ANNEX A1

Engineering CDR

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 and Affinity 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 and Affinity 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.

Minworth SRO

Severn Trent Water & Affinity Water

Concept Design Report

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Severn Trent Water
A7W13155

Minworth SRO
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Concept Design Report

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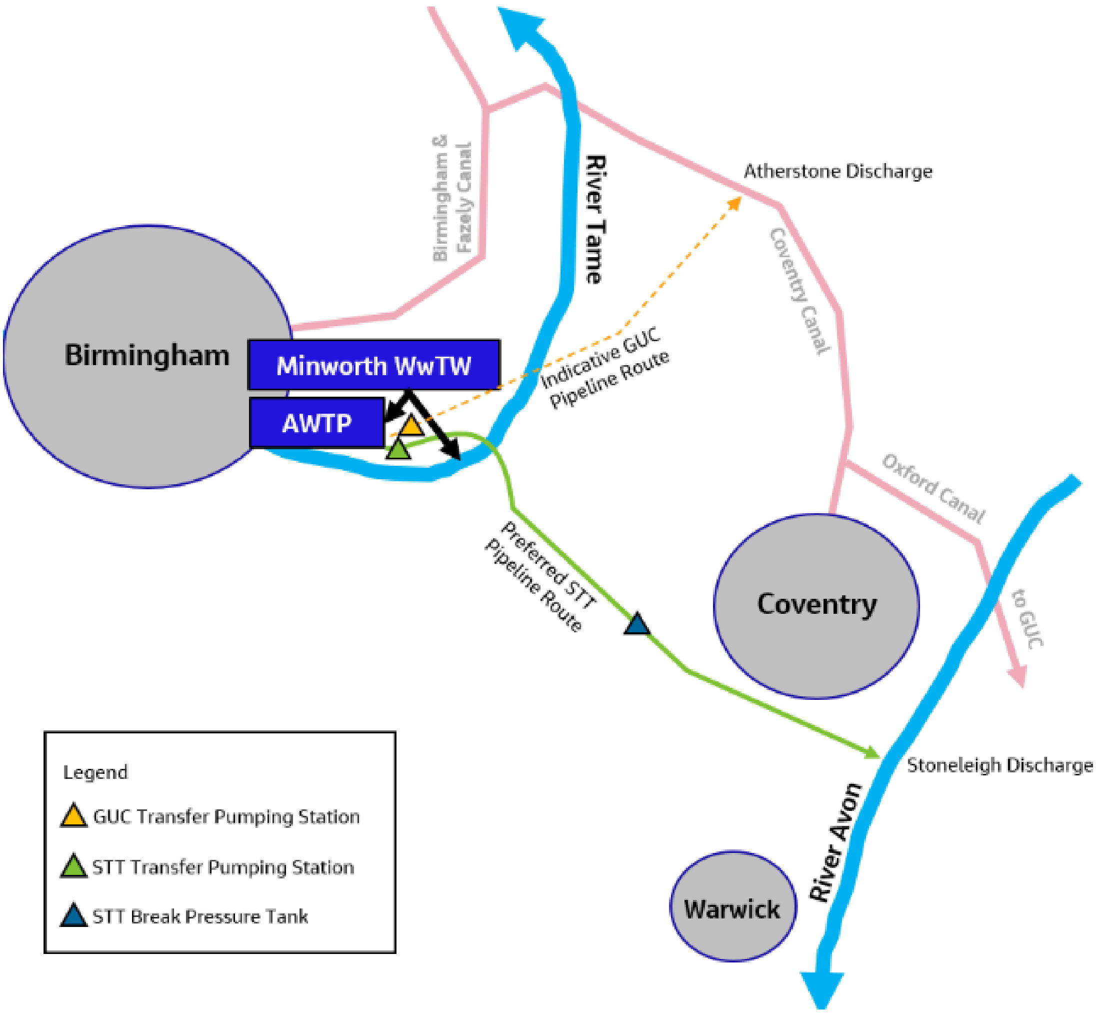
Executive Summary

Minworth Strategic Resource Option (SRO) is included as an SRO in the Price Review 19 Final Determination as a source option for the Severn to Thames Transfer (STT) SRO and Grand Union Canal (GUC) SRO. The project is now advancing through the Regulators' Alliance for Progressing Infrastructure Development (RAPID) gated process and is proceeding to Gate 2.

This concept design report details the concept design of the engineering elements of the scheme including the treatment works (which serves both STT and GUC) and the pumping station, rising main, break pressure tank, gravity pipeline and outfall (which only serve STT). Details of GUC pipeline can be found in GUC Annex A1 Engineering CDR.

Figure S-1: Scheme Overview



As shown in Figure S-1 above, the scheme consists of a combined Advanced Water Treatment Plant (AWTP) which outputs treated effluent to the STT and GUC schemes, each of which have their own transfer pipeline routes. The concept design for the STT route and its components is included in this report, whereas the GUC transfer components, including the route, are designed by the GUC SRO project team.

GUC and STT pipelines transfer water to different receptors and are likely to be constructed at different timescales. If both STT and GUC schemes move forward to Gate 3, there may be an opportunity for the construction of the initial sections of the two pipelines to be combined.

During Gate2, the routes developed during Gate 1 and WRMP19 were included in a route appraisal exercise to allow comparison with three alternative options developed during Gate 2. One preferred route was then selected following an evaluation of the six Gate 1 and 2 options. For further details of the route appraisal please refer to Minworth Annex A2 Pipeline Route Appraisal.

Figure S-2: Advanced Water Treatment Plant (AWTP) schematic

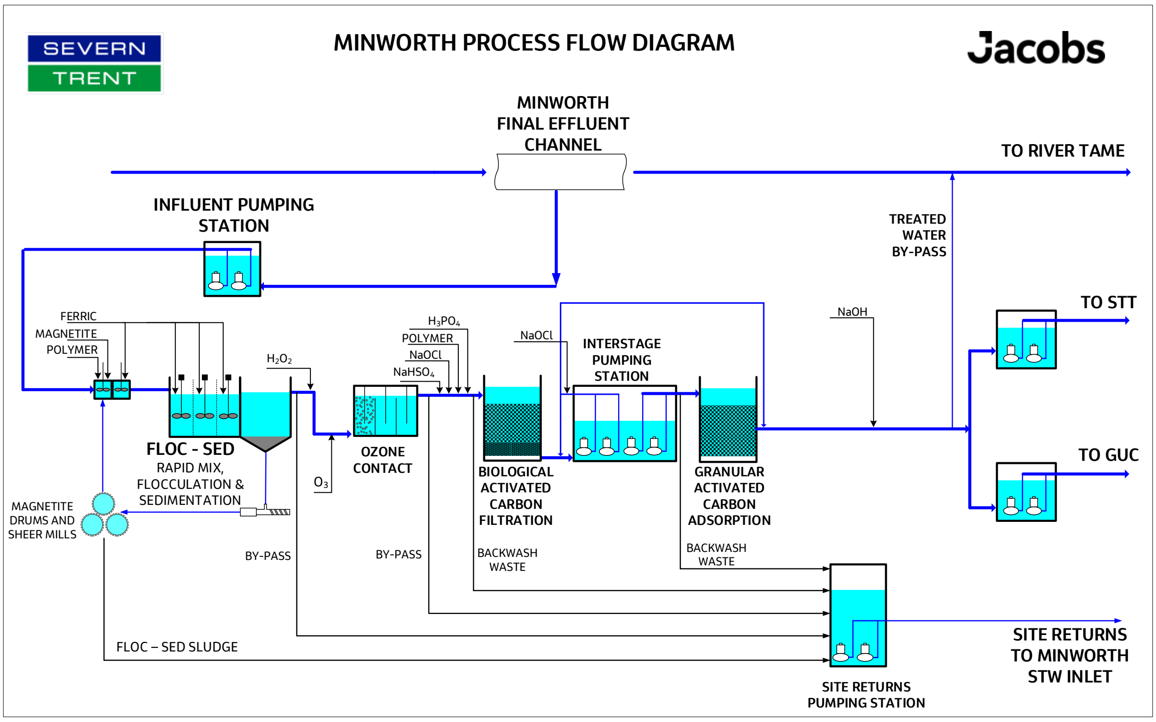


Figure S-3 Minworth Advanced Water Treatment Works Process Flow Diagram

Figure S-3 details the overview of the treatment process for all flow options (57Mld to 230Mld). The treated effluent will be abstracted from the outfall channel of the Minworth WwTW and diverted into the AWTP, with the backwash being returned to the inlet of the WwTW and the ability to divert treated effluent back to the final effluent channel/ River Tame via a by-pass pipe, before being transferred to the respective SRO schemes via their respective pumping stations.

There is an alternative treatment scheme for 2 of the flow options which, due to significantly reduced environmental permit discharge conditions, results in a significantly reduced treatment process requirement. The schematic for the alternative treatment scheme is shown in Figure S4.

Figure S-4: Advanced Water Treatment Plant (AWTP) schematic - Alternative

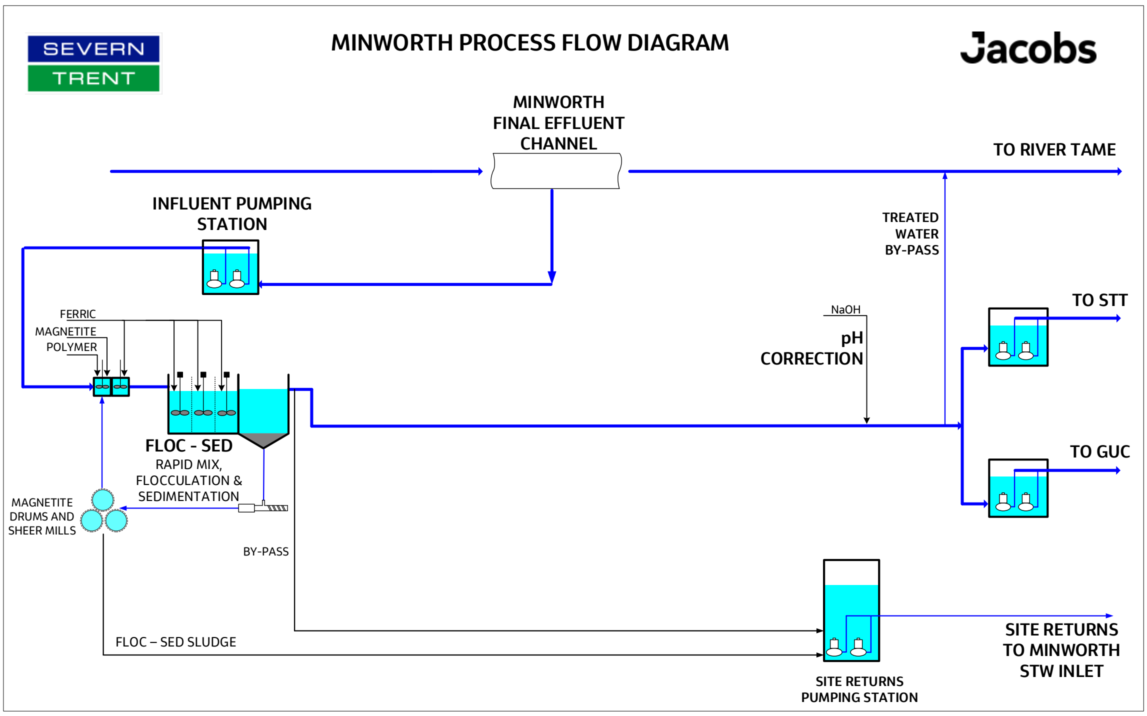


Table S-1: Treated Flow Options

Option	Diverted flow (Mld)	Returned as Backwash (Mld)	Transferred Flow (Mld)
TREAT57	62	5	57 to STT 57 to GUC
TREAT57.ALT	57.9	0.9	57 to STT
TREAT115	123	8	115 to STT 115 to GUC 57 to STT and 57 to GUC
TREAT115.ALT	116.8	1.8	115 to STT
TREAT172	184	12	115 to STT and 57 to GUC 115 to GUC and 57 to STT
TREAT230	246	16	115 to STT and 115 to GUC

The treatment works site, and the associated plant and components were designed to 4 flow options, corresponding to different flow outputs to the GUC and STT schemes, as detailed in Table S-1 above. The diverted flow is higher than the transferred flow because it includes an amount of flow returned to the works as backwash. Suffixes of GUC and STT are used to show the intended transfer receptor for each treatment option. Whilst this has no effect on the CAPEX, differing operational regimes between GUC and STT mean the OPEX/carbon/ AIC are different depending on the transfer requirement.

Table S-2: Pipeline Options

Option	Transferred Flow (Mld)
STT57	57 to STT*
STT115	115 to STT

*Although only 57Mld is transferred, this pipeline has the capacity to transfer 115Mld.

The flow solutions are a combination of the pipeline and treatment options:

Table S-3: Solutions

Flow Solution	Transferred Flow (Mld)
TREAT57 & GUC57	GUC Transfer 57Mld*
TREAT115 & GUC115	GUC Transfer 115Mld*
STT57 & TREAT57	STT Transfer 57Mld
STT57 & TREAT57.ALT	STT Transfer 57Mld
STT115 & TREAT115	STT Transfer 115Mld
STT115 & TREAT115.ALT	STT Transfer 115Mld
STT57 & TREAT115	STT Transfer 57Mld & GUC Transfer 57Mld*
STT115 & TREAT172	STT Transfer 115Mld & GUC Transfer 57Mld*
STT57 & TREAT172	STT Transfer 57Mld & GUC Transfer 115Mld*
STT115 & TREAT230	STT Transfer 115Mld & GUC Transfer 115Mld*

*Requires construction of pipeline from Minworth to GUC SRO.

Contents

Appendices

Tables

Figures

1 Introduction

This concept design report details the concept design of the engineering elements of the scheme including the treatment works (which serves both STT and GUC) and the pumping station, rising main, break tank, gravity pipeline and outfall (which only serve STT).

This concept design report covers the treatment and transfer of water to STT but does not cover the pumping station and transfer pipeline required to transfer the treated water to GUC which is covered in GUC Annex A1 Engineering CDR.

1.1 Background

Water resources are coming under increasing pressure from population growth, economic development, and climate change. Other increasing water resources pressures are the significant environmental challenges. These include the regulatory constraints such as WFD No Deterioration and Environmental Destination. New national water supply resources are urgently needed to avoid water restrictions in the near future, particularly in the Southeast of England. Water companies are working together to develop Strategic Resource Options (SROs) to meet this need.

To support the progression of strategic water resource options, the Regulators' Alliance for Progressing Infrastructure Development (RAPID) has been established to help accelerate the development of new water infrastructure. RAPID is working with the water companies to promote the development of national water resources infrastructure that is in the best interests of water users and the environment. RAPID is comprised of representatives from Ofwat, the Environment Agency and the Drinking Water Inspectorate.

A gated process for SROs has been designed by RAPID to ensure funding to develop the schemes are spent on time and to high quality standards. Water companies exploring agreed strategic solutions need to submit deliverables at each gate to demonstrate their progress. This is in addition to any planning consents. The process is intended to support water companies in progressing the investigation and development of solutions more quickly to the 'construction ready' state and considering the carbon ambition target in its components which set Net-Zero emissions from Scope 1 and 2 by 2030; and Scope 3 by 2050.

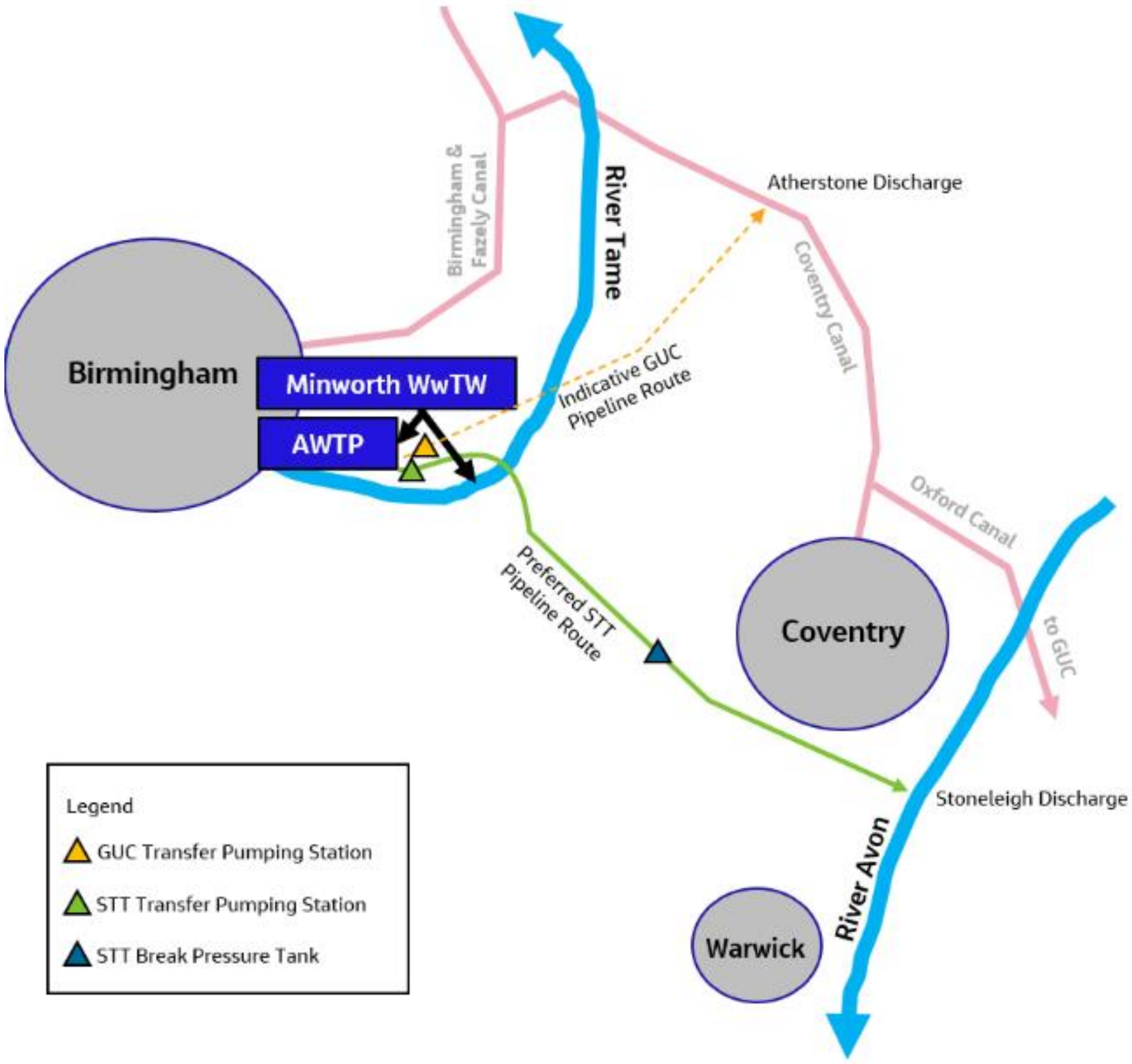
Minworth Strategic Resource Option (SRO) was included as an SRO in the Price Review 19 Final Determination as a source option for the Severn to Thames Transfer (STT) SRO being developing by Severn Trent Water (STW) and Grand Union Canal (GUC) SRO being developed by Affinity Water.

1.2 Scheme Overview and Location

1.2.1 Project Details

Minworth SRO will provide water to the Severn to Thames Transfer (STT) SRO by diverting some of the Minworth WwTW final effluent to the River Avon which is a tributary of the River Severn as well as to the Grand Union Canal (GUC) via the Coventry Canal. Minworth WwTW is located to the East of Birmingham near Sutton Coldfield. The WwTW treats wastewater from an equivalent population of 2.5 million people. Additional treatment at Minworth WwTW – the Advanced Water Treatment Plant (AWTP) will be provided to ensure water quality is appropriate for discharge to the River Avon and the Coventry Canal allowing water to be diverted from the final effluent flow at Minworth and transferred to a combination of the River Avon and Coventry Canal.

Figure 1-1: Scheme Overview



1.2.2 Programme

The scheme has passed RAPID's Gate 1, with the project team now focused on developing concept designs.

The scheme will be submitted to RAPID for Gate 2 review on 14th November 2022 with a draft decision from RAPID on whether the scheme can commence to Gate 3 in March 2023.

Should the scheme be taken forward to construction, Minworth WwTW upgrade and pipeline will be construction ready in AMP8 (2025 to 2030). The project could be ready to provide water for the Severn to Thames Transfer (STT) by 2032 and for the Grand Union Canal transfer by 2031. For further detail refer to section 3.6.

1.3 Next Steps & Gate 1 Development

1.3.1 Next Steps

Decisions about whether a solution goes ahead will be made by the RAPID gated process and confirmation of need through the intra-regional and inter-regional water resources planning process.

Following Gate 2, the proposals will be developed by commencing a programme of pre-planning activities, including comprehensive community and stakeholder engagement, and developing the mitigations for the potential environmental impacts of each scheme.

Working collaboratively with our SRO partners, we will undertake further data collection to support detailed modelling and engineering feasibility work. These further investigations will allow us to identify the optimum option configuration to meet the need of the two transfer SROs.

1.3.2 Gate 1 Development

At Gate 1 the treatment process was developed to allow Minworth to meet a 0.2mg/l total phosphorus target.

For the GUC at Gate 1, the removal of trace determinants was not considered due to the lack of sampling data of the Canal. The recommendation was for this to be progressed at Gate 2. Furthermore, there was a design inconsistency at Gate 1 whereupon a BioMag treatment process was designed instead of CoMag. This meant the Gate 1 cost underestimated the overall treatment CAPEX as the BioMag process does not include the following process units which are critical to the operation of a CoMag plant; CoMag Flocculation Tanks, CoMag Clarification Tanks, CoMag Specific Ferric Dosing and Storage.

The Gate 1 GUC design does not account for the need to remove trace chemicals as this aspect was to be addressed once sampling data had become available.

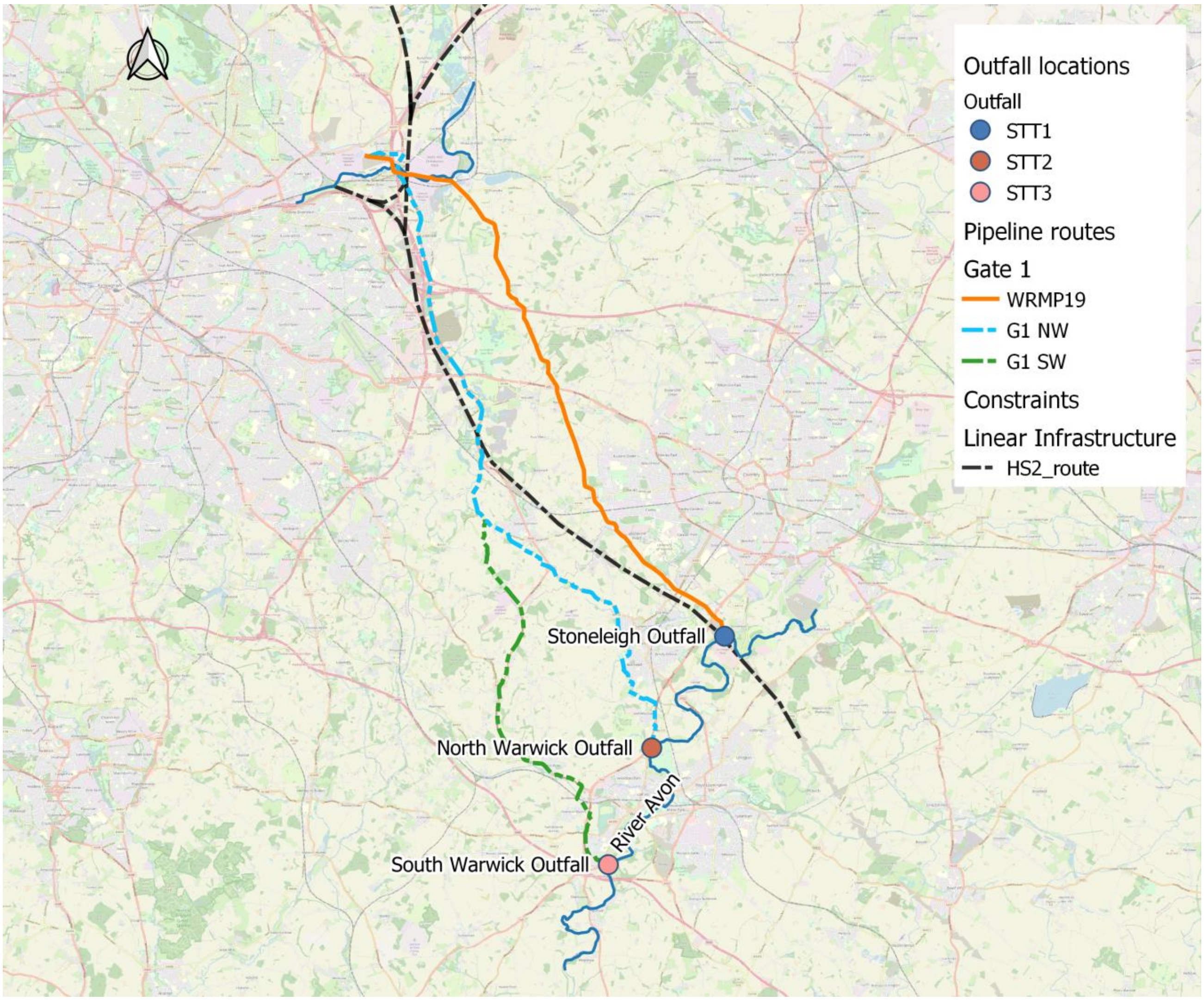
The Gate 1 solution for the River Avon gave the following treatment solution: CoMag, UV Disinfection and GAC Adsorption. As described above the BioMag process was costed instead of CoMag. The UV disinfection at Gate 1 was proposed to prevent biofouling in the GAC and the GAC process was added to address trace organics. This proposed treatment train presents 4 challenges in terms of workability;

- BioMag cannot be implemented at Minworth without making significant design changes to the existing Activated Sludge Plant to prevent the magnetite settling in the ASP basins and Return Activated Sludge lines.
- The absence of ozonation means the plant does not have the capability of breaking down recalcitrant trace organics especially pesticides and herbicides.
- UV cannot be applied to minimise biofouling in the GAC filtration as this is driven by the overall biological load being presented to the GAC.
- Without upstream Ozone and Biological Treatment ahead of the GAC, the media's adsorption capacity will not be targeted at micro-pollutant removal but may largely be applied in biological treatment and adsorption of the total organic carbon (TOC). The media will likely require frequent and unsustainable regeneration to meet target trace chemical removal requirements.

At Gate 1 two pipeline routes were developed, one to the North of Warwick and one to the South of Warwick, which also discharged to the GUC. In addition to these, a further route was developed during WRMP19, to a discharge location downstream of the confluence of River Avon and River Sowe. See Figure 1-2 below. The Gate 2 solution will offer lower embodied carbon than Gate 1. The routes developed during Gate 1 were reviewed and updated at Gate 2. Gate 1 routes are complicated areas due to extending the pipeline within the urban highway. The reviewed version of those routes included in Gate 2 avoids going through urban or rural highways and instead targets open fields where construction will be less challenging and more efficient.

GUC and STT pipelines transfer water to different receptors and are likely to be constructed at different timescales. If both STT and GU schemes move forward to Gate 3, there may be an opportunity for the construction of the initial sections of the two pipelines to be combined.

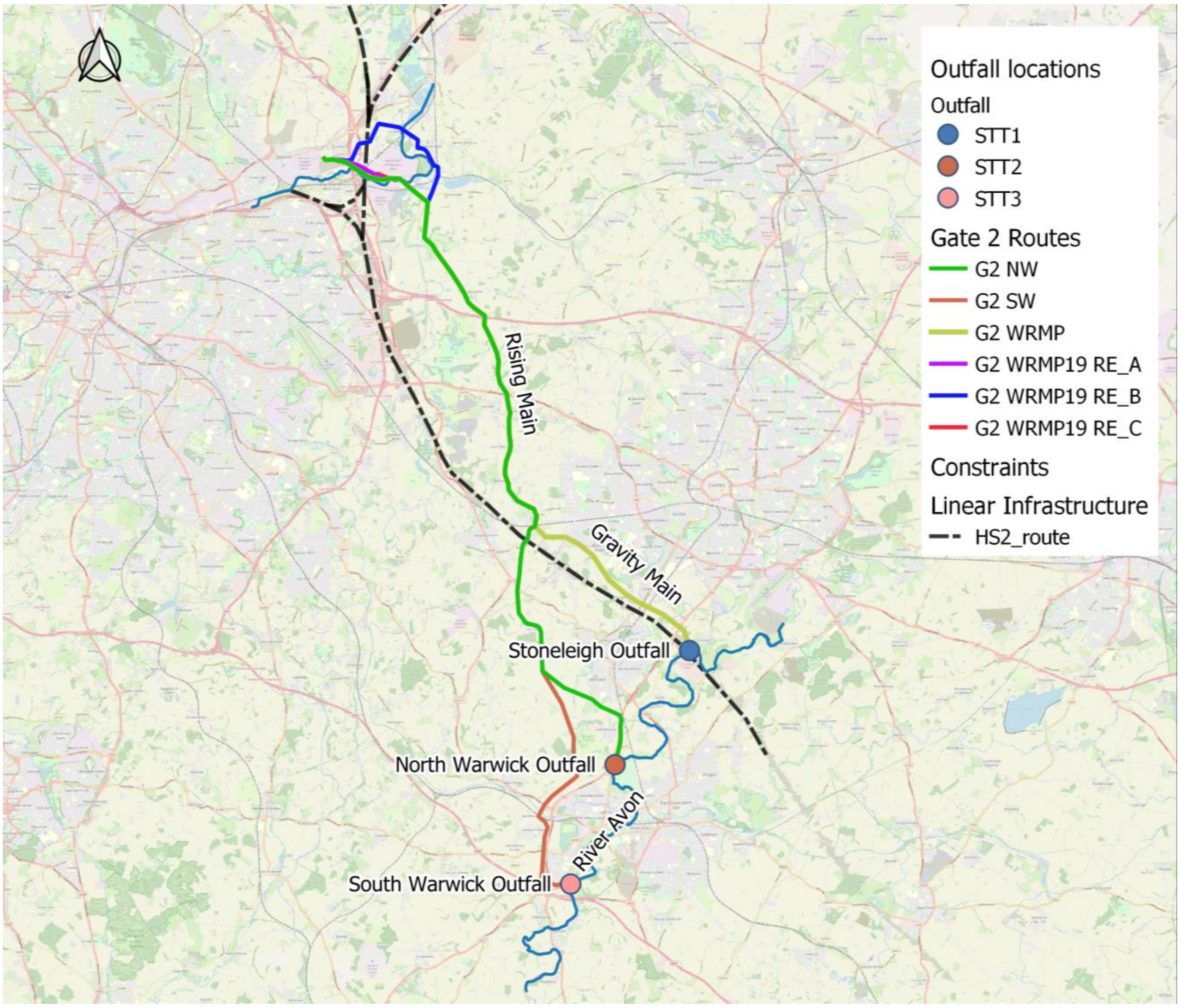
Figure 1-2: Gate 1 and WRMP19 Route Overview



During Gate2, the routes developed during Gate 1 and WRMP19 were included in a route appraisal exercise to allow comparison with three alternative options developed during Gate 2. One preferred route was then selected following an evaluation of the six Gate 1 and 2 options. The preferred route is shown in Figure 1-3 below. For further details of the route appraisal please refer to Minworth Annex A2 Pipeline Route Appraisal. The treatment processes have changed from Gate 1 to Gate 2, additional treatment stages were added to reach the required water quality.

For the pipeline, additional items were added to the cost such as the transfer pumping station (including equipment and civils), and the flow control valves, and the outfall structure, as well as more detailed costs considered for the crossings including pipejacking which was not part of the costs for Gate 1.

Figure 1-3: Gate 2 routes - Note that the preferred route is G2 WRMP19 RE_ B discharging at Stoneleigh outfall



1.4 Sizing and Phasing

This section provides an overview of the sizing and phasing for the concept design of Minworth SRO and considers key option constraints. The sizing and phasing of these options aligns with the options that go into the WRSE modelling.

1.4.1 Advanced Water Treatment Plant (AWTP) Options

The AWTP treats water to supply both STT via the River Avon and GUC via the Coventry Canal. Additional treatment is required because of the more stringent requirements identified for discharges into the GUC and STT systems.

Table 1-1 outlines the four flow options that have been considered that cover the required flows for each/both SROs as well as the two alternative treatment schemes that have been considered due to potential variations in the required environmental permit. Refer to Annex A3(ii) Process Options Report for further details.

Table 1-1: Treated Flow options

Option	Diverted flow (Mld)	Returned as Backwash (Mld)	Transferred Flow (Mld)	Flow transfer options (Mld)
TREAT57	62	5	57	▪ 57 to STT ▪ 57 to GUC
TREAT57.ALT	57.9	0.9	57	▪ 57 to STT
TREAT115	123	8	115	▪ 115 to STT ▪ 115 to GUC ▪ 57 to STT and 57 to GUC
TREAT115.ALT	116.8	1.8	115	▪ 115 to STT
TREAT172	184	12	172	▪ 115 to STT and 57 to GUC ▪ 115 to GUC and 57 to STT
TREAT230	246	16	230	▪ 115 to STT and 115 to GUC

Minworth is permitted to a 20 percentile flow Q80 (also known as the dry weather flow (DWF)) of 450Mld. The Minworth effluent measured Q80 between 2018 and 2021 was 417Mld while the average flow during the same period was 533Mld.

Between 2018 and 2020 the River Tame upstream of Minworth averaged 421Mld and with a Q80 flow of 180Mld.

With the River Tame 20 percentile flow (Q80) averaging 180Mld upstream of the site and Minworth current Q80 measuring 417Mld in the same period, effluent from Minworth currently makes up approximately 70% of the total Q80 flow downstream in the river.

The four flow options for Minworth SRO, as identified in Table 1-1: Treated Flow options above, are as high as 230 Mld, which is approximately 55% of the current measured Minworth Q80. From a flow capacity perspective, this therefore implies that there is likely to be sufficient volumes for transfer throughout the year. This will be subject to demonstrating no adverse environmental or navigational impacts on the River Tame, Trent or Humber.

Note that the diverted flow is higher than the transferred flow because it includes an amount of flow returned to the works as backwash.

1.4.2 Pipeline Options

The scope of this concept design includes the pumping station and transfer pipeline to STT only. The treatment could be built in two phases of 57 Mld, however the STT transfer pipeline will only be constructed in one phase. STT57 is a pipeline that is the same size as STT115 but only transfers 57Mld and included for the purposes of calculating alternative OPEX/Carbon/AIC figures.

Table 1-2: Pipeline options

Option	Transferred Flow (Mld)
STT57	57 to STT*
STT115	115 to STT

This concept design does not include a description of the pumping station and pipeline that would supply the GUC system – this is being developed by others.

*Although only 57Mld is transferred, this pipeline has the capacity to transfer 115Mld.

1.4.3 Combined Solutions

By combining elements above of the AWTP and pipeline, the following solutions combinations are achieved.

Table 1-3: Combined Solutions

Flow Solution	Transferred Flow (Mld)
TREAT57	GUC Transfer 57Mld
TREAT115	GUC Transfer 115Mld
STT57 & TREAT57 or TREAT57.ALT	STT Transfer 57Mld
STT115 & TREAT115 or TREAT115.ALT	STT Transfer 115Mld
STT57 & TREAT115	STT Transfer 57Mld & GUC Transfer 57Mld
STT115 & TREAT172	STT Transfer 115Mld & GUC Transfer 57Mld
STT57 & TREAT172	STT Transfer 57Mld & GUC Transfer 115Mld
STT115 & TREAT230	STT Transfer 115Mld & GUC Transfer 115Mld

Elements that indicate GUC require construction of a pipeline from Minworth to GUC (refer to GUC SRO for further details)

1.5 Links with Other Options, Schemes and Elements

1.5.1 Dependencies

Minworth SRO as a source is not dependent on any other SRO schemes, however, in order for the water to supply London and the Southeast wider aspects of either STT and / or GUC SRO's are required to be constructed.

1.5.2 Mutual Exclusivities

The combined solutions listed above in Table 1-3: Combined Solutions are all mutually exclusive. By the nature of the choice available, none of the above combined options would be constructed together. However, there is a solution that for STT (115Mld), the treatment capacity may be built in 2 phases so solution STT115 & TREAT57 may be combined with another TREAT57.

2 Conceptual Design

2.1 Design Principles

During the Gate 2 Conceptual Design process, the All Company Working Group (ACWG) issued “ACWG Design Principles, Process and Gate 2 Interim Guidance” to maintain consistency throughout SROs.

The ACWG Design Principles comprise the four principles of the National Infrastructure Commission (Climate, People, Place, Value) with two cross-cutting principles that apply across all four categories.

Sections 2.1.1 to 2.1.5 summarise how this project followed these design principles. STW reviewed and updated these design principles to achieve the multi-functions and multi-benefits needed from this project.

2.1.1 Cross Cutting Design Principles

#	Design Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
1	Be specific: Develop project-specific design vision and principles based on an understanding of the objectives of each project and the people and places it will affect.	1.1. Development of project specific vision and principles mapped against the NIC and ACWG Principles. 1.2. Development of a clear, concise narrative describing the story behind your Vision and Principles.	The design vision for this scheme is for efficient but robust concept design with due consideration for the environment in particular to ensure that no detriment is caused to either of the receiving watercourses.	Annex A1 CDR Section 2.1
2	Safe and well: Actively and collectively develop designs that can be built, used, and maintained without unacceptable risks to the health and safety of workers - particularly during hazardous construction and operational activity. Manage risks to members of the public thoughtfully with an approach that balances maximising wellbeing benefits with protection from risks that could cause significant harm.	2.1. No accidents, incidents or harm to people during construction and operation. 2.2. Use of best practice procedures in design risk management following HSE Guidance and CDM Legislation. 2.3. Design informed by understanding potential risks to the public and management of these so far as reasonably practicable. Use of appropriate guidance including but not limited to: a. RoSPA and the National Water Safety Forum's Guiding Principles for Managing Drowning and Water Safety Risks. b. Visitor Safety in the Countryside. 2.4. Consideration of security early in the design of fence, gate and boundary treatments.	Reference the Outline Designers Risk Assessment which highlights the potential significant and/or unusual risks with potential mitigations. The design has been completed with due consideration of Safety in Design Principles incorporated within the CDM regulations. Safety reviews incorporating members of the consultant design team including constructability experts has been completed during the development of the scheme	Annex A1 CDR Section 3.3 CDM Implementation Appendix D.2 Design Hazard Elimination and Risk Register

2.1.2 Climate

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
1	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. 1.2. Timely - preparation of proposals ready to construct in 2025-2030 will involve early and rigorous development of design objectives followed by proposals. 1.3. Alignment with other relevant environmental policy, plans and strategies such as Catchment Management and Local Nature Recovery Plans (see also Place 2).	The engineering design has been informed by the emerging environmental consenting requirements being led by the environmental consultants working on GUC and STT schemes. 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.	Annex A1 CDR Section 3.6 Delivery Programme
2	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 and The Carbon Ambition. Projects must be efficient in embodied carbon in both construction and operation. 2.2. Projects should investigate if existing infrastructure assets could be repurposed and reused. 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.	The design has considered the minimisation of new works and reducing carbon. The scheme ensures maximum efficiency of the existing treatment process before then proposing the new treatment works.	Annex A1 CDR Section 2.2.10 Energy Recovery and Renewable Energy Opportunities Annex A2 Pipeline Route Appraisal Appendix N Environmental Constraints Technote
3	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. 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. 3.3. Where proposals add to the resilience of the broader system this should be accounted for in its social	This concept design meets the requirements of the flow profiles identified.	Annex A1 CDR Section 2.2.1 Source Water Abstraction Design Components

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
		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. 3.5. Deploy nature-based approaches to resilience wherever possible (see also Place 2).		

2.1.3 People

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
1	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 1.2. Designs developed to maximise their social value. 1.3. Proposals reflect local community views as to how they interact with and experience the infrastructure as far as possible.	The concept design has been developed with resilience in mind with minimal single points of failure and the source of the water is the combined final effluent stream at Minworth.	Annex A1 CDR Section 3.6 Delivery Programme Appendix D.3 Operational Philosophy
2	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). 2.2. The views of local stakeholders have shaped the design, where possible. 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. 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)).	The feedback from Gate 1 has been used to develop this Gate 2 proposal. The engagement activity for this SRO is framed within the water resources planning landscape to ensure that stakeholders understand the overall process, the key decision points and opportunities to contribute. We are collaborating with Water Resources South East (WRSE) and Water Resources West (WRW) to ensure that all of our key messages are consistent and aligned. 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	Annex A1 CDR Section 3.6 Delivery Programme Appendix D.3 Operational Philosophy

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
			models for visualisation/animation, GIS systems, precedent pictures of similar schemes/components.	
3	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 economy, social inclusion and education.	3.1. Find opportunities to improve people's health, wellbeing and understanding of the natural environment, through access to waterside and green spaces for recreational and other purposes (see Note 1). 3.2. Maximise opportunities for workers to access sites via sustainable transport during construction and operation. Minimise disruption to travel routes in areas affected by a project during construction and operation.	The STT pipeline route has been developed with public rights of way in mind and tried to avoid them and to cross them efficiently where this is not possible to minimise impact during construction.	Annex A1 CDR Section 2.2 Scheme Components and Operating Philosophy

2.1.4 Place

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
1	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). 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. 1.3. 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. 1.4. Develop proposals in light of a clear understanding of the area's landscape and history.	The pipeline routing options was carried out to minimise the impact on Place. 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. Environmental assessments have been undertaken using spatial data and option footprints, however further consideration will be required for Gate 3 as the scheme matures. Similarly, landscape proposals will evolve during the detailed design required for Gate 3. Refer to environmental statements on the SRO approach to achieving Environmental Net Gain within the Design Vision and Principles.	Annex A1 CDR Section 2.1 Design Principles Section 3.6 Delivery Programme Appendix D.3 Operational Philosophy

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
2	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). 2.2. Deploy nature-based approaches to integration and mitigation as the first-choice solution where possible. 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. 2.4. Work with landowners and land managers to develop mutually beneficial solutions where practicable.	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. Further work during Gate 3 can establish if there is any way Minworth could contribute to nature recovery - or any other nearby developments of this nature.	Annex A2 Pipeline Route Appraisal Appendix N Environmental Constraints Technote
3	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. 3.2. Develop designs and, where appropriate, artworks that bring narrative (meaning), beauty and interest to the proposals. 3.3. Consideration of context in every aspect of design including its location, layout, form, scale, appearance, landscape, materials and detailing.	Reference environmental statements for detail of how this is intended to be accomplished.	Annex A1 CDR Section 2.2.2 Advanced Water Treatment Plant Design Components Section 2.2.4 Pipeline Design Components

2.1.5 Value

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
1	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. 1.2. Design of infrastructure capable of adaptation to reasonable future demands (see also Climate 3). 1.3. Site selection processes and layouts that assist (or as a minimum, do not prevent) local development except where absolutely necessary. 1.4. Reinstatement, landscape and mitigation proposals that improve the existing situation, - e.g. through better biodiversity, carbon sequestration, surface water infiltration and reduced	The impact on the local environment has been taken into account 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. Primarily, B1 Biodiversity Net Gain Assessment, Natural Capital Assessment..	Annex A1 CDR Appendix D.3 Operational Philosophy

#	Principle	Target(s)	Gate 2 Indicators	Documentation in Gate 2 Submission
		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		
2	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 relevant catchment management plans and proposals that support the delivery and enjoyment of a healthy water environment.	2.1. Strategic project selection is informed by cross-sectoral engagement to maximise social benefit and reduce the use of customers money (see note 3). 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. 2.3. Be honest and realistic with partners as to what you might be able to offer as an organisation.	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 for details on the SRO's aspirations and capability to deliver additional value. There have been on-going discussions regarding hands off flow (HoF) with the Environment Agency to better understand how STW can work with other WCs and the EAs permitting team to protect water resources.	Annex A1 CDR Section 1.5 Links with Other Options, Schemes and Elements
3	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. 3.2. Full consideration of potential benefits in the Cost Benefit analysis and investment case for the SRO. 3.3. Clear communication of value of the scheme to stakeholders, communities and within the industry.	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.	Annex A1 CDR Section 1.5 Links with Other Options, Schemes and Elements Section 4 Water Resources

2.2 Scheme Components and Operating Philosophy

2.2.1 Source Water Abstraction Design Components

2.2.1.1 Connection to existing Final Effluent Channel and Inlet Pipework

The existing final effluent channel for the Minworth WwTW is a 5m x 5m concrete channel, with an invert level of 75mAOD. A new connection into this channel is required to allow a new 1300mm diameter abstraction pipeline to connect into the downstream influent pumping station (PS). Reference Appendix A. The new abstraction pipeline will be connected into the channel by forming a new opening in the existing wall past the point at which the main site works return flows, from the multiple streams, have sufficiently mixed. Water will flow under gravity down the abstraction pipeline into the influent PS.

2.2.1.2 Influent Pumping Station

The influent PS feeds final effluent from the Minworth WwTW to the first stage of the AWTP. The PS is sized to overcome approximately 6m total headloss and to accommodate the peak flows as outlined in Table 2-1. For the various flows, the PS shall consist of active pumps (duty/assist) and standby pumps.

Table 2-1: Influent Pumping Station Key Design Data

	TREAT57	TREAT115	TREAT172	TREAT230
Number of Pumps	3	4	5	5
Pumping Arrangement	Duty/Assist/Standby	Duty/Assist/Assist/ Standby	Duty/Assist/Assist/ Assist/Standby	Duty/Assist/Assist/ Assist/Standby
Peak pumping station flow	62 Mld	123 Mld	184 Mld	246 Mld
Average total head	6.04m	6.14m	6.32m	6.58m
Total Power requirement	112kW	336kW	597kW	746kW
Indicative building size	15m (L) x 15m (W) x 12m (H)	15m (L) x 20m (W) x 12m (H)	25m (L) x 20m (W) x 12m (H)	25m (L) x 30m (W) x 12m (H)
Wet Well Size	2700m^3	3600m^3	6000m^3	9000m^3

The key data for the influent pumping station is the same for either treatment alternative considered (TREAT57.ALT and TREAT115.ALT).

2.2.2 Advanced Water Treatment Plant Design Components

This section describes the elements of the Advanced Water Treatment Plant (AWTP). The AWTP process units were selected to help meet the identified environmental discharge requirements and mitigate the deterioration of the receiving water courses. This was achieved by undertaking a surface water pollution risk assessment to take account of potential future permitting requirements. Refer to Annex A3 (ii) Process Options report for further details.

The AWTP will be designed to treat bulk organics, nutrients and priority contaminants. An activated carbon-based treatment train has been proposed with the following key process units: Flocculation, and sedimentation (floc/sed) followed by ozone oxidation, biologically active carbon (BAC) filtration, and granular activated carbon (GAC) adsorption.

A membrane-based treatment process consists of MF, Reverse Osmosis, and UVAOP, has not been selected for Minworth SRO. The disadvantage with RO is the highly concentrated water reject (brine) stream that is created in the process, which is typically about 15% of all treated flows. This reject stream has challenging implications on the current effluent quality if it is returned to the same treatment plant that is supplying the flow as it increases the nutrient load and organic load (the magnitude of increase is dependent on the flow rate selected for the SRO) and results in the cycling up of TDS and trace organics that are otherwise not removed in the WwTW process.

Minworth WwTW discharges to the inland River Tame so installing an RO solution would result in the discharge of highly concentrated salt brine to non-estuarial waters which can be problematic in respect of the water ecology and environment as well as to other downstream users of the water. The discharge to the River Tame might not result in a higher salt loading by mass to the river, as the site already discharges into the River Tame, however returning the reject RO water to the treatment works will increase the concentration of salts as well as organic chemicals such as PFOS in the final effluent and in the River Tame. Although chemical toxicity can be measured on overall discharge volumes, it is the concentration that mainly affects water quality and as such permits are based on the Environmental Quality Standards which are concentrations and not overall loads.

Ocean disposal is the most common method of brine management. Compared to marine estuaries, the comparatively lower levels of dilution in the River Tame will lead to a net deterioration of the river water quality. The Q80 (20 percentile flow) flow of the River Tame directly downstream of Minworth averages around half of a typical estuarial river. Transferring 115MLD to STT and / or GUC will reduce effluent flows by nearly 20% in the River Tame. If RO was selected and the brine returned to Minworth WwTW, accounting for chemicals such as PFOS, which are likely not captured in the treatment process, a greater than 10% increase in the concentration in the River Tame may occur, subject to detailed modelling, which is likely to result in a net deterioration of river water quality. Deterioration is defined as a >10% increase, accounting for future growth. In comparison, estuarial rivers offer higher dilution levels often ensuring the increased concentration from the RO brine stream will not constitute a net deterioration in the river water quality.

In non-coastal areas, deep well injection of the brine flow is commonly practiced. This requires a deep well (typically >1,000 meters deep) and high pressure to inject the brine into a formation that is not connected to the water table. Where deep well injection is not appropriate, evaporation ponds and/or mechanical evaporation can be used to minimize the brine flow and recover salts in the brine stream. However, brine management options are extremely expensive and further increase the overall cost and energy consumption / carbon implications of the treatment process.

2.2.2.1 AWTP Hydraulics

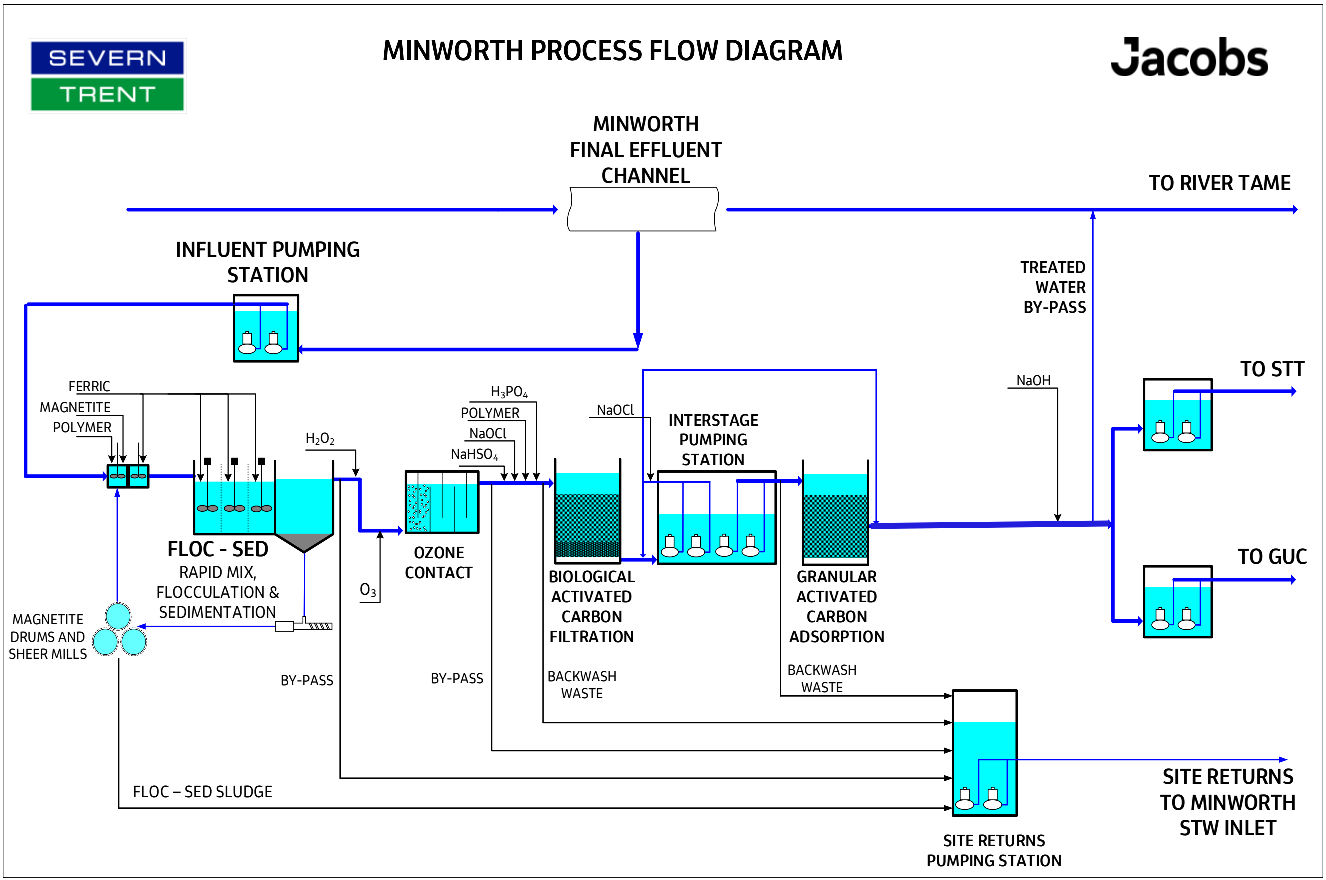
Table 2-2: Flow – Design Basis

	Design Abstracted Flow (Mld)	Final Treated flow (Mld)
TREAT57	62	57
TREAT115	123	115
TREAT172	184	172
TREAT230	246	230

2.2.2.2 Treatment Works System Overview

This section gives an overview of the components of the AWTP. A detailed design of the treatment plant including the process design criteria, specific plant sizes and chemical requirements has been discussed in a separate report titled A7W13155-WT-REP-221001 Process Options Report.

Figure 2-1: Advanced Water Treatment Plant schematic



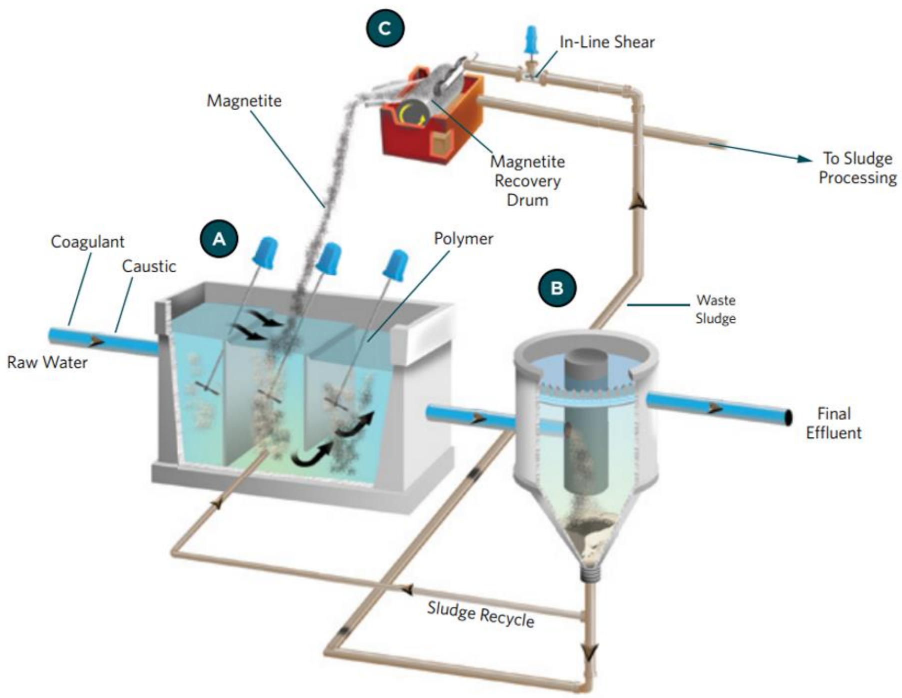
2.2.2.3 Floc-Sed (Co-Mag®) System

The floc-sed process provided by a CoMag® system, developed by Evoqua, is an enhanced coagulation, flocculation and clarification system that efficiently reduces total suspended solids, total phosphorus and turbidity below the level achieved by conventional treatment solutions. It uses magnetite to ballast chemical flocs, thus enhancing agglomeration and settling rates.

Magnetite (Fe_3O_4) is fully inert (does not rust) iron ore particles, with a high density. In this process, it is used as a ballasting agent to physically bind to particulate flocs. It is non-abrasive and magnetically retrievable allowing for high recovery in the sludge stream.

The process is described in the sections below and is displayed in Figure 2-2 which shows the reaction tank (A), the clarifier (B) and the recovery system (C).

Figure 2-2: CoMag System schematic (Evoqua, 2022)



With the CoMag® system, the fundamental separation technique is based on the traditional process of flocculation, coagulation, and clarification. The improvements and efficiencies are realised from the addition of the magnetite. In the reaction tank alum, ferric or poly-aluminium chloride is added to the influent stream. The chemical floc it then infused with magnetite, thus increasing the bulk density of the resulting solid flocs. These magnetite ballasted flocs pass through to the clarifiers.

The high-density magnetite ballasted flocculants enter a modified high-rate clarifier where they settle rapidly, leaving a clear effluent. The size of the clarifier required is smaller than conventional clarifiers due to the use of magnetite. The clarifier has baffle plates included to aid in directing the flow for optimal settling. A sludge rake is used to collect the sludge in a sump at the bottom.

A sludge recycle function is also included to help increase the performance of the system and the final effluent clarity. Approximately 80% of the clarifier underflow is recirculated back into the reaction tank. A high-speed shear mixer is positioned in the recycle loop where the magnetite is separated from the floc. The slurry is passed into a magnetic recovery drum where more than 99% of the magnetite is returned to the system (according to Evoqua). This continual recovery of the magnetite provides a sustainable process with claimed low operating costs. The sheared sludge, without the magnetite, is sent for dewatering.

The system allows for rapid start-up and process optimisation where frequent shutdown and restarts may be required. The system is also fully automated with minimal operator attention required (Evoqua, 2022).

Feedback on current operational plants suggests higher magnetite loss rates. This shall be investigated further at the next design stage

2.2.2.4 Ozonation

Ozone (O_3) is utilised in water treatment facilities for a range of disinfection and oxidation purposes. Ozone is formed when oxygen (O_2) is exposed to a source of high energy causing the O_2 to dissociate and subsequently collide with other O_2 molecules to form the unstable gas, ozone (O_3).

In this application, ozone is primarily utilised to oxidize trace and bulk organics, although the system will also benefit from its disinfection capabilities. Ozone is a very powerful oxidant that is able to break down a wide range of organic compounds and microorganisms (EPA, 1999). Ozone attacks the surfaces of microorganisms and destroys their cell walls. Ozone also has the capability to oxidise metallic ions to produce insoluble solid oxides which can then be separated by filtration or sedimentation.

Figure 2-3: Supplier proprietary ozone generator (Courtesy of Xylem Wedeco)

2.2.2.4.1 Ozone Generation

Due to ozone's short half-life, it must be produced onsite. It can be generated from dried, compressed air or oxygen. The use of air requires additional mechanical units such as compressors, coolers and dryers, and produces a low concentration of ozone. As such, pure oxygen is generally the preferred generation source. This can be purchased as liquid oxygen (LOX) or generated onsite by pressure swing adsorption (PSA) or vacuum swing adsorption (VSA). Onsite pure oxygen generation is generally only economical where the oxygen demand is very high, with LOX being the preferred method where possible. At the current design stage, LOX has been selected due to its general ease to both store and manage.

The most commercially viable type of ozone generation from oxygen at municipal water treatment facilities is Corona Discharge. Horizontal, medium/high frequency, large diameter tube generators are most commonly used due to their reliability, their proven usage in municipal water treatment and their efficiency. The ozone if formed via an electrical discharge that is diffused over an area using a dielectric to create the Corona Discharge. As the oxygen passes through the Corona Discharge it is converted to ozone.

The effectiveness of ozonation is dependent on susceptibility of the target organisms in the influent, the contact time selected, and the ozone dose used. The ozone process primarily oxidizes effluent organic matter and degrades some of the trace chemicals. This increases the biodegradable matter which would have passed through the activated sludge process untreated. Hence it is essential that this treatment step is followed by biological treatment.

2.2.2.4.2 Ozone Dose

The ozonation system shall be designed to deliver average and maximum applied ozone doses of 7 and 10 mg/l, respectively (subject to pilot testing), with a 5-minute contact time. Sampling facilities and online monitoring shall be provided including the ozone residual and off-gas post destruction.

Online monitoring of the influent nitrite levels shall be provided as nitrite exerts a large ozone demand and will make operation of the ozone system quite challenging. It is imperative that the Minworth STW produces consistent, low (<0.2 mg-N/L) nitrite concentrations.

2.2.2.5 Biological Activated Carbon (BAC) Filtration

This is a multi-media filter bed with 0.3m sand under 1.5m of granular activated carbon. The sand filters out particulates and the activated carbon is used to develop a biological community to biodegrade the organics that the ozone process has made assimilable.

Due to the accumulation of particles and sloughing of biological matter, biofilters typically require backwashing every 24-48 hours. This requires a combination of both water and air scouring of the media, similar to conventional filters used in drinking water treatment. Backwashing of the biofilters constitutes the bulk of the site returns to the Minworth STW inlet.

Empty bed contact time (EBCT) is the primary design criteria for biofilters, along with the filter loading rate. EBCT is the residence time of the filtered water in the activated carbon media. The design EBCT for this project is 10 minutes at the specified design flow with all filters in service. This will provide sufficient time for biological degradation to occur while maintaining a reasonable site footprint.

At this stage, gravity-fed biofilters are preferred, however a pressure filter arrangement can be considered if it is deemed to have advantageous life cycle costs. The activated carbon media is typically replaced every 15-20 years and consideration shall be made for working access and how media can both be fed and withdrawn from the filters.

Figure 2-4: BAC Filtration Treatment cell (courtesy of Xylem-Leopold)

2.2.2.6 Interstage Pumping Station

Approximately 5-6 m of headloss is expected through both the BAC filters and the GAC adsorbers. Given both are currently planned to be gravity filters, there either needs to be a 5-6 m elevation difference between the two processes or an interstage pumping station. A pump station is currently assumed so that the BAC filters and GAC adsorbers can have the same site elevation and can potentially be located in a combined building.

The interstage PS shall consist of a set of active and standby pumps with a forward configuration to feed to the GAC and another set of active and standby pumps for backwashing the filters. The PS is sized to accommodate the range of flows outlined in .

Table 2-3: Interstage Pumping Station Key Design Data

	TREAT57	TREAT115	TREAT172	TREAT230
Number of Pumps	6	8	6	8
Pumping Arrangement	Duty/Assist/ Standby (Forward) Duty/Assist/ Assist (Backwash)	Duty/Assist/Assist/ Standby (Forward) Duty/Assist/Assist/ Assist (Backwash)	Duty/Assist/Assist/ Assist/ Standby (Forward) Duty/Assist/Assist/ Assist (Backwash)	Duty/Assist/Assist/ Assist/Assist/Standby (Forward) Duty/Assist/Assist/ Assist/Assist (Backwash)
Peak pumping station flow	62 Mld	123 Mld	184 Mld	246 Mld
Average total head	6.03m	6.13m	6.28m	6.51m
Total Power requirement	223+559kW	447+597kW	597+746kW	746+746kW
Indicative building size	15m (L) x 25m (W) x 12m (H)	25m (L) x 30m (W) x 12m (H)	15m (L) x 25m (W) x 12m (H)	25m (L) x 30m (W) x 12m (H)
Wet well size	3298 m^3	4049 m^3	5962 m^3	7948 m^3

2.2.2.7 Granular Activated Carbon (GAC) Adsorption

Similar to BAC, GAC is also an activated carbon adsorption technology. However, this process relies on adsorption as the primary removal mechanism and thus requires frequent replacement or regeneration of the media (every 12-24 months, subject to pilot testing). While the GAC media will develop some biological activity, it does not have a sand layer and is not considered a particle barrier. The GAC media has a micro-crystallite structure that consists of fused hexagonal rings of carbon. This structure allows for spaces (pores) in between individual micro-crystallites where adsorption takes place. Adsorption on the micro-crystallite structures is a result of both physical (physisorption) and chemical (chemisorption) bonding.

GAC is suitable for the removal of both bulk and trace organic matter, thus allowing for a reduction in total organic carbon (TOC) together with trace chemicals. Removing TOC in the floc-sed and BAC processes upstream of GAC preserves more of the GAC adsorption sites for chemical adsorption, reducing the regeneration frequency.

Similar to BAC filters, GAC adsorbers can either be installed as pressurised or gravity fed beds, depending on life cycle cost considerations. At the flow rates being considered for the Minworth AWTW, gravity filters and adsorbers present the lowest capital and operating cost and have been selected at this stage.

EBCT is the primary design criteria for GAC adsorbers. These units have been sized to run at an EBCT time of 20 minutes at average flow with all units in service. Backwashing is also required for GAC adsorbers, but because they are downstream of the primary particle removal barrier (BAC filters), backwashing is only expected to be needed once or twice per month. Air scour is typically not used to backwash GAC adsorbers and instead a water-only backwash procedure is followed at a slightly lower backwash loading rate compared to BAC filters.

Replacement or regeneration of the GAC media is one of the highest operating costs for this treatment scheme and, as such, it is important that the replacement frequency is minimized. It is expected that replacement will be needed every 12-24 months, but this is dependent on many variables, including the influent TOC, trace organic concentrations and the GAC effluent water quality goals. More information, and pilot testing, is needed to better estimate life cycle costs for the GAC facility. A risk of the absence of supply chain currently for GAC media used in FE tertiary treatment applications should be considered.

Figure 2-5: GAC Adsorption Treatment Cell (courtesy of Xylem-Leopold)

2.2.2.8 Site Returns Pumping Station

The site returns PS shall be used to pump water required to backwash the BAC and GAC filters from the final effluent of the AWTP. The PS is sized to overcome a headloss of approximately 12m and to accommodate the range of flows outlined in Table 2-4. The PS is sized to overcome a headloss of approximately 12m and to accommodate the range of flows outlined in Table 2-4: Site Returns Pumping Station Key Design Data

Table 2-4: Site Returns Pumping Station Key Design Data

	TREAT57	TREAT115	TREAT172	TREAT230
Number of Pumps	2	2	3	3
Pumping Arrangement	Duty/Standby	Duty/ Standby	Duty/Assist/ Standby	Duty/Assist/ Standby
Peak pumping station flow (l/s)	69	139	208	266
Average total head	15.17m	24.47m	18.30m	22.23m
Total Power requirement	15kW	37kW	74.6kW	74.6kW
Indicative building size	10m (L) x 10m (W) x 5m (H)	10m (L) x 10m (W) x 5m (H)	10m (L) x 15m (W) x 5m (H)	10m (L) x 15m (W) x 5m (H)
Wet well size	3572 m^3	4532 m^3	8594 m^3	8701m^3

2.2.2.9 Chemical Dosing Requirements

The treatment process requires chemical storage and feed systems to function properly and efficiently.

- The floc-sed process requires a coagulant, ferric chloride, and non-ionic polymer to improve total phosphorus and total solids removal.
- Ozone oxidation is enhanced by the presence of hydrogen peroxide, which is currently included in the design. Sodium bisulfite is also included to quench the ozone and hydrogen peroxide residuals prior to BAC filtration.
- BAC filtration performance is improved with the continuous addition of phosphoric acid and non-ionic polymer and intermittent addition of sodium hypochlorite to control excessive biological growth.

Sodium hydroxide is currently included in the design to make up for the pH decrease anticipated with ferric chloride addition. Bench and pilot testing shall be used to verify whether pH correction is carried forward at the next design stage.

15-days of chemical storage at the maximum design flow rate and at the average chemical dose rate, is currently assumed for the chemical storage and feed facilities, utilising a mixture of bulk chemical tanks and movable intermediate bulk containers (IBCs).

For wastewater sites, the Severn Trent Specification requires at least 30 days storage if the volume required is less than $10m^3$. For larger volumes the specification is 10 days storage plus 1 tanker. This plant sits between wastewater treatment and drinking water treatment, and this affects the criticality of each process asset, hence a design decision to allow for 15 days storage was taken.

2.2.2.10 Treated Water Quality Monitoring

All treated water is required to be monitored to ensure that it is sufficient quality to be transferred to STT / GUC according to the agreed permit.

2.2.2.11 Treated Water Returns

For the purposes of commissioning and in the case of unacceptable treatment levels, provision for returning flows to the final effluent chamber is provided at each stage of treatment including before and after the flow reaches the transfer pumping station for maximum operational flexibility.

2.2.3 AWTP (Alternative) Design Components

This section describes the elements of the Advanced Water Treatment Plant (AWTP) Alternative. The AWTP (Alternative) was selected to meet the alternative environmental discharge requirements and mitigate the deterioration of the receiving water course. The AWTP (Alternative) will be designed to treat bulk organics, nutrients and priority contaminants.

An activated carbon-based treatment train has been proposed with the following key process units: flocculation, and sedimentation (floc/sed). Refer to Annex A3 (ii) Process Options report for further details.

2.2.3.1 AWTP (Alternative) Hydraulics

2 alternative flows have been assessed for the alternative process requirements.

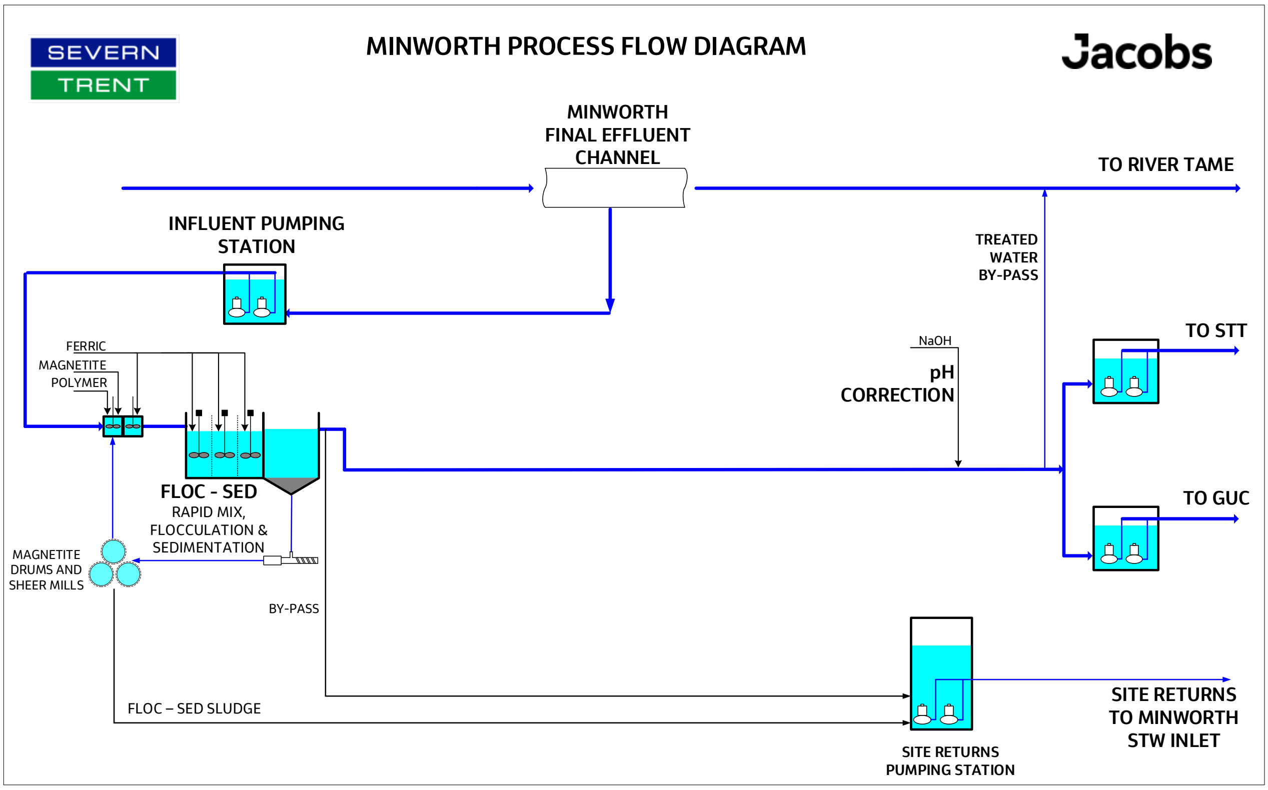
Table 2-5: Flow – Design Basis

	Design Abstracted Flow (Mld)	Final Treated flow (Mld)
TREAT57	57.9	57
TREAT115	116.8	115

2.2.3.2 Treatment Works System Overview

This section gives an overview of the components of the AWTP (Alternative). A detailed design of the treatment plant including the process design criteria, specific plant sizes and chemical requirements has been discussed in a separate report titled A7W13155-WT-REP-221001 Process Options Report.

Figure 2-6: Advanced Water Treatment Plant schematic



2.2.3.3 Floc-Sed (Co-Mag®) System

Refer to section 2.2.2.3 above for details.

2.2.3.4 Site Returns Pumping Station

The site returns PS shall be used to pump the sludge returns from the Floc-Sed process to the Minworth WWTP inlet.. The PS is sized to overcome a headloss of approximately 12m and to accommodate the range of flows outlined in Table 2-4.

Table 2-6: Site Returns Pumping Station Key Design Data

	TREAT57.ALT	TREAT115.ALT
Number of Pumps	2	2
Pumping Arrangement	Duty/Standby	Duty/ Standby
Peak pumping station flow (l/s)	61	123
Average total head	15.17m	24.47m
Total Power requirement	15kW	37 kW
Indicative building size	10m (L) x 10m (W) x 5m (H)	10m (L) x 10m (W) x 5m (H)
Wet well size	120 m^3	240 m^3

2.2.3.5 Chemical Dosing Requirements

The treatment process requires chemical storage and feed systems to function properly and efficiently.

- The floc-sed process requires a coagulant, ferric chloride, and non-ionic polymer to improve total phosphorus and total solids removal.
- Sodium hydroxide is currently included in the design to make up for the pH decrease anticipated with ferric chloride addition. Bench and pilot testing shall be used to verify whether pH correction is carried forward at the next design stage.

15-days of chemical storage at the maximum design flow rate and at the average chemical dose rate, is currently assumed for the chemical storage and feed facilities, utilising a mixture of bulk chemical tanks and movable intermediate bulk containers (IBCs).

For wastewater sites, the Severn Trent Specification requires at least 30 days storage if the volume required is less than $10m^3$. For larger volumes the specification is 10 days storage plus 1 tanker. This plant sits between wastewater treatment and drinking water treatment, and this affects the criticality of each process asset, hence a design decision to allow for 15 days storage was taken.

2.2.3.6 Treated Water Quality Monitoring & returns

Instrumentation to monitor the quality of treated water shall be a combination of Turbidity, pH, Ortho-phosphate and Ammonia.

Floc-Sed sludge returns to the Minworth inlet will have suspended solids concentration of approximately 0.25% (2500mg/l). This equates to approximately 2.25 Tonnes Dry Solids (TDS) per day for the 57Mld and 4.5 TDS for the 115Mld case.

Minworth can digest approximately 185TDS per day depending on serviceability of assets hence this returned sludge will likely constitute between 1 - 2% of the digester feed and as such is unlikely to trigger a requirement for additional digestion capacity.

2.2.4 Pipeline Design Components

2.2.4.1 System Hydraulics

Details about flow conditions, pipeline hydraulics, and surge analysis are presented in this section. For the breakdown calculations of the system hydraulics, please refer to Appendix D.5. Steady State Hydraulics.

2.2.4.1.1 Flow Conditions

The pipeline scope of Minworth SRO proposes the provision of a pipeline to transfer 57Mld or 115Mld from Minworth AWTP to the River Avon to supply STT SRO.

Table 2-7: Flow parameters

Option	Peak Flow	Sweetening Flow	% Of the year at Peak flow	% Of the year at sweetening flow
TREAT57	57Mld	3Mld (5% peak flow)	10%	90%
TREAT115	115Mld	3Mld (3% peak flow)	10%	90%

Running time: 24hrs per day – both sweetening flow and peak flow

2.2.4.1.2 Sweetening Flow

The sweetening flow is calculated at 3Mld which offers operational cost savings for the pumping station. The reduced sweetening flow is measured by calculating the volume of water inside the entire pipeline which is 21.980 ML. and dividing that volume by 7 days, which is the allowed age of water before reaching stagnation. Note that 7 days is still conservative as the AWTP treats the water to a high quality.

The operation of the transfer pipeline is expected to be refined at Gate 3 where alternatives such as draining down the pipeline or operating a pulsed flow can be considered. Draining down the entire pipeline may introduce issues associated with cleanliness when the pipeline is recommissioned.

2.2.4.1.3 Pipeline Hydraulics

Please reference Annex A 2 Pipeline Route Appraisal for details of the route optioneering study. The preferred route selected is labelled as WRMP19.RE_B reflecting the original source of the route option.

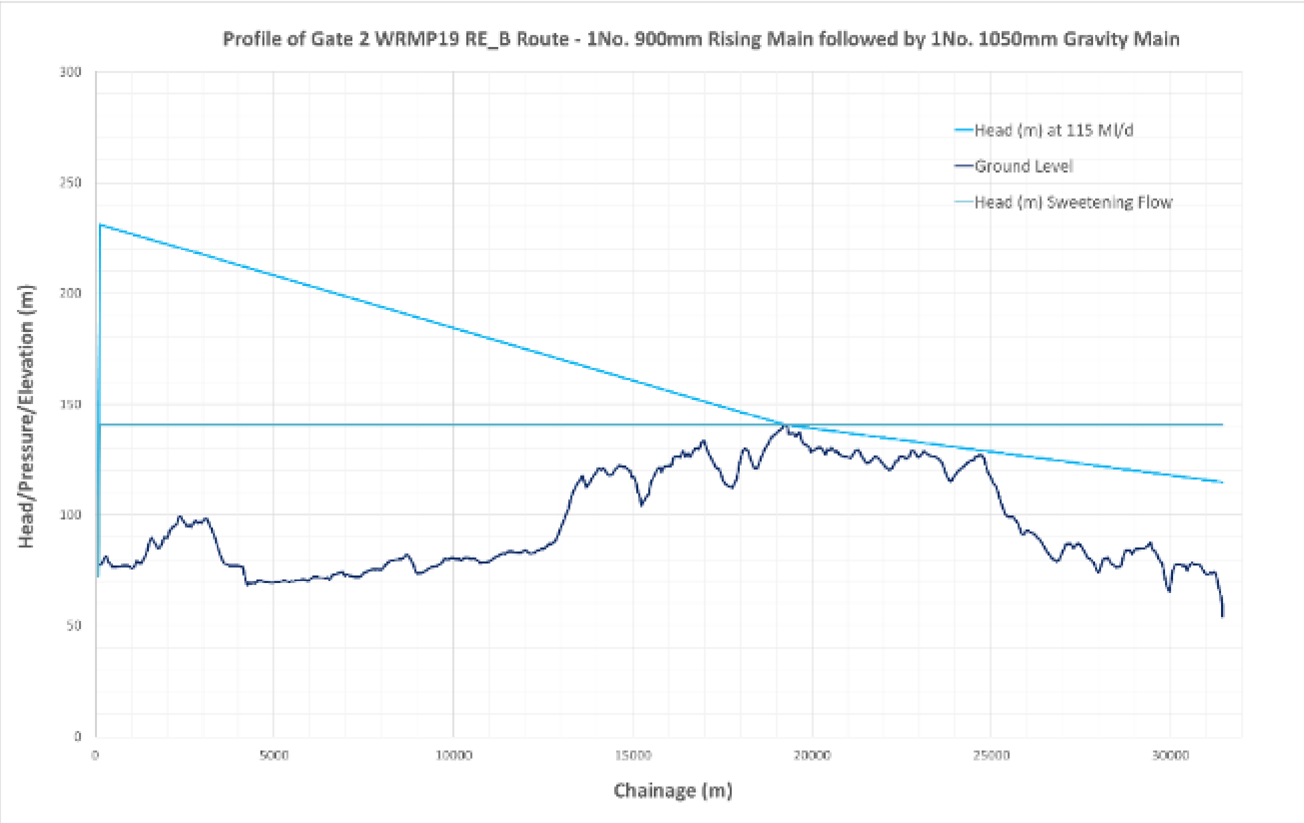
The steady state hydraulic profile for the preferred route (titled WRMP19 RE_B) is shown in Figure 2-7 below. This shows the headloss along the pipeline based on the pipe sizes and lengths.

Velocities in the pipeline if flows are maintained constantly:

- Rising main (900mm): 3MLd - 0.05 m/s ; 57 Mld - 1.03 m/s; 115 Mld - 2.09 m/s
- Gravity main (1050mm): 3MLd - 0.04 m/s ; 57 Mld - 0.76 m/s; 115 Mld - 1.54 m/s

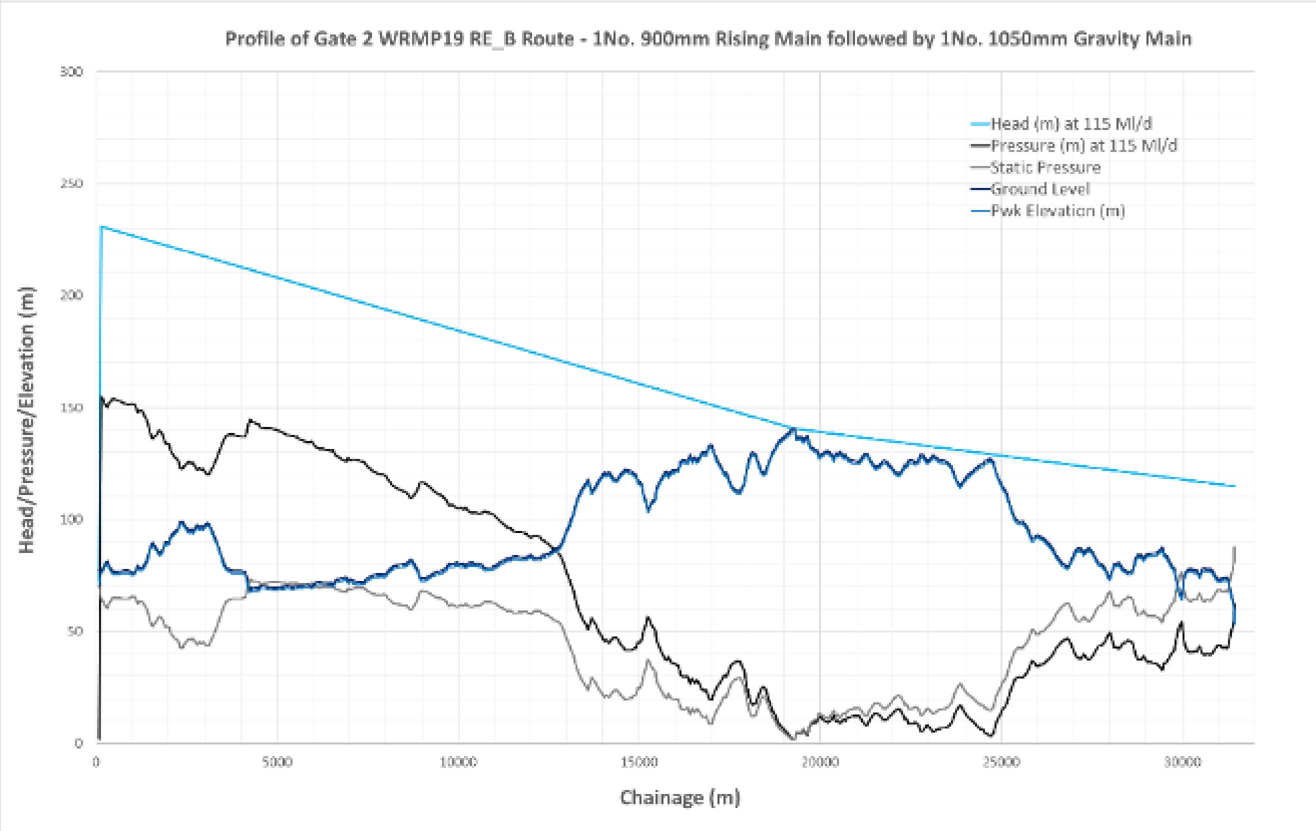
The headloss calculations have been based on a pipe roughness 0.3mm, and fittings losses of 15% of total headloss. For the rising main, a roughness sensitivity exercise has been conducted to account for the variation in the roughness value as the pipeline gets older, the lower bound used is 0.15mm and the higher bound used is 1.5mm. the results are presented below in section 2.2.4.1.4 Surge Analysis.

Figure 2-7: Steady state profile of the Preferred Route "Gate 2 WRMP19 RE_B" for peak flow & sweetening flow



The graph in Figure 2-8 below shows the static pressure and steady state pressure within the pipeline for 115Mld flow. The pressure head is raised to 230m AOD by the pumping station at the start of the pipeline and is reduced by losses to 140m AOD at the level of the Break Pressure Tank (BPT). The pressure at this point within the system is also at atmospheric pressure, as the BPT is not pressurised. A steel pipe with pressure rating of PN16 is proposed to account these pressures but more detailed analysis will be required especially at the pumping station to ensure that the selected pipe accounts for these pressures.

Figure 2-8: Static pressure and steady state pressure for Gate 2 WRMP19 115Mld flow



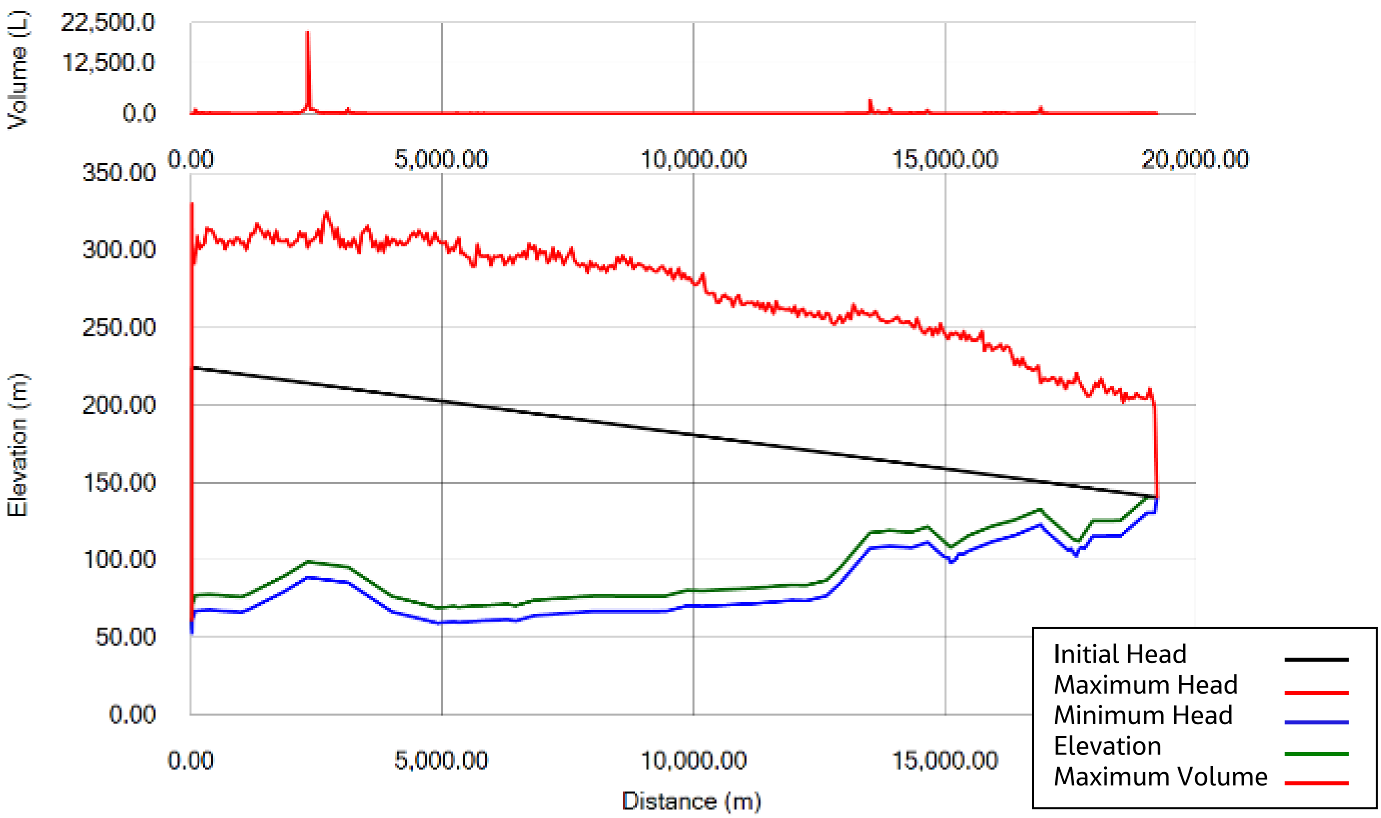
2.2.4.1.4 Surge Analysis

A high-level surge assessment was carried out for the preferred route option peak flow of 115Mld, in order to establish the need for surge protection on the 19.3km rising main DN900. The critical transient case analysed was pumps trip (power failure) after five seconds during the simulation at peak flow. The assessment provided indicative sizes for the surge suppression required but this will need to be refined at Gate3 when a more detailed analysis of the pipeline hydraulics will be undertaken once ground conditions are better understood.

The simulation showed that without any surge mitigation the minimum pressures would reach full vacuum along the entire length of the pipeline and significant overpressure when the vacuum pockets collapse. See below Figure 2-9 below, these transient conditions are not acceptable hence the need for surge mitigation plant.

Operating pressure can be derived from the head in the pipeline by dividing by a factor of 10.

Figure 2-9: Rising main profile in case of pump trip without surge mitigation equipment



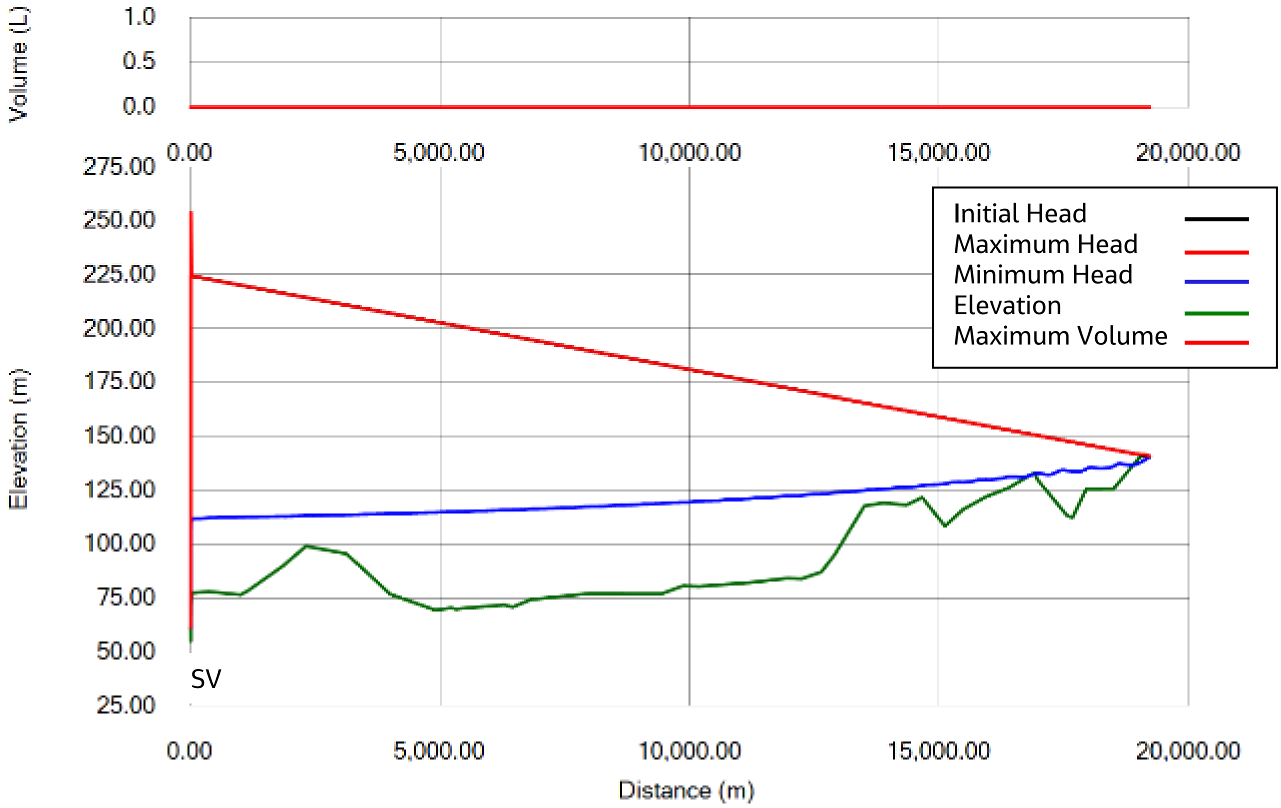
Surge vessels at the pumping station of the order of 105m³ (with a total volume of 125m³) would be required to prevent negative pressure occurring. The maximum pressures would also be then limited to less than 15 bar. (225m minus 75m ground level = 150m = 15 bar). A 105m³ surge vessel was found to sufficiently mitigate the negative pressures for the 115Mld peak flow; however, at this stage a 20% allowance has been added to this volume and a 125m³ vessel is included in the design, proposed vessel length 6.37m, and vessel diameter 5m. Note that dimensions of the vessel are indicative and can be replaced by a bank of smaller vessels if the current size didn't fit on site.

The surge vessel was modelled as a horizontal unvented model. See Table 2-8.

Table 2-8: Surge Mitigation - 120m³ Surge Vessel

ID	Chainage	Length (m)	Diameter (m)	Volume Including Additional 20% (m³)
Surge Vessel	At pumping station	6.37m	5	125

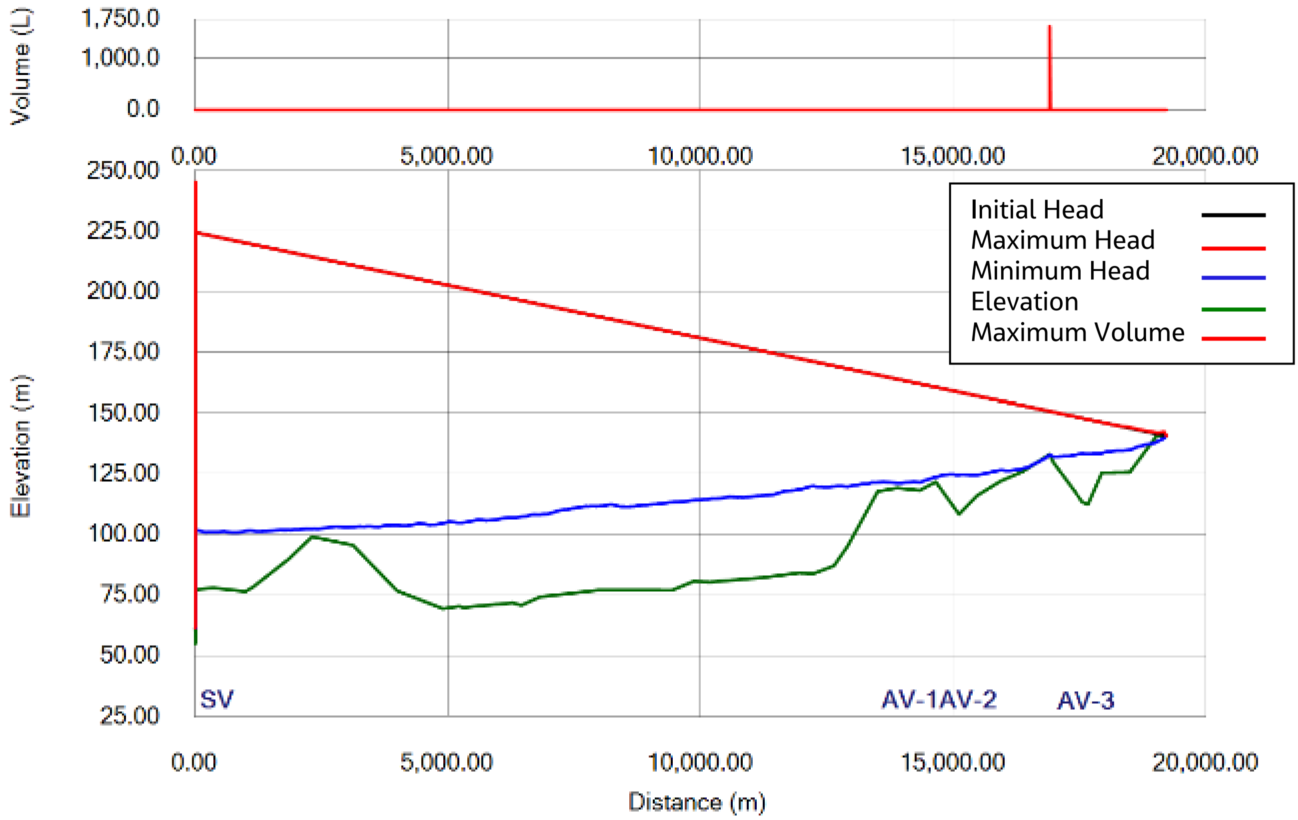
Figure 2-10: Rising Main Profile with Surge Mitigation – 125m³ Surge Vessel



Another option for surge mitigation is to add a smaller size surge vessel at the pumping station and add three air-valves at the three main peaks of the rising main, this will allow surge vessel size reduction down to 70m³. See below Figure 2-11. The Surge vessel at the pumping station of the order of 70m³ would prevent negative pressure occurring. The maximum pressures in this case would also be then limited to less than 15 bar. A 70m³ surge vessel was found to sufficiently mitigate the negative pressures for the 115Mld peak flow; however, at this stage a 20% allowance has been added to this volume and an 85m³ vessel is included in the design, vessel length 6.8m, vessel diameter 4m. The surge vessel was modelled as a horizontal unvented model. See Table 2-9.

Note that adding air valves will reduce the size of the surge vessel which will introduce cost savings, but this solution will require regular maintenance of the valves which are located in remote areas, it's recommended to use the bigger surge vessel size and not rely on air valves, however, the final decision has to be made at a future stage based on a cost and benefit analysis and a detailed surge study.

Figure 2-11: Rising Main Profile with Surge Mitigation – 85m³ Surge Vessel and 3 Air-Valves



Air valves are required at every intermediate high point along the pipeline to allow the pipeline to be commissioned and facilitate drain-down for maintenance.

A roughness sensitivity exercise has been conducted to account for the variation in the roughness value as the pipeline gets older, the lower bound used is 0.15mm and the higher bound used is 1.5mm. The simulation results showed that the sizing of the vessel is adequate across all roughness values considered. Note that gravity main surge protection should be analysed in the next stage of the design process. Transient events might occur in the gravity main due to fast closure of gate valves.

Table 2-9: Surge Mitigation – 80m³ Surge Vessel and 3 Air-Valves

ID	Chainage	Length (m)	Diameter (m)	Volume Including Additional 20% (m³)
Surge Vessel	At pumping station	6.8	4	85
ID	**Chainage**	**Air Inflow Orifice Diameter (mm)**	**Air Outflow Orifice Diameter (mm)**	**Air Valve Type**
Air Valve 1	13,500	50	25	Fast acting shutter
Air Valve 2	14,655	50	25	Fast acting shutter
Air Valve 3	16,900	75	25	Fast acting shutter

2.2.4.2 STT Transfer Pumping Station

The treated water from the AWTP shall be collected by a new transfer pumping station for delivery via a new 15km long rising main with total head of around 145m (at peak flow) to a new break pressure tank. From here a pressurized gravity main will transfer flow to the outfall at the River Avon.

Due to the flow conditions, the station is operated at a relatively low flow at high head application for most of the time under this system characteristics.

The design of the pumping station is outlined in the following sections for the proposed type of pumping station, pumping system, flow and pressure measurement, odour and noise control.

2.2.4.2.1 Type of Pumping Station

The pumping station shall be designed as a dry-well type with four duty pumps and one standby pump of differing capacities as shown below in Figure 2-12. One pump shall serve for sweetening flow and four pumps for peak flow condition to ensure pumping in a continuous state of prime under good level of available net positive suction head (NPSH) and avoid unnecessary civil work with deep excavations in pump sump. The approximate size of the pumping station building is 12m high, 25m long and 20m wide.

The incoming treated effluent shall be channelled into the pumping station via a rectangular inlet culvert to damp out fluctuations in flow, ensuring velocities uniform and steady with no entrained air when flow approaches the intake section of the pumping station. Pumps shall be connected to the incoming effluent stream in the inlet culvert with a common suction manifold with a turn-down bellmouth intake design as shown in Figure 2-13, allowing flow to accelerate smoothly into the inlet pipe. The manifold and branch pipework shall be sized to feed flows to pumps at optimal velocity under 1.5 m/s. Pumps shall be cascaded in and out based on the control levels of different water levels in culvert according to the demand. The discharge lines are connected to a common discharge manifold with a single outlet pipe to the rising mains. Figure 2-12 shows the proposed full-size layout of dry-well type pumping station under TREAT 115 Mld.

In the case of only transferring 57Mld (TREAT57), the plant operator can operate one pump with rated capacity of 230 l/s for sweetening flow while two pumps, each with rated capacity of 370 l/s, for peak flow at adequate pump running speed under VSD control to suit the actual operational needs.

Figure 2-12: Proposed layout of the dry-well type pumping station

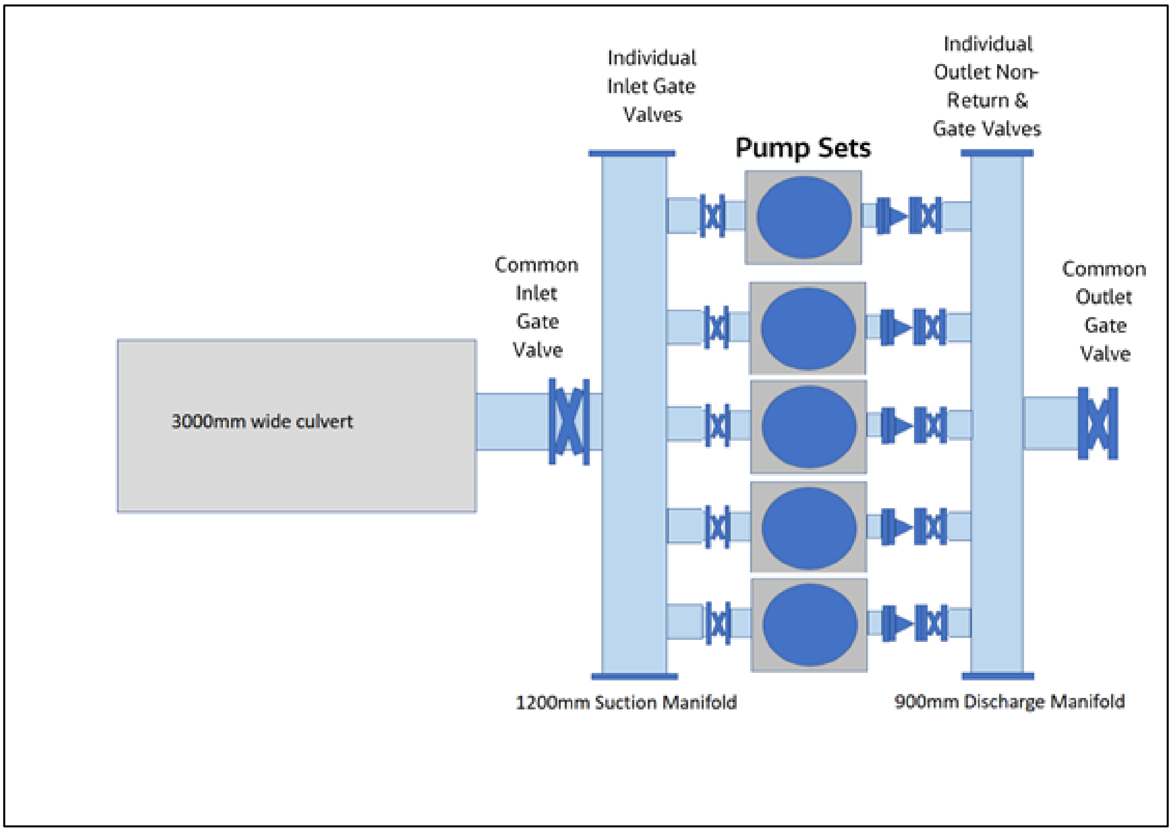
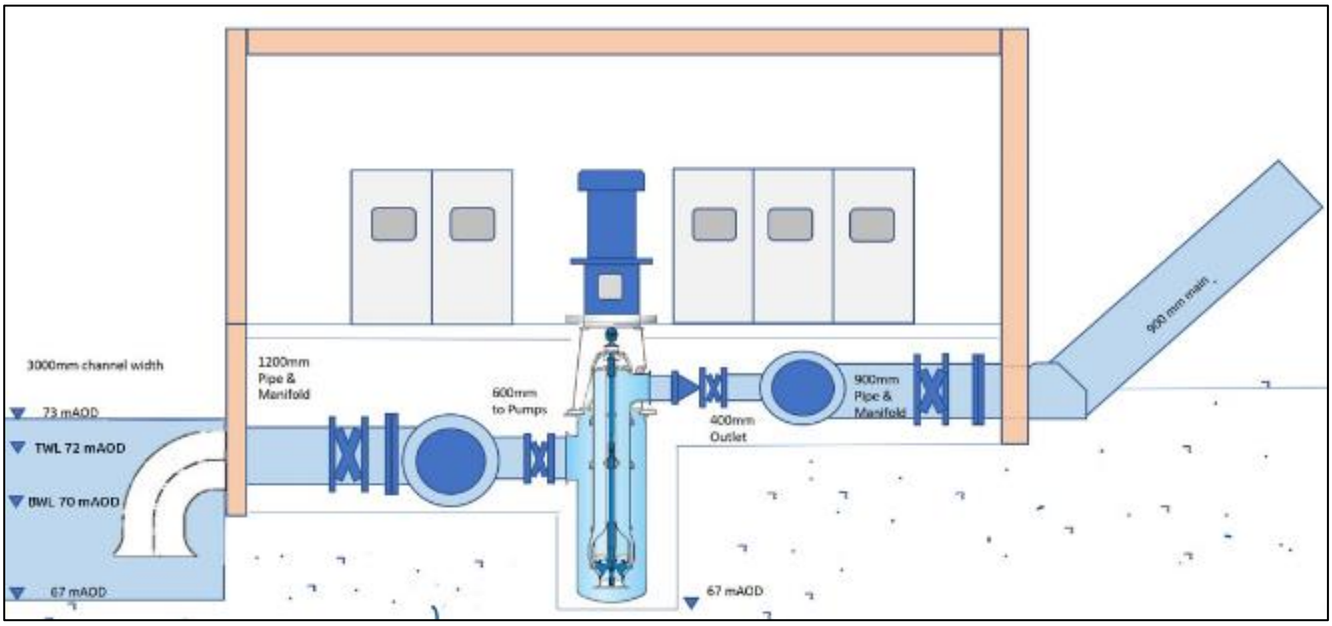


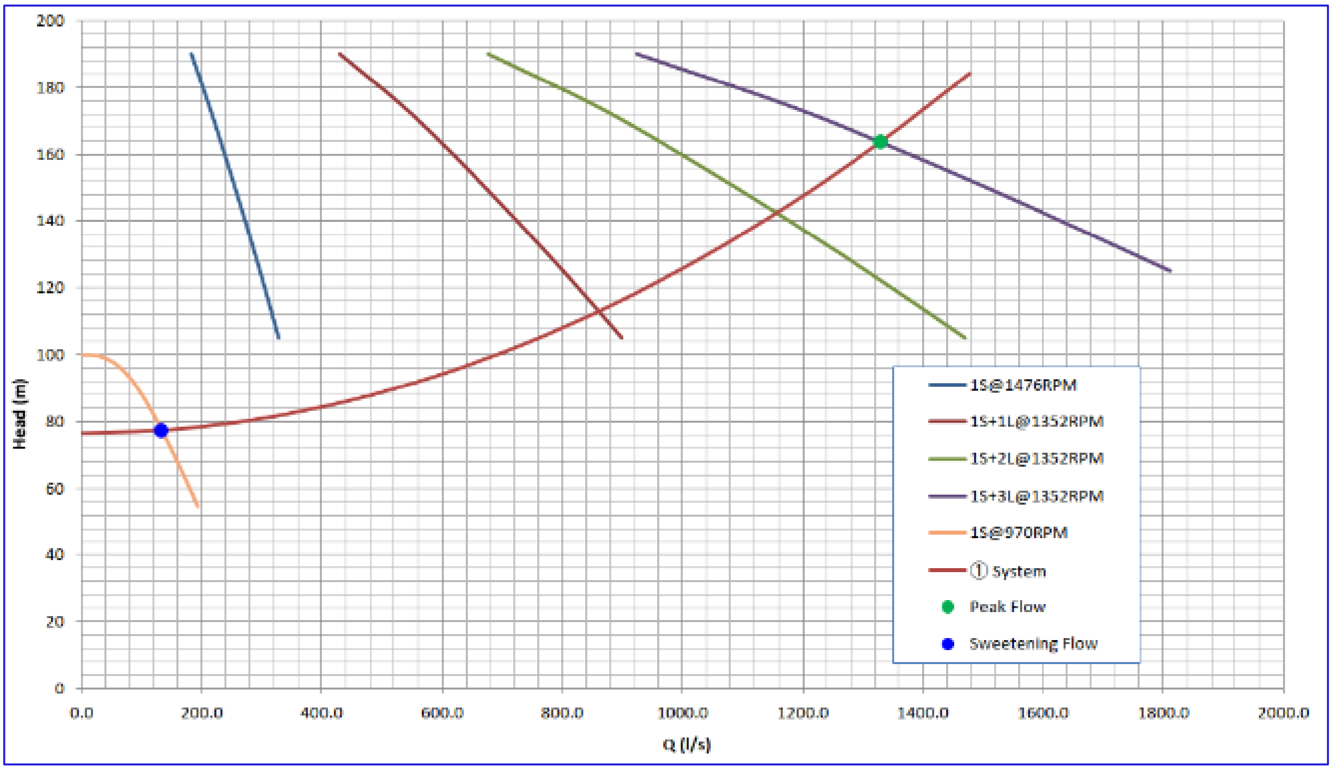
Figure 2-13: Proposed sectional view of the pumping station



2.2.4.2.2 Pumping System

The multi-stage canister pumps with variable speed drives are adopted for this pipeline pumping station with maximum efficiency occurring at its duty points. The canister pumps shall have 3-stage liquid chambers connected in series for the benefit of better efficiency, mounted vertically in the dry well of the pump house. The system characteristics and different pump operating curves are shown in Figure 2-14.

Figure 2-14: System characteristics and pump curves for pumping station



The pumping station shall be operated by 4 nos. duty/assisted pumps of differing capacities (one pump for sweetening flow while four pumps for peak flow condition). For the majority of the time, sweetening flows shall be provided by a small pump (1 duty and 1 standby) with rated capacity of around 230 l/sec to cater for the low flow condition by adjusting the VSD to the desired flow. For peak flow condition, the 1 small duty pump shall start up for ramping up at more or less at full load for base-load supply, while the 3 large pumps (each rated at around 370 l/sec) shall be cascaded and rotated in and out or service based on the water level controls. Table 2-10 shows the pump sizing and configuration and Table 2-11 summaries the proposed control levels of the pumping system.

Table 2-10: Pump sizing and configuration

	Peak Flow (10% running time)			Sweetening Flow (90% running time)		
Pump Station Flow Rate	1331 l/s			35 l/s		
Required Total Head	163m			77m		
Proposed Pump Configuration	Duty/Assist/Assist/Assist			Duty/Standby		
Pump Numbers	1 small pump + 3 large pumps			1 small pump (With 1 standby small pump)		
Pump details	Rated Pump Capacity (l/s)	Operating Pump Speed (RPM)	Operating Pump Power (kW)	Rated Pump Capacity (l/s)	Operating Pump Speed (RPM)	Operating Pump Power (kW)
Small Pump	230	1476	550	220	1000 to 1476	150 to 550
Large Pump	370	1352	850	---		

Table 2-11: Control levels of the pumping station

Control Levels	1st Duty	2nd Assisted	3rd Assisted	4th Assisted
Ground Level (mAOD)	73			
High Level Alarm (mAOD)	72.5			
Pump Cut-in Level (mAOD)	70.5	71	71.5	72
Pump Cut-out Level (mAOD)	70	70.5	71	71.5
Low Level Alarm (mAOD)	70			
Sump Bottom Level (mAOD)	67			

2.2.4.2.3 Flow and Pressure Measurement

Flow meters and pressure transmitters shall be installed at the pumping station and new rising main in a measurement pit to record the flow and pressure data. The equipment status and control signals from the I/O or field bus from the pumps and instrumentation shall be connected to the SCADA workstations at Minworth STW. There should be ultrasonic level sensors to monitor water levels between the BPT's TWL and BWL. The signal of BPT's TWL and BWL shall be fed back to STT Transfer PS. The pump control shall interlock with the BPT's water level sensors and tune down pump speed to reduce flow when approaching BPT's TWL.

2.2.4.2.4 Odour and Noise Control

To alleviate odour impacts, the inlet culvert shall be enclosed with covers. New odour control facilities would be installed where necessary to remove the septic condition.

For noise impacts, the pumping station shall be designed in such a way that the operating noise as measured from equipment at 1m shall be less than 80 dB(A), where acoustic enclosures or accessories be installed to suit the operational and environmental needs.

2.2.4.2.5 Electrical Arrangement

The estimated electricity input requirement for the STT Pumping Station is summarized in Table 2-12 below. For details of the existing power capacity and the impact of these proposals, please refer to Section 2.2.9.

Table 2-12: Electricity Input Requirement

M&E Equipment	Total Rated Power	Power Factor	Supply Voltage	Total Running Current
Pumps' motor (Small)	1100kW	0.8	400 V	1985 A
Pumps motor (Large)	2550kW	0.8	3.3kV	557 A
Lighting	28kW	0.8	400 V	50A
Ventilation	28KW	0.8	400 V	50A
Building services*	56KW	0.8	400 V	100A

* Included estimates for fire service installation, lifting appliances, security and access control and other building service installations

The pumping station is supplied from the same sources as the new treatment works and the existing works and therefore will have the same level of resilience as Minworth WwTW.

2.2.4.2.6 Initial Flood Risk Assessment

The pumping station falls inside the boundaries of Flood Zone 2 which according to Gov.UK is a low-risk zone, meaning that each year this area has a chance of flooding of between 0.1% up to 1%. This considers the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped or fail. The control panels should be elevated, and waterproof in case of a flooding event.

2.2.4.3 Pipeline

The pipeline consists of a section of pumped pressurised pipework rising up from the transfer pumping station (rising main) followed by a section of gravity pressurised pipework (gravity main) falling from the break pressure tank to the outfall. Please reference Annex A 2 Pipeline Route Appraisal for details of the route optioneering study.

2.2.4.3.1 Pipe Diameters

Table 2-13 identifies the pipe diameters included in the conceptual design. Pipe diameters were chosen to accommodate the flow whilst keeping flow velocities between 0.5m/s and 2.0 m/s as per BS EN 805. Given the pipeline is required to accommodate different peak flows for a fixed diameter, the actual velocity observed will vary. The pipe diameter selection is therefore undertaken on a balance of OPEX and CAPEX, since larger pipes would result in lower velocities, lower headloss, and therefore a reduced pumping energy demand - when compared to smaller diameter pipes for the same flow rate.

Due to the significant difference between the peak delivery flow and the sweetening flow, it is not possible to achieve a velocity between the recommended range for a single pipe diameter. Therefore, the pipe diameters recommended in Table 2-13 below provide a balance between the peak and sweetening flow demands.

The Gate 2 solution reduces pipe diameter of the gravity main, compared to the Gate 1 solution, resulting in approximately 62m head remaining at the outfall.

Table 2-13: Pipeline sizing

Section	Length (km)	Static lift (m)	Pipeline types	Flow (Mld)	Velocity (m/s)	Headloss (m)	Nominal bore (mm)	Assumed Material
Rising main	19.2km	67.9	Pressurised rising main	115	2.13	72.4	900	Steel
				3	0.06	0.102		
Gravity main	12.2km	n/a	Pressurised gravity main	115	1.56	25.6	1050	Steel
				3	0.04	0.027		

The headloss calculations have been based on a pipe roughness 0.3mm for a steel pipe, and fittings losses of 15% of total frictional headloss.

2.2.4.3.2 Rising Main

The rising main transfers the treated water 15.9km from the transfer pumping station to the break pressure tank. The route of the rising main is shown on Figure 2-15. The rising main is assumed to a be a thin wall steel pipe, however further assessment as to the optimal pipe material is to be undertaken at the next stage of design. Air release, washout, and line valves, located within buried chambers, will be located along the pipeline to enable operation and maintenance. In addition, hatch boxes are to be located along the pipeline, providing means of accessing and cleaning. Table 2-14 identifies the typical spacing of these assets along the pipeline and provides and indicative total number. The final number of valves will be dependent on the detailed design of the vertical pipeline alignment.

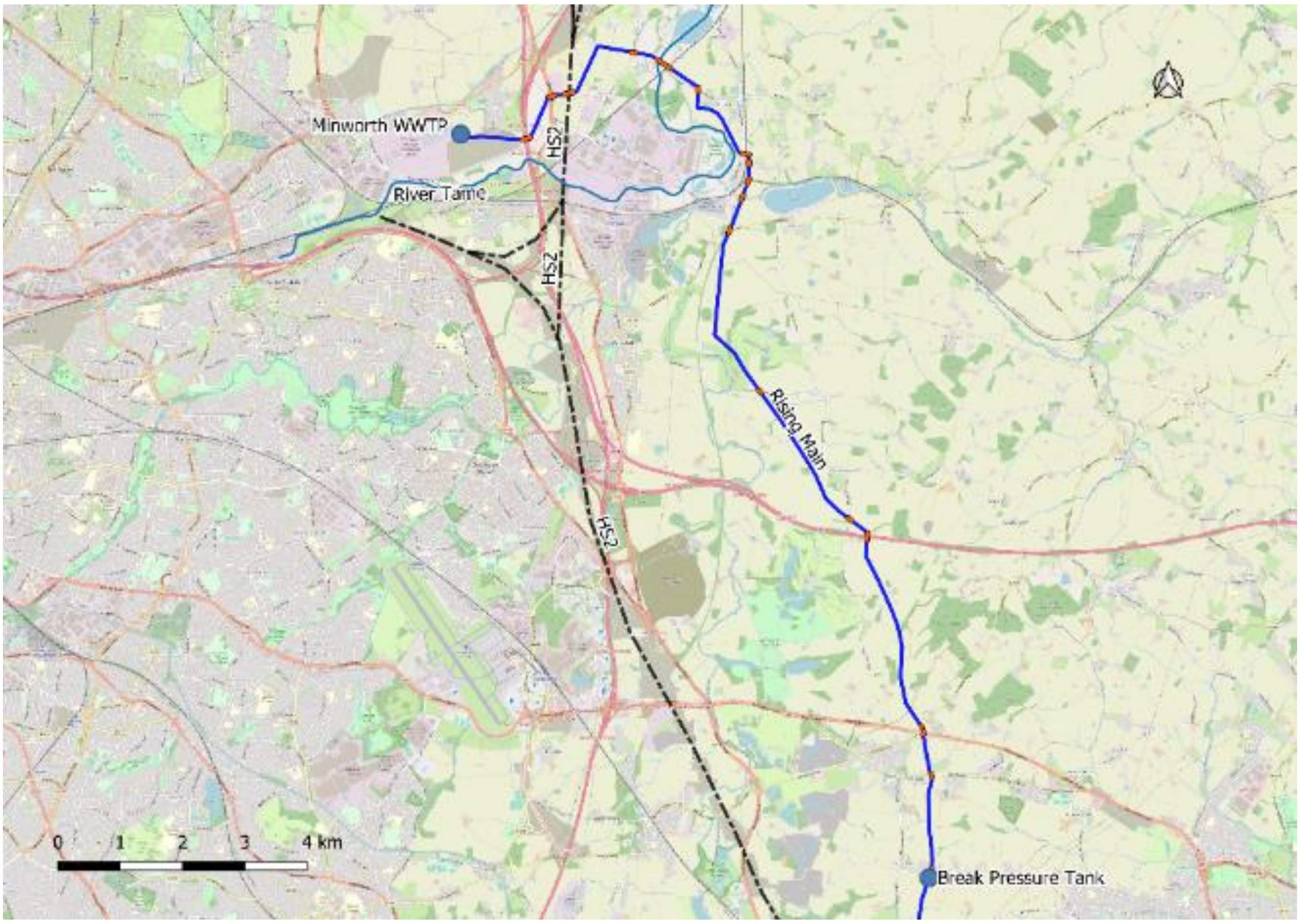
Table 2-14: Rising Main Valve Requirements

Asset Type	Typical Spacing	Total Number	Comments
Line Valve	5km	3	Excludes line valves located at the BPT and Transfer Pumping Station
Air Release Valve	300m	64	The number of air valves is dependent on the vertical alignment of the pipeline. Air valves will be located at all high points and intermediate valves on rising sections of pipe greater than 1km. The total number provided is therefore indicative and subject to change at detailed design.
Washout Valve	300m	64	The number of washouts is dependent on the vertical alignment of the pipeline. Washout valves will be located at all low points along the pipeline. The total number provided is therefore indicative and subject to change at detailed design.
Hatch Boxes	500m	39	

In open cut sections, it is assumed that the pipeline will be buried at a minimum cover of 1.2m, up to a maximum depth of 6m. Without full ground investigation a full assessment of the pipe bedding requirements cannot be undertaken. For the purposes of this Gate 2 design, it is assumed that 90-95% of the as dug material will be recycled for use as pipe bedding with the steel pipe. Where the recycled pipe bedding does not meet the required quality to be used as backfill, imported granular material will be required.

Section 3.2.1 discusses the working corridor required for construction of the rising main. The following Figure 2-15 indicates the preferred route for the rising main pipeline.

Figure 2-15: Rising Main Preferred Route. Orange lines indicate trenchless sections.



2.2.4.3.3 Rising Main Crossings

Trenchless technique is proposed for the following crossings on the rising main.

Table 2-15: Trenchless crossings on the rising main

No.	Length (m)	Section of Pipe	Trenchless Technique	Crossings
R1	147	Rising main	Pipe Jack	M42
R2	103	Rising main	Pipe Jack	A446, HV
R3	153	Rising main	Pipe Jack	HS2
R4	77	Rising main	Auger	Minor Road
R5	266	Rising main	Pipe Jack	River Tame, Minor Road, Rail
R6	80	Rising main	Auger	Minor Road
R7	119	Rising main	Pipe Jack	Rail, Minor Road
R8	62	Rising main	Auger	Minor Road
R9	85	Rising main	Auger	Rail
R10	84	Rising main	Auger	River Bourne
R11	82	Rising main	Auger	B4114

No.	Length (m)	Section of Pipe	Trenchless Technique	Crossings
R12	57	Rising main	Auger	Coleshill Road
R13	72	Rising main	Auger	Packington Lane
R14	116	Rising main	Pipe Jack	M6
R15	23	Rising main	Auger	Fillongley Road
R16	55	Rising main	Auger	Meriden Bypass
R17	49	Rising main	Auger	Old Road B
R18	36	Rising main	Auger	Back Lane

2.2.4.3.4 Break Pressure Tank

Location details redacted

The break pressure tank (BPT) would be constructed as a pre-cast reinforced concrete tank. The tank would be partially buried, so there would be a need for excavation, and the appropriate cut and fill balance calculation and detailed hydraulic review would determine the base slab level.

The BPT is identified on the pipeline route Figure 2-15 above. The BPT will be located at the high point of the pipe route, at the following address: [redacted]

The rising main will deliver water to the tank and water will be fed by gravity to the discharge point. The tank is assumed to have 60 mins peak flow storage. The 60-minute storage requirement represents a suitable volume of water allowing a safe controlled shutdown of the transfer pumping station without dewatering the pipeline and provides transient protection in case of a power failure at the transfer pumping station. This retention time could be reduced to 30 mins of peak flow after conducting transient analysis during detailed design phase, which has the potential to introduce CAPEX cost savings. The tank site will consist of:

- Partly buried covered tank, landscaped to reduce visual impact. It is assumed the tank will be made of pre-cast concrete, with two cells;
- Inlet chamber, with cross connections and isolation valves to direct the flow to either or both cells. Isolation valves will have bypasses to facilitate valve operations
- Inlet meter chamber
- Outlet meter chamber
- Inlet float control
- Outlet isolation valve chamber with cross connections as above to allow isolation of each cell
- Telemetry kiosk
- Access road and parking area
- Security equipment and fencing

After construction and testing, the BPT would be covered with earth, topsoil and seeded with grass. Approximate tank dimensions are shown in Table 2-16.

Table 2-16: Break Pressure Tank dimensions

Peak Flow	1hr Storage Volume	Approx. Size (m)	Permanent BPT Site size
57 Mld	2.4Ml / 2400 m^3	1 nr 22 x 22 x 5	85 x 85m
115 Mld	4.8Ml / 4800 m^3	2 nr 22 x 22 x 5	85 x 85m

The plan and long section drawings are included in Appendix B which also includes detail drawings showing the layout of the BPT compound and the access road. The temporary compound area, adjacent to the main site, will be used to temporarily accommodate welfare and storage for the construction of the pipe runs next to the BPT.

2.2.4.3.5 Gravity Main

The gravity main transfers the treated water 12.3km from the BPT to the River Avon discharge outfall. The route of the gravity main is shown on Figure 2-16. The gravity main is assumed to a be a thin wall steel pipe, however further assessment as to the optimal pipe material is to be undertaken at the next stage of design. Air release, washout, and line valves, located within buried chambers, will be located along the pipeline to enable operation and maintenance. In addition, hatch boxes are also located along the pipeline, providing means of accessing and cleaning. Table 2-17 identifies the typical spacing of these assets along the pipeline and provides and indicative total number. The final number of valves will be dependent on the detailed design of the vertical pipeline alignment.

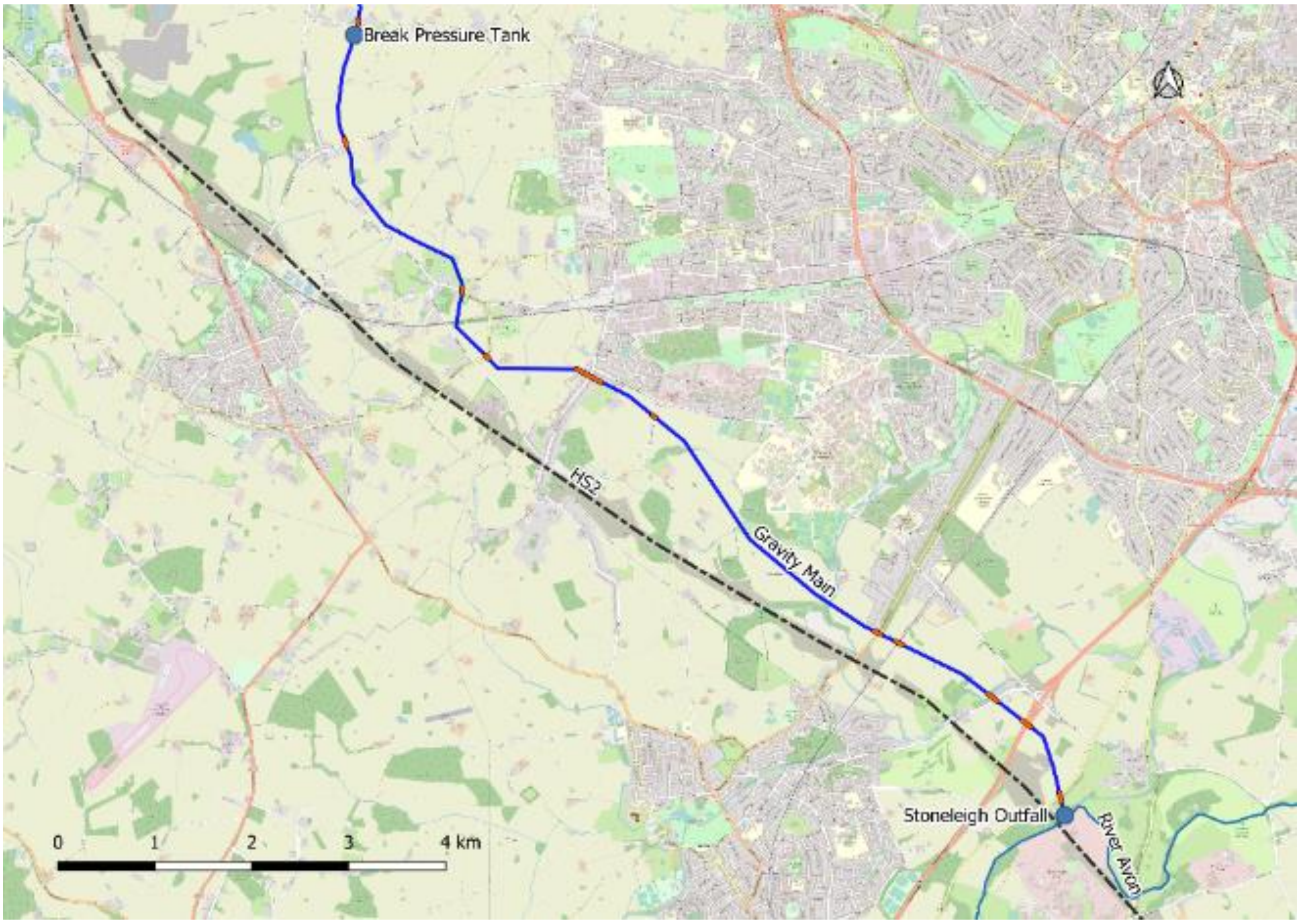
Table 2-17: Gravity Main Valve Requirements

Asset Type	Typical Spacing	Total Number	Comments
Line Valve	5km	2	Excludes line valves located at the BPT and Transfer Pumping Station
Air Release Valve	300m	41	The number of air valves is dependent on the vertical alignment of the pipeline. Air valves will be located at all high points and intermediate valves on rising sections of pipe greater than 1km. The total number provided is therefore indicative and subject to change at detailed design.
Washout Valve	300m	41	The number of washouts is dependent on the vertical alignment of the pipeline. Washout valves will be located at all low points along the pipeline. The total number provided is therefore indicative and subject to change at detailed design.
Hatch Boxes	500m	25	

In open cut sections, it is assumed that the pipeline will be buried at a minimum cover of 1.2m, up to a maximum depth of 6m. Without full ground investigation a full assessment of the pipe bedding requirements cannot be undertaken. For the purposes of this Gate 2 design, it is assumed that 90-95% of the as dug material will be recycled for use as pipe bedding with the steel pipe. Where the recycled pipe bedding does not meet the required quality to be used as backfill, imported granular material will be required.

Section 3.2.1 discusses the working corridor required for construction of the rising main. The following Figure 2-16 indicates the preferred route for the rising main pipeline.

Figure 2-16 Gravity Main Preferred Route. Orange lines indicate trenchless sections.



2.2.4.3.6 Gravity Main Crossings

Trenchless technique is proposed for the following crossings on the gravity main:

Table 2-18: Trenchless crossings for preferred gravity main route

ID	Length (m)	Section of Pipe	Trenchless Technique	Crossings
G1	81	Gravity	Auger	Coventry Road
G2	54	Gravity	Auger	Spencer's Lane
G3	50	Gravity	Auger	Nailcore Lane
G4	294	Gravity	Pipe Jack	Cromwell Lane
G5	43	Gravity	Auger	Bockendon Road
G6	77	Gravity	Auger	A429
G7	77	Gravity	Auger	Rail
G8	127	Gravity	Pipe Jack	Dalehouse Lane
G9	113	Gravity	Pipe Jack	A46
G10	98	Gravity	Auger	B4115

The following open cut crossings are also proposed for the gravity main:

Table 2-19: Open cut crossings for preferred route

No.	Crossing
3	Minor Roads
3	High Voltage
7	Ordinary Watercourses

2.2.4.4 River Avon Discharge Outfall

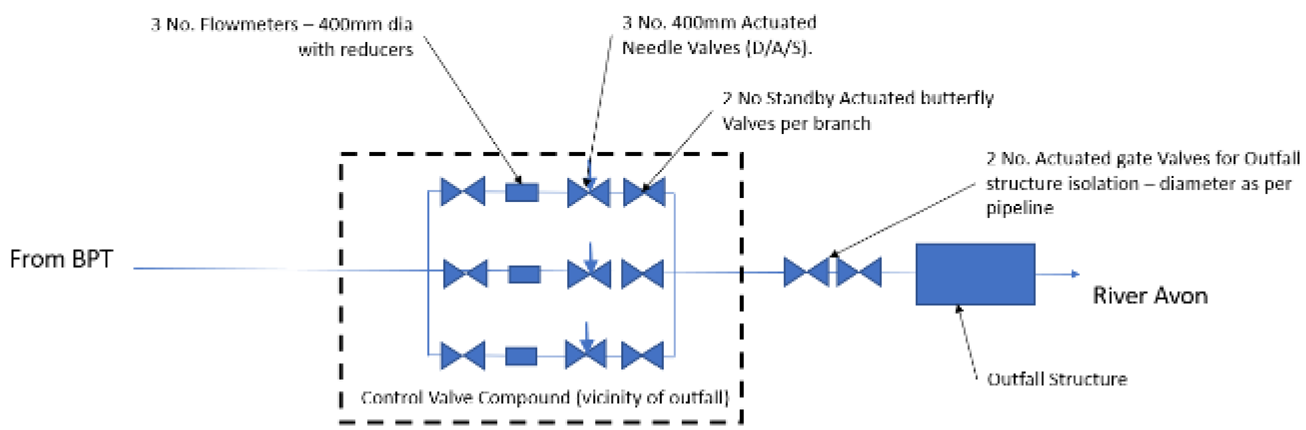
Location details redacted

The discharge outfall structure would be constructed within the banks of the River Avon, just after the confluence with the River Sowe. The address of discharge location is Stoneleigh, [redacted] Reference Figure 2-17 below and Drawing A7W13155-CY-DRA-216531.

Figure 2-17: Discharge location at Stoneleigh

3No. flow control valves are required at the River Avon discharge outfall to provide control of the outlet flow and ensuring that the gravity pipe remains charged. Due to the range of flow demands, the flow control valves will operate in a duty / assist / standby arrangement. The gravity main will branch into 3No. pipe runs. Each branch will contain a flow meter and a flow control valve, along with 2No. actuated butterfly valves allowing isolation of the branch. The control valve compound will include a control and sampling kiosk and sampling chamber.

Figure 2-18 Flow control valve compound arrangement



Downstream of the flow control compound, a headwall structure allows the pipe to discharge into the River Avon. 2No. actuated control valves (duty / standby) are required to allow isolation of the structure from the pipeline, preventing backflow of river water into the pipe during maintenance.

The headwall structure is an in-situ curved concrete stepped gravity weir, approximately 10m long, based on a broad crested weir with 200mm head over the weir. Detailed consideration of the cascade will be carried out in later design phases to minimise the impact of the discharge on the local environment and river.

Vehicular access to the site is achieved by a new access track, connecting into an existing private track off the B4115. Agreement with the private track owner will be required to allow utilisation for access to the outfall structure site. The new and existing tracks will be required to allow infrequent access for cranes for maintenance of the flow control valve. An assessment is required at the next design stage to confirm the suitability of the existing access track to cater for the required traffic movements.

The proposed outfall site topography is flat at 54mAOD. A review of the EA flood maps indicates that this location sits within a medium risk flood zone, meaning that each year this area has a chance of flooding of between 1% and 3.3%. The detailed design for the outfall site shall take this into account and electrical equipment located outside of the flood zone where possible, or above the flood level.

2.2.5 Ground Conditions

2.2.5.1 Introduction and Resources

The preferred pipeline route option comprises the installation of a shallow buried pipe (≈2.5m depth) in a trench across open ground. However, the route crosses major third party owned / operated infrastructure including Railways (e.g., a future HS2 route), Major roads (Trunk Roads and A Roads), Motorways and watercourses. These will require the pipeline to be installed at depth under the infrastructure, requiring the drilling of trenchless crossings to install the pipeline.

Trenchless crossings are the main geotechnical obstacle / risk requiring investigation due to the variable ground and groundwater conditions expected to be encountered to determine the most appropriate crossing methods to be employed.

The installation of the pipeline in open ground will be by shallow trenches installed in a construction corridor; however, these will be affected by the ground and groundwater conditions, where temporary works comprising sheet piles / localized dewatering or benching of the excavations may be required to install the pipelines, support excavations and control groundwater.

This geotechnical appraisal has been compiled from the following available information:

British Geological Survey (BGS) on-line database http://mapapps.bgs.ac.uk/geologyofbritain/home.html

BGS online Geological Maps #168 Birmingham, #184 Warwick
https://webapps.bgs.ac.uk/data/maps/maps.cfc?method=listResults&MapName=&series=E50k&scale=&getLatest=Y&pageSize=100

Highways England Geotechnical Data Management System (HAGDMS)
https://www.hagdms.co.uk/

Groundsure enviro data viewer
https://www.groundsure.io/#

2.2.5.2 Geotechnical Analysis Summary

Table 2-20: Geotechnical Analysis Summary

Section	Trenchless Crossings	Geotechnical Issues – Superficial Deposits	Geotechnical Issues – Bedrock	Comments
Treatment Works	NA	Superficially the ground is made ground (soft to firm gravelly clay) with a mixture of loose to medium dense granular materials expected to be found where the ground is still in its natural condition.	Cohesive layers comprising weathered upper layers of bedrock - a firm to stiff silty clay overlaid over sandstone bedrock which may have groundwater in its top layers.	The site has had previous usage as a sewage works and all potential hazards that that entails.
Pipeline	Identified potential individual trenchless crossing locations; however, the number could be reduced by combining individual crossings into a longer drive.	Both granular and cohesive materials are expected along the entire route, which will have potentially high groundwater, especially near water courses. These may require groundwater control by trenching and/or dewatering.	Both granular and cohesive materials typically comprising the weathered upper layers of the bedrock, are expected along the entire route. These will have the potential for, but limited groundwater where outcropping at ground level.	The route does not follow highways, therefore is in open ground with potentially limited buried services, but multiple landowners and potential access issues.

2.2.5.3 Geology / Groundwater

The Minworth WwTW is underlain by superficial deposits of the River Terrace Deposits, comprising of loose to medium dense Sands & Gravels, between 3m to 5m deep. However, due to the industrial nature of the site, this material has been re-worked as Made Ground in some locations across the WwTW site. Its composition varies between soft to firm gravelly clay, to depths between 1m to 5m deep. Alluvial deposits, comprising of clay/silt, sand or gravels may be present in the southern side of the Minworth WwTW site, associated with the River Tame. The superficial deposits and made ground overlay the bedrock deposits of the Sidmouth Mudstone Formation. This is described a firm to stiff silty Clay with fine to medium grained gravel. This is the weathered top of the Sidmouth Sandstone Formation. The solid bedrock (unweathered) sandstone is encountered between 6m to 10m.bgl. Groundwater was encountered in the weathered bedrock between 4m to 6m.bgl.

The pipeline route's underlying ground conditions comprise of loose granular and / or soft cohesive superficial deposits which are mainly located in the Northern part of the route. These are associated with, and in the vicinity of, water courses that will be crossed, requiring the construction of trenchless crossings. The deposits are likely to have a high groundwater (potentially variable due to seasonal conditions), which may require control by either temporary work to cut off the groundwater (sheet piles if route / access corridors are limited or by the benching of excavations if space is available), combined with localized dewatering where pipeline trenches are being installed across country. There is no single route that avoids these potential issues.

In the central section of the route there are stretches where there are no superficial deposits recorded, indicating that bedrock outcrops at ground level. This will be either a stiff clay, being the upper weathered layers of the underlying mudstones, or a medium dense to dense granular material comprising sand and / or gravel sized fragments sourced from the various sandstone bedrock types. Groundwater may be present in these but is unlikely to be present in significant volumes requiring temporary works of sheet piles or dewatering.

A suitable, specified, ground investigation to determine the ground conditions, i.e., granular, cohesive or bedrock and the strength and groundwater regimes, will be required to determine the best suited methods to be adopted for trenchless crossings.

2.2.6 Land Requirements

There is a sufficient space on the existing Minworth site to fit the new water treatment elements, both permanent and temporary for up to the maximum size of works (TREAT230). Space required for offsite assets such as the BPT and Outfall are also identified below. Assumptions for compound sizes are as follow:

- Pipeline construction right of way: minimum of 40m wide (20m on each side of the trench)
- Temporary satellite compound: minimum area of 1,600 m^2

Table 2-21: Land Requirements

Option	Estimated Land Area required (Permanent) m^2	Estimated Land Area required (Temporary) m^2
TREAT57	36,000 m^2	36,000 + 7,500 = 43,500 m^2
TREAT57.ALT	28,000 m^2	28,000 + 7,500 = 35,500 m^2
TREAT115	38,000 m^2	38,000 + 7,500 = 45,500 m^2
TREAT115.ALT	32,000 m^2	32,000 + 7,500 = 39,500 m^2
TREAT172	42,000 m^2	42,000 + 7,500 = 49,500 m^2
TREAT230	52,000 m^2	52,000 + 7,500 = 59,500 m^2
GUC Transfer PS	Covered in GUC SRO	Covered in GUC SRO
STT115 – Transfer PS	25 x 20 = 500 m^2	40 x 40 = 1,600 m^2
STT115 – Rising Main	1500 m^2	2,000 + 702,000 = 704,000 m^2
STT115 – Break Pressure Tank	85 x 85 + 8 x 250 = 9,225 m^2	9,225 + 42 x 42 = 10,989 m^2
STT115 – Gravity Main	1200 m^2	2,050 + 450,000 = 452,050 m^2
STT115 – Outfall	900 + 8 x 50 = 1,300 m^2	1,300 + 3,600 = 4,900 m^2

2.2.7 Operating Philosophy

The proposed operating modes for the AWTP are:

- Normal operation – AWTP is operating in normal automatic control and delivering water for onward transfer to either STT or GUC or both.
- Hot Standby – mode of operation where the AWTP runs at 20% of peak flow, with a 'duty' stream under normal operation in rotation with other plant streams in standby. This mode allows the plant to return into normal operation mode within 17days. This mode provides the sweetening flow(s) for the pipeline(s) which are less than the AWTP minimum flow.
- Non-operational – AWTP is out of service and there is minimal ongoing expenditure.

The pipeline elements of the scheme will be run in parallel with the operation of the AWTP. Therefore, the transfer pumping station and pipeline would be run in a hot standby mode for the same period that the AWTP is, with the minimum turn-down treated flows being available to be discharged via the pipeline to the river when required. Excess flows not required to support sweetening flow within the pipeline could be returned to the FE channel to reduce operational cost and carbon.

Refer to Operating Philosophy in Appendix D.3 for further details.

2.2.8 Inter Site Control System Requirements

The control system for the whole STT / GUC transfer system has yet to be developed. A mechanism will be required to be implemented to determine what level of treatment capacity the AWTP shall operate at and whether all the flow treated will be transferred to STT and / or GUC transfer PS.

The ability of the AWTP to treat the final effluent from Minworth is dependent on the quality of the final effluent being of sufficient quality to meet the current environmental permit for discharge. Abstraction from the final effluent channel will only be appropriate if the current environmental permit for discharge is being met Therefore a control loop will be required between the final effluent monitoring station and the AWTP inlet pumping station.

The operation of the transfer pumping stations will be dependent on the quality of the effluent meeting the requirement of the environmental permit for discharge.

Telemetry signals from the proposed AWTP will be tied into the existing site telemetry infrastructure. The AWTP will need to be tied into the existing site network.

2.2.9 Power Requirements

The current Available Supply Capacity (ASC) for Minworth STW is 8.5MVA. Based on monthly maximum demand data over the previous 12 months (04/21 – 03/22), the average maximum demand was 7MVA with 3 separate periods surpassing 8MVA. It is therefore assumed that the proposed AWTP or the AWTP Alternative will require increased capacity to be installed which will entail modifications to be made to the existing site infrastructure.

There are 2 options to provide the necessary power to the AWTP: provide a new standalone supply or upgrade the existing site infrastructure:

1. Provide a new standalone supply – A new 11kV supply from the DNO terminating at a new HV substation. Additional 11kV/3.3kV and 3.3kV/415kV step-down transformers will terminate at each individual Motor Control Centre (MCC) to distribute power to the respective treatment areas.
2. Upgrade the existing site supply – A new interconnector fed from the main HV switchboard terminating at a new substation via a 11kV/3.3kV step-down transformer located outside the substation. Additional 3.3kV/415kV step-down transformers will terminate at each individual Motor Control Centre (MCC) to distribute power to the respective treatment areas. Alternatively upgrade the existing site by extending the ring main with the AWTP integrated into the existing site 11kV or 3.3kV ring.

At this stage it is assumed that a new standalone supply is provided and that the additional supply capacity from the local Distribution Network Operator (DNO) is available. Loss of telemetry at the BPT as well as loss of power to the flow control valves will result in the valves remaining in their current state which is acceptable if the pumping conditions remain stable. To maintain optimum conditions, UPS could be added.

Table 2-22: Table of demands (kVA)

	TREAT57	TREAT57.ALT	TREAT115	TREAT115.ALT	TREAT172	TREAT230
Inlet PS	112	133	309	309	340	505
CoMag	25	25	39	39	53	77
Ozonation	336	-	691	-	1031	1394
BAC	10	-	10	-	10	10
Interstage PS	634	-	933	-	1224	1368
GAC	10	-	10	-	10	10
Site Return PS	15	15	37	37	75	75
STT Transfer PS	2724	2724	2724	2724	2724	2724

	TREAT57	TREAT57.ALT	TREAT115	TREAT115.ALT	TREAT172	TREAT230
GUC Transfer PS	0	0	0	0	Defined by GUC (assumed to be 2724)	Defined by GUC (assumed to be 2724)
Break pressure tank	5	5	5	5	5	5
Outlet control	15	15	15	15	15	15
Total	3886	2917	4773	3129	8211	8907

2.2.10 Energy Recovery and Renewable Energy Opportunities

2.2.10.1 Hydropower

There is approximately 62m pressure available within the gravity pipeline which discharges to the River Avon when the pipeline is transferring 115Mld – it may be possible to install a turbine in this length to recover this head as electricity. Hydraulic analysis has shown that it is not possible to reduce this head to zero (highest carbon saving) so this is an opportunity which could be developed.

Power is the rate of producing energy. Power is measured in Watts (W). Energy is what is used to do work and is measured in kilowatt-hours (kWh).

Using the Hydropower equation to estimate the amount of energy recovery:

$P = f \times g \times H(\text{net}) \times \eta$

Where:

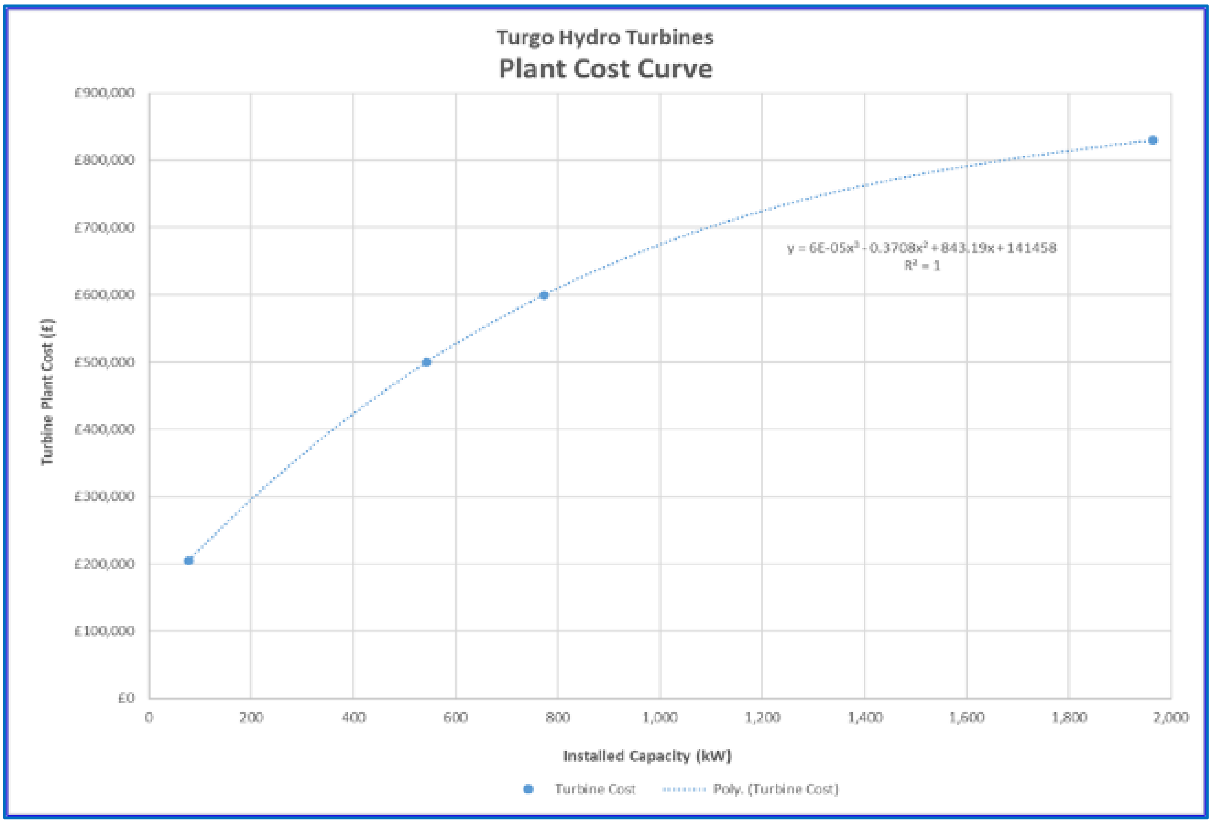
- P: power, measured in Watts (W)
- f: the flow rate in litres/second
- g: the gravitational constant, which is $9.81 m/s^2$
- H (net): the net head (pressure)
- η : the product of all of the component efficiencies, which are normally the turbine, drive system and generator. For a typical hydro system, the turbine efficiency would be 85%, drive efficiency 95% and generator efficiency 93%, so the overall system efficiency would be: 0.85 x 0.95 x 0.93 = 0.751 i.e., 75.1%

For the purposes of assessing annual energy outputs, it has been assumed that the bypass pipeline would be operated at the full design flow for 10% of the time, with a sweetening flow of 3 Mld passed for 90% of the time if required. It has also been assumed that separate turbines would be provided for full flow and sweetening flow operation, as the main turbine would be unable to operate efficiently at very low flows.

Turgo turbines are impulse machines that can operate efficiently over a wide range of flows and have deflector plates that can be utilised to gradually reduce the flow in the event of an emergency shutdown. Turgo turbines are for medium head applications of between 30m and 200m and thus well suited to this site and have a high efficiency over a wide range of flows.

We have derived a cost curve for Turgo impulse turbines, based on plant costs supplied by Gilkes of Kendal that includes the cost of the turbine, generator, and control equipment, but excluding cabling, transformer, civil works for the powerhouse and the grid connection. The plant cost curve is presented in Figure 2-19.

Figure 2-19: Turgo hydro turbines cost curve Commercial information redacted



Cabling and transformer costs have been estimated at 17% of the plant cost plus a further 50% for the powerhouse civils costs. A 32.14% contingency, covering an allowance for optimism bias, has also been included in the total CAPEX costs. The cost of a LV grid connection has been estimated at £150k based on the local DNO on-line cost estimator, although a fully priced quotation would need to be sought once the turbine site has been fixed and a route for the grid connection determined. Annual DNO use of system charges have been taken as [redacted]p/kWh for transmission and [redacted]p/kWh as an annual fee.

Table 2-23: Hydro Turbine Performance Summary

Q (Mld)	Installed Capacity (kW)	Net Head (m)	Annual Energy Generation (kWh/yr)	Total Capital Cost (£)
Maximum flow (115)	605	61.7	530,297	1,212,695
Sweetening flow (3)	26	61.3	206,049	252,379

An economic evaluation for each scenario has been carried out based on the following criteria:

- Discount Rate: 3.5% (Treasury Green Book)
- Utilisation Factor: 10% for main plant with 90% for sweetening flow plant
- Energy Value: [redacted]p/kWh
- DNO Charges:[redacted]p/kWh ([redacted]p/kWh transmission and [redacted]p/kWh annual fee)
- OPEX costs: 2% of M&E and 1% of Civils CAPEX cost per annum

It has been assumed that as Turgo turbines have flow control spear valves, with deflector plates, which may be operated either with or without the turbo generator in operation. This would thus obviate the need for a separate flow control valve, with a resulting cost saving estimated at approximately 20% of the turbine plant cost.

This has produced the following estimated unit cost of generation of [redacted] £/kWh when the pipeline is run at full capacity (115 Mld, 10% of time) and 0.090 £/kWh when only sweetening flow (3 Mld, 90% of time) passes through the turbine. This shows that the estimated unit cost of generation is less than the energy value of [redacted]p per kWh.

The costs for the additional sweetening flow plant have been based on the assumption that the main plant, station building, and electrical connection have already been provided for.

A net present value (NPV) analysis for this situation has thus been carried out by discounting the total CAPEX and OPEX costs, as well as the total annual energy revenues, over the life of the asset to derive the total NPV benefit as presented in the table below.

Table 2-24: Total NPV Benefit

Q (Mld)	Total NPV Benefit (£)
Maximum flow (115)	607,762
Sweetening flow (3)	495,442

This shows that the installation of energy recovery turbines would have a positive NPV benefit (at the 3.5% Treasury Green Book discount rate), based on a 10% utilisation and energy value of 21p/kWh. Note also that the optional sweetening flow turbine (with an 90% utilisation) also has a positive NPV benefit.

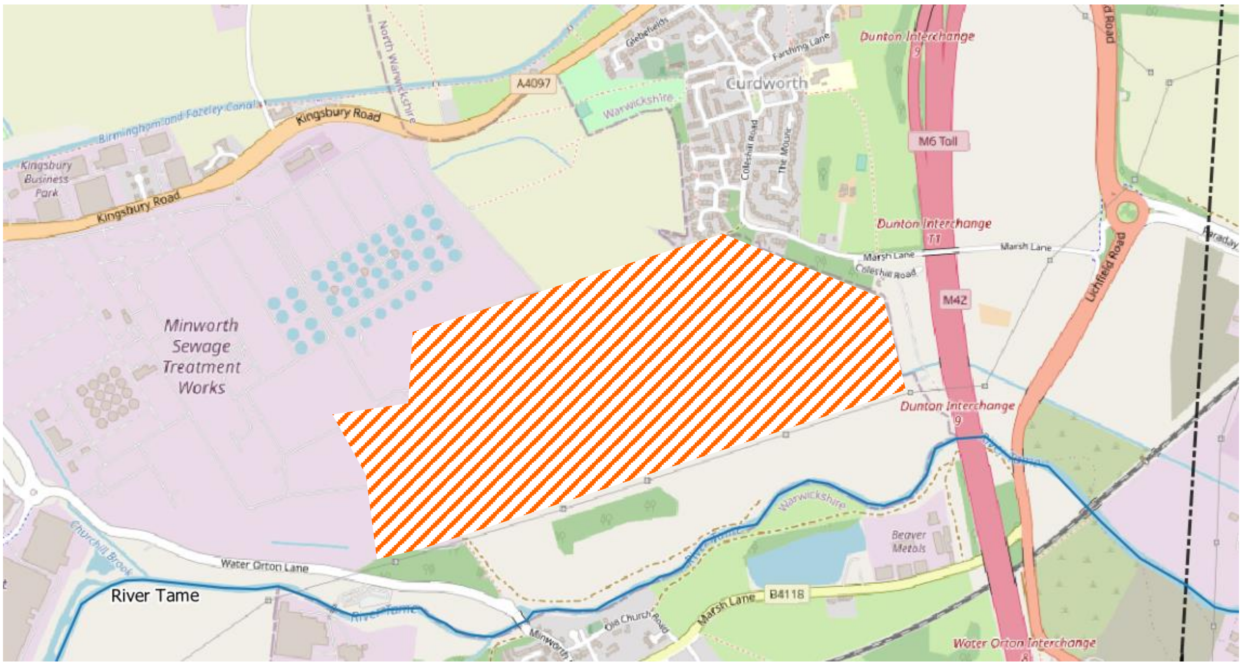
This demonstrates that it would be economically feasible to provide energy recovery turbines for a flow rate of 115 Mld and that provision of a separate, smaller sweetening flow turbine should also be economically feasible.

Power and energy generation can be maximised by keeping the inlet screen clear of debris which maintains a maximum system head.

2.2.10.2 Solar

There is approximately 57Ha of available land owned by STW adjacent to Minworth WwTW. This is the maximum possible size of land that could be used to install solar panels to reduce the carbon impact of the scheme as well as reduce operational cost through renewable energy. It is unlikely that the whole area could be used for this purpose due to requirements for wayleaves for existing assets, maintenance access and ecological reasons, however this section gives an indication of the maximum possible savings that could be made. Figure 2-20 shows the location of this maximum permissible area.

Figure 2-20: Maximum area available for the installation of solar panels.



It is estimated that 1Ha of ground mounted solar array has a capacity of 0.5MW and generates a saving of 95tCO2e per year. The net estimated savings (costs less income) for the installation are £[redacted]/Ha/year (at July 2022 prices).

Table 2-25 summarises the estimated maximum capacity and performance of the site if all the available area was utilised for installing solar panels. As noted above, It is unlikely that the whole area is used for this purpose and allowances for access roads, maintenance and wayleaves would be required. The financial and environmental benefits of the installation would need to be weighed against the ecological implications of transforming such a large area into a solar farm. It is not thought that the area would conflict with the local flight paths but this would be an important consideration for a development of this size.

Table 2-25: Solar panels performance summary

	Performance
Site area	57 Ha
Maximum potential capacity	28.5 MW
Carbon maximum savings	5,415 tCO2e per year
Net maximum savings	£[redacted]/year (July 2022 prices)

2.2.11 Carbon Opportunities

The carbon ambition has been set by an SRO-led task-and-finish group, consisting of the water companies with SROs, Water UK, RAPID and Ofwat, which seeks to cover Scope 1, 2 & 3 carbon emissions:

Scope 1 & 2 aligns with the Water UK stated ambition which set Net-Zero emissions by 2030.

Scope 3 aligns with the UK 2050 ambition but recognizes there is more to do on standardisation.

The early stages of the design process provide the greatest opportunity for carbon reduction through optimization of assets, reduction in the extent of new construction through route analysis and maximizing asset operation. The calculation considers the carbon embedded in construction, as well as operational carbon for the next 80 years. The results of the calculations are presented in Section 5. The SRO will reduce carbon through design and mitigations during future gates as necessary.

The scheme offers a low level of embodied carbon when compared to Gate 1 options and its updated options of North and South Warwick routes in Gate 2.

Throughout the design the following capital carbon reduction potentials considering lean construction practices and the principles of the circular economy have been considered:

- Low carbon concrete, substituting cement with other materials/ additives
- Novel alternatives to steel reinforcement in reinforced concrete (e.g., fibre-reinforced polymer bars).
- Use of steel pipeline with an end-of-life recovery rate of 85% with a potential saving of 1.31kgCO2e per kg
- Where new materials are required, utilising materials that have a high recycled content such as recycled steel and concrete mixes with ground granulated blast furnace slag.
- Selecting materials that have a long-life span and require minimal maintenance.
- Reduce demolition through trenchless techniques and avoid infrastructures such as railway lines, canals, motorways, highways, and urban areas.
- Re-use demolished material and existing available materials, e.g., processing, re-use of excavated material as fill.
- Minimising removal of vegetation to prevent loss of carbon storage in soils. Minimising removal of trees as they have a higher potential to sequester carbon.
- Prioritising local suppliers to reduce the distance travelled to site and with a certified carbon management system.
- Minimising material import. Where required sourcing material from other nearby projects to reduce the amount of virgin material used and also reduce transport emissions.
- Efficient methods of work, e.g., more sustainable transport solutions.
- Generally focussing on sustainable construction materials. Where new materials are required, utilising materials that have a high recycled content such as recycled steel and concrete mixes with ground granulated blast furnace slag.
- Selecting materials that have a long-life span and require minimal maintenance.

2.3 Interactions with Other SROs and WRMP24 Options

The Minworth SRO has the potential to provide water for both STT and GUC. To provide water for the GUC, a transfer pumping station and pipeline must also be constructed to the Coventry canal. For STT to be able to utilise the Minworth SRO as a source other infrastructure must be constructed such as the transfer between the River Severn and the River Thames.

2.4 Opportunities and Future Benefits Realisation

To realise the benefits of this additional water resource for discharge to STT, STT transfer between the River Severn and the River Thames has to be constructed to transfer water to Thames catchment. If this is not completed the water will be lost to the River Severn.

3 Scheme Delivery

3.1 Advanced Water Treatment Plant Construction Strategy

3.1.1 Advanced Water Treatment Plant

The AWTP will mainly consist of offsite fabricated components with minimal site connections and site preparation works. The larger components such as CoMag Tanks, Ozone contact tanks, and BAC/GAC will be brought to site either partially or fully assembled and lifted into position or cast in-situ as required. Pipework will then be installed to connect the process units together. The process units will need to be installed on reinforced concrete foundations. These will require local excavation to facilitate reinforcement fixing and shuttering. Concrete will be brought to site in ready-mix wagons and discharged directly into the formwork or placed using a mobile concrete pump. This is standard water treatment works construction methodology.

3.1.2 Other Civil Infrastructure

An inlet pipe to the AWTP will be installed from the existing final effluent channel. The majority of this ~300m long pipeline will be installed without affecting the FE channel. A small cofferdam will be required to be constructed within the FE channel to allow the WwTW to continue to operate whilst the works take place to construct a new opening in the FE channel wall. This methodology allows any strengthening of the FE channel wall that may be required to be undertaken in the "dry" without limitation on time scale. An assessment will be required to ensure that the FE channel is still capable of passing forward the required flows. If this is not possible with the cofferdam in place, then an over pumping assist arrangement will be required.

At the same time as the installation of the inlet pipework, the connection of the treated water returns pipework into the FE channel would be made using the same principals as outlined above.

The waste products from the AWTP backwash process will be returned to the head of the works for processing. This will be conveyed via a ~1,000m long pipeline. This pipe could be laid at ground level to assist with installation and reduce the associated construction risk of breaking ground. To maintain a constant elevation pipe supports may be required to accommodate the existing ground profile. Pipe sections will require lifting during the installation process and this will be undertaken by either a telehandler or a small excavator.

3.1.3 Construction Risks and Opportunities

When breaking ground in the location of the AWTP there is always a risk of discovering unidentified utilities. To mitigate this risk a GPR survey of the site in accordance with PAS128 should be undertaken prior to a contractor mobilising to site.

During construction of the AWTP foundations there is a construction risk caused by excavation. All Temporary Works procedures should be followed to ensure that slopes are stable and excavations safe, prior to setting teams to work. As the foundation construction progresses there are site risks associated with fixing rebar, installing shuttering, and placing concrete. These risks are not seen as significant and can all be mitigated by a competent contractor undertaking the works.

The process plant is mainly modular which reduces many of the site risks associated with in-situ construction. However, care should be taken to address the secondary construction risks associated with modular construction such as lifting provision, site logistics routes, and jointing of preassembled units.

The overground backwash return pipework will require interface with Minworth STP operations. During construction planning safe working corridors and exclusion zones should be identified to deconflict the contractor from site operations. Consideration should also be given to segregation of plant and personnel routing.

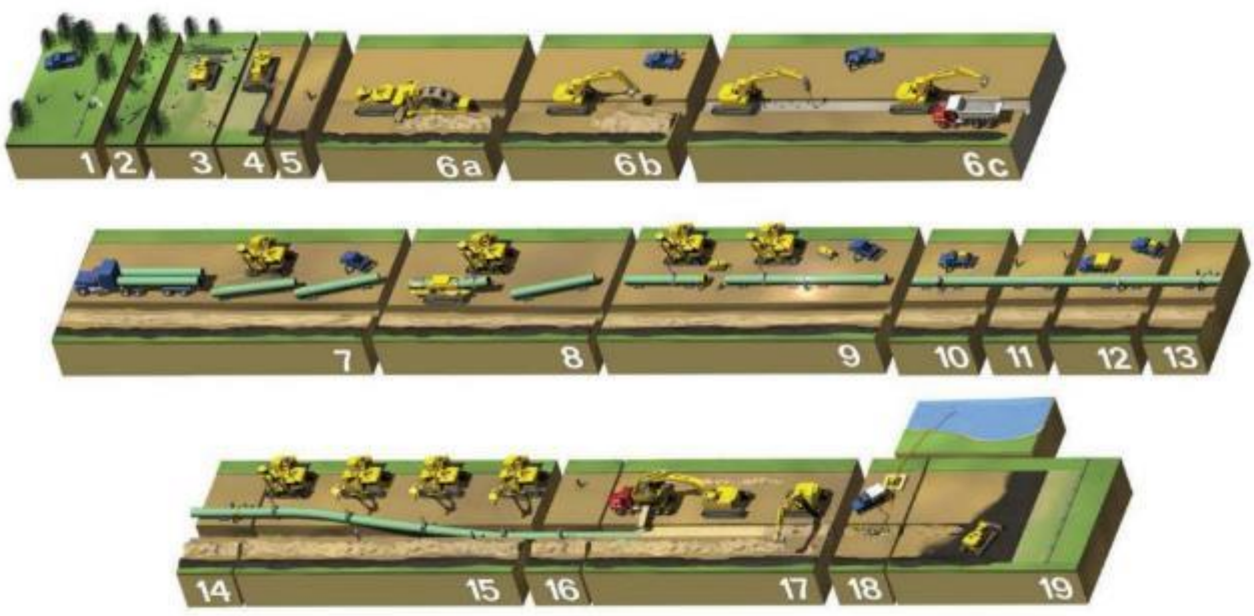
3.2 Pipeline Construction Strategy

3.2.1 Working Corridor

Except for the northern section the pipe alignment is in greenfield land. This provides few physical constraints to a contractor undertaking the works provided they have a suitable working corridor, and access to it, to undertake the works.

To specify a suitable working corridor the pipe installation sequence and construction methodology needs to be considered. Figure 3-1 outlines the typical construction activities associated with pipeline construction.

Figure 3-1: Typical Pipeline Construction Sequence (Source: Natural Resource Group Inc)



- 1-5. Right of Way (ROW) Preparation: Crews clear tress and debris from the ROW, grade the surface to provide a level workspace, segregate topsoil where necessary and re-stake the centreline of the route.
- 6a-c. Trenching: Team digs the trench for the pipeline using a wheel trencher, backhoe or rock trencher depending on the terrain.
- 7-8. Stringing and Bending: Stringing crew uses specialized equipment to move the pipe from the pipe yard to the ROW. When necessary, pipes are bent to conform to the topography and to follow the curves of the route.
- 9-13. Welding and Coating: Teams connect sections of pipe together to form one continuous length. Welds are visually inspected multiple times and at least once using x-ray technology. Each weld is also coated to inhibit corrosion.
- 14-16. Lowering: Highly skilled operators lift the pipe and lower it into the trench.
- 17. Backfilling and Final Grading: Teams return the soil to the trench in reverse order, so the topsoil remains on top and then grade the ROW to the final contour.
- 18. Hydrostatic Testing: Before the pipeline is put in service, crews pressure test the entire length using water.
- 19. ROW Restoration: This team is responsible for stabilizing the soil, cleaning up the ROW and returning the land as closely as possible to pre-construction conditions.
- These illustrations are conceptual and general in nature; specific construction and restoration techniques could vary depending on circumstances.

To facilitate these construction activities a working width of approximately 40m, 20m either side of the pipe centreline, has been identified along the route. This will allow room for pipeline construction activities, buffer zones, and logistics movements up and down the working corridor.

In the northern section of the pipeline route the pipe runs through brownfield and industrial land. The same 40m working corridor has been allowed in this section. Once initial discussion with landowners and operators have taken place there may be additional constraints that need to be applied which may amend these working corridors, and access routes, locally.

3.2.2 Working within Contaminated Land

The pipeline route and working corridor intersects area's which have been identified as historical landfill sites.

Site survey works (boreholes and trial pits) will be required to verify desktop records and inform installation methods and management methodology to safely overcome the presence of contaminated material.

Contaminated land has the potential to expose receptors to hazardous environments and is therefore required to be managed prior to and during construction. There are typically three contaminated land management methods which are commonly used and should be considered to manage or eliminate the exposure to harmful in-situ substances:

- Soil removal
- Containment
- Soil treatment

The Waste (England and Wales) Regulations 2011 details a waste hierarchy which prioritises management options from prevention to disposal to best protect the environment. Considering this regulation, the hierarchy of waste management principles and the area of contaminated land which the pipeline intersects, on-site remediation would be the preferred method of contaminated land management.

The main benefit of on-site remediation is the elimination of materials being sent to land fill and the reduction of vehicular movements and subsequent carbon emissions. Soil can be treated using biological, chemical, washing and vapour extraction techniques. The use of mobile on-site soil treatment and remediation methods should be further explored.

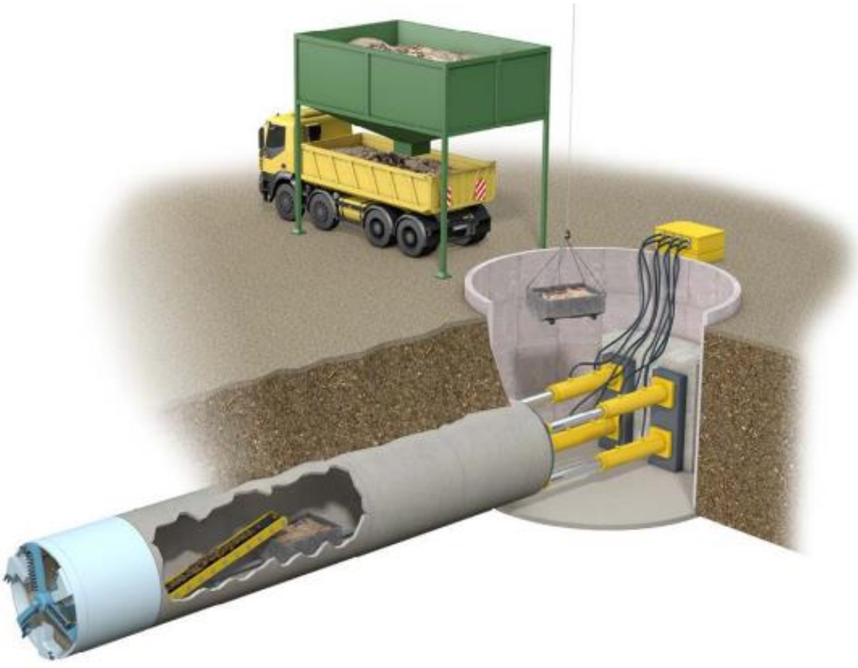
A cost and environmental impact assessment would benefit the decision process and ensure the correct methodology is selected based on the types of and volume of contamination (once identified), and the treatment methods.

3.2.3 Trenchless Pipe Sections

Where the pipe alignment interfaces with a physical constraint such as a highway, railway, or a river the design proposes to utilise trenchless techniques to install the pipe. Pipe jacking, or micro tunnelling, is a non-disruptive method of installing utility tunnels and conduits by thrusting pipes through the ground as controlled excavation is undertaken at the face. Due to the local geotechnical conditions along the route two types of micro tunnelling is proposed; conventional pipe jack Figure 3-2 , and auger bore.

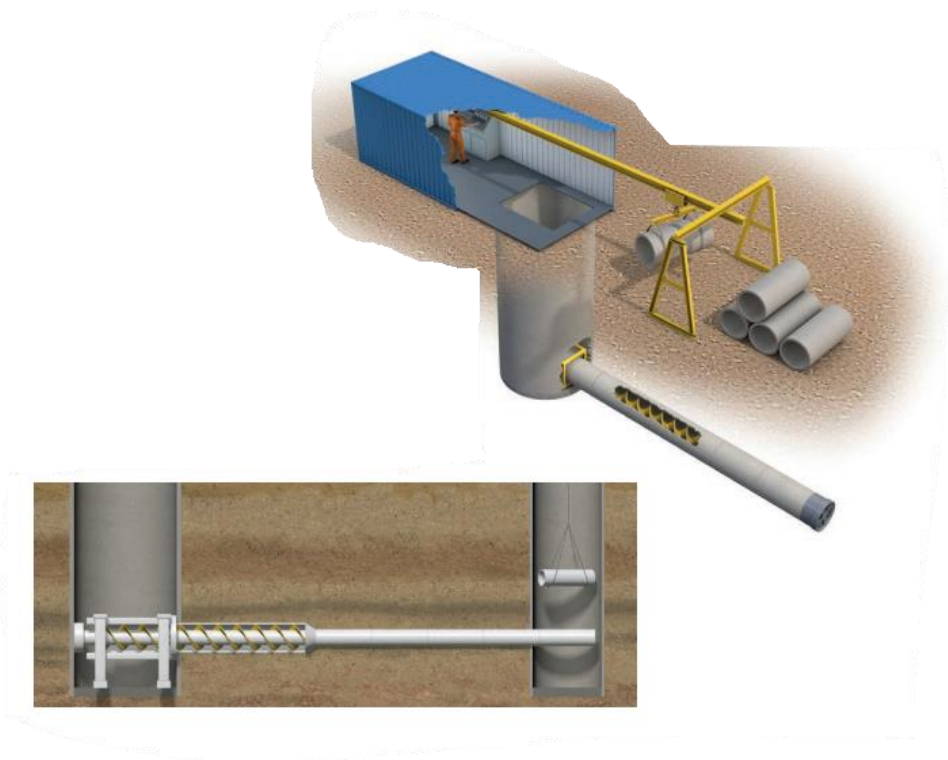
Figure 3- shows the relatively small entry pit with associated hydraulic jacking rig. The cutter head is installed initially and driven to allow a pre-cast concrete pipe section to be installed behind it. The hydraulic rams then apply a force to push the cutter head and pipe section through the ground. The cutter head and hydraulic rams are controlled remotely from the top of the entry shaft. By applying different force to each of the hydraulic rams the cutter head can be guided along the design pipe alignment. Spoil is transported through the installed pipe sections via conveyor. When it reaches the entry pit it is removed from the pit via crane and skip to a waiting HGV for disposal on or off site. Dependent on the type of ground expected different cutter heads can be used this may require additional support infrastructure such as slurry batching and filtration systems for a closed face slurry mix machine. A second reception pit is installed at the other side of the physical constraint to be tunnelled under. This allows the cutter head to be removed and reused once all pipe sections have been installed.

Figure 3-2: Typical Pipe Jacking Arrangement (Source: Pipe Jack Association)



Similar to pipe-jacking, Figure 3-3 shows a typical auger bore arrangement. This method utilises the same entry and reception pit to jack steel pipe sections through the ground. The difference is that the cutter head is replaced with an auger. The conveyor system is not required as the auger transports spoil along the installed pipe to the entry shaft for muck away.

Figure 3-3: Typical Auger Bore Arrangement (Source: Pipe Jack Association)



Production rates and cost of auger bore can be preferable over conventional pipe-jack however, the technique is limited to smaller diameters over shorter distances. The technique is generally only used for soft ground with no or low ground water as the cutting face is not sealed. The system also has limited steering capacity which makes it unsuitable for crossings where line and level accuracy is required

To undertake the micro tunnelling works, thrust and reception pits are required. These would normally be constructed by sinking pre-cast concrete rings into the ground and excavating within them. Alternatively, a sheet pile cofferdam can be driven to facilitate the micro tunnelling activity.

The working area required by a contractor to construct the thrust and reception pits will generally fit within the 40m wide pipeline working corridor however an additional 5m clearance around the perimeter of the shaft will be required by a contractor to safely install and operate the shaft. An example of this additional working room can be seen in Figure 3-4. If this working room cannot be achieved due to a fixed constraint it is advised that the location of the shaft is adjusted.

Figure 3-4: Example of additional working room required around the perimeter of a shaft.

3.2.4 Ground Water Mitigation

Along the pipe route there is expected to be sections with high ground water. The number of locations may increase during the winter months when higher rainfall is expected. To mitigate ground water and provide a suitable excavation to install pipe sections, a contractor may need to undertake a dewatering design which could deploy several solutions to suite the expected ground water ingress rate. CIRIA113 - Groundwater in Temporary Works outlines a suitable methodology but in summary there are three cost-effective solutions for varying levels of ground water ingress.

- Low ingress rates - Sump pump - A sump is dug at one end of the excavated trench. An electric submersible pump is then installed to remove water.
- Medium ingress - Well points - A well point, or series of well points, is installed into the excavated trench, or alongside it, to lower the ground water level as the works progress. The well points are generally a steel tube with perforations that only allows water to enter the tube. Inside the tube a well pump is installed to remove water.

- High Ingress - Cut off structure - Generally a temporary sheet pile wall is driven to toe into an impervious underlying stratum. This 'cuts off' and prevents water from penetrating into the excavation. Cut off structures may require propping and other dewater techniques to be implemented in parallel.

Discharge points for ground water pumping systems need to be considered, and possibly consented, as does the secondary impacts of removing ground water from the local area. This could be significant in pipelaying areas adjacent to farmland.

3.2.5 Poor Ground Mitigation

The design requires pipe installation at a depth of ~3.5m, from ground level. If the ground conditions are not favourable, as anticipated at several points along the route, this will require a departure from the typical construction methodology identified in Section 3.1.1.

Poor ground can be mitigated by a contractor in several ways:

- Decrease the angle of the excavated batter so that the material remains stable during the pipe installation process.
- Increase the number of benches, and therefore the height of each bench, to ensure that the material remains stable during the pipe installation process.
- Install trench boxes, or sheet piles to retain the poor ground as the pipe is installed.
- Consider alternatives to cut and cover methodology such as large diameter pipe plough, Horizontal Directional Drilling, or micro tunnelling.

The first two options will increase the volume of excavated material and land take requirements for the pipe laid in poor ground. At this stage of the project, it is felt that the methods could be accommodated within the planned 40m working corridor.

The first three options will have an impact in the production rates for pipe laying as there are additional activities in the pipe laying cycle over and above the typical pipe laying methodology. These options are seen as the most likely techniques that a contractor would deploy to overcome poor ground.

The fourth option is a significant departure from the typical cut and cover solution and would have a significant impact on the scheme cost and delivery programme. The use of HDPE pipe would also need to be considered to facilitate effective use of HDD or large diameter pipe plough solutions. At this stage of the project, it is not anticipated that the ground conditions are poor enough to warrant a change in construction methodology.

3.2.6 Access Points

Efficient supply of labour, plant, and materials to, and from, the works location is essential for a contractor undertaking the works. Generally, access to the works location will be along the working corridor however, where this corridor does not intersect with the Local Road Network (LRN) access needs to be provided. The access layout easements need to consider the plant, materials and operation required at that location

Access locations have been identified as part of the pipeline design and will need to be considered as part of the schemes temporary land take requirements. When considering the location of these access points the following has been taken into consideration:

- Where possible at least two access points to each cut and cover pipe run. Where larger pipe runs are required intermediate access points are proposed to shorten logistics routes.
- That access points are located as close as practicable to the shaft locations to shorten haul distances for micro tunnelling arisings and delivery of pre-cast concrete products.
- Grouping access points from the LRN to minimise Temporary Traffic Management requirements and to reduce travel time for the main contractor between sites.
- Existing access points and routes are utilised to minimise the impact of the work on the local environment and minimise enabling and reinstatement activities.

- Width of access points is 5.5m to allow two HGVs to pass side by side. Where this is not possible passing places will be utilised. The length of access points between LRN and working corridor will be as short as practicable.

3.2.7 Office and Welfare Strategy

To construct the pipeline design, a contractor will need to provide office and welfare facilities that comply with Schedule 2 of the CDM Regulations 2015, and HSE Guidance Sheet No59. These main welfare facilities will be located at either end of the route and at the break pressure tank location. Smaller satellite welfare compounds will be required at intermediate locations along the route for emergency provision and to minimise travel times between the main welfare and the works.

3.2.8 Break Pressure Tank

The two 22x22m break pressure tanks are to be partly buried. To facilitate this the footprint of the tanks will need to be excavated down to formation. Suitable allowances will need to be considered for either a battered excavation or a retaining solution to provide a safe and stable working platform from which to construct the tanks. The excavated material will be stockpiled on the site before being reused as backfill around the newly constructed tanks.

The tanks will be gravity structures and will not require any foundation piling to be undertaken. Instead, a reinforced concrete foundation slab will be cast which will require multiple readymix concrete wagon deliveries over a short period. A concrete pump will also be required to place concrete across the footprint of the structure and ensure that the slab is cast monolithically.

The tanks are proposed to be constructed from pre-cast concrete panels, Figure 3-5. These panels will be brought to site on articulated delivery wagons from the supplier and lifted into position using a medium size mobile crane. The suitability of temporary access routes and crane platforms needs to be considered during planning of the works.

Figure 3-5: Proprietary pre-cast concrete tanks (Source: Shay Murtagh)

3.2.9 Outfall

To facilitate construction of the outfall structure a water excluding temporary works structure will be required. This could take the form of a driven sheet pile cofferdam, Figure 3-6 or a more lightweight portadam structure, Figure 3-7.

Figure 3-6: Sheet Pile Cofferdam for Outfall Construction (Source: Aarsleff Ground Engineering)

Figure 3-7: Portadam Cofferdam for Outfall Construction (Source: Portadam)

This will likely be installed from the riverbank without the need for working from the river. However, other river users will need to be notified of the works and an exclusion zone placed within the river to segregate construction operations and river users.

Once dewatered a large open excavation will be required to construct the new outfall and weir structures. The landside working area around the excavation will be secured during construction by security hoarding around the site perimeter and access to the site will be controlled. The site area will include sufficient space for offices, vehicle parking, welfare facilities and storage for plant and materials. During construction the riverbank footpath will need to be temporarily closed and diverted around the site.

The new intake structure will be constructed from reinforced concrete. The structure base and walls will be cast in situ and the top cover slabs are likely to be precast concrete planks and will be cast off site and craned into position. When complete, the excavation will be backfilled around the structure and the mechanical and electrical equipment can be installed. The water excluding temporary works will then be removed and the riverbank profile on either side of the structure will be reinstated. The footpath will be re-routed over the outfall. Mechanical and electrical equipment at ground level will be enclosed in kiosks or by secure fencing. The permanent works will also include installation of electrical power supply, vehicular access and connection pipework to the main pipeline pipe.

3.2.10 Interface with 3rd Parties

3.2.10.1 HS2

The pipe alignment to the north of the scheme traverses the route of HS2. To construct the pipeline pipe route at the same time as HS2 presents a construction risk and would require significant coordination between the pipeline contractor and HS2. Although the section of pipeline pipe is jacked under the HS2 route, a pipeline contractor would still need access to the areas controlled by HS2 to construct both launch and reception pits, and to install the cut and cover pipe approaches. These interfaces need discussion with HS2 at the earliest opportunity to explore if the two projects can be constructed in parallel. If the interface issues cannot be overcome, then the pipeline aspects of the scheme in this area should be left until HS2 conclude their works in this location.

3.2.10.2 Private Landowners

Across the pipeline route there will be an interface with private landowners. These interfaces should be clearly mapped and become the basis for a comprehensive stakeholder management plan. The pipeline contractor should be included in the stakeholder plan to ensure that lines of communication are clearly defined and that any reinstatement or compensatory works are fully understood.

3.2.10.3 Utilities

There are a number of utilities in the vicinity of the pipe alignment. The design should not require a contractor to work in close proximity to these utilities. If works are planned in the general location of utilities, such as in the North of the scheme where OHV and pipe alignment run parallel for ~900m, then the contractor should follow HSE Guidance Note GS6.

In the North of the scheme the pipe alignment traverses a number of brownfield and industrial areas. These sections should be the subject of Site Investigation at later stages of the project to identify any utilities as the risk of unmarked or abandoned utilities is higher.

3.2.10.4 ABP Rail Freight Depot

The LRN around the ABP Rail Freight Depot is required to facilitate access to several pipe jack shafts and cut and cover sections of pipe. The LRN is used heavily by road freight for parking and turning prior to offload at the rail freight depot. This interface needs to be managed at both pre-construction and construction stages to ensure that access is maintained for the rail depot and pipeline contractor as any lack of access throughout the works would be detrimental to both rail depot and construction works.

3.2.11 Construction Risks and Opportunities

The standard pipelaying methodology that has been outlined in this CDR could be augmented with emerging best practice from other pipeline projects in the UK, such as the Anglian Water Strategic Pipeline Alliance, SPA. There are some opportunities that could be explored as Minworth SRO is developed into Gate3 to reduce carbon, time and cost impacts:

- Trench arisings should be processed and reused as backfill as much as possible. This minimises the volume of import and export on the project and reduces the HGV movements across the scheme.
- Pipe lengths have been increased from 6 to 12m. This incurs logistics challenges but reduced the number of insitu welds driving up productivity and improving quality.
- Only 3 sticks of 12m pipe are welded together at ground level. This means that excavators can be used to install the pipe length instead of specialist side booms. This minimises the volume of plant required to install pipe and maintains high utilisation.
- To mitigate poor weather a mobile weld tent is used to cover the pipe welding and installation activities. This 'factory in a field' approach has maintained production rates, quality, and H&S of the pipe laying operation.
- Hygienic pipe laying processes have been deployed to ensure that swabbing and commissioning could be undertaken as quickly as practical. All pipe lengths are delivered from the fabricator with end caps, pipes were stored on chocks, site cleanliness and cleanliness training is promoted heavily.
- Innovative zero splatter weld systems have been developed to allow welding to be taken place from outside of the pipe without damaging the internal lining. This significantly improves quality and remediation activities needed as part of conventional welded systems.
- There are opportunities to reduce the number of trenchless crossing by undertaking cut and cover install methods where the pipeline intersects with minor roads. Consultation and application with local councils is required in advanced to manage lane or road closures and diversions.
- Developing technology is being trialled that is yielding production and quality benefits over conventional methods. The trial of large diameter pipe ploughs has yielded a significant increase in pipe laying over cut and cover methods. The working corridor has also been reduced from ~40m to ~20m Although this is limited to ~340mm diameter HDPE pipes at present, further trials are ongoing for larger diameters. Figure 3-8 shows a plough installing HDPE pipe.

Figure 3-8: Pipe plough installing HDPE Pipe

- Commissioning can also utilise near waterless systems which has reduced the required volume of water significantly over conventional commissioning methodology. The use of digital site QA systems has also improved the commissioning process allowing issues to be identified and closed out quickly and transparently.

3.3 CDM Implementation

In the Gate 2 process, Jacobs was appointed by Severn Trent Water as a designer in accordance with the Construction Design and Management (CDM) Regulations 2015.

Initial pre-construction information from STW was requested, and potential hazard information was extracted. Site visits were carried out by Designers to verify feasibility of the conceptual designs as well as to gather information on site conditions which could potentially cause health and safety hazards. Hazard information was also extracted from geotechnical baseline study.

Measures which could be taken to eliminate the hazards or to mitigate the risks during Gate 2 were incorporated into the conceptual design, and elimination or mitigation actions to be taken at the future design stages were identified.

Potential significant and/or unusual health and safety risks in the Minworth scheme are associated with interfaces with the HS2 scheme and the magnitude of the scheme.

The hazard information collected, the design measures taken in Gate 2, as well as the measures to be taken at the future stages will be handed over to Gate3 Principal Designers and Designers for further "Safety in Design" activities in conformance with the CDM Regulations 2015.

Table 3-1: Outline of Potential Significant and/or Unusual Health & Safety Risks with Potential Mitigations

Potential significant and/or unusual health and safety risks	Potential mitigations
The pipeline alignment traverses the HS2 scheme and requires the pipeline contractor to work within areas controlled by HS2.	Early engagement with HS2 to identify interfaces and develop mitigation plan. HS2 undertake pipeline works that are within their working areas.
The scheme is extensive and interfaces with a large number of stakeholders.	Develop a comprehensive stakeholder plan and ensure that the contractor is central to its delivery.

3.4 Construction Environmental Management Plan

Refer to Minworth SRO environmental consultant documentation.

3.5 Transportation of Construction Materials and Spoils

3.5.1 Pipeline and Trenchless Section Construction Materials Delivery

All the pipeline and trenchless work sites will require construction materials to be delivered for shaft and/or trenchless construction. These will be transported to site using HGVs, which will have an impact on the surrounding road networks. The number of HGVs for transportation of this material has been estimated at each shaft site, see 3.5.3 The pipeline along its whole length will produce a significant quantity of spoil and require the importation of fill material to support the pipe. There are no alternative carbon efficient transport methodologies (such as canal or rail) that have been identified as being suitable.

3.5.2 Spoil Disposal

All the work sites will generate spoil from trench excavation, shaft construction, BPT construction, and pipe jacking activities. The spoil produced during construction would normally be transported along the working corridors using all terrain dump trucks to the access point. Once at the access point the spoil would be loaded onto HGV's for transport via the LRN to point of disposal. These vehicle movements will have an impact on the surrounding road networks.

The quantities of spoil have been estimated based upon assumed depths of the trench excavation, shaft depths and pipe jack diameters stated earlier in the report and readily available ground information. Appropriate bulking factors have also been assumed for the different types of ground anticipated.

No opportunities for rail / canal transport have been identified during Gate 2 to reduce the carbon impact. Suitable spoil disposal locations would need to be identified and consideration should be given to using the Definition of Waste: Code of Practice to reduce waste arising from the project.

3.5.3 Vehicle Movements During Construction

A summary of the vehicle movements at the individual site locations for spoil disposal and material transportation during construction are presented in the following tables:

Table 3-2: Summary of Vehicle Movements for the Treatment Works

	Estimated number of HGVs for spoil removal	Estimated number of concrete wagons	Estimated number of concrete wagons for site roads	Estimated number of HGVs for pipes	Estimated number of HGVs for process plant
TREAT230	Minimal spoil generated, retained onsite for landscape bunds	191	122	21	100
TREAT115		140	81	21	50
TREAT115.ALT		102	65	15	30

Table 3-3: Summary of Vehicle Movements for Trenchless Sections STT115

ID	Location	Estimated number of HGVs for spoil	Estimated number of HGVs for pipe deliveries
RM1	M42 and M6 toll	44	9
RM2	A446	42	8
RM3	HS2	45	9
RM4	Haunch Lane	39	6
RM5	River Tame and Railway	51	12
RM6	Birmingham Road	39	6
RM7	Station Road and Railway	42	8
RM8	Hogrills End Lane	38	6
RM9	Rail	39	7
RM10	water courses	39	7
RM11	Blythe Road, Berried railway	39	7
RM12	Coleshill Road	38	6
RM13	Packington Lane	39	6
RM14	M6	41	7
RM15	Fillongley Road	35	5
RM16	Meriden Bypass	38	6
RM17	Old Road, B	37	5
RM18	Back Lane	36	5
G1	Coventry Road	40	7
G2	Spencer's Lane	38	6
G3	Nailcore Lane	38	6

ID	Location	Estimated number of HGVs for spoil	Estimated number of HGVs for pipe deliveries
G4	Cromwell Lane	57	15
G5	Bockendon Road	37	5
G6	A429, Rail	59	16
G7	Dalehouse Lane	44	9
G8	A46	43	8
G9	B4115	42	7

Notes: Spoil Removed in 13m^3 HGV tippers, pipes delivered on 27.5tn articulated flatbed HGVs, thrust and reception pits 7.5m diameter and 2 to 3m deep.

Table 3-4: Summary of Vehicle Movements for Cut and Cover Pipe Sections STT115

Chainage Start	Chainage Finish	Estimated number of HGVs for spoil removal.	Estimated number of HGVs for pipe deliveries.	Estimated number of HGVs for pipe bedding import.
0	1010	154	10	104
1163	1839	103	6	70
1990	2100	17	1	11
2285	3700	216	13	146
3756	4111	54	3	37
4381	4920	82	5	56
5000	6352	206	13	140
6476	6580	16	1	11
6642	6865	34	2	23
6953	7149	30	2	20
7233	7707	72	4	49
7792	10584	425	26	289
10696	13097	366	23	248
13209	13516	47	3	32
13655	16839	485	30	329
16867	16923	9	1	6
17006	17621	94	6	64
17704	19129	217	13	147
19213	19296	13	1	9
19352	20413	201	14	135
20525	22508	376	26	253
22620	23374	143	10	96
23430	24351	175	12	117
24686	25245	106	7	71
25357	28484	593	40	399
28903	29824	175	12	117
30047	30299	48	3	32
30466	31192	138	9	93
31304	31445	27	2	18

Notes: Spoil Removed in 13m^3 HGV tippers, pipes delivered on 27.5tn articulated flatbed HGVs, 6m Long Steel Pipes Used, Nominal 100mm pipe surround, Trench width twice pipe diameter.

Table 3-5: Summary of Vehicle Movements for Break Pressure Tank

Estimated number of HGVs for spoil removal	Estimated number of concrete wagons for foundation slab	Estimated number of HGVs for Pipes
186	65	11

3.6 Delivery Programme

High level durations and logic have been applied to key elements of the Minworth SRO scheme to generate high-level scheme schedules. Refer to Appendix D.1 for the Indicative Implementation Programmes for the 230Mld works and the 115.ALT alternative scheme.

The schedule has been prepared to Level 2 (L2) detail. A L2 schedule represents the overall project broken down into its major components and shows the critical path that flows from start to finish. The schedule can be integrated into the Level 1 project schedule to control the overall program, or to compare different options.

3.6.1 Planning, Development and Enabling Stage

The pre-construction phase of the project covers everything that facilitates making the project 'shovel ready' and allows the contractor to start work onsite. This phase starts at the Tender Award / CAP award for the Contractor in place to start work (assumed latest date for this programme) and finishes at the start on-site date. This includes the following:

- Contract Management – The scheme has passed RAPID's Gate 1, with the project team now focused on developing concept designs. The scheme will be resubmitted to RAPID for Gate 2 review on 14th November 2022 with a draft decision from RAPID on whether the scheme can commence to Gate 3 in March 2023. During Gate 3, the proposals will be developed by commencing a programme of pre-planning activities, including comprehensive community and stakeholder engagement, and developing the mitigations for the potential environmental impacts of each scheme. Decisions about whether a solution goes ahead will be made through water resources planning and subsequently applications for planning and environmental consents. Should the scheme be taken forward to construction, Minworth WwTW upgrade and pipeline will be construction ready in AMP8 (2025 to 2030). The project could be ready to provide water for the Severn to Thames Transfer (STT) by 2032 depending on the solution chosen and for the Grand Union Canal transfer by 2031.
- Detailed Design – Detailed Design stage for the AWTP will be relatively complex due to novel technologies in the UK and complex process & MEICA interfaces. Simultaneous design stages for the pipeline assets which will be simpler but detailed in terms of 3rd party interfaces, trenchless crossings, and break pressure tank. Design shall require 3D models, 100s of GA's, complex operational and restart procedures. This design stage also allows for the completion of site ground Investigation works and incorporation of the findings into the design. 18 months for these activities has been allowed for but this is reduced to 12 months for the alternative scheme as this is less complex. This difference in design duration is the significant difference in the total programme length as the construction of the treatment works isn't on the critical path.
- Procurement – The design is at an early stage of maturity and therefore the specifics of the material procurement strategy cannot be developed. However, from the information available the key items are: pipes, valves, pumps, MCCs, power supplies, and process plant. Each of these items will have an element of material, design, and sub-contracting. The trenchless crossing pipe jack equipment should also be considered long lead especially if these components are non-standard. The Main Contractor will be in place to tender, award, and manage these elements, however the design team should be fully integrated into the procurement process to ensure that information is incorporated into the detailed design as required. A conservative 6 months has been included on the L2 schedule for each of this item. Due to the nature of the procurement of the pipeline, choosing the alternative scheme would not affect this period.
- Enabling Works – The enabling works is the final pre-construction element that prepares the ground of the main construction works. This is generally focused on mitigation of issues found during survey and consenting. The L2 schedule shows the following items: Environmental and Ecological mitigation, Archaeological Mitigation. The duration of these activities is subjective and will depend on the outcome of the consenting and survey process. On a scheme such as Minworth with multiple discrete sites the enabling works

can be phased with main construction. The other elements of enabling works will be contractor's mobilisation. This could include establishing a contractor's compound or project office, providing access to the works. The enabling works duration for Minworth is 18.5 months

3.6.2 Construction and Commissioning Stages

The L2 schedule for Minworth option has five elements: AWTP construction, open cut pipe laying, pipe-jacking, BPT construction, and outfall construction. The critical path flows through the open-cut pipe laying activities, with trenchless crossings being undertaken in advance and valving work following on. The pipe laying duration is resource driven therefore deploying more gangs on the activity, will shorten the activity duration. As pipe laying is on the critical path any change in duration will directly impact the planned completion date of the project. It is for this reason that the project durations between the different treatment options do not vary significantly.

The optimal resource level for pipe laying should be explored further in Gate 3 in discussion with the client on the required operation date for the scheme. For the Gate 2 schedule a single pipe laying gang is assumed.

To aid continuity of the main pipeline installation works, it is proposed that the trenchless crossings are completed progressively in advance of the main route. The programme identifies 2 pipe-jack teams are required to achieve this. The pipe-jacking gang would likely consist of two halves: jacking/reception pit team, and pipe-jack team. The first half would work ahead of the second installing pits on a just in time basis so that the pipe-jacking equipment is never underutilised. Once pipe had been jacked the jacking/reception pit team would fall back and make good each location and prepare the connection for the pipe laying gangs to tie into.

It is proposed that the air valve and washout arrangements are constructed by separate dedicated resources. This element of the works is scheduled to commence after the initial pipe laying activities and continue in parallel until the pipeline is complete.

The remaining three elements of the scheme are not driven by resource and are the outfall construction, BPT construction and AWTP construction.

There are opportunities to bring forward the operational benefits of the schemes by commencing pipeline construction directly after design or at a point in the design development whereby design change will not have any significant impact on pipelaying activities.

The outfall can be scheduled for construction at any time within the construction period and has significant free float. It is shown on the L2 schedule at its latest start which coincides with installation of the approach pipework. This timing also coincides with favourable summer weather construction periods when river levels are likely to be lower. The duration of outfall construction is shown as ~6 months.

The modular nature of the AWTP and relatively minor associated civils works means that there is free float associated with this schedule element. However, the innovative nature of the process systems and the required interventions with the Minworth STW operations teams mean that there is inherent programme risk associated with the construction and commissioning works. For this reason, this schedule element has been shown in its earliest start date allowing time to address issues as they arise without impacting the project completing date. The duration for AWTP activities is shown as 39 months plus 37 months (for the 230Mld scheme) and 28 months for the alternative scheme. This duration reflects supplier engagement feedback regarding onsite installation and commissioning durations.

The BPT is shown as being constructed shortly after the first section of open cut pipework is installed. This approach reduces the management risk to a contractor posed by mobilising and commencing multiple work fronts. The BPT is complete by the time the approach pipework is installed. This allows the pipe laying gangs to tie into the inlet and outlet pipework improving production efficiency and reducing rework.

To establish the L2 Schedule baseline output rates were assumed to be as follows:

Table 3-6: L2 Schedule Baseline Output Rates

Item	Rate
Pipe laying – Easy Access	60m/day/gang
Pipe laying – Difficult Access	15m/week/gang
Jacking/Reception Shaft Construction	1 ring/day
Pipe Jacking - 1m Diameter	12m/day
Note. There are minor deviations from these rates to account for local constraints	

In production of the schedule some baseline assumptions and output criteria needed to be applied these were as follows:

- The calendar for the project was based on a 5-day work week. With no allowance for night, possession, or tidal working.
- It was assumed that there would be no financial constraints imposed on the schedule for annualised spend
- It was assumed that no seasonal constraints were applied and that outputs were normalised for winter and summer working
- No planning, ecological, archaeological, environmental, access, traffic management or rail possession constraints were applied
- The construction durations have been based on methodology identified in the Conceptual Design Reports

The L2 schedule does not allow for Time Risk Allowance, or Terminal Float as these will add duration to the programme presented however cannot be quantified at this time due to design maturity and time available for L2 schedule production.

Table 3-7 and Table 3-8 summarise the durations and timescales for the major elements of the scheme and the alternative scheme. Some durations run concurrently - refer to the schedules in Appendix D.1 for full details. The GUC finish dates noted below only reflect the treatment aspect of the GUC scheme and not the pipeline aspect of the GUC project.

Table 3-7: Indicative Implementation Programme Summary - STT115 TREAT230

Task Name	Duration (months)	Start Date	STT Finish Date (230Mld)	GUC Finish Date (115Mld)
Contract Management	135.75	04/10/22	28/02/33	07/01/32
Pre-Construction	20	01/12/26	12/06/28	12/06/28
Procurement	6	18/05/27	01/11/27	01/11/27
Enabling Works	18.5	12/01/27	12/06/28	12/06/28
Construction	55.05	31/05/27	18/08/31	27/05/30
System Commissioning Works	46.5	18/09/28	29/03/32	06/01/31
Benefit Delivery date			2032	2031

This summary is also applicable to other solutions adjusted as outlined below:

- For the STT115 TREAT172 solutions, the schedule will be slightly shorter for STT as the treatment works is slightly smaller than the 230Mld works. Assuming that the 115Mld part of the works is designed to supply the GUC, GUC finish dates will be the same.
- For the STT115 TREAT115 solutions, the schedule will be the same as for the GUC (115Mld) dates noted above.
- For the STT57 TREAT57 solutions, the schedule will be slightly shorter than the GUC (115Mld) dates noted above due to the smaller nature of the treatment works. The same will be true for the GUC treatment works

Table 3-8: Indicative Implementation Programme Summary - STT115 TREAT115.ALT

Task Name	Duration (months)	Start Date	STT Finish Date
Contract Management	121	04/10/22	08/01/32
Pre-Construction	20	01/12/26	12/06/28
Procurement	6	18/05/27	01/11/27
Enabling Works	18.5	12/01/27	12/06/28
Construction	46.2	31/05/27	12/12/30
System Commissioning Works	25.5	23/2/29	06/02/31
Benefit Delivery date			2031

This summary is also applicable to the STT115 TREAT57.ALT solutions as the pipeline is on the critical path. A slight reduction in overall timeframe could be considered if the overlaps between the elements of the scheme were adjusted as the treatment works is smaller in this case.

3.6.3 Integration with Other SRO Programmes

The only construction interface with other SRO programmes is the construction of the GUC transfer pumping station which must be constructed adjacent to the STT transfer pumping station adjacent to the AWTP site on the Minworth WwTW site. Agreements will need to be made to decide the contractual arrangements for constructing this works which will depend on the timing of the need for the GUC SRO to transfer water.

RAPID's three tests for DPC suitability have been completed and DPC is not applicable for Minworth SRO. However, in a scenario where the STT pipeline were delivered separately from the treatment element, DPC may be applicable to the STT pipeline. In terms of the planning route, it is assumed that Minworth SRO will progress as Associated Development to the GUC SRO and mirror the same timescales; there may be an opportunity to shorten the planning timeline via a TCPA route. Refer to Annex E1 (Procurement) and G1 (Planning & Consents Strategy) for further information.

4 Water Resources

4.1 SRO Deployable Output

The SRO transfer capacities are defined as above. This scheme will benefit the WRSE region either via STT SRO or GUC SRO, or in combination. Deployable Output benefits will be realised through a combination of the inter-regional transfer SROs detailed above and new or existing treatment and distribution systems in the WRSE region. All losses within the proposed treatment works at Minworth are accounted for within the design such that the required DO is able to be provided. The DO for Minworth/GUC will be introduced to the Affinity Water network in the Lee Community (WRZ3). Reference "Capacity Needs and Utilisation Profile for Strategic Options" technical note for further information on the GUC DO.

4.2 Regulation and Licensing

A new environmental permit for discharge will be required for the new River Avon and Coventry Canal discharges, along with an amendment or a new environmental permit for discharge for discharges to the River Tame. Planning permission may be required however it is not anticipated that compulsory purchase orders would be required.

5 Economics and Carbon Costs

Refer to Annex A4 Costs and Carbon Report

6 Assumptions, Risks, Uncertainty of Benefits and Opportunities

6.1 Key Assumptions

Key assumptions that have been made in this conceptual design report are listed below:

- That the site adjacent to the existing treatment works, the proposed site of the break pressure tank and the proposed site of the outfall are available for development for the scheme.
- That an environmental permit (variation or new) will be granted by the Environment Agency to allow water to be diverted from the final effluent chamber to the scheme.
- That the Minworth STW final effluent quality is maintained at its current level and will not require further treatment to feed the AWTP.
- An environmental permit will be required by the EA for discharge into the River Avon for transfer into the STT system
- It is assumed that there will be no issues with land access for the construction of the pipeline
- An environmental permit will be required by the EA for discharge into the Coventry Canal for transfer into the GUC system.

6.2 Key Risks

Key risks associated with this scheme are listed as follows:

- It is believed to be acceptable to discharge all waste streams to the inlet works of Minworth whilst any excess treated water will be returned to the final effluent channel.
- There is a risk that there will be a delay with obtaining the environmental permit for discharge.
- The current power supply capacity of Minworth STW is not sufficient to support the new AWTP, therefore power distribution and supply by the Distribution Network Operator is accounted for; however, there is a risk that connection to the Distribution Network may require a network upgrade.
- There is a risk that trenchless section construction will encounter unexpected ground conditions.
- There is a likelihood of encountering buried structures and uncharted utilities
- Contaminated material excavated from uncharted landfill sites requires suitable handling and disposal.
- Assumption that the majority of excavated material can be reused may not always be true.

6.3 Uncertainty of Benefits

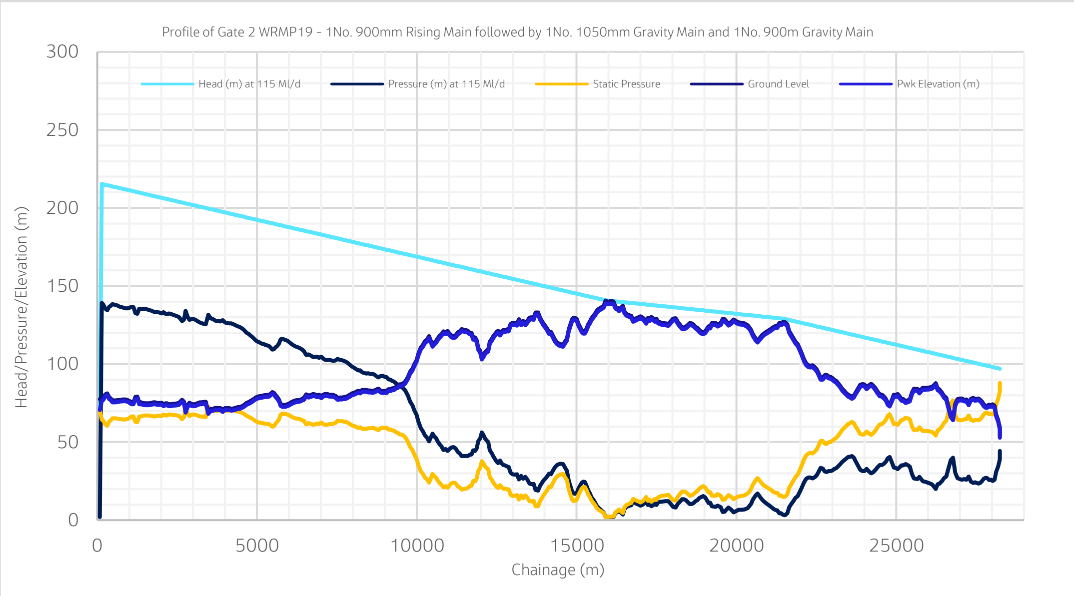
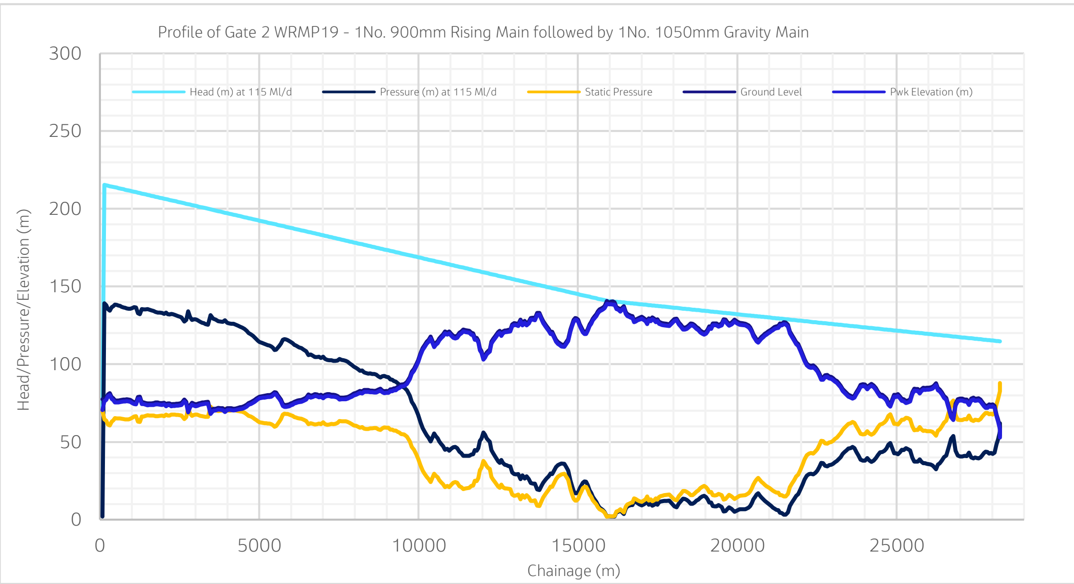
Key uncertainties identified that could impact on the realisation of the Deployable Output or other benefits are listed as follows:

- A long pipeline project will be high profile and high cost. There is a potential to face challenge from approving authorities.
- Environmental permits for discharge could be challenged regarding environmental effects. It may be required to reduce yield to mitigate cumulative environmental impact on the River Avon and the GUC.
- Although a small-scale experimental plant has been constructed and operated in the past, STW has limited experience in delivering and operating water treatment plants with a combination of CoMag, Ozonation, BAC, and GAC.
- Specific to the design, there has been no consultation at this stage with local authorities or local communities regarding environmental challenge and associated mitigation.

6.4 Opportunities

Key opportunities identified in the conceptual design are listed in the table below.

Table 6-1: Key Opportunities

Category	Opportunities
Process Design	There is an opportunity to rationalise and develop best outcome treatment requirements through pilot work and/or full engagement with stakeholders and regulators DWI and EA with regards to expectation of treatment processes, customer acceptability and engagement and environmental outcomes.
Pipeline Design	There is an opportunity to optimise the preferred pipeline route by reducing the size of the gravity main after crossing Tile hill peak. This will improve the hydraulic profile of the pipeline and will also reduce the CAPEX cost. Approximate the last 7 km of the pipeline can be reduced to 900mm instead of the current 1050mm. This would reduce the head remaining at the outfall from 62m to 44m. Figure 6-1: Opportunity for cost saving by reducing gravity main to 900mm after Tile Hill  The pipeline route is currently costed for one gravity main at 1050mm, see Figure 6-2. Figure 6-2: Pipeline currently sized and costed for one gravity main at 1050mm 

Category	Opportunities
Pipeline Design	The rising main will deliver water to a break pressure tank and water will be fed by gravity to the discharge point. The tank is assumed to have 60 mins peak flow storage. The 60-minute storage requirement represents a suitable volume of water allowing a safe controlled shutdown of the transfer pumping station without dewatering the pipeline and provides transient protection in case of a power failure at the transfer pumping station. This retention time could be reduced to 30 mins of peak flow after conducting transient analysis during detailed design phase, which has the potential to introduce CAPEX cost savings.
Pipeline Design	The pipeline material is assumed to a be a thin wall steel pipe, however further assessment as to the optimal pipe material is to be undertaken at the next stage of design to balance availability, sustainability, carbon impact, constructability and cost.
Pipeline Design	Smaller pipeline diameters with accompanying economic benefits may be achievable, however, would have hydraulic and operational implications.

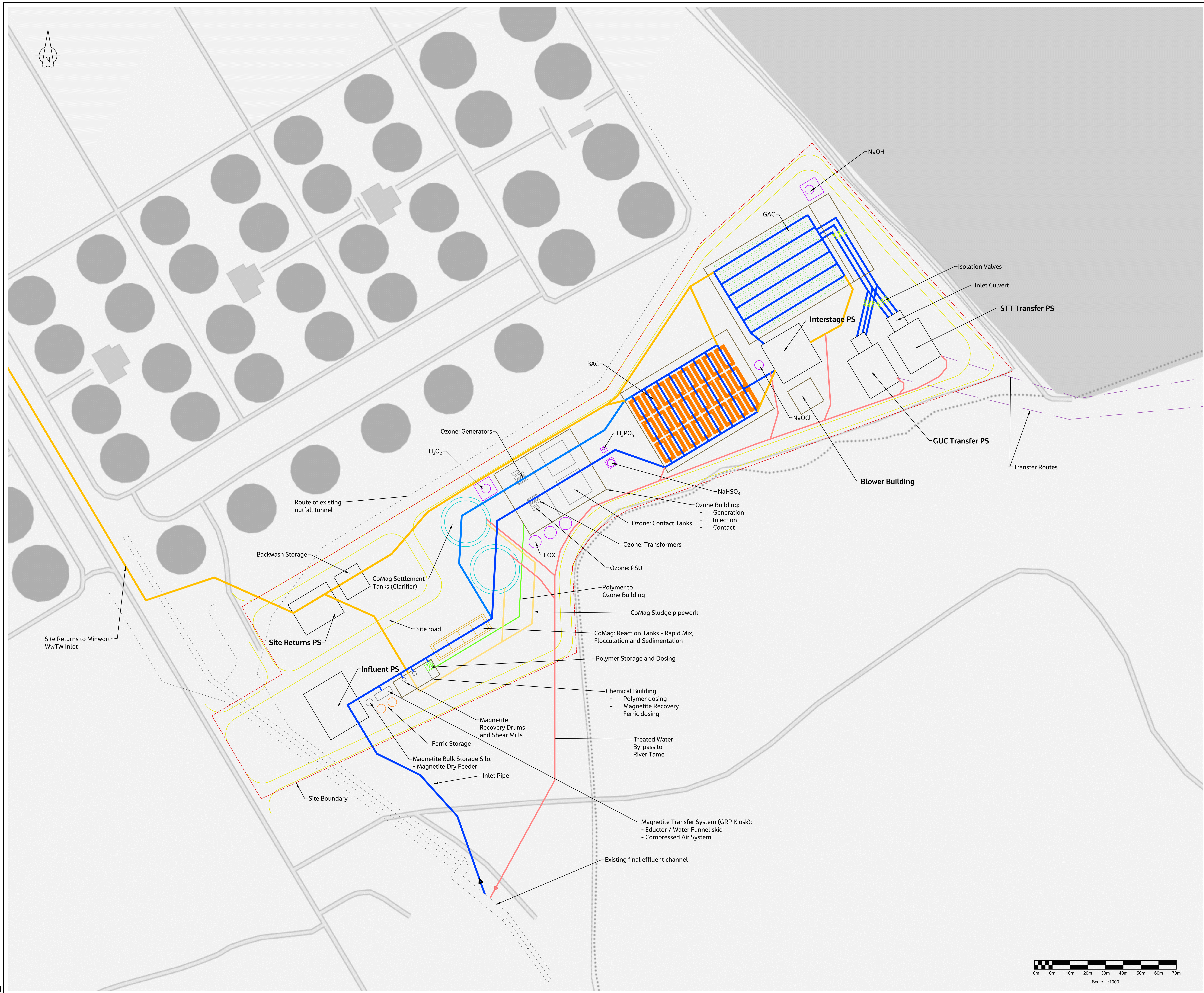
7 Glossary

Acronym	Definition
AMP	Asset Management Period
AWTP	Advanced Water Treatment Plant
BAC	Biologically Active Carbon
BPT	Break Pressure Tank
CAPEX	Capital Expenditure
CDM	Construction Design and Management Regulations 2015
CDR	Concept Design Report
CoMag	Coagulation Magnetite
DO	Deployable Output
DWF	Dry Weather Flow
DWI	Drinking Water Inspectorate
EA	Environment Agency
EBCT	Empty Bed Contact Time
GAC	Granular Activated Carbon
GIS	Geographic Information System
GUC	Grand Union Canal
HoF	Hands off Flow
LOX	Liquid Oxygen
LRN	Local Road Network
MEICA	Mechanical, Electrical, Instrumentation, Control and Automation
Mld	Mega litres per day
NPSH	Net Positive Suction Head
OPEX	Operational Expenditure
PS	Pumping Station
PSA	Pressure Swing Adsorption
RAPID	Regulators’ Alliance for Progressing Infrastructure Development
SRO	Strategic Resource Option
STT	Severn Thames Transfer
STW	Severn Trent Water
TOC	Total Organic Carbon
VSA	Vacuum Swing Adsorption
WRMP19	Water Resource Management Plan 2019
WRSE	Water Resources South East
WRW	Water Resources West
WwTW	Wastewater Treatment Works

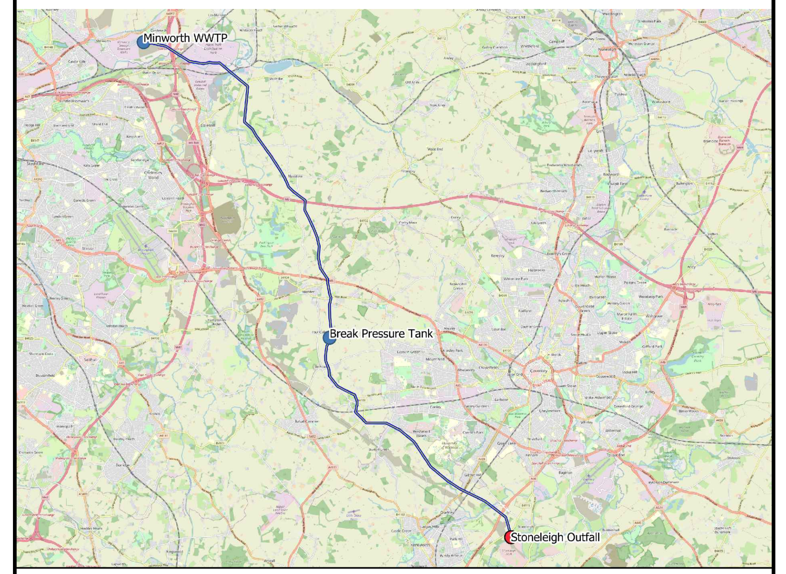
8 Appendices

A. AWTP Site Layout

A7W13155-WT-DRA-226500	Site Layout - TREAT230
A7W13155-WT-DRA-226501	Site Layout - TREAT115.ALT



PREFERRED ROUTE OVERVIEW



NOTES:

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN METRES AND ALL LEVELS ARE IN METRES AOD UNLESS OTHERWISE STATED.
3. LOCATION AND ARRANGEMENT OF ALL STRUCTURES, MECHANICAL AND ELECTRICAL EQUIPMENT, PIPEWORK AND ANCILLARY SYSTEMS TO BE CONFIRMED ON SITE DURING DETAIL DESIGN.
4. THE LOCATIONS OF EXISTING SERVICES ARE NOT SHOWN FOR CLARITY.
5. LONG SECTION DRAWINGS OF CONVEYANCE PIPELINE ARE SHOWN IN A7W13155-CY-DRA-216212 TO A7W13155-CY-DRA-216216.
6. APPROXIMATE SITE COORDINATES X: 417216, Y: 292146

LEGEND:

- SITE ROAD
- SITE BOUNDARY
- PIPELINE
- PIPELINE: SECOND TREATMENT TRAIN
- EXISTING OUTFALL TUNNEL NETWORK
- PUMPING STATIONS AND BACKWASH STORAGE
- MAGNETITE SYSTEM
- FERRIC STORAGE
- BUILDINGS
- POLYMER DOSING AND STORAGE
- COMAG REACTION TANKS
- COMAG SETTLEMENT TANKS (CLARIFIER)
- ADDITIONAL CHEMICALS: STORAGE AND DOSING
- OZONATION
- BIOLOGICAL ACTIVATED CARBON (BAC) FILTERS
- GRANULAR ACTIVATED CARBON (GAC) FILTERS
- ISOLATION VALVES
- TRANSFER ROUTES
- BACKWASH SITE RETURNS TO WWTW INLET
- TREATED WATER BY-PASS TO RIVER TAME
- COMAG SLUDGE PIPEWORK

Author names redacted

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
0A	April 2022	Preliminary Draft	[redacted]			
0B	July 2022	Concept Design				

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Client

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Project

Minworth Strategic Resource Option (SRO)

Drawing title

Site Layout - TREAT230

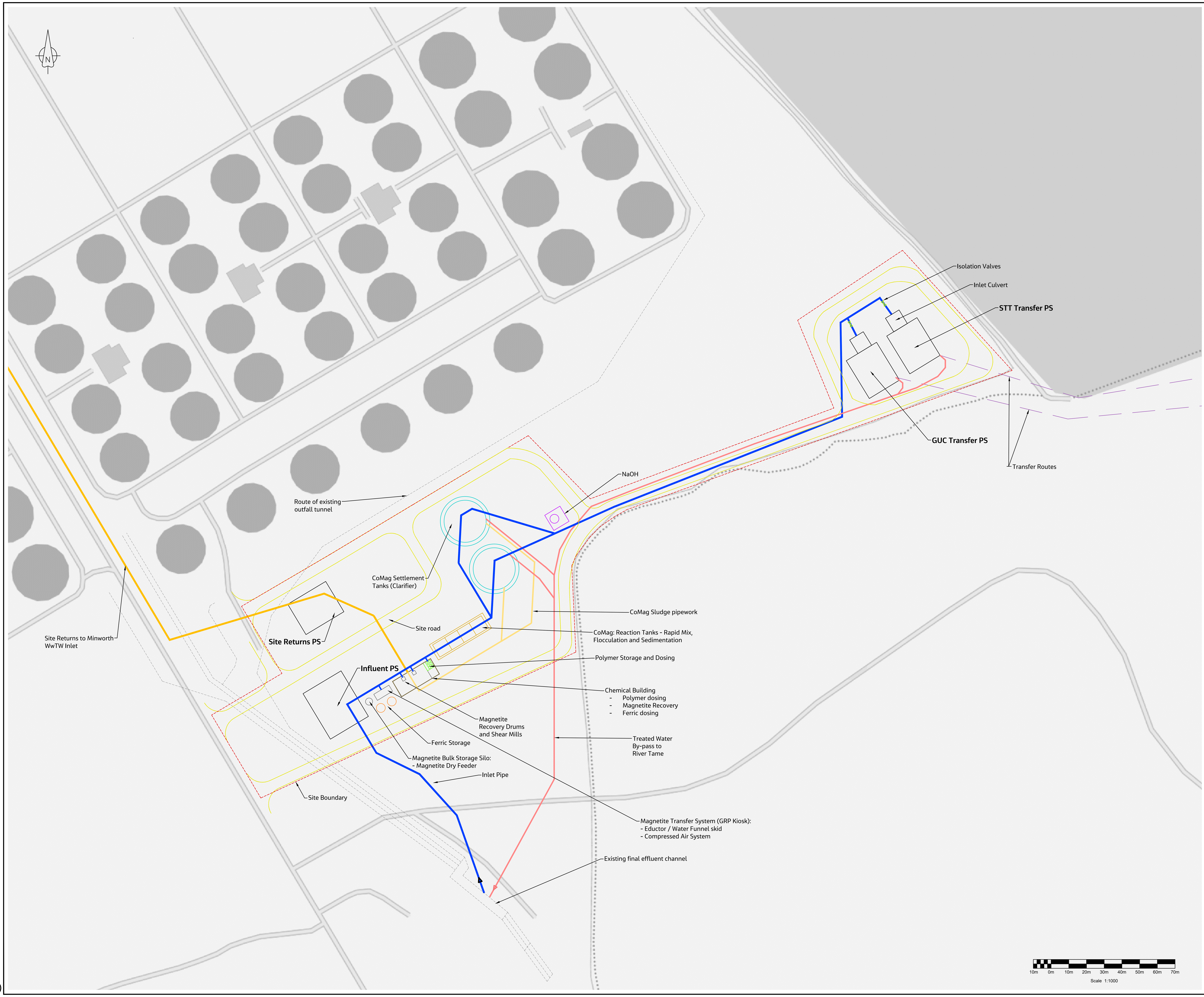
Drawing status

Preliminary

Scale	1:1000 @ A1	DO NOT SCALE	
Jacobs No.	B19589CF	Rev	0B
Client no.	A7W13155		

Drawing number

A7W13155-WT-DRA-226500



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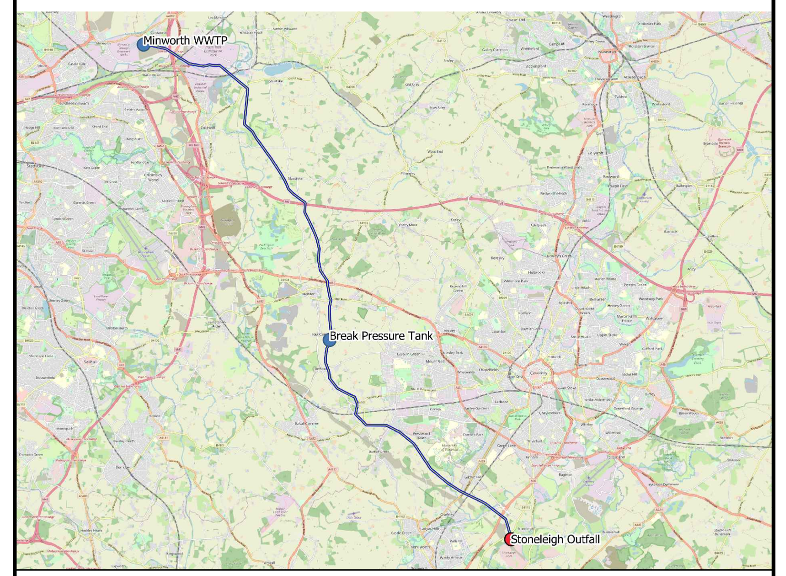
PREFERRED ROUTE OVERVIEW



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4. THE LOCATIONS OF EXISTING SERVICES ARE NOT SHOWN FOR CLARITY.
5. LONG SECTION DRAWINGS OF CONVEYANCE PIPELINE ARE SHOWN IN A7W13155-CY-DRA-216212 TO A7W13155-CY-DRA-216216.
6. APPROXIMATE SITE COORDINATES X: 417216, Y: 292146

LEGEND:

- SITE ROAD
- SITE BOUNDARY
- PIPELINE
- EXISTING OUTFALL TUNNEL NETWORK
- PUMPING STATIONS AND BACKWASH STORAGE
- MAGNETITE SYSTEM
- FERRIC STORAGE
- BUILDINGS
- COMAG REACTION TANKS
- COMAG SETTLEMENT TANKS (CLARIFIER)
- ADDITIONAL CHEMICALS: STORAGE AND DOSING
- OZONATION
- BIOLOGICAL ACTIVATED CARBON (BAC) FILTERS
- GRANULAR ACTIVATED CARBON (GAC) FILTERS
- ISOLATION VALVES
- TRANSFER ROUTES
- BACKWASH SITE RETURNS TO WWTW INLET
- TREATED WATER BY-PASS TO RIVER TAME
- COMAG SLUDGE PIPEWORK

Author names redacted

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
0A	August 2022	Concept Design	[redacted]			

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Project: Minworth Strategic Resource Option (SRO)

Drawing title: Site Layout - TREAT115.ALT

Drawing status: Preliminary

Scale	1:1000 @ A1	DO NOT SCALE
Jacobs No.	B19589CF	Rev 0A
Client no.	A7W13155	

Drawing number: A7W13155-WT-DRA-226501-0A

B. Detail Drawings

A7W13155-CY-DRA-216531	Outfall layout - STT115
A7W13155-CY-DRA-216538	Break Pressure Tank layout - STT115

[redacted]

PREFERRED ROUTE OVERVIEW

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4. THE LOCATIONS OF EXISTING SERVICES ARE NOT SHOWN FOR CLARITY.
5. LONG SECTION DRAWINGS OF CONVEYANCE PIPELINE ARE SHOWN IN A7W13155-CY-DRA-216212 TO A7W13155-CY-DRA-216216.
6. THE DESIGN IS BASED ON A NOMINAL 1050mm DIAMETER PIPELINE DELIVERING A MAXIMUM FLOW OF 115 Ml/d.
7. THE LAND FOR THE PERMANENT SITE IS INTENDED TO BE PURCHASED. THE TEMPORARY COMPOUND AREA WILL BE USED TEMPORARILY AND WILL BE REINSTATED UPON COMPLETION OF THE CONSTRUCTION WORKS.
8. APPROXIMATE SITE COORDINATES X: 432278, Y: 272277

LEGEND:

- 1050mm GRAVITY PIPELINE
- OUTFALL STRUCTURE: AERATION CASCADE
- PERMANENT SITE AREA
- TEMPORARY COMPOUND AREA
- 40m CONSTRUCTION BUFFER ZONE
- FLOW CONTROL VALVES

Site layout redacted

Author names redacted

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
0A	APR 2022	Preliminary Draft	[redacted]			

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Project
Minworth Strategic Resource Option (SRO)

Drawing title
Outfall Layout - STT115

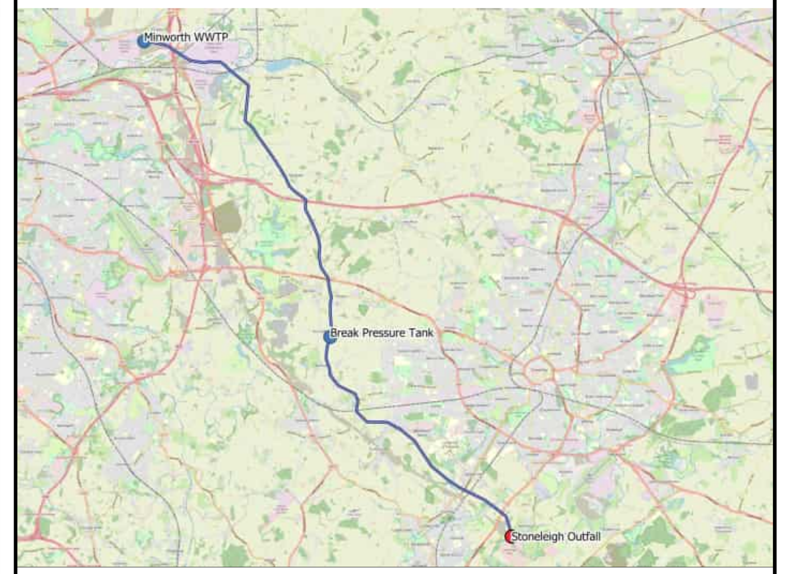
Drawing status
Preliminary

Scale	1:500 @ A1	DO NOT SCALE	
Jacobs No.	B19589CF	Rev	0A
Client no.	A7W13155		

Drawing number
A7W13155-CY-DRA-216531-0A

[redacted]

PREFERRED ROUTE OVERVIEW



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4. THE LOCATIONS OF EXISTING SERVICES ARE NOT SHOWN FOR CLARITY.
5. LONG SECTION DRAWINGS OF CONVEYANCE PIPELINE ARE SHOWN IN A7W13155-CY-DRA-216212 TO A7W13155-CY-DRA-216216.
6. THE DESIGN IS BASED ON A NOMINAL 900mm DIAMETER RISING MAIN AND 1050mm DIAMETER GRAVITY MAIN PIPELINE DELIVERING A MAXIMUM FLOW OF 115 Ml/d.
7. THE LAND FOR THE PERMANENT SITE IS INTENDED TO BE PURCHASED. THE TEMPORARY COMPOUND AREA WILL BE USED TEMPORARILY AND WILL BE REINSTATED UPON COMPLETION OF THE CONSTRUCTION WORKS.
8. APPROXIMATE SITE COORDINATES X: 424939, Y: 280338

LEGEND:

- 900mm RISING PIPELINE
- 1050mm GRAVITY PIPELINE
- BREAK PRESSURE TANK CELLS
- PERMANENT SITE AREA
- TEMPORARY COMPOUND AREA
- 40m CONSTRUCTION BUFFER ZONE

Site layout redacted

Author names redacted

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
0A	APR 2022	Preliminary Draft	[redacted]			

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Minworth Strategic Resource Option (SRO)

Drawing title

Break Pressure Tank Layout - STT115

Drawing status

Preliminary

Scale	1:500 @ A1	DO NOT SCALE
Jacobs No.	B19589CF	Rev 0A
Client no.	A7W13155	

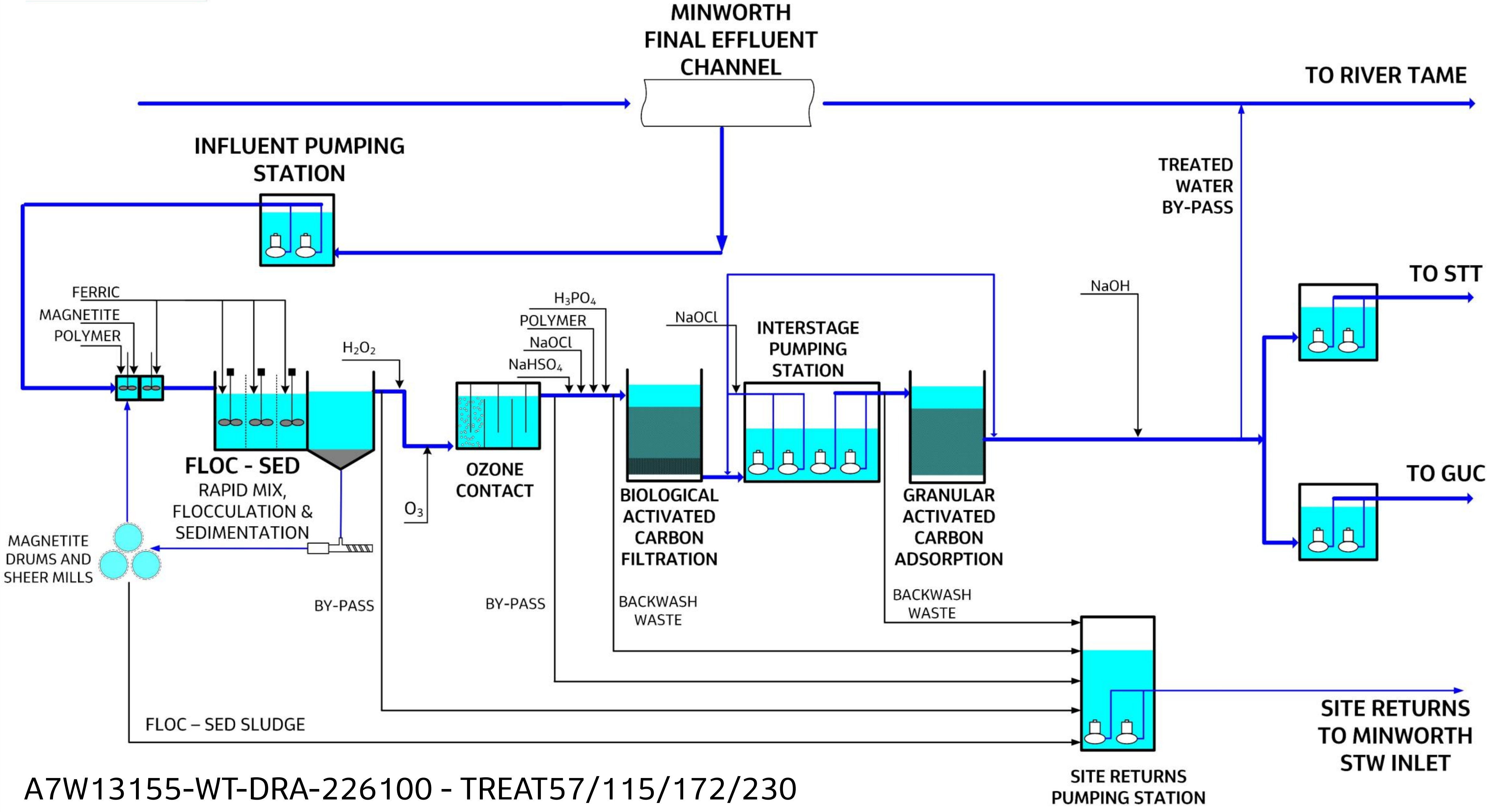
Drawing number

A7W13155-CY-DRA-216538-0A

C. Outline Process Flow Diagrams

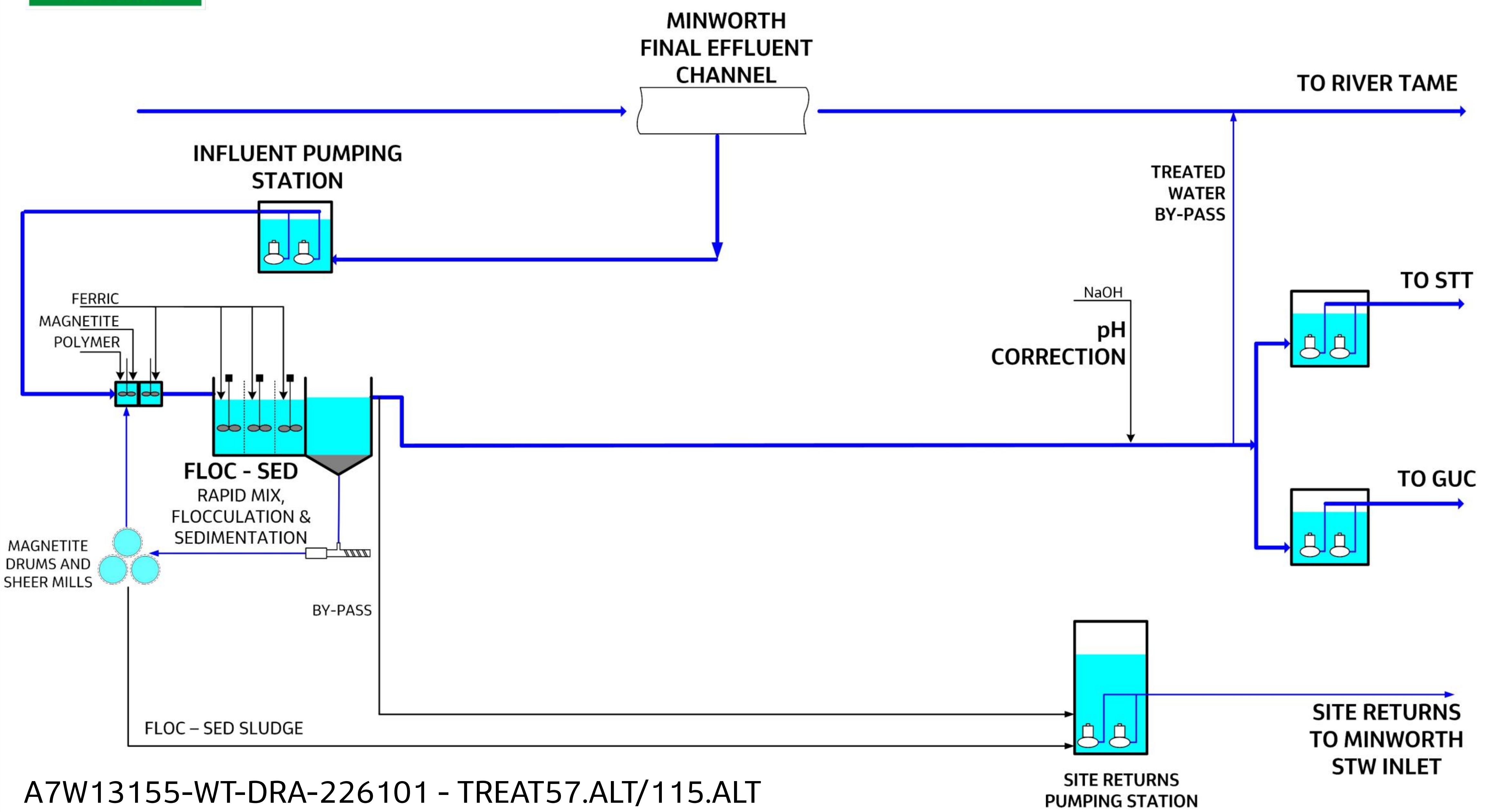
A7W13155-WT-DRA-226100	Process Flow Diagram TREAT57/115/172/230
A7W13155-WT-DRA-226101	Process Flow Diagram TREAT57.ALT/115.ALT

MINWORTH PROCESS FLOW DIAGRAM



A7W13155-WT-DRA-226100 - TREAT57/115/172/230

MINWORTH PROCESS FLOW DIAGRAM



A7W13155-WT-DRA-226101 - TREAT57.ALT/115.ALT

D. Additional Technical Material

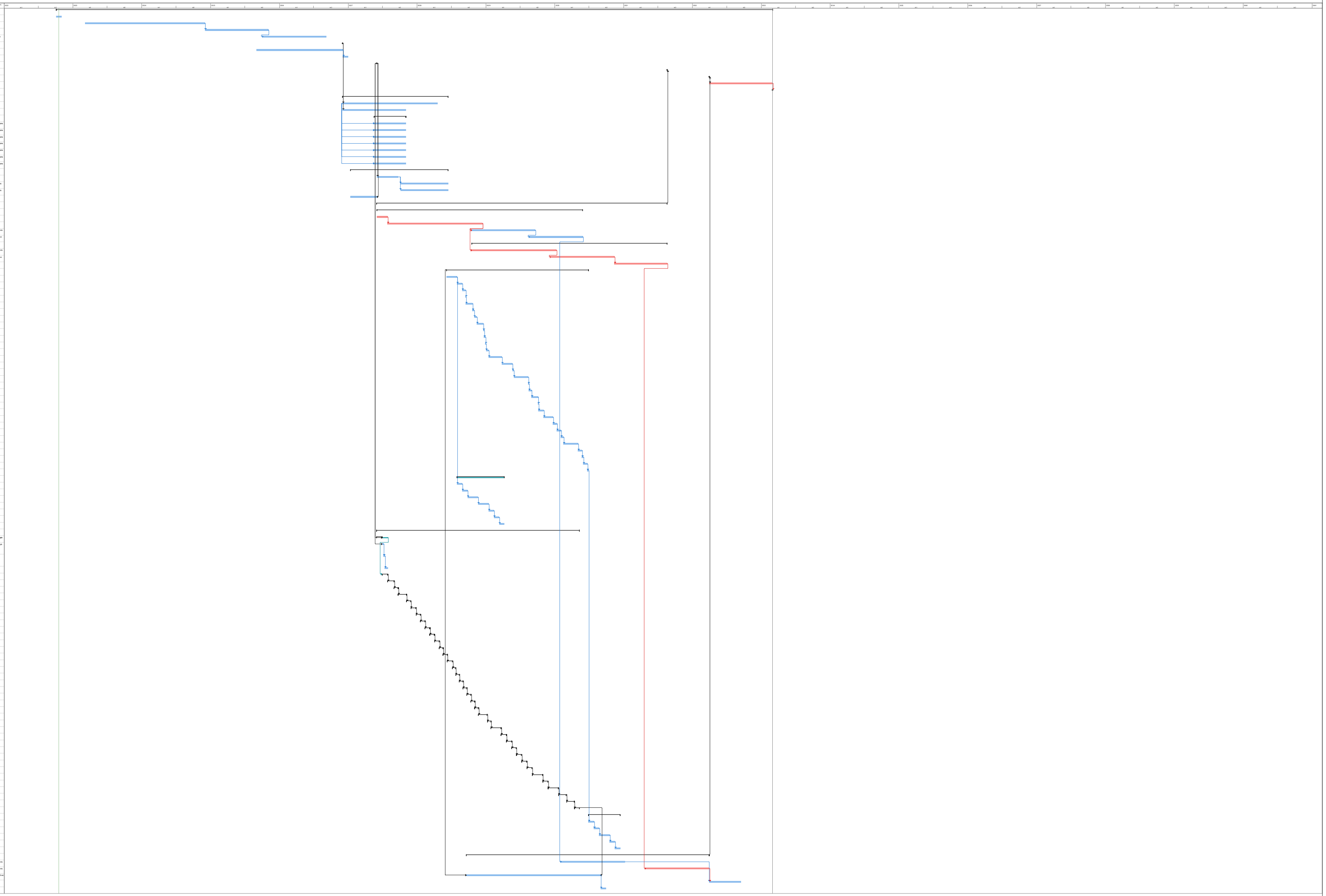
D.1 Indicative Implementation Programmes

A7W13155-GT-SCH-200024	Programme STT115 TREAT230
A7W13155-GT-SCH-200050	Programme STT115 TREAT115.ALT

High Level Construction - Gate 2
Version 2.0

Minworth SRO - 230MLD

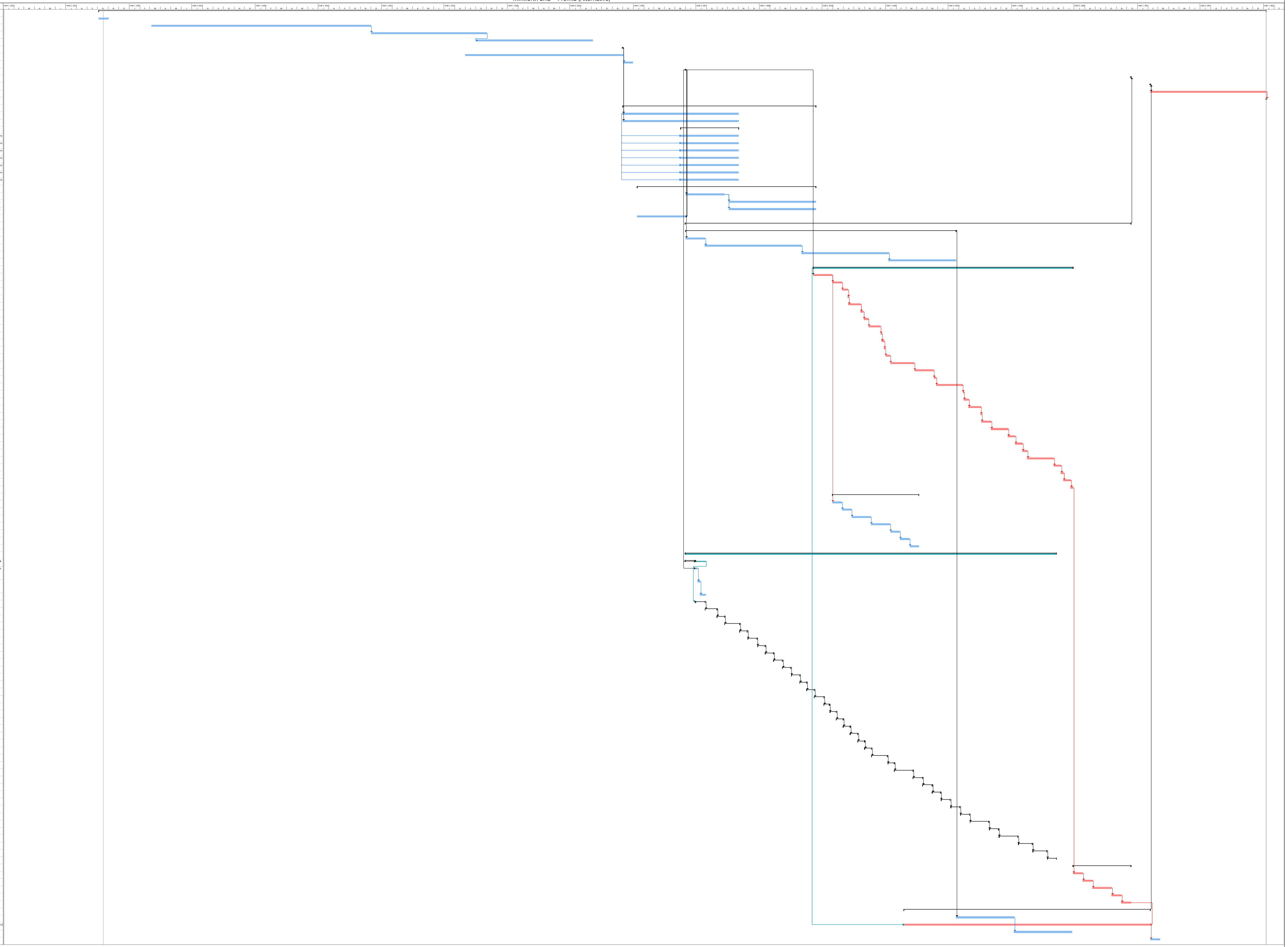
ID	WBS	Task Name	Duration	Start	Finish	Predecessors
1	1	**Contract Management**	**135.75 mons**	**Tue 04/10/22**	**Mon 28/02/33**	
2	1.1	Submission to RAPID Gate 2	1 mon	Tue 04/10/22	Mon 31/10/22	
3	1.2	RAPID Decision on Scheme Progression to Gate 3	22.75 mons	Mon 06/03/23	Fri 29/11/24	
4	1.3	Final Procurement Documentation and ITT	12 mons	Mon 02/12/24	Fri 31/10/25	3
5	1.4	Tender Award / CAP Award	12 mons	Mon 06/10/25	Fri 04/09/26	4FS-1 mon
6	1.5	Contractor in Place to Start Work	0 mons	Tue 01/12/26	Tue 01/12/26	
7	1.6	DCO Exam & Determination	16.35 mons	Mon 01/09/25	Tue 01/12/26	
8	1.7	Planning Consent	1 mon	Wed 02/12/26	Tue 29/12/26	7
9	1.8	Start Onsite	0 mons	Tue 01/06/27	Tue 01/06/27	
10	1.9	Construction Completion	0 mons	Mon 18/08/31	Mon 18/08/31	30
11	1.10	Commissioning Completion and Handover to ST	0 mons	Mon 29/03/32	Mon 29/03/32	234
12	1.11	Defects Period	12 mons	Tue 30/03/32	Mon 28/02/33	11
13	1.12	Retention Released	0 mons	Mon 28/02/33	Mon 28/02/33	12
14	2	**Pre-Construction**	**20 mons**	**Tue 01/12/26**	**Mon 12/06/28**	
15	2.1	Detailed Design	18 mons	Tue 01/12/26	Mon 17/04/28	6
16	2.2	Site GI	12 mons	Tue 01/12/26	Mon 01/11/27	6
17	2.3	**Procurement**	**6 mons**	**Tue 18/05/27**	**Mon 01/11/27**	
18	2.3.1	Pipeline Materials and Valves	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
19	2.3.2	MCCs	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
20	2.3.3	Pumps	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
21	2.3.4	Power Supplies	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
22	2.3.5	Process Plant (Ozone, BAC, GAC)	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
23	2.3.6	Pipejack Segments	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
24	2.3.7	Microtunnel Shafts Equipment	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
25	2.4	**Enabling Works**	**18.5 mons**	**Tue 12/01/27**	**Mon 12/06/28**	
26	2.4.1	Main Project Office/Site Establishment	4 mons	Tue 01/06/27	Mon 20/09/27	9
27	2.4.2	Archaeological Advanced Work	9 mons	Tue 05/10/27	Mon 12/06/28	26FS+2 wks
28	2.4.3	Environmental Mitigation	9 mons	Tue 05/10/27	Mon 12/06/28	26FS+2 wks
29	2.4.4	Fencing	5 mons	Tue 12/01/27	Tue 01/06/27	9FF
30	3	**Construction**	**55.05 mons**	**Mon 31/05/27**	**Mon 18/08/31**	
31	3.1	**Minworth STW Works 115MLD**	**39 mons**	**Tue 01/06/27**	**Mon 27/05/30**	
32	3.1.1	Establish Site Compound	2 mons	Tue 01/06/27	Mon 26/07/27	
33	3.1.2	General Civil Work	18 mons	Tue 27/07/27	Mon 11/12/28	32
34	3.1.3	MEICA Fit Out	12 mons	Tue 17/10/28	Mon 17/09/29	33FS-2 mons
35	3.1.4	Dry and Wet Testing	10 mons	Tue 21/08/29	Mon 27/05/30	34FS-1 mon
36	3.6	**Minworth STW works 230 MLD**	**37 mons**	**Tue 17/10/28**	**Mon 18/08/31**	
37	3.6.8	General Civil Work	16 mons	Tue 17/10/28	Mon 07/01/30	33FS-2 mons
38	3.6.9	MEICA Fit Out	12 mons	Tue 11/12/29	Mon 11/11/30	37FS-1 mon
39	3.6.10	Dry and Wet Testing	10 mons	Tue 12/11/30	Mon 18/08/31	38
40	3.7	**Pipe Laying**	**26.95 mons**	**Mon 05/06/28**	**Thu 27/06/30**	
41	3.7.64	Establish Working Coridor, Access Routes, Compoun	2 mons	Mon 05/06/28	Fri 28/07/28	
42	3.7.65	0 to 1010 (1010m)	20 days	Mon 31/07/28	Fri 25/08/28	41
43	3.7.66	1163 to 1839 (676m)	12 days	Mon 28/08/28	Tue 12/09/28	42
44	3.7.67	1990 to 2100 (110m)	2 days	Wed 13/09/28	Thu 14/09/28	43
45	3.7.68	2285 to 3700 (1415m)	25 days	Fri 15/09/28	Thu 19/10/28	44
46	3.7.69	3756 to 4111 (355m)	6 days	Fri 20/10/28	Fri 27/10/28	45
47	3.7.70	4381 to 4920 (539m)	10 days	Mon 30/10/28	Fri 10/11/28	46
48	3.7.71	5000 to 6352 (1352m)	25 days	Mon 13/11/28	Fri 15/12/28	47
49	3.7.72	6476 to 6580 (104m)	2 days	Mon 18/12/28	Tue 19/12/28	48
50	3.7.73	6642 to 6865 (223m)	5 days	Wed 20/12/28	Tue 26/12/28	49
51	3.7.74	6953 to 7149 (196m)	3 days	Wed 27/12/28	Fri 29/12/28	50
52	3.7.75	7233 to 7707 (474m)	10 days	Mon 01/01/29	Fri 12/01/29	51
53	3.7.76	7792 to 10584 (2792m)	50 days	Mon 15/01/29	Fri 23/03/29	52
54	3.7.77	10696 to 13097 (2401m)	40 days	Mon 26/03/29	Fri 18/05/29	53
55	3.7.78	13209 to 13516 (307m)	5 days	Mon 21/05/29	Fri 25/05/29	54
56	3.7.79	13655 to 16839 (3184m)	55 days	Mon 28/05/29	Fri 10/08/29	55
57	3.7.80	16857 to 16923 (56m)	2 days	Mon 13/08/29	Tue 14/08/29	56
58	3.7.81	17006 to 176521 (615m)	10 days	Wed 15/08/29	Tue 28/08/29	57
59	3.7.82	17704 to 19129 (1425m)	25 days	Wed 29/08/29	Tue 02/10/29	58
60	3.7.83	19213 to 19296 (83m)	2 days	Wed 03/10/29	Thu 04/10/29	59
61	3.7.84	19380 to 20413 (1061m)	20 days	Fri 05/10/29	Thu 01/11/29	60
62	3.7.85	20525 to 22508 (1983m)	35 days	Fri 02/11/29	Thu 20/12/29	61
63	3.7.86	22620 to 23374 (754m)	15 days	Fri 21/12/29	Thu 10/01/30	62
64	3.7.87	23430 to 24351 (921m)	15 days	Fri 11/01/30	Thu 31/01/30	63
65	3.7.88	24686 to 25245 (559m)	10 days	Fri 01/02/30	Thu 14/02/30	64
66	3.7.89	25357 to 28484 (3127m)	55 days	Fri 15/02/30	Thu 02/05/30	65
67	3.7.90	28903 to 29824 (921m)	15 days	Fri 03/05/30	Thu 23/05/30	66
68	3.7.91	30047 to 30299 (252m)	5 days	Fri 24/05/30	Thu 30/05/30	67
69	3.7.92	30466 to 31192 (726m)	15 days	Fri 31/05/30	Thu 20/06/30	68
70	3.7.93	31304 to 31445 (141m)	5 days	Fri 21/06/30	Thu 27/06/30	69
71	3.8	**Break Pressure Tanks**	**9 mons**	**Mon 31/07/28**	**Fri 06/04/29**	
72	3.8.15	Site Clearance and Topsoil Removal	1 mon	Mon 31/07/28	Fri 25/08/28	41
73	3.8.16	Excavation	1 mon	Mon 28/08/28	Fri 22/09/28	72
74	3.8.17	Cast Foundation Slabs	2 mons	Mon 25/09/28	Fri 17/11/28	73
75	3.8.18	Place Pre-Cast Wall and Roof Units	2 mons	Mon 20/11/28	Fri 12/01/29	74
76	3.8.19	Valving and Chambers	1 mon	Mon 15/01/29	Fri 09/02/29	75
77	3.8.20	Earthworks Reinstatement	1 mon	Mon 12/02/29	Fri 09/03/29	76
78	3.8.21	Dry and Wet Testing	1 mon	Mon 12/03/29	Fri 06/04/29	77
79	3.9	**Trenchless Crossings**	**38.5 mons**	**Mon 31/05/27**	**Fri 10/05/30**	



High Level Construction - Gate 2

Minworth SRO - 115Mld (Alternative)

ID	WBS	Task Name	Duration	Start	Finish	Predecessors
1	**1**	**Contract Management**	**120.9 mons**	**Tue 04/10/22**	**Thu 08/01/32**	
2	1.1	Submission to RAPID Gate 2	1 mon	Tue 04/10/22	Mon 31/10/22	
3	1.2	RAPID Decision on Scheme Progression to Gate 3	22.75 mons	Mon 06/03/23	Fri 29/11/24	
4	1.3	Final Procurement Documentation and ITT	12 mons	Mon 02/12/24	Fri 31/10/25	3
5	1.4	Tender Award / CAP Award	12 mons	Mon 06/10/25	Fri 04/09/26	4FS-1 mon
6	1.5	Contractor in Place to Start Work	0 mons	Tue 01/12/26	Tue 01/12/26	
7	1.6	DCO Exam & Determination	16.35 mons	Mon 01/09/25	Tue 01/12/26	
8	1.7	Planning Consent	1 mon	Wed 02/12/26	Tue 29/12/26	7
9	1.8	Start Onsite	0 mons	Tue 01/06/27	Tue 01/06/27	
10	1.9	Construction Completion	0 mons	Thu 12/12/30	Thu 12/12/30	30
11	1.10	Commissioning Completion and Handover to ST	0 mons	Thu 06/02/31	Thu 06/02/31	230
12	1.11	Defects Period	12 mons	Fri 07/02/31	Thu 08/01/32	11
13	1.12	Retention Released	0 mons	Thu 08/01/32	Thu 08/01/32	12
14	**2**	**Pre-Construction**	**20 mons**	**Tue 01/12/26**	**Mon 12/06/28**	
15	2.1	Detailed Design	12 mons	Tue 01/12/26	Mon 01/11/27	6
16	2.2	Site GI	12 mons	Tue 01/12/26	Mon 01/11/27	6
17	**2.3**	**Procurement**	**6 mons**	**Tue 18/05/27**	**Mon 01/11/27**	
18	2.3.1	Pipeline Materials and Valves	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
19	2.3.2	MCCs	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
20	2.3.3	Pumps	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
21	2.3.4	Power Supplies	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
22	2.3.5	Process Plant	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
23	2.3.6	Pipejack Segments	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
24	2.3.7	Microtunnel Shafts Equipment	6 mons	Tue 18/05/27	Mon 01/11/27	15SS+6 mons
25	**2.4**	**Enabling Works**	**18.5 mons**	**Tue 12/01/27**	**Mon 12/06/28**	
26	2.4.1	Main Project Office/Site Establishment	4 mons	Tue 01/06/27	Mon 20/09/27	9
27	2.4.2	Archaeological Advanced Work	9 mons	Tue 05/10/27	Mon 12/06/28	26FS+2 wks
28	2.4.3	Environmental Mitigation	9 mons	Tue 05/10/27	Mon 12/06/28	26FS+2 wks
29	2.4.4	Fencing	5 mons	Tue 12/01/27	Tue 01/06/27	9FF
30	**3**	**Construction**	**46.2 mons**	**Mon 31/05/27**	**Thu 12/12/30**	
31	**3.1**	**Minworth STW Works**	**28 mons**	**Tue 01/06/27**	**Mon 23/07/29**	
32	3.1.1	Establish Site Compound	2 mons	Tue 01/06/27	Mon 26/07/27	9
33	3.1.2	General Civil Work	10 mons	Tue 27/07/27	Mon 01/05/28	32
34	3.1.3	MEICA Fit Out	9 mons	Tue 02/05/28	Mon 08/01/29	33
35	3.1.4	Dry and Wet Testing	7 mons	Tue 09/01/29	Mon 23/07/29	34
36	**3.2**	**Pipe Laying**	**26.95 mons**	**Mon 05/06/28**	**Thu 27/06/30**	
37	3.2.24	Establish Working Coridor, Access Routes, Compoun	2 mons	Mon 05/06/28	Fri 28/07/28	9
38	3.2.25	0 to 1010 (1010m)	20 days	Mon 31/07/28	Fri 25/08/28	37
39	3.2.26	1163 to 1839 (676m)	12 days	Mon 28/08/28	Tue 12/09/28	38
40	3.2.27	1990 to 2100 (110m)	2 days	Wed 13/09/28	Thu 14/09/28	39
41	3.2.28	2285 to 3700 (1415m)	25 days	Fri 15/09/28	Thu 19/10/28	40
42	3.2.29	3756 to 4111 (355m)	6 days	Fri 20/10/28	Fri 27/10/28	41
43	3.2.30	4381 to 4920 (539m)	10 days	Mon 30/10/28	Fri 10/11/28	42
44	3.2.31	5000 to 6352 (1352m)	25 days	Mon 13/11/28	Fri 15/12/28	43
45	3.2.32	6476 to 6580 (104m)	2 days	Mon 18/12/28	Tue 19/12/28	44
46	3.2.33	6642 to 6865 (223m)	5 days	Wed 20/12/28	Tue 26/12/28	45
47	3.2.34	6953 to 7149 (196m)	3 days	Wed 27/12/28	Fri 29/12/28	46
48	3.2.35	7233 to 7707 (474m)	10 days	Mon 01/01/29	Fri 12/01/29	47
49	3.2.36	7792 to 10584 (2792m)	50 days	Mon 15/01/29	Fri 23/03/29	48
50	3.2.37	10696 to 13097 (2401m)	40 days	Mon 26/03/29	Fri 18/05/29	49
51	3.2.38	13209 to 13516 (307m)	5 days	Mon 21/05/29	Fri 25/05/29	50
52	3.2.39	13655 to 16839 (3184m)	55 days	Mon 28/05/29	Fri 10/08/29	51
53	3.2.40	16857 to 16923 (56m)	2 days	Mon 13/08/29	Tue 14/08/29	52
54	3.2.41	17006 to 176521 (615m)	10 days	Wed 15/08/29	Tue 28/08/29	53
55	3.2.42	17704 to 19129 (1425m)	25 days	Wed 29/08/29	Tue 02/10/29	54
56	3.2.43	19213 to 19296 (83m)	2 days	Wed 03/10/29	Thu 04/10/29	55
57	3.2.44	19380 to 20413 (1061m)	20 days	Fri 05/10/29	Thu 01/11/29	56
58	3.2.45	20525 to 22508 (1983m)	35 days	Fri 02/11/29	Thu 20/12/29	57
59	3.2.46	22620 to 23374 (754m)	15 days	Fri 21/12/29	Thu 10/01/30	58
60	3.2.47	23430 to 24351 (921m)	15 days	Fri 11/01/30	Thu 31/01/30	59
61	3.2.48	24686 to 25245 (559m)	10 days	Fri 01/02/30	Thu 14/02/30	60
62	3.2.49	25357 to 28484 (3127m)	55 days	Fri 15/02/30	Thu 02/05/30	61
63	3.2.50	28903 to 29824 (921m)	15 days	Fri 03/05/30	Thu 23/05/30	62
64	3.2.51	30047 to 30299 (252m)	5 days	Fri 24/05/30	Thu 30/05/30	63
65	3.2.52	30466 to 31192 (726m)	15 days	Fri 31/05/30	Thu 20/06/30	64
66	3.2.53	31304 to 31445 (141m)	5 days	Fri 21/06/30	Thu 27/06/30	65
67	**3.5**	**Break Pressure Tanks**	**9 mons**	**Mon 31/07/28**	**Fri 06/04/29**	
68	3.5.15	Site Clearance and Topsoil Removal	1 mon	Mon 31/07/28	Fri 25/08/28	37
69	3.5.16	Excavation	1 mon	Mon 28/08/28	Fri 22/09/28	68
70	3.5.17	Cast Foundation Slabs	2 mons	Mon 25/09/28	Fri 17/11/28	69
71	3.5.18	Place Pre-Cast Wall and Roof Units	2 mons	Mon 20/11/28	Fri 12/01/29	70
72	3.5.19	Valving and Chambers	1 mon	Mon 15/01/29	Fri 09/02/29	71
73	3.5.20	Earthworks Reinstatement	1 mon	Mon 12/02/29	Fri 09/03/29	72
74	3.5.21	Dry and Wet Testing	1 mon	Mon 12/03/29	Fri 06/04/29	73
75	**3.6**	**Trenchless Crossings**	**38.5 mons**	**Mon 31/05/27**	**Fri 10/05/30**	
76	**3.6.97**	**RM1 (150m)**	**1.1 mons**	**Mon 31/05/27**	**Tue 29/06/27**	**9SS+20 days**
77	3.6.97.10	Jacking Pit	0.25 mons	Tue 29/06/27	Mon 05/07/27	9SS+20 days
78	3.6.97.11	Reception Pit	0.25 mons	Tue 06/07/27	Mon 12/07/27	77
79	3.6.97.12	Pipe Jack	0.6 mons	Tue 13/07/27	Wed 28/07/27	78
80	**3.6.98**	**RM2 (120m)**	**1 mon**	**Wed 30/06/27**	**Tue 27/07/27**	**76**
84	**3.6.99**	**RM3 (165m)**	**1.2 mons**	**Wed 28/07/27**	**Mon 30/08/27**	**80**
88	**3.6.100**	**RM4 (80m)**	**0.8 mons**	**Tue 31/08/27**	**Tue 21/09/27**	**84**
92	**3.6.101**	**RM5 (270m)**	**1.6 mons**	**Wed 22/09/27**	**Thu 04/11/27**	**88**
96	**3.6.102**	**RM6 (80m)**	**0.8 mons**	**Fri 05/11/27**	**Fri 26/11/27**	**92**
100	**3.6.103**	**RM7 (120m)**	**1 mon**	**Mon 29/11/27**	**Fri 24/12/27**	**96**
104	**3.6.104**	**RM8 (60m)**	**0.8 mons**	**Mon 27/12/27**	**Mon 17/01/28**	**100**
108	**3.6.105**	**RM9 (85m)**	**0.9 mons**	**Tue 18/01/28**	**Thu 10/02/28**	**104**
112	**3.6.106**	**RM10 (85m)**	**0.9 mons**	**Fri 11/02/28**	**Tue 07/03/28**	**108**
116	**3.6.107**	**RM11 (85m)**	**0.9 mons**	**Wed 08/03/28**	**Fri 31/03/28**	**112**
120	**3.6.108**	**RM11 (85m)**	**0.9 mons**	**Mon 03/04/28**	**Wed 26/04/28**	**116**
124	**3.6.109**	**RM12 (57m)**	**0.7 mons**	**Thu 27/04/28**	**Tue 16/05/28**	**120**
128	**3.6.110**	**RM13 (72m)**	**0.8 mons**	**Wed 17/05/28**	**Wed 07/06/28**	**124**
132	**3.6.111**	**RM14 (116m)**	**1 mon**	**Thu 08/06/28**	**Wed 05/07/28**	**128**
136	**3.6.112**	**RM15 (23m)**	**0.6 mons**	**Thu 06/07/28**	**Fri 21/07/28**	**132**
140	**3.6.113**	**RM16 (55m)**	**0.7 mons**	**Mon 24/07/28**	**Thu 10/08/28**	**136**
144	**3.6.114**	**RM17 (50m)**	**0.7 mons**	**Fri 11/08/28**	**Wed 30/08/28**	**140**
148	**3.6.115**	**RM18 (36m)**	**0.7 mons**	**Thu 31/08/28**	**Tue 19/09/28**	**144**
152	**3.6.116**	**RM19 (81m)**	**0.8 mons**	**Wed 20/09/28**	**Wed 11/10/28**	**148**
156	**3.6.117**	**RM20 (54m)**	**0.7 mons**	**Thu 12/10/28**	**Tue 31/10/28**	**152**
160	**3.6.118**	**RM21 (50m)**	**0.7 mons**	**Wed 01/11/28**	**Mon 20/11/28**	**156**
164	**3.6.119**	**RM22 (295m)**	**1.7 mons**	**Tue 21/11/28**	**Fri 05/01/29**	**160**
168	**3.6.120**	**RM23 (43m)**	**0.7 mons**	**Mon 08/01/29**	**Thu 25/01/29**	**164**
172	**3.6.121**	**RM24 (325m)**	**1.9 mons**	**Fri 26/01/29**	**Tue 20/03/29**	**168**
176	**3.6.122**	**RM25 (127m)**	**1 mon**	**Wed 21/03/29**	**Tue 17/04/29**	**172**
180	**3.6.123**	**RM26 (113m)**	**1 mon**	**Wed 18/04/29**	**Tue 15/05/29**	**176**
184	**3.6.124**	**RM27 (100m)**	**0.9 mons**	**Wed 16/05/29**	**Fri 08/06/29**	**180**
188	**3.6.125**	**G1 (81m)**	**1 mon**	**Mon 11/06/29**	**Fri 06/07/29**	**184**
192	**3.6.126**	**G2 (54m)**	**1 mon**	**Mon 09/07/29**	**Fri 03/08/29**	**188**
196	**3.6.127**	**G3 (50m)**	**1 mon**	**Mon 06/08/29**	**Fri 31/08/29**	**192**
200	**3.6.128**	**G4 (294m)**	**2 mons**	**Mon 03/09/29**	**Fri 26/10/29**	**196**
204	**3.6.129**	**G5 (43m)**	**1 mon**	**Mon 29/10/29**	**Fri 23/11/29**	**200**
208	**3.6.130**	**G6 (325m)**	**2 mons**	**Mon 26/11/29**	**Fri 18/01/30**	**204**
212	**3.6.131**	**G7 (127m)**	**1.5 mons**	**Mon 21/01/30**	**Fri 01/03/30**	**208**
216	**3.6.132**	**G8 (113m)**	**1.5 mons**	**Mon 04/03/30**	**Fri 12/04/30**	**212**
220	**3.6.133**	**G9 (98m)**	**1 mon**	**Mon 15/04/30**	**Fri 10/05/30**	**216**
224	**3.7**	**Outfall Works**	**6 mons**	**Fri 28/06/30**	**Thu 12/12/30**	
225	3.7.6	Install Temporary Works	1 mon	Fri 28/06/30	Thu 25/07/30	66
226	3.7.7	Excavate to Formation	1 mon	Fri 26/07/30	Thu 22/08/30	225
227	3.7.8	Cast Concrete Structures	2 mons	Fri 23/08/30	Thu 17/10/30	226
228	3.7.9	Remove Temporary Works	1 mon	Fri 18/10/30	Thu 14/11/30	227
229	3.7.10	Install access covers, gratings, landscaping, and fenc	1 mon	Fri 15/11/30	Thu 12/12/30	228
230	**5**	**System Commissioning Works**	**25.5 mons**	**Fri 23/02/29**	**Thu 06/02/31**	
231	5.1	Treatment Works	6 mons	Tue 24/07/29	Mon 07/01/30	31
232	5.2	Conveyance	25.5 mons	Fri 23/02/29	Thu 06/02/31	36SS,229FF+2
233	6	Performance Testing (Treatment works)	6 mons	Tue 08/01/30	Mon 24/06/30	231
234	7	Performance testing (Pipeline)	1 mon	Fri 07/02/31	Thu 06/03/31	232



Project: Minworth 115Mld (Alternativ
Date:

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

D.2 Design Hazard Elimination and Risk Register

A7W13155-GT-SPR-200014	DHERR

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Jacobs

Latest Meeting Date

Phase	
C	Construction
M	Maintain / Clean
U	Use as Workplace
D	Demolish

Update Critical Risk Table

Project Name:	Minworth SRO Gate 2
Project Number:	A7W13155
Client:	Severn Trent Water

Probability	Worst Potential Severity (WPS) of Impact
1: Highly Unlikely 2: Unlikely 3: Possible 4: Likely 5: Highly Likely	1: Nil or slight injury / illness, property damage or environmental issue. 2: Minor injury / illness, property damage or environmental issue. 3: Moderate injury or illness, property damage or environmental issue. 4: Major injury or illness, property damage or environmental issue. 5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue. 10. Multiple fatalities and catastrophic event

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Risk ID.	Formal Review Description	Phase	Activity	Potential Hazard	Person(s) Most at Risk	Prob	WPS	Initial Risk Rating	Discipline	Design Measures to Eliminate Hazards	Design Measures to Reduce Risk	Residual Prob	Residual WPS	Residual Risk Rating	Residual Risk Description
1	4: Routine Design Team Meeting	C	Large vehicles movement through rural areas to access break pressure tank location during construction	Poor manouverability through rural areas to access break pressure tank compound throughout construction. There is a risk of injuring the general public.	Public	3	5	15	Civil / Structural	Break pressure tank (BPT) is traditionally requiered on a high point at a pipeline of this nature (needed for hyraulics) therefore, hazard may not be eliminated	Assess whether the BPT is required Consider the location and size Shorten the construction period by considering pre-cast reinforced concrete for the tank Reduce the requirement for temporary works	2	5	10	Although the risk of injuring general public in residential areas is reduced, it is still possible that large vehicles may injure general public during transportation to site.
2	4: Routine Design Team Meeting	C	Construction of shafts for crossings	Operative will be wokring with shafts around 5 to 10m deep. Risk of operative falling during installation of services, working platfroms or any other activity within dropshafts	Construction	4	5	20	Civil / Structural	Hazard cannot be completely eliminated.	Tried to reduce number of crossings	2	5	10	Experienced Contractor should be aware of and know appropriate construction methods to reduce risks and have a Safe System of Work.
3	4: Routine Design Team Meeting	C	Section of works at the beginning of pipeline	Potentially run over an underground service such as a gas pipeline due to the high number of crossings at this section of works	Construction	4	5	20	Civil / Structural	Hazard cannot be completely eliminated.	Tried to reduce number of crossings	3	5	15	Experienced Contractor should be aware of and know appropriate construction methods to reduce risks and have a Safe System of Work.
4	4: Routine Design Team Meeting	C	Section of works at the beginning of pipeline	Potentially run into the historic sludge cake when extending the pipe at Coleshill water reclamation works, which might release gas or pathogens	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid this historic lanfill by changing the route of the pipeline	2	5	10	No residual risk present if the alignment of pipeline is adjusted.
5	4: Routine Design Team Meeting	C	Edison road crossing	Wet fields at Edison road crossing not suitable for open/cut trenches	Construction	4	4	16	Civil / Structural	Try to avoid this wet field by changing the pipeline route or use trenchless crossing	Tried to avoid this wet field by changing the pipeline route or use trenchless crossing	2	4	8	Contractor to be informed of the location of exisiting watercourses. Apply the appropriate method of containing spills, treating and discharging contaminated water
6	4: Routine Design Team Meeting	C	Edison road crossing	Open/cut trenches are adjacent to HV powerline	Construction	4	5	20	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid this HV powerline by changing the route of the pipeline	2	5	10	Contractor to be informed of the location of overhead cables. Safe systems of work to be employed and agreed with Utility company
7	4: Routine Design Team Meeting	C	Extending the pipeline	Pipeline breaks at bends and junctions	Construction	3	4	12	Civil / Structural	Use HDPE pipe material to allow bending flexibility in pipeline	Tried to creat a pipeline route as straight as possible to avoid bends	1	4	4	No residual risk present if the HDPE pipes are used
8	4: Routine Design Team Meeting	C	Pump commissioning and pumping water through rising main	Occurrence of water transient in pipeline due to pump failier or gate valve quick closure	Operations	3	5	15	Commissioning	Hazard cannot be completely eliminated but it can be reduce dramatically by undertaking proper surge analysis	Undertake surge analysis and amend the pipeline accordingly by adding air valves and surge vessels at the proper surge points	1	4	4	No residual risk present if surge assessment is conducted
9	4: Routine Design Team Meeting	C	Electrical system at pumping station	Occurrence of faults in electrical system	Operations	3	5	15	Commissioning	Hazard cannot be completely eliminated.	Install and test the proper control panels that are compatible with the water pumps	2	5	10	No residual risk present if EICA assessment is conducted
10	4: Routine Design Team Meeting	C	Laying the rising main under motorways	Highways England stipulations may be imposed upon the works (shaft locations and construction access)	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid these crossings by changing the route of the pipeline	2	5	10	Delays and potential additional costs
11	4: Routine Design Team Meeting	C	Laying the rising main in a public road	Highways England stipulations may be imposed upon the works	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid these crossings by changing the route of the pipeline	2	5	10	Delays and potential additional costs
12	4: Routine Design Team Meeting	C	Laying the rising main under railways	National Rail stipulations may be imposed upon the works	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid these crossings by changing the route of the pipeline	2	5	10	Delays and potential additional costs
13	4: Routine Design Team Meeting	C	Laying the rising main under HS2 route	HS2 stipulations may be imposed upon the works	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid these crossings by changing the route of the pipeline	2	5	10	Delays and potential additional costs
14	4: Routine Design Team Meeting	C	Laying the rising main under canals	Canal & River Trust stipulations may be imposed upon the works	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid these crossings by changing the route of the pipeline	2	5	10	Delays and potential additional costs
15	4: Routine Design Team Meeting	C	Underground Utilities	Route adjustment required.	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid these crossings by changing the route of the pipeline	2	5	10	Delays and potential additional costs
16	4: Routine Design Team Meeting	C	Routing of rising main	Laying pipeline in areas with high aquifer productivity potential	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to avoid aquifer potential zones as much as possible. Identify any potential areas for further investigation and mitigation measures	2	5	10	Difficult and dangerous construction, poor stability in excavations and/or potential aquifer contamination
17	4: Routine Design Team Meeting	C	Routing of rising main	Laying pipeline in areas with underneath commercial and residential properties	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Tried to Avoid passing the pipeline underneath residential and commercial properties as much as possible	2	5	10	Presents a risk of property damage, injury or death, loss in property value
18	4: Routine Design Team Meeting	C	Manual Handling (Musculoskeletal)	Lifting/moving pipes, valves, pump components etc	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Minimised as much as possible the weight of units being used. Where possible heavy units were installed at ground level.	2	5	10	Risk of injury due to falling items or strenuous lifting
19	4: Routine Design Team Meeting	C	Working in a strenuous position e.g. stretching, reaching, bending etc.	Lifting/moving pipeline fittings, MEICA parts, components and associated equipment	Construction	4	5	20	Civil / Structural	Hazard cannot be completely eliminated.	Minimised as much as possible the weight of units being used. Where possible heavy units were installed at ground level.	2	5	10	Positioning may warrant strenuous lifting during commissioning, operation, maintenance and decommissioning

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DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date	
Phase	
C	Construction
M	Maintain / Clean
U	Use as Workplace
D	Demolish
Project Name:	Minworth SRO Gate 2
Project Number:	A7W13155
Client:	Severn Trent Water

Update Critical Risk Table

Probability	Worst Potential Severity (WPS) of Impact
1: Highly Unlikely 2: Unlikely 3: Possible 4: Likely 5: Highly Likely	1: Nil or slight injury / illness, property damage or environmental issue. 2: Minor injury / illness, property damage or environmental issue. 3: Moderate injury or illness, property damage or environmental issue. 4: Major injury or illness, property damage or environmental issue. 5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue. 10. Multiple fatalities and catastrophic event

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description
20	4: Routine Design Team Meeting	C	Working in confined spaces	Excavations may present environment for a confined space hazard	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Minimised units and chambers in enclosed spaces. Minimised depths of excavation where possible and incorporated trenchless methods to minimise open excavations	2	5	10	Risk of working in a confined space
21	4: Routine Design Team Meeting	C	Unstable slopes	Excavations	Construction	4	5	20	Civil / Structural	Hazard cannot be completely eliminated.	Minimised depths of excavation where possible and incorporated trenchless methods to minimise open excavations	2	5	10	Death or serious injury resulting from falling into the trench
22	4: Routine Design Team Meeting	C	Routing of pumping main at Birmingham	Laying pipeline in environmentally designated area	Construction	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Avoided environmental areas where possible. Ensure construction methods selected have manageable impact	2	5	10	Construction may damage the designated area
23	4: Routine Design Team Meeting	C	Routing of pumping main at Birmingham	Laying pipeline in proximity to tree roots	Construction	3	4	12	Civil / Structural	Hazard cannot be completely eliminated.	Avoided trees where possible. Ensured deep trenchless methods in congested areas	2	5	10	Construction may damage and/or kill trees. Construction may cause tree to collapse presenting an injury/death risk
24	4: Routine Design Team Meeting	C	Routing of pumping main at Birmingham	Laying pipeline in areas prone to landslide and/or seismic activity	Construction	2	5	10	Civil / Structural	Hazard cannot be completely eliminated.	Aligned pipeline routes to avoid such areas	2	5	10	Construction may trigger a landslide or seismic event presenting an injury/death risk
25	4: Routine Design Team Meeting	C	Treatment process lines	Risk of blockages	Staff	2	4	8	Civil / Structural	Hazard cannot be completely eliminated.	Sufficient cleansing locations, and having above ground pipelines	1	4	4	Leaks and bloackages
26	4: Routine Design Team Meeting	C	Treatment tanks and processes	Access and working in confined spaces	Staff	4	5	20	Civil / Structural	Hazard cannot be completely eliminated.	Consider access when desining the general arrangements of the process, and create an operator virtual walkthrough	2	5	10	
27	4: Routine Design Team Meeting	C	Pressure vessels for filtration	Leakages	Staff	3	5	15	Civil / Structural	Hazard cannot be completely eliminated.	Consider the design unpressurised vessels with a larger footprint. Taken offline for maintenance	2	4	8	
28	4: Routine Design Team Meeting	C	Ground conditions of settlement tanks	Hitting bedrock while excavating	Construction	2	5	10	Civil / Structural	Hazard cannot be completely eliminated.	conduct ground Site Investigations before chosing the location of the settlement tanks or make them partially above ground	1	5	5	
29	4: Routine Design Team Meeting	C	The ozonation plant requires oxygen to operate	Oxygen storage and delivery arrangements	Operations	3	5	15	Non Jacobs Designer	Hazard cannot be completely eliminated.	reconsider the design	2	4	8	
30	4: Routine Design Team Meeting	C	Treatment process	Chemicals used for treatment	Operations	3	5	15	Non Jacobs Designer	Hazard cannot be completely eliminated.	Make sure staff and operators are well trained in chemicals handling, with regular refresher training	2	4	8	
31	4: Routine Design Team Meeting	C	Treatment process	Handeling ferric - delivery and use	Operations	3	5	15	Non Jacobs Designer	Hazard cannot be completely eliminated.	Make sure staff and operators are well trained in chemicals handling, with regular refresher training	2	4	8	
32	4: Routine Design Team Meeting	C	Working at height	Falling from high platforms	Construction	2	5	10	Non Jacobs Designer	Hazard cannot be completely eliminated.	Make sure staff and operators are well trained in working at height, with regular refresher training	2	5	10	
33	4: Routine Design Team Meeting	C	Large vehicle movement adjacent to site using the same road access	Traffic incidents	Operations	2	5	10	Non Jacobs Designer	Hazard cannot be completely eliminated.	Make sure drivers are well trained.	2	5	10	
34	4: Routine Design Team Meeting	C	Security	Stealing equipement	Staff	2	5	10	Non Jacobs Designer	Hazard cannot be completely eliminated.	try to build the treatment plant in a hidden spot away from public access and rotate the processes to make the most expensive items deep inside the plant rather than at the edge of the plant . Other measures such as fences, lighting, CCTV, and security	2	5	10	
35															
36															
37															
38															
39															
40															
41															
42															

D.3 Operational Philosophy

A7W13155-GT-REP-200023	Operational Philosophy

Operational Philosophy

Document no: A7W13155-GT-REP-200023
Revision no: 0D

Severn Trent Water
A7W13155

Minworth SRO
18 October 2022

Author names redacted

Operational Philosophy

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Project name:	Minworth SRO
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Contents

1. Introduction

Minworth Strategic Resource Option (SRO) was included as an SRO in the Price Review 19 Final Determination as a source option for the Severn to Thames Transfer (STT) SRO and Grand Union Canal (GUC) SRO.

This report describes the operational philosophy assumed for the operation of the Minworth SRO scheme should it be selected through the RAPID gated process.

The flow required by the STT and GUC SROs is expected to fluctuate throughout the year. The table below indicates the expected flows for each SRO in relation to the Advanced Water Treatment Plant (AWTP) production and the portion of the year that each of the flows is expected to be sustained.

Table 1-1: STT and GUC operating regimes

	Delivered flow (to the SRO)		Operating time
STT operating regimes	Maximum flow	100% of peak plant capacity	10% of the year (1 month)
	Minimum flow	5.3% of peak flow (if peak flow is 57Mld) 2.6% of peak flow (if peak flow is 115Mld)	90 % of the year (11 months)
GUC operating regimes	Maximum flow	100% of peak plant capacity	25% of the year (3 months)
	Medium flow	50% of peak plant capacity	17% of the year (2 months)
	Minimum flow	20% of peak plant capacity	58% of the year (7 months)

2. Scheme Operation

2.1. Advanced Water Treatment Plant Operation

2.1.1. Types of Operating Mode

The operating regime of the AWTP will depend on the treatment and conveyance options selected. A total of 8 operating regimes for the AWTP have been defined based on the possible combinations of treatment options and the capacity of the STT and GUC pipelines.

The AWTP must always maintain a minimum throughput of 20% of the design flow. When the treatment works is producing more water than required for pipeline sweetening then the extra treated water would be returned to the FE channel.

The types of operating modes proposed are:

- Normal operation – AWTP is operating in normal automatic control (typically 20-100% of peak output) and delivering water for onward transfer to either STT or GUC or both.
- Hot Standby – mode of operation where the AWTP runs at 20% of peak flow, with a 'duty' stream under normal operation in rotation with other plant streams in standby. This mode allows the plant to return into normal operation mode within 17days. This mode provides the sweetening flow(s) for the pipeline(s) which are less than the AWTP minimum flow.
- Non-operational – AWTP is out of service and there is minimal ongoing expenditure.

The combination of the flows delivered by the STT and GUC pipelines will dictate the production requirements of the AWTP and its operating regime. Table 2-1 below summarises the AWTP regimes and indicates the required production volumes of the plant and the percentage of the year when each of the outputs should be delivered.

Appendix A.1 shows the details for the calculation of the AWTP outputs and operating regimes.

Table 2-1: AWTP operating regimes and production volumes

Treatment option	Flow requirement	AWTP production			
TREAT57	STT – 57 Mld GUC – 0	57 Mld 10% of the year	11 Mld 90% of the year		
	STT – 0 GUC – 57 Mld	57 Mld 25% of the year	28.5 Mld 17% of the year	14 Mld 58% of the year	
TREAT115	STT – 115 Mld GUC – 0	115 Mld 10% of the year	23 Mld 90% of the year		
	STT – 0 GUC –115 Mld	115 Mld 25% of the year	58 Mld 17% of the year	29 Mld 58% of the year	
	STT – 57 Mld GUC –57 Mld	115 Mld 9% of the year	60 Mld 17% of the year	32 Mld 17% of the year	23 Mld 57% of the year
TREAT172	STT – 115 Mld GUC – 57 Mld	172 Mld 9 % of the year	60 Mld 17% of the year	34 Mld 74% of the year	
	STT – 57 Mld GUC – 115 Mld	172 Mld 9% of the year	118 Mld 17% of the year	61 Mld 17% of the year	34 Mld 57% of the year
TREAT 230	STT – 115 Mld GUC – 115 Mld	230 Mld 9% of the year	118 Mld 17% of the year	61 Mld 17% of the year	46 Mld 57 % of the year

2.1.2. Changing Modes

The hot standby mode will operate a reduced flow, with only a 'duty stream' treating water. This stream ensures a sufficient flow is available to maintain water quality within the pipeline and to keep the treatment works available to be ramped up quickly. Ensuring a constant flow allows the process units to be ramped up over 17 days to full capacity which is useful for summer months when there is less water availability and thus increased demand.

Ramping Up from Hot Standby to Normal Operation:

- This is largely controlled by the time required to bring each "train" online through water quality testing
- As the conveyance assets are full and discharging the hot standby sweetening flow, less maintenance and commissioning is required to ramp up to full capacity
- If the AWTP is ramped up first, then the conveyance assets will be ramped up to match the AWTP output (subject to acceptable levels of treatment being achieved)

Ramping down to hot standby mode only requires adjusting flows on the SCADA system to the reduced proportion of total capacity. This minimum flow will then be rotated around the various streams in the plant to maintain availability. Returning to normal operation is equally straightforward to ramp up flows to 20-100% of maximum output.

Under normal operation or hot standby, as well as during the ramp up process, in the event of a quality failure, the AWTP will "fail safe", and the flows will run to waste back to the final effluent channel at Minworth for discharge to the Tame. The treatment facilities are monitored at Critical Control Points (CCPs) for the required water quality parameters and will initiate an auto-shutdown / diversion of flow in the event of registering out of bound ("critical limit") quality parameters or catastrophic failure of the plant.

2.1.3. Maintenance

Whilst the AWTP runs in normal mode, maintenance is expected to be minimal, to the extent to keep the plant operating at optimum performance. The regular asset maintenance schedule will be undertaken whilst the plant is run in hot standby mode.

The following recommendations are provided for the periods where ATWP water is not needed:

1. Continue to pump Minworth STW effluent to the Minworth ATWP at minimum capacity

2. Pump the STW effluent through a single floc/sed train but do not add any chemicals. Solids system may need to be operated daily to pump out solids even though no coagulant is added. The other floc/sed trains can be drained and idle.

3. Allow floc/sed effluent to flow through one ozone contactor but do not add any ozone. Other ozone contactors can be drained and idle. Prior to re-starting the AWTP, the ozone contactor should be drained and cleaned out.

4. Allow ozone effluent to flow through all biofilters at a low loading rate. This will keep the biology happy through the offline period and eliminate the need to reacclimate the media when the AWTP starts back up (can be a 4–8-week period). Biofilters may need to be backwashed once a month or so (with potable water) but will not be strictly operated for turbidity removal so only need to be backwashed when the headloss accumulation is too high. No chemical addition is needed at the biofilters.

5. Route the biofilter effluent through filter to waste to the recycle basin and then pump directly to the Minworth STW outfall for discharge with the rest of the Minworth STW flow.

6. Keep the GAC adsorbers wet with potable water. Pump new potable water into the adsorbers each week to maintain a DO above 5 mg/L. This should keep the media ready for the restart without consuming unnecessary adsorption sites.

7. Pump the chemicals out of chemical piping/tubing so that chemicals are not sitting in the piping/tubing. No chemicals will be used during the AWTP offline period.

8. STT and GUC pipelines to be drained down to prevent septicity.

2.2. Pipeline Operation

This section describes the operation of the pipeline which supplies STT. The description of the pipeline which supplies GUC can be referenced in GUC Annex A1 Engineering CDR.

The pipeline elements of the scheme will be run in parallel with the operation of the AWTP. Therefore, the transfer pumping station and pipeline would be run in a hot standby mode for the same period that the AWTP is, with the minimum turn-down treated flows being available to be discharged via the pipeline to the river when required. Excess flows not required to support sweetening flow within the pipeline could be returned to the FE channel to reduce operational cost and carbon.

2.2.1. Transfer Pumping Station Operation and Maintenance

The operation and maintenance of the STT Transfer Pumping Station will follow the regular asset maintenance schedule for the AWTP.

The operation and maintenance of the GUC Pumping Station will likely follow the same regular asset maintenance schedule for the AWTP, however the GUC transfer pumping station is not in the scope of this report.

2.2.2. Pipeline Operation and Maintenance

A sweetening flow of 2.6% of the maximum flow (if the maximum flow is 115Mld) and 5.3% of the maximum flow (if the maximum flow is 57Mld) would be sufficient to keep the flow "sweet" for the pipeline whilst in "hot standby" modes. This would be needed to avoid the water in the pipeline deteriorating when the option is in minimum turndown and not in normal operational use. It has been calculated that it would take less than a day to transition from hot standby to normal operation for the pipeline.

The sweetening flow is normally assumed as 10% of the peak flow, however, as an opportunity for cost savings, the sweetening flow has been assessed in detail and has been reduced to 3Mld (approx. 3%) offering operational cost savings for the pumping station. The reduced sweetening flow is measured by calculating the volume of water inside the entire pipeline which is 21.980 ML. and dividing that volume by 7 days, which is the allowed age of water before reaching stagnation. Note that 7 days is still conservative as the AWTP treats the water to a high quality.

As a further opportunity to reduce OPEX, a fully drained scenario could be considered at Gate 3. Under the non-operational scenario, the STT pipeline would need to be drained down to prevent septicity. The volume of water to be discharged to the environment is 21.98Ml. Given the topography of the terrain where the pipeline would be installed, several adequate discharge points should be identified along the pipeline. Changes in pressure when the pipeline is returned to service may increase the risk of deterioration of the pipe.

2.2.3. Break Pressure Tank

The break pressure tank has been designed with 2 cells so that during operation (either normal or hot standby) a cell can be shut down and cleaned and maintained.

Access to the break pressure tank will be via the public highway to the compound with no facilities. Procedures and arrangements for safe access and egress to the break pressure tanks will need to be confirmed at outline design with Severn Trent Operations to comply with current H&S guidelines.

2.2.4. Treated Water Discharge Location

The discharge location for the treated water for STT is proposed to be positioned on the bank of the River Avon. Adequate access will have to be negotiated at the time of construction to ensure there is protected and appropriate access into the site for maintenance.

Procedures and arrangements for safe access and egress to the discharge site will need to be confirmed at outline design with Severn Trent Operations to comply with current H&S guidelines.

The discharge location for the treated water for GUC is into the GUC pumping station located on Minworth site. Procedures and arrangements for safe access and egress to the pumping station will need to be confirmed at outline design with Severn Trent Operations to comply with current H&S guidelines.

2.3. Operational Resources

2.4. Normal Operation

Conventional treatment processes operate at peak capacity requiring:

- Chemicals for chemical dosing
- Full-time staff
- AWTP operational maintenance to maintain efficiency
- Operational Plan
- Normal fault finding & resolution to ensure water quality

2.5. Ramp Up (from Hot Standby to Normal) - up to 2 weeks (full plant commissioning)

- One at a time, bring all trains online, with water quality assessments using the opportunity to run to waste to ensure quality maintained at the outfall
- One at a time, bring all assist pumps online

2.6. Ramp Down (from Normal to Hot Standby) - up to 2 weeks (change from all trains operating to duty cycle)

- Decommission non-necessary assets
- Carry out pipeline valve changes for any run-to-waste/sweetening flow operation

2.7. Hot Standby - plant in a state of operational readiness

As per operating regime with one train operational only, regular cycling of each train with maintenance/cleaning of others. Conventional treatment processes continue operating at a reduced rate requiring:

- High-level power requirements to keep plant running throughout the year
- Additional resources to replace equipment on rotation
- Chemicals for chemical dosing
- Full-time staff
- AWTP maintenance
- One duty pump used for all scenarios, no assists (periodic cycling)
- Pipeline assets are to have been maintained and ensured ready for use, sweetening flow through the full lengths

2.8. Non-operational

Most of the treatment facilities (flocculation and sedimentation, ozone and chemical feed systems) in the Minworth AWTP can be turned on/off with few challenges and could remain non-operational subject to the operating regime noted above. If these processes are sitting idle, it would be recommended to check the equipment monthly and potentially bump all equipment to make sure it is still functional. A two-week recommissioning period prior to start is required to fully recommission the plant.

BAC filtration and GAC adsorption treatment processes are more challenging. These should not be left completely idle as there will be negative consequences to the media. Operating the facility at 20% of its design capacity already brings some challenges as it will provide extremely low loading rates that may impact the filterability of the water without adequate cycling of the assets. It is therefore recommended the plant remains operational to eliminate these issues.

A. Appendices

A.1 AWTP operating regimes

TREAT57

STT57

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
STT Output (Mld)	3	3	3	3	3	3	57	3	3	3	3	3
STT Operation Regime	5%	5%	5%	5%	5%	5%	100%	5%	5%	5%	5%	5%
AWTP Output (Mld)	11	11	11	11	11	11	57	11	11	11	11	11
AWTP Operation Regime	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%

TREAT57

GUC57

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GUC Output (Mld)	14	14	14	14	29	57	57	57	29	14	14	14
GUC Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%
AWTP Output (Mld)	14	14	14	14	29	57	57	57	29	14	14	14
AWTP Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%

TREAT115

STT115

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
STT Output (Mld)	3	3	3	3	3	3	115	3	3	3	3	3
STT Operation Regime	3%	3%	3%	3%	3%	3%	100%	3%	3%	3%	3%	3%
AWTP Output (Mld)	23	23	23	23	23	23	115	23	23	23	23	23
AWTP Operation Regime	20%	20%	20%	20%	20%	20%	100%	20%	20%	20%	20%	20%

TREAT115

GUC115

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GUC Output (Mld)	29	29	29	29	58	115	115	115	58	29	29	29
GUC Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%
AWTP Output (Mld)	29	29	29	29	58	115	115	115	58	29	29	29
AWTP Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%

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TREAT115

STT57 & GUC57

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
STT Output (Mld)	3	3	3	3	3	3	57	3	3	3	3	3
STT Operation Regime	5%	5%	5%	5%	5%	5%	100%	5%	5%	5%	5%	5%
GUC Output (Mld)	14	14	14	14	29	57	57	57	29	14	14	14
GUC Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%
AWTP Output (Mld)	23	23	23	23	32	60	114	60	32	23	23	23
AWTP Operation Regime	20%	20%	20%	20%	28%	53%	100%	53%	28%	20%	20%	20%

TREAT172

STT115 & GUC57

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
STT Output (Mld)	3	3	3	3	3	3	115	3	3	3	3	3
STT Operation Regime	3%	3%	3%	3%	3%	3%	100%	3%	3%	3%	3%	3%
GUC Output (Mld)	14	14	14	14	29	57	57	57	29	14	14	14
GUC Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%
AWTP Output (Mld)	34	34	34	34	34	60	172	60	34	34	34	34
AWTP Operation Regime	20%	20%	20%	20%	20%	35%	100%	35%	20%	20%	20%	20%

TREAT172

STT57 & GUC115

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
STT Output (Mld)	3	3	3	3	3	3	57	3	3	3	3	3
STT Operation Regime	5%	5%	5%	5%	5%	5%	100%	5%	5%	5%	5%	5%
GUC Output (Mld)	29	29	29	29	58	115	115	115	58	29	29	29
GUC Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%
AWTP Output (Mld)	34	34	34	34	61	118	172	118	61	34	34	34
AWTP Operation Regime	20%	20%	20%	20%	35%	69%	100%	69%	35%	20%	20%	20%

TREAT230

STT115 & GUC115

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
STT Output (Mld)	3	3	3	3	3	3	115	3	3	3	3	3
STT Operation Regime	3%	3%	3%	3%	3%	3%	100%	3%	3%	3%	3%	3%
GUC Output (Mld)	29	29	29	29	58	115	115	115	58	29	29	29
GUC Operation Regime	25%	25%	25%	25%	50%	100%	100%	100%	50%	25%	25%	25%
AWTP Output (Mld)	46	46	46	46	61	118	230	118	61	46	46	46
AWTP Operation Regime	20%	20%	20%	20%	26%	51%	100%	51%	26%	20%	20%	20%

D.4 Traffic Volumes Estimate

A7W13155-CY-CAL-215001	Traffic Volumes Estimate

Treatment Works 230MLD	Dimensions			Excavation		Foundation Slab	Pipe		Vehicle Movements							
Item	Width (m)	Length (m)	Depth (m)	Depth (m)	Excavation Volume (m3)	Volume (m3)	Length of Pipe (m)	Total Number (no)	Number of Process Pieces (no)	HGVs (no)	Total Spoil Removal (m3)	HGVs (no)	Concrete Volume (m3)	Concrete Wagons (no)	Weight of Pipes (tns)	Pipe Wagons (no)
Backwash Pipework		1000					6	167					0	0	403	15
Inlet Pipework		401					6	67							162	6
COMAG Tank 1	25		0.25			123							123	20	0	
CoMag Tank 2	25		0.25			123							123	20	0	
BAC	30	20	0.25			150							150	25	0	
GAC	30	20	0.25			150							150	25	0	
O3 Contact 1	15	15	0.25			56							56	9	0	
O3 Contac 2	15	15	0.25			56							56	9	0	
GAC Interstage	15	15	0.25			56							56	9	0	
Conveyance PS	25	20	0.25			125							125	21	0	
Backwash PS	25	20	0.25			125							125	21	0	
Outfall Return	15	15	0.25			56							56	9	0	
Backwash Storage	25	20	0.25			125							125	21	0	
Various Prefab									100	100						
Site Road (Asphalt wagon)	6.5	1500	0.15			1463								122	122	
						2608		234		100			1145	313	686	20.5

Assume		
Capacity Flat bed Wagon	27.5	tns
Capacity of tipper	13	m3
Cover	0.6	m3
Bipe Bedding	0.1	m
1300mm 6m Pipe Steel (403kg/m)	2418	kg/pipe
Concrete Wagon Volume	6	m3
Asphalt lay	4	m2/t (100mm)
Asphalt Wagon	20	tns
All excavation arisings used onsite		

Treatment Works 115MLD	Dimensions			Excavation		Foundation Slab	Pipe		Vehicle Movements							
Item	Width (m)	Length (m)	Depth (m)	Depth (m)	Excavation Volume (m3)	Volume (m3)	Length of Pipe (m)	Total Number (no)	Number of Process Pieces (no)	HGVs (no)	Total Spoil Removal (m3)	HGVs (no)	Concrete Volume (m3)	Concrete Wagons (no)	Weight of Pipes (tns)	Pipe Wagons (no)
Backwash Pipework		1000					6	167					0	0	403	15
Inlet Pipework		401					6	67							162	6
COMAG Tank 1	25		0.25			123							123	20	0	
CoMag Tank 2	25		0.25			123							123	20	0	
BAC	30	10	0.25			75							75	13	0	
GAC	30	10	0.25			75							75	13	0	
O3 Contact 1	15	7	0.25			26							26	4	0	
O3 Contac 2	15	7	0.25			26							26	4	0	
GAC Interstage	15	7	0.25			26							26	4	0	
Conveyance PS	25	20	0.25			125							125	21	0	
Backwash PS	25	20	0.25			125							125	21	0	
Outfall Return	15	15	0.25			56							56	9	0	
Backwash Storage	25	10	0.25			63							63	10	0	
Various Prefab									50	50						
Site Road	6.5	1000	0.15			975								81		
						1818		234		50			843	222	565	21

Assume		
Capacity Flat bed Wagon	27.5	tns
Capacity of tipper	13	m3
Cover	0.6	m3
Bipe Bedding	0.1	m
1300mm 6m Pipe Steel (403kg/m)	2418	kg/pipe
Concrete Wagon Volume	6	m3
Asphalt lay	4	m2/t (100mm)
Asphalt Wagon	20	tns
All excavation arisings used onsite		

Treatment Works 115MLD Alt	Dimensions			Excavation		Foundation Slab	Pipe		Vehicle Movements							
Item	**Width (m)**	**Length (m)**	**Depth (m)**	**Depth (m)**	**Excavation Volume (m3)**	**Volume (m3)**	**Length of Pipe (m)**	**Total Number (no)**	**Number of Process Pieces (no)**	**HGVs (no)**	**Total Spoil Removal (m3)**	**HGVs (no)**	**Concrete Volume (m3)**	**Concrete Wagons (no)**	**Weight of Pipes (tns)**	**Pipe Wagons (no)**
Backwash Pipework		1000					6	167					0	0	403	15
Inlet Pipework		401					6	67							162	
COMAG Tank 1	25		0.25			123							123	20	0	
CoMag Tank 2	25		0.25			123							123	20	0	
BAC																
GAC																
O3 Contact 1																
O3 Contac 2																
GAC Interstage																
Conveyance PS	25	20	0.25			125							125	21	0	
Backwash PS	25	20	0.25			125							125	21	0	
Outfall Return	15	15	0.25			56							56	9	0	
Backwash Storage	25	10	0.25			63							63	10	0	
Various Prefab									30	30						
Site Road	6.5	800	0.15			780								65		
						1394		234		30			614	167	565	15

Assume		
Capacity Flat bed Wagon	27.5	tns
Capacity of tipper	13	m3
Cover	0.6	m3
Bipe Bedding	0.1	m
1300mm 6m Pipe Steel (403kg/m)	2418	kg/pipe
Concrete Wagon Volume	6	m3
Asphalt lay	4	m2/t (100mm)
Asphalt Wagon	20	tns
All excavation arisings used onsite		

Trenchless Sections						Launch Pit							Reception Pit							Trenchless Section					Vehicle Movements			
id	Length (m)	Dia (m)	Section of Pipe	Trenchless Technique	Crossings	Diameter (m)	Depth (m)	Segments Per Ring (no)	Total Segments (no)	Segment Weight (tns)	Total Weight (tns)	Spoil Volume (m3)	Diameter (m)	Depth (m)	Segments Per Ring (no)	Total Segments (no)	Segment Weight (tns)	Total Weight (tns)	Spoil Volume (m3)	Spoil Volume (m3)	Pipe Length (m)	Pipe Sections (No)	Pipe Weight (tns)	Total Pipe Weight (tns)	Weight of PCCUs at Location (tns)	HGVs (No)	Spoil at Location (m3)	HGVs (No)
1	150	0.9	Rising main	Pipe Jack	M42 and M6 toll	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	95.44	2.5	60	2.1	126	234	9	567.84	44
2	120	0.9	Rising main	Pipe Jack	A446	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	2.2	99	220.92	76.35	3.5	34	3.1	106	259	9	548.13	42
3	165	0.9	Rising main	Pipe Jack	HS2	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	3.2	144	220.92	104.98	4.5	37	4.1	150	348	13	592.18	46
4	80	0.9	Rising main	Pipe Jack	Haunch Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	4.2	189	220.92	50.90	5.5	15	5.1	74	317	12	516.03	40
5	270	0.9	Rising main	Pipe Jack	River Tame and Railway	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	5.2	234	220.92	171.79	6.5	42	6.1	253	541	20	695.23	53
6	80	0.9	Rising main	Pipe Jack	Birmingham Road	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	6.2	279	220.92	50.90	7.5	11	7.1	76	409	15	517.58	40
7	120	0.9	Rising main	Pipe Jack	Station Road and Railway	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	7.2	324	220.92	76.35	8.5	14	8.1	114	492	18	556.20	43
8	60	0.9	Rising main	Pipe Jack	Hogrills End Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	8.2	369	220.92	38.18	9.5	6	9.1	57	480	17	499.32	38
9	85	0.9	Rising main	Pipe Jack	Railway	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	9.2	414	220.92	54.08	10.5	8	10.1	82	550	20	523.61	40
10	85	0.9	Rising main	Pipe Jack	River Bourne	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	10.2	459	220.92	54.08	11.5	7	11.1	82	595	22	523.89	40
11	85	0.9	Rising main	Pipe Jack	Blythe Road/Coleshill Road	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	11.2	504	220.92	54.08	12.5	7	12.1	82	640	23	524.12	40
12	57	0.9	Rising main	Auger	Coleshill Road	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	36.27	2.5	23	2.1	48	156	6	489.72	38
13	72	0.9	Rising main	Auger	Packington Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	45.81	2.5	29	2.1	60	168	6	502.32	39
14	116	0.9	Rising main	Pipe Jack	M6	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	73.81	2.5	46	2.1	97	205	7	539.28	41
15	23	0.9	Rising main	Auger	Fillongley Road	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	14.63	2.5	9	2.1	19	127	5	461.16	35
16	55	0.9	Rising main	Auger	Meriden Bypass	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	34.99	2.5	22	2.1	46	154	6	488.04	38
17	49	0.9	Rising main	Auger	Old Road, B	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	31.18	2.5	20	2.1	41	149	5	483.00	37
18	36	0.9	Rising main	Auger	Back Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	22.91	2.5	14	2.1	30	138	5	472.08	36
19	81	1.015	Gravity	Auger	Coventry Road	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	65.55	2.5	32	2.5	81	189	7	522.84	40
20	54	1.015	Gravity	Auger	Spencer's Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	43.70	2.5	22	2.5	54	162	6	495.84	38
21	50	1.015	Gravity	Auger	Nailcore Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	40.46	2.5	20	2.5	50	158	6	491.84	38
22	294	1.015	Gravity	Pipe Jack	Cromwell Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	237.92	2.5	118	2.5	294	402	15	735.84	57
23	43	1.015	Gravity	Auger	Bockendon Road	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	34.80	2.5	17	2.5	43	151	5	484.84	37
24	325	1.015	Gravity	Pipe Jack	A429, Rail	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	263.00	2.5	130	2.5	325	433	16	766.84	59
25	127	1.015	Gravity	Auger	Dalehouse Lane	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	102.77	2.5	51	2.5	127	235	9	568.84	44
26	113	1.015	Gravity	Pipe Jack	A46	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	91.44	2.5	45	2.5	113	221	8	554.84	43
27	98	1.015	Gravity	Auger	B4115	7.5	5	9	45	1.2	54	220.92	7.5	5	9	45	1.2	54	220.92	79.31	2.5	39	2.5	98	206	7	539.84	42
									1215			5965				1215			5965	2046		878				295		1128

Assume		
Capacity Flat bed Wagon	27.5	tns
Capacity of tipper	13	m3

Cut & Cover Sections					Trench		Pipe Bedding/Surround		Pipe Length		Selected Backfill		Vehicle Movements					
id	Chainage Start	Chainage Finish	Length (m)	Dia (m)	Width (m)	Spoil Volume (m3)	Depth (m)	Volume (m3)	Length of Pipe (m)	Number of Pipes (no)	Depth (m)	Volume (m3)	Weight of Pipe Sections (tns)	HGVs (no)	Total Spoil Removal (m3)	HGVs (no)	Pipe Bedding Import (m3)	HGVs (no)
1	0	1010	1010	0.9	1.8	2909	1.1	1357	6	168	0.50	909	263	10	1999.80	154	1357	104
2	1163	1839	676	0.9	1.8	1947	1.1	908	6	113	0.50	608	176	6	1338.48	103	908	70
3	1990	2100	110	0.9	1.8	317	1.1	148	6	18	0.50	99	29	1	217.80	17	148	11
4	2285	3700	1415	0.9	1.8	4075	1.1	1901	6	236	0.50	1274	368	13	2801.70	216	1901	146
5	3756	4111	355	0.9	1.8	1022	1.1	477	6	59	0.50	320	92	3	702.90	54	477	37
6	4381	4920	539	0.9	1.8	1552	1.1	724	6	90	0.50	485	140	5	1067.22	82	724	56
7	5000	6352	1352	0.9	1.8	3894	1.1	1817	6	225	0.50	1217	352	13	2676.96	206	1817	140
8	6476	6580	104	0.9	1.8	300	1.1	140	6	17	0.50	94	27	1	205.92	16	140	11
9	6642	6865	223	0.9	1.8	642	1.1	300	6	37	0.50	201	58	2	441.54	34	300	23
10	6953	7149	196	0.9	1.8	564	1.1	263	6	33	0.50	176	51	2	388.08	30	263	20
11	7233	7707	474	0.9	1.8	1365	1.1	637	6	79	0.50	427	123	4	938.52	72	637	49
12	7792	10584	2792	0.9	1.8	8041	1.1	3752	6	465	0.50	2513	726	26	5528.16	425	3752	289
13	10696	13097	2401	0.9	1.8	6915	1.1	3226	6	400	0.50	2161	624	23	4753.98	366	3226	248
14	13209	13516	307	0.9	1.8	884	1.1	413	6	51	0.50	276	80	3	607.86	47	413	32
15	13655	16839	3184	0.9	1.8	9170	1.1	4278	6	531	0.50	2866	828	30	6304.32	485	4278	329
16	16867	16923	56	0.9	1.8	161	1.1	75	6	9	0.50	50	15	1	110.88	9	75	6
17	17006	17621	615	0.9	1.8	1771	1.1	826	6	103	0.50	554	160	6	1217.70	94	826	64
18	17704	19129	1425	0.9	1.8	4104	1.1	1915	6	238	0.50	1283	371	13	2821.50	217	1915	147
BBT	19213	19296	83	0.9	1.8	239	1.1	112	6	14	0.50	75	22	1	164.34	13	112	9
BBT	19352	20413	1061	1.015	2.03	3694	1.215	1758	6	177	0.50	1077	378	14	2616.90	201	1758	135
21	20525	22508	1983	1.015	2.03	6904	1.215	3286	6	331	0.50	2013	706	26	4890.97	376	3286	253
22	22620	23374	754	1.015	2.03	2625	1.215	1250	6	126	0.50	765	268	10	1859.70	143	1250	96
23	23430	24351	921	1.015	2.03	3206	1.215	1526	6	154	0.50	935	328	12	2271.60	175	1526	117
24	24686	25245	559	1.015	2.03	1946	1.215	926	6	93	0.50	567	199	7	1378.75	106	926	71
25	25357	28484	3127	1.015	2.03	10886	1.215	5182	6	521	0.50	3174	1113	40	7712.59	593	5182	399
26	28903	29824	921	1.015	2.03	3206	1.215	1526	6	154	0.50	935	328	12	2271.60	175	1526	117
27	30047	30299	252	1.015	2.03	877	1.215	418	6	42	0.50	256	90	3	621.55	48	418	32
28	30466	31192	726	1.015	2.03	2528	1.215	1203	6	121	0.50	737	258	9	1790.64	138	1203	93
29	31304	31445	141	1.015	2.03	491	1.215	234	6	24	0.50	143	50	2	347.77	27	234	18
						83328		39222		4459		25278	7958	289	58050	4465	39222	3017

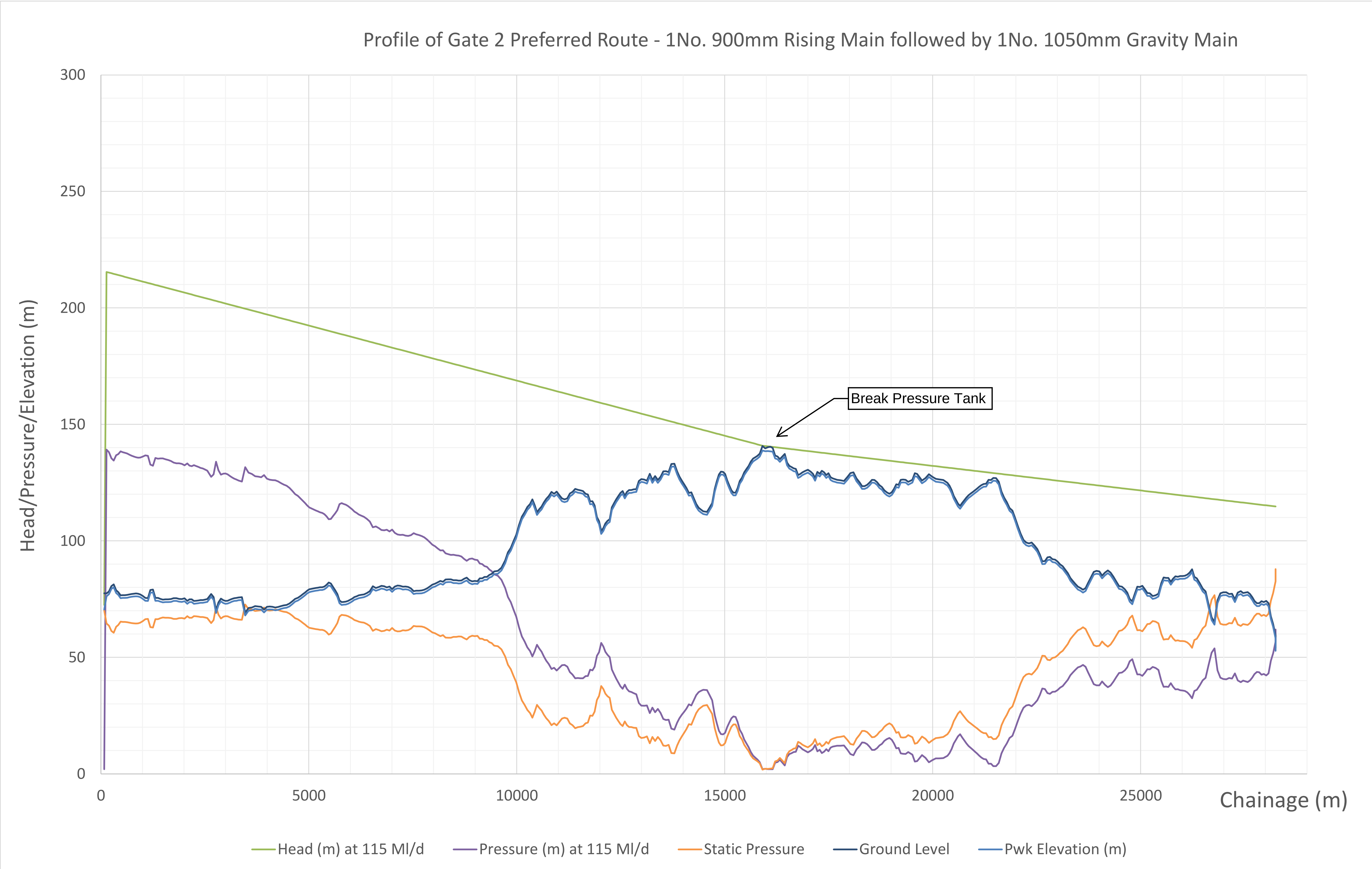
Assume		
Capacity Flat bed Wagon	27.5	tns
Capacity of tipper	13	m3
Cover	0.6	m
Bipe Bedding	0.1	m
900mm 6m Pipes Steel (260kg/m)	1560	kg/pipe
1015mm 6m Pipe Steel (356kg/m)	2136	kg/pipe

Break Pressure Tank	Tank 1			Tank 2			Excavation		Foundation Slab		Tank		Selected Backfill		Vehicle Movements					
id	Width (m)	Length (m)	Depth (m)	Width (m)	Length (m)	Depth (m)	Depth (m)	Excavation Volume (m3)	Depth (m)	Volume (m3)	Number of PCCUs Per Tank (no)	Total PCCUs (no)	Depth (m)	Volume (m3)	Weight of PCC Sections (tns)	HGVs (no)	Total Spoil Removal (m3)	HGVs (no)	Concrete Volume (m3)	Concrete Wagons (no)
1	22	22	5	22	22	5	2.5	2723	0.40	387	40	80	2.50	303	300	11	2420	186	387	65

Assume		
Capacity Flat bed Wagon	27.5	tns
Capacity of tipper	13	m3
Cover	0.6	m3
Bipe Bedding	0.1	m

D.5 Steady State Hydraulics

A7W13155-CY-CAL-212001	Preferred Route Hydraulics


Profile of Gate 2 Preferred Route - 1No. 900mm Rising Main followed by 1No. 1050mm Gravity Main
Head/Pressure/Elevation (m)
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
Chainage (m)
Break Pressure Tank
Head (m) at 115 Ml/d
Pressure (m) at 115 Ml/d
Static Pressure
Ground Level
Pwk Elevation (m)