organisation.		
Value	Capture and measure embedded and additional value: Have clear narratives about how you are contributing to society beyond the core scope of your project. Quantify these benefits so they can be considered meaningfully in conversations on value, financing and risk. Share your experience and knowledge widely.	3.1. Gathering of project specific data and improvement in the tools we have to measure, and monitor added and additional value across the sector.	1. Details of the best-value metrics used in determination of the Regional Plans and WRMPs and a clear narrative on how these have influenced option selection so far.	Refer to the environmental statements (Strategic Environmental Assessment) for the best-value metrics used in determination of the Regional Plans and WRMPs and a clear narrative on how these have influenced option selection so far.
		3.2. Full consideration of potential benefits in the Cost Benefit analysis and investment case for the SRO.	2. Inclusion of a description within the project plan of how these will be developed and monitored at subsequent gates.	
		3.3. Clear communication of value of the scheme to stakeholders, communities and within the industry	3. Initial narrative (description) of the value of the scheme in plain English.	

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