Anglian Water

11E. AW REVISED DWRMP 2019 SUPPORTING TECHNICAL – SUPPLYSIDE OPTION DEVELOPMENT V2

Draft Determination Representation, August 2019

RESPONSIBLE BUSINESS OF THE YEAR 2017
BUSINESS IN THE COMMUNITY

THE QUEEN'S AWARDS FOR ENTERPRISE: SUSTAINABLE DEVELOPMENT 2015

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Revised draft WRMP 2019 Technical Document:

SUPPLY-SIDE OPTION DEVELOPMENT

September 2018

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RESPONSIBLE BUSINESS OF THE YEAR 2017
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This is the revised technical supporting report.

The key changes to this document from dWRMP to revised dWRMP are as follows:

Section 1 Introduction	
1.1 Report structure	Additional appendix has been added
Section 3 Stage 2A Unconstrained Options	
Main section	Updated to reflect output from Ofwat's market information platform.
Section 4 Stage 2B Feasibility Studies	
4.1.1 Transfer Options Routes	Updated with new process used for developing routes for pipeline options.
4.1.2 Potable transfer option capacities	Added description of how minimum capacity of transfer options has been calculated
4.1.3 Intra-WRZ transfer options	New section to describe the requirement for intra-WRZ transfer options to supply discrete planning zones
4.3 Resource sharing and third party options	Minor text updates
Section 5 Stage 2c Feasible Options Set	
Figure 5.1	Figure updated
Figure 5.2	Figure updated
5.4.6 Problem characterisation	Minor text updates. Demand management section from text box removed as described in Managing Uncertainty and Risk report.
5.4.7 Our approach to assessing social and environmental impacts	Text updates
5.4.8 Qualitative Ecosystems Services Assessment	Text updates
5.4.9 Customer engagement research	Text Updates Table removed with Customer engagement research as this is covered in Customer and Stakeholder Engagement technical document.
5.4.10 Societal Valuation	Minor text updates
5.5.5 Carbon cost estimates	Updated with data used for revised dWRMP
Table 5-14 Supply-side Option Implementation Periods	Updated for reservoir and water reuse options
Section 5.7 Customer support for options	'Our customers with customer' section removed as covered by Customer and Stakeholder Engagement technical document.
5.8 Resource sharing and third party options	Table 5.17 added to describe the process of developing third party options and the number of options identified.
Figure 5.5	Figure updated.

Section 6 Water Resource Zone Options		
Bury Haverhill WRZ	6.2.3 Intra-WRZ Transfer Options	Section added to describe the Intra-WRZ options in this WRZ.
Central Lincolnshire WRZ	6.4.2 Feasible Options	Section added to describe the revised representation of the Central Lincolnshire WRZ in the economic appraisal and how the options fit within this.
Ixworth WRZ	6.11.2 Feasible Options	Section added to describe the representation of the Ixworth and Thetford options in the revised dWRMP.
North Norfolk Rural WRZ	6.15.3 Intra-WRZ Transfer Options	Section added to describe the Intra-WRZ options in this WRZ.
Ruthamford North WRZ	Table 6.162 Ruthamford North WRZ feasible options not taken through to economic modelling	Description of the options considered for the dWRMP which have not been included in the economic modelling for the revised dWRMP.
Ruthamford South WRZ	Table 6.173 Ruthamford South WRZ feasible options not taken through to economic modelling	Description of the options considered for the dWRMP which have not been included in the economic modelling for the revised dWRMP.
	6.20.3 Intra-WRZ Transfer Options	Section added to describe the Intra-WRZ options in this WRZ.
Ruthamford West WRZ	Table 6.185 Ruthamford West WRZ options not taken through to economic modelling	Description of the options considered for the dWRMP which have not been included in the economic modelling for the revised dWRMP.
Generic	Feasible options	Minimum capacity of each option has been updated.
	Transfer Options details	The engineering data for the transfer options has been updated.
	Environmental Considerations	The output from the revised the following assessments has been updated in the various tables in this report, • WFD no deterioration • SEA • HRA
	Costs	All capex, opex, and carbon have been updated in the relevant tables in this report.
	Costs	The AIC ASIC ranking data has been updated for all options.
Appendix E Appraisal of Environmental and Social Impacts		
New Appendix added to report		
Appendix F Comparison of Water Reuse and Desalination Options between PR14 and PR19		
New Appendix added to report		

CONTENTS

1. INTRODUCTION

The Water Resources Management Plan (WRMP) requires water companies to complete a robust, transparent appraisal of options to ensure security of supply whilst protecting the environment at a cost acceptable to customers.

The appraisal includes options that reduce demand, provide new supply-side resources and transfer water from areas in surplus to those in deficit. This report describes the development of the supply-side options which includes all new resource and transfer options.

The development of the supply-side options has been carried out in accordance with the Water Resources Planning Guideline (WRPG)[1] and the WRMP 2019 – Water company checklist[2]. This document describes how we have met the technical requirements set out in the WRPG, and we have cross-referenced the relevant points in the checklist in each chapter.

This report only covers supply-side options, there is a separate report that describes the development of the demand management options.

1.1 Report structure

The report includes:

1. Preamble

   - Describes the methodology used to develop supply-side options
   - Demonstrates compliance with the WRPG and checklist

2. Water Resource Zone Summaries

   - Provides details of the unconstrained options and reasons for rejecting options
   - Describes each of the feasible options
   - Includes summaries of all the environmental considerations including INNS, SEA, HRA, WFD no-deterioration and climate change
   - Provides capex, opex and carbon estimates
   - Details inter-dependencies, links and synergies

3. Appendices

   A Abbreviations used in report

   B Rejection register

   C List of feasibility reports

   D INNS risk assessments

   E Appraisal of environmental and social impacts

A list of all abbreviations referred to in the report is contained in Appendix A.

[1] *Environmental Agency & Natural Resources Wales, April 2017, 'Water Resources Planning Guideline: Interim update'*
[2] *Environmental Agency & Natural Resources Wales, May 2017WRMP guideline supplementary document: WRMP 2019 – Water company checklist*

2. SUPPLY-SIDE OPTION DEVELOPMENT PROCESS

The supply-side options have been developed following the 8-stage framework set out in UKWIR Guidance on decision making processes[3] and the WRPG. For the development of the options we have expanded Stage 2 of the decision making framework, this is shown in Figure 2.1. Steps 2a-2c are the focus of this report.

Figure 2.2 shows the details of each of these stages and how rejected options are recorded in the rejection register throughout the process.

Figure 2.1: 8-stage option appraisal process showing the 3 sub-steps for the development of the supplyside options

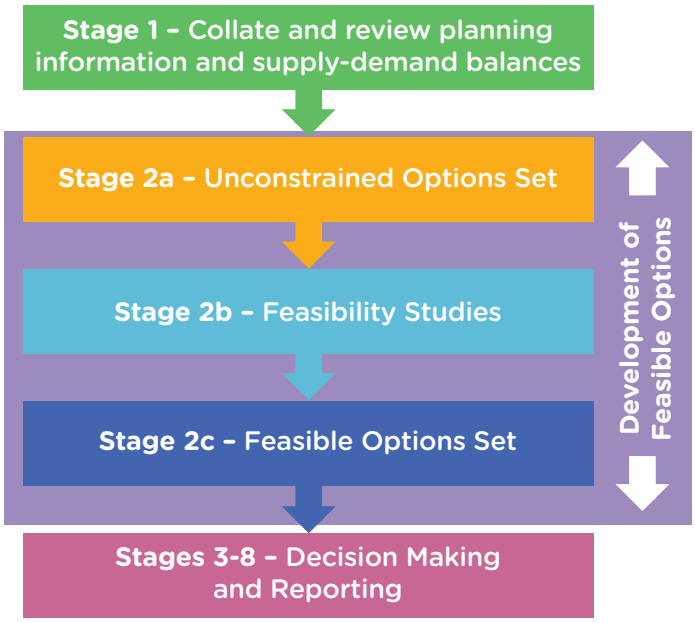
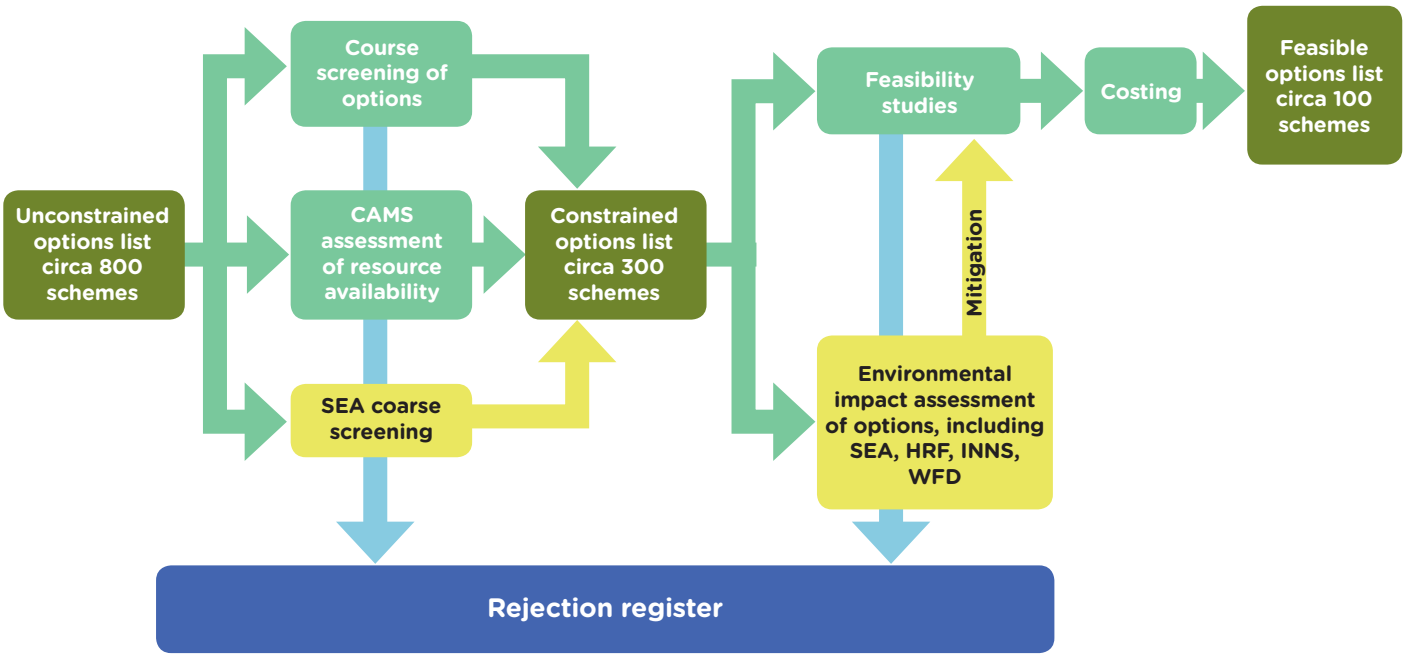


Figure 2.2: Development of supply-side options



[3]UKWIR 2016, WRMP 2019 Methods – Decision Making Process: Guidance

3. STAGE 2A UNCONSTRAINED OPTIONS

Table 3.1: WRMP 2019 – Water company checklist: 6.6 Unconstrained List

Number	Action
222	You have developed an unconstrained list of all plausible technically feasible options, including drought measures, and have at least considered options presented in WR27 Water resources tools (UKWIR, 2012) and the EBSD method.
223	For water companies in England, you have included third party options (see 6.3) in the unconstrained list, and have demonstrated you have invited or considered third party collaborations or provide a clear explanation of why third party option have not been included.

Table 3.2: WRMP 2019 – Water company checklist: 6.7 Feasible list

Number	Action
225	You have communicated your feasible list to the Environment Agency and/or Natural Resources Wales as soon as possible and discussed it with them.
226	You have clearly described the screening criteria you have used to identify feasible options and have applied these consistently to achieve a balance between the number of options included and availability of realistic choices.

We have compiled a list of all possible options that could reasonably be used in our plan. The unconstrained options identified are not all completely free from environmental or planning issues but are considered technically feasible. We have included known resource sharing with other water companies and third party trading options in the unconstrained list. No other options have emerged through Ofwat's market information platform at the time of revised dWRMP publication.

We have developed a template based on the list of "generic" options provided in Economics of Balancing Supply and Demand (EBSD)[4] and in the UKWIR WR27[5] report. The template was populated at a series of workshops with key internal staff covering regional areas of Anglian Water:

- North and West – which covered Lincolnshire and the Ruthamford system
- East – which covered Norfolk, and
- South – which covered Essex and Suffolk.

The workshops were attended by representatives from Water Services, Water Resources Management Team and Asset Planning. The focus was the supply side options; demand management options and NEP options were identified and screened as a separate activity.

At the workshops we reviewed all the unconstrained options developed for previous WRMPs and identified new technically feasible options. Unconstrained options were considered for all water resource zones (WRZs), even those without a deficit, including Hartlepool.

Our unconstrained option list for all WRZs lists circa 800 options.

3.1 Constrained options

A series of screening stages were used to refine the unconstrained list to develop the constrained options set. These constrained options were taken forward for more detailed assessment in the Stage 2b Feasibility studies. The criteria used to screen the unconstrained options are describes in the following sections. The options discounted at this stage are recorded in the rejection register along with the reasons why they were not considered suitable to investigate further, see Appendix B.

[4] *UKWIR,2002, The Economics of Balancing Supply and Demand (EBSD) Guidelines, Report Ref 02/WR/27/4, Table 3.1*
[5] *UKWIR, 2012, Water Resources Planning Tools: Economics of Balancing Supply and Demand Report Ref. WR27, Table 5*

We discussed the screening process and the constrained options list with the Environment Agency at three methods discussion meetings held in January 2017.

Our constrained option list includes circa 300 options.

3.1.1 Coarse screening criteria

The coarse screening criteria were developed expanding the criteria set out in the EBSD methodology[6] (see table below).

Table 3.3: Coarse screening criteria

Main screening criteria	Sub-criteria category	Sub-criteria description
Does not address problem	Programme	• Is the forecast Deployable Output (DO) likely to be ready in xx period/ by year xx? (i.e. from a water resource availability point of view)
	Sustainability	• Will the option be resilient and deliver the predicted DO and water quality both now and in the future (i.e. within the option's life)?
	Technical	• Does the option provide the required DO? (average and peak) Are there any likely significant outage risks?
Breaches unalterable planning constraint	Third party	• Are there any likely significant risks at this stage to regulators and other third parties that may make the option difficult to implement (e.g. abstraction licence issues, etc.)?
Option is not promotable	Cost	• Is the option likely to be involving "excessive" whole life cost (capex and opex) that is not worth progressing further for more detailed costing?
	Sustainability	• Are there any likely significant environmental/ecological risks (including Water Framework Directive compliance risks) that would make the option too risky when an environmental / social assessment is undertaken?
	Third party	• Are there any likely significant risks at this stage to regulators and other third parties that may make the option difficult to implement (e.g. abstraction licence issues, etc.)? • Are there any likely significant risks to Anglian Water customers that may make the option difficult to implement?
High Risk of Failure	Programme	• Is the forecast DO output likely to be ready in xx period/by year xx? (i.e. from a water resource availability point of view) • Are the likely construction / technology complexity/supply chain risks acceptable to ensure the option will be delivered on time? (i.e. forecasted time)
	High Risk of Failure	• Are technical/technology risks acceptable to ensure technical viability of the option? • Does the option involve the use of available and reliable data to be able to progress the technical assessment and the option being delivered on time? • Does the option provide the required DO? (average and peak) Are there any likely significant outage risks?
	Programme/ Technical	• Will the option be resilient deliver the predicted DO and water quality both now and in the future (i.e. within the option's life)? • Are there any likely significant environmental/ecological risks (including WFD compliance risks) that would make the option too risky when an environmental / social assessment is undertaken?

[4] *UKWIR,2002, The Economics of Balancing Supply and Demand (EBSD) Guidelines, Report Ref 02/WR/27/4, Page 24*

3.1.2 Catchment Abstraction Management Strategies

As part of the unconstrained options workshops we identified all possible new resources within each WRZ. In order to determine if water is available for

the options identified, we reviewed the Environment Agency's Catchment Abstraction Management Strategies (CAMS). This resulted in the rejection of options such as new groundwater abstractions in catchments that are currently over-abstracted or over-licenced.

3.1.3 Environmental coarse screening

We completed high-level environmental screening, designed to identify environmental risks and constraints. Where impacts were identified, the process either recommended high level mitigation or the rejection of the option.

This process was also used to refine the transfer pipeline routes. The initial environmental screening identified that some pipelines were passing too close to environmental designated sites and these routes were refined to account for this, see Section 4.1.

4. STAGE 2B FEASIBILITY STUDIES

Table 4.1: WRMP 2019 – Water company checklist: 6.7 Feasible list

Number	Action
224	Your feasible list is a subset of your unconstrained list and you have demonstrated that all options on your preferred list are suitable for promotion.

We have completed feasibility studies for the constrained options to confirm the feasible option set. As shown in Figure 2.2, the option set is further

refined with the output from the various environmental assessments (see section 5.4). These assessments suggest mitigation measures which need to be added to the scope of some feasible options or they may mean options are moved onto the rejection register.

A list of all the feasibility reports can be found in Appendix C.

4.1 Transfer options

4.1.1 Transfer option routes

For all the raw water transfers, potable water transfer and pipelines within new resource options we have used a GEO PLM pipeline routing tool, developed by our consultants to automatically route the transfers. This makes use of shape files showing key features (e.g. roads, environmental designated site, archaeology) that the pipelines are likely to interact with, which are then ranked in accordance to their significance to the route of the pipeline.

The software processes this information and directs the pipeline route accordingly. For example, a feature that implies either a very high cost such as a lake, or an area to be avoided such as an SSSI, will not be crossed by the pipeline unless there is no reasonable alternative. The sensitivity of the software may be adjusted to control the length of the route.

Following the automatic GEO PLM routing a manual check has been completed and minor manual refinements made where appropriate. The output is information about each route required to cost the option, including length, elevation along the route, type of land and number of crossings.

The environmental coarse screening (Section 3.1.3) identified pipeline routes that required altering so that pipeline and working zones avoided areas of environmental significance. This included:

- 500m buffer for ecological areas such as SSSI, RAMSAR, SPA, SAC, LNR
- 10m buffer on heritage sites, listed buildings, registered parks gardens and battlefields, and
- 15m buffer on ancient woodlands.

The pipeline routes been omitted from this report due to the requirements of the Security and Emergency Measures (SEMD)[7], however details of each feasible modelled option are described in section 6.

4.1.2 Potable transfer option capacities

The potable water transfers are just conduits for transferring water between WRZs rather than new resources of water. They can either transfer:

- Existing surpluses from one zone to another, and
- Or a new resource development in one WRZ to another zone in deficit.

We have provided our economic model with a number of alternative capacities for each transfer route to allow real choices to be made when developing our plan.

To enable the flexibility of options to adapt to future uncertainty, the transfers have been sized to meet deficits in all scenarios, see Figure 4.1.

The minimum capacity for each transfer option is based on 'turning over' the pipe volume twice in one week. The length and diameter of each option has been used for the calculation, details of these are in the Transfer Options Details table for each WRZ in Section 6.

[7] *Water Industry Act 1991, The Security and Emergency Measures (Water and Sewage Undertakers) Direction 1998*

4.1.3 Intra WRZ transfer options

Due to the capping of time limited licenses we have found that there are now deficits in discrete parts of some WRZs. These local deficits are not seen at WRZ level and as such would not appear within the WRZ supply demand balances in the WRP Tables. We have completed smaller scale supply demand balances for discrete Planning Zones (PZs). This analysis identified deficits in the following WRZ,

WRZ	Planning Zone	Deficit 2045 (Ml/d)
Bury Haverhill	Haverhill	2.2
Ruthhamford South	Woburn	2.6
Ruthamford South	Meppershall	1
Norfolk Rural North	Didlington	0.4

The following transfer options have been included in the Best Value Plan and are listed in the WRP Table 5 but they are not taken through to the final supply demand balances in WRP Table 9.

- BVH Intra1 – Bury Haverhill Intra WRZ transfer (Haverhill PZ)
- RTS Intra1 – Ruthamford South Intra WRZ Transfer 1 (Woburn PZ)
- RTS Intra2 – Ruthamford South Intra WRZ Transfer 2 (Meppershall PZ)
- NNR Intra1 – North Norfolk Rural Intra WRZ Transfer (Didlington PZ)

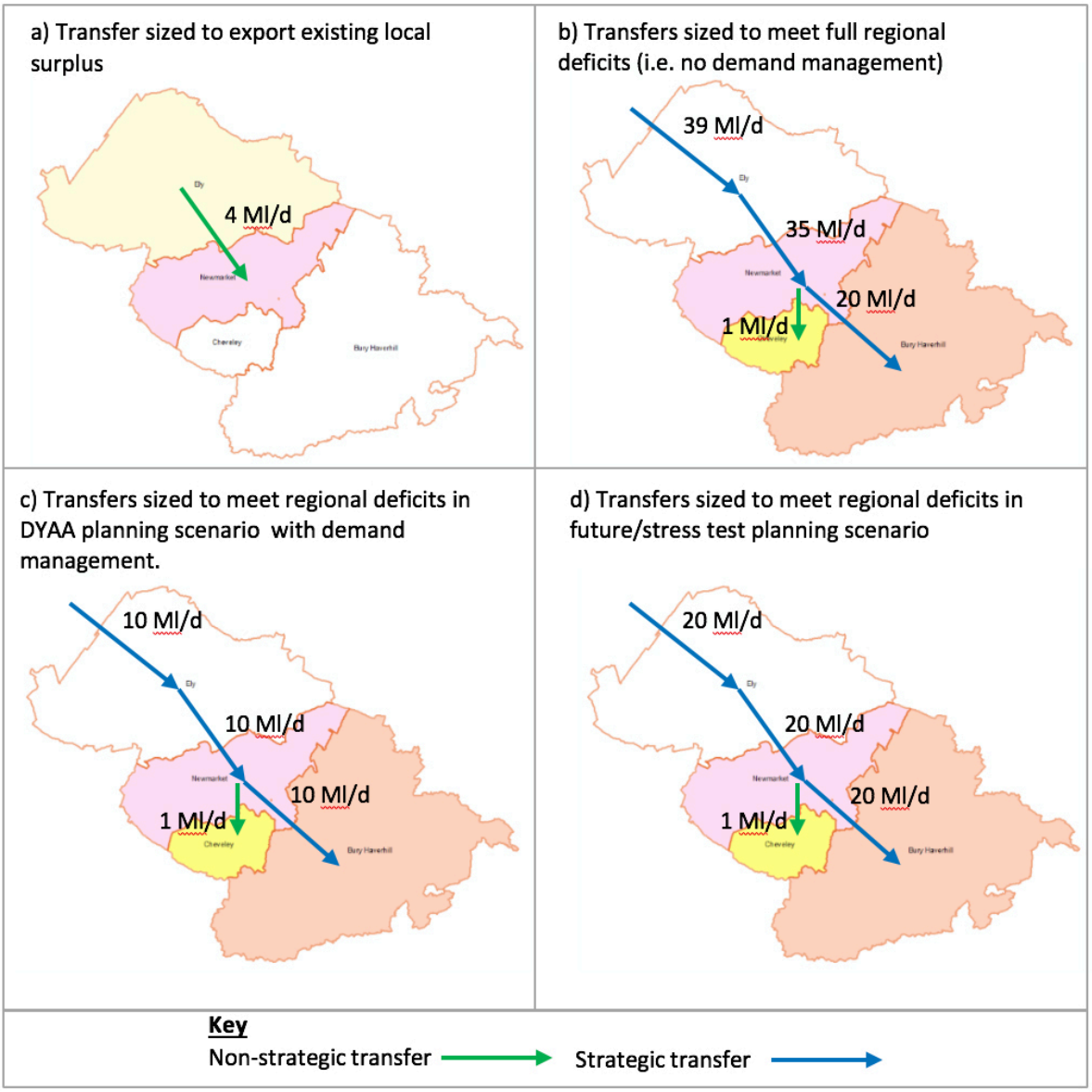
Details of these options can be found in the relevant WRZ section in Section 6.

4.1.4 Raw water transfer capacities

The raw water transfers require a different approach to the potable water transfers as they are moving a new resource into the Anglian Water region. They are sized to gain the optimal additional Water Available for Use (WAFU) so that the economic model can determine how to best utilise them in the various scenarios. For example for some options the raw water transfer is not available 365 days a year and so is combined with storage (existing or new). In these cases the capacity of the raw water pipe would be based on the optimal transfer of available resource (e.g. 100Ml/d) but because that transfer isn't available 365 days a year after this has been stored the equivalent gain in WAFU maybe only be 20Ml/d.

The raw water transfers are also adjusted to ensure they are compatible with the planning problem, see section 5.9.

Figure 4.1: Potable water transfers capacities



4.1.5 Transfer option risks

Many of the risks associated with new long distance pipeline transfers (potable or raw) are generic and so they have been listed here rather than against the individual options described in the WRZ summaries in section 6.

The identified risks with transfer options:

- Cost risks: Any modifications to the pipeline route could have an impact on both capex and opex costs and the time to implement the solution
- Programme risks: Detailed consultation with Highways England, Environment Agency, Local

Authorities and land owners could impact the costs and the time to implement the solution.

4.2 New Resources

The new resources options were grouped together into option type and the feasibility of each option assessed and reported; see Appendix C for list of reports. For the feasible options the following has been produced:

- Schematic
- Detailed scope to allow capex, opex and carbon estimates, and
- WAFU assessment for historic, climate change and design drought (if appropriate).

For the options not considered feasible the reasons are recorded in the rejection register.

To calculate the WAFU for options utilising existing assets (e.g. raw water transfers) we have used the spreadsheet method for calculating DO, as described in the Supply Forecast report[8].

4.3 Resource sharing and third party options

We are leading a number of collaborative water resource planning efforts. These include:

- Water UK Water Resources Long-Term Planning Framework (WRLTPF)
- Water Resources East (WRE) project, and
- Trent and Ouse Working Groups.

The purpose of these collaborations is to develop a common understanding of water resource planning issues and to identify cost-effective options for sharing available resources, including transfers and trading.

The Trent and Ouse working groups were specifically set up to produce a coordinated approach to the development of options in neighbouring water company Draft WRMPs. The revised dWRMP and Customer and Stakeholder Engagement technical document contain details of the WRLTPF and WRE. Through these groups we have developed a number of shared resource and third party options which have been appraised following the same method for other supply-side options as set out in this report. Section 5.8 has details of the feasible resource sharing and third party options.

4.3.1 Trent Working Group

The River Trent has the potential to provide significant raw water resource to feed a number of new water resource and storage options. As such, it is a key strategic resource and it is possible that several water companies may develop options that rely on water from the Trent. There are many complex issues associated with the development of Trent resource, including the availability of water and the environmental and drinking water quality implications of regional transfers, and the need to protect existing abstractions, including by the power sector.

Given the above, it is important that water companies and others develop a shared understanding of these issues and a coordinated approach to the development of Draft WRMP 2019. Consequently, we established and chaired the Trent Working Group to ensure that options for Draft WRMP 2019 are mutually inclusive and take into account the interests of all stakeholders. The specific objectives of the WG as set out in the Terms of Reference were to develop a shared understanding of:

- The current and future availability of water resources in the River Trent
- The options available for resource development, including:
- Storage (such as the South Lincolnshire Reservoir)
- Transfers (such as a Trent Ruthamford transfer and canal transfers from Birmingham to Ruthamford)
- Any related environmental issues (such as WFD no- deterioration and invasive non-native species), and
- The options available for future raw or treated water transfers and trades between sectors.

The group included representatives from Anglian Water, Severn Trent Water, South Staffordshire Water, Affinity Water, Yorkshire Water, the Environment Agency, Natural England, Energy UK and the Canal and Rivers Trust.

A draft final report was issued to the Group in November 2017. This will be updated in due course to reflect any Trent water resources options that emerge through company specific water resource plans.

4.3.2 Ouse Working Group

Options to use water resources in the lower Ouse system emerged during discussions between the water companies operating in the Anglian region. The Ouse Working Group was established to drive a fully coordinated and collaborative approach between all key stakeholders. The overall purpose of the Group was to develop a shared understanding of:

- Current and future resource availability in the lower Ouse system, including the Ely Ouse Essex Transfer and Great Ouse Groundwater Development schemes
- The options available for resource development in the lower Ouse systems including:
- Storage in the lower Ouse area (for example, Fenland Reservoir), and
- Transfers utilising the Ely Ouse and Essex Transfer Scheme.

Outputs from the Group have been included in feasible option sets for both the WRE and Water Company dWRMPs.

[8] *Anglian Water, Draft WRMP 2019: Supporting Technical Reports -Supply Forecast, December 2017*

5. STAGE 2C FEASIBLE OPTIONS SET

The items from checklist for WRPG 6.7 Feasible list have been spilt between the sub-section of this part of the report and the WRZ summaries in section 6.

5.1 Climate change and drought

Table 5.1: WRMP 2019 – Water company checklist: 6.7 Feasible list

Number	Action
232	You have appropriately assessed and reported the risks and uncertainties associated with each option, including the likelihood of reduced yield due to factors such as climate change, environmental constraints and customer behaviour. You have considered the flexibility of the option to adapt to future uncertainty.

As part of our assessment of the risks and uncertainties we have assessed the yield for all new resource options for the following supply forecast scenarios:

- Baseline (historic flows), and
- Baseline (historic flows) with climate change (spatially coherent projection 8, medium emissions scenario).

And where relevant we have also assessed the yield for:

- Stochastic drought, and
- Stochastic drought with climate change (spatially coherent projection 8, medium emissions scenario).

Details of the supply forecast scenarios are described in the Supply Forecast report[9].

5.2 Water quality

Table 5.2: WRMP 2019 – Water company checklist: 4.10 Drinking water quality

Number	Action
139	You have considered options to reduce losses where possible, especially if your plan has a supply-demand balance deficit.

Table 5.3: WRMP 2019 – Water company checklist: 6.7 Feasible list

Number	Action
229	Where you are transferring water / commissioning new sources and this increases the risk of non-compliance, you have included steps to mitigate those risks (e.g. INNS, discolouration, nitrates, pesticides).

We have included options to reduce process losses at existing water treatment works (WTW) in our constrained options set however none of the options were taken forward into the options set to be modelled. In most cases the washwater is already recovered by being returned to the raw water reservoir and therefore not lost from the system.

See Appendix B for the rejection register.

We have assessed each of the supply side options to ensure compliance under Section 68 of the Water Industry Act 1991, which sets out our statutory duty to supply wholesome water. The requirements for wholesomeness are further described in the Water Supply (Water Quality) Regulations 2016 (in England) and the Water Supply (Water Quality) Regulations 2010 (in Wales), and associated amendments.

[9] *Anglian Water, Draft WRMP 2019: Supporting Technical Reports -Supply Forecast, December 2017*

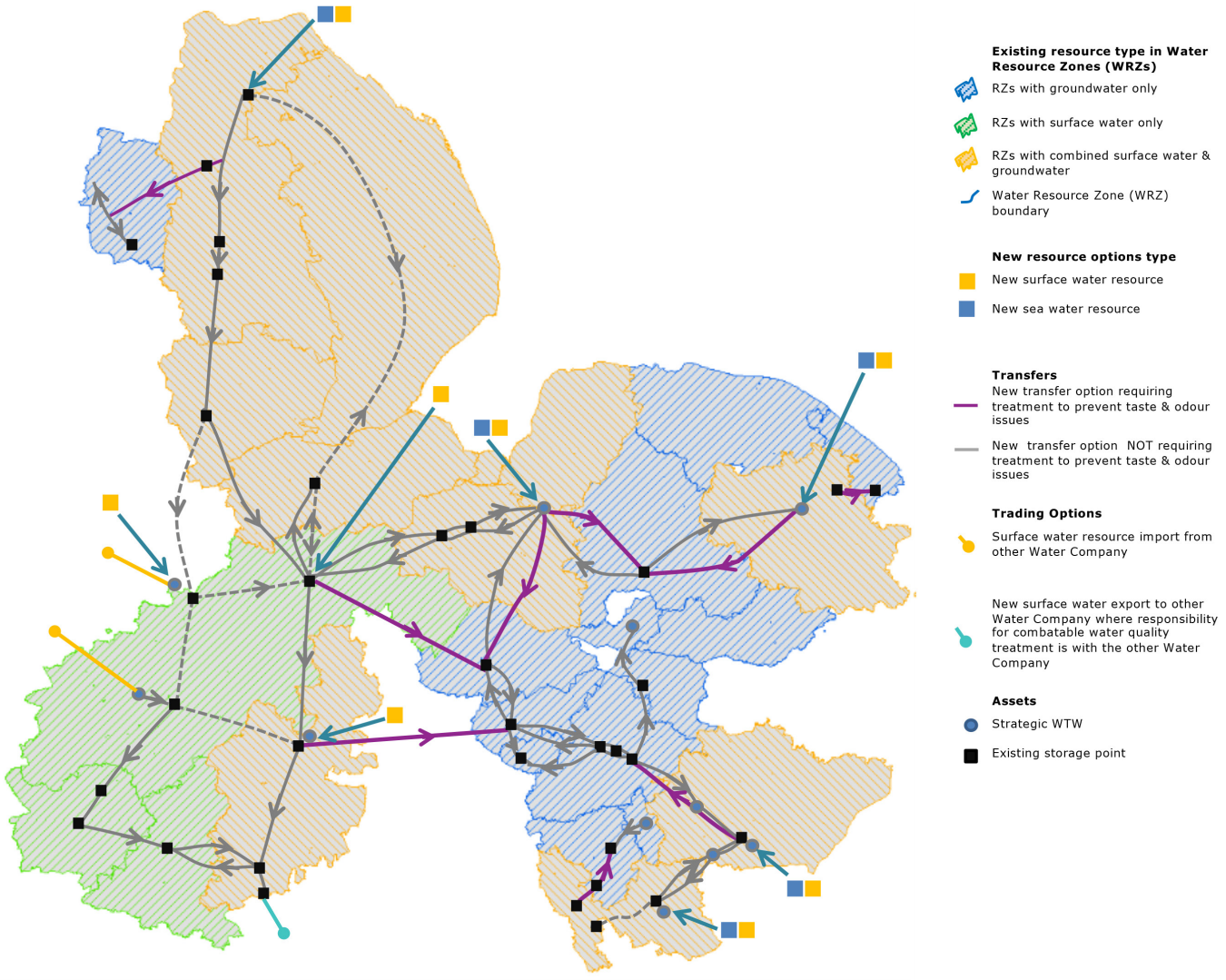
To meet the requirements of Regulation 15 of the Water Supply (Water Quality) Regulations 2016 (in England) we have carried out appropriate risk assessments for all new sources, cross boundary bulk transfers and internal company transfers. This includes an assessment of the potential impact of mixing of different water types within our distribution network.

Water quality data from existing WTWs and WRZs have been analysed and compared against recipient WRZs to identify variations. The main differences relate to differing hardness and alkalinity between the donor and recipient zones. The options we have considered to address this are:

- Chemical dosing, however the dosing requirements are complex requiring multiple chemicals to be dosed at high rates, and
- Control of the flow in transfer to ensure changes in water quality are slow and that the proportion of the donor water is regulated to below a certain proportion. However there are risks with this approach if transfers are needed to be maximised at short notice due to resilience events.

We have also identified where treatment to address the risks related to transfer of chloraminated water to a chlorinated zone is required. The transfers that require additional treatment process are shown in Figure 5.1.

Figure 5.1: Transfer options requiring treatment to prevent water quality impacts from mixing water types



Our duty to supply wholesome water under Regulation 4 requires us to ensure that all supply side options do not cause deterioration due to Metaldehyde and other pesticides. None of our supply options expose consumers to greater risk of exposure to unwholesome water and water quality obligations are planned to be met.

We currently have 4 Undertakings (under Section 19 of the Water Industry Act 1991) that cover 19 water treatment works that have been identified as being at risk of supplying unwholesome water due to the presence of Metaldehyde. We have included treatment to remove Metaldehyde for the following types of options:

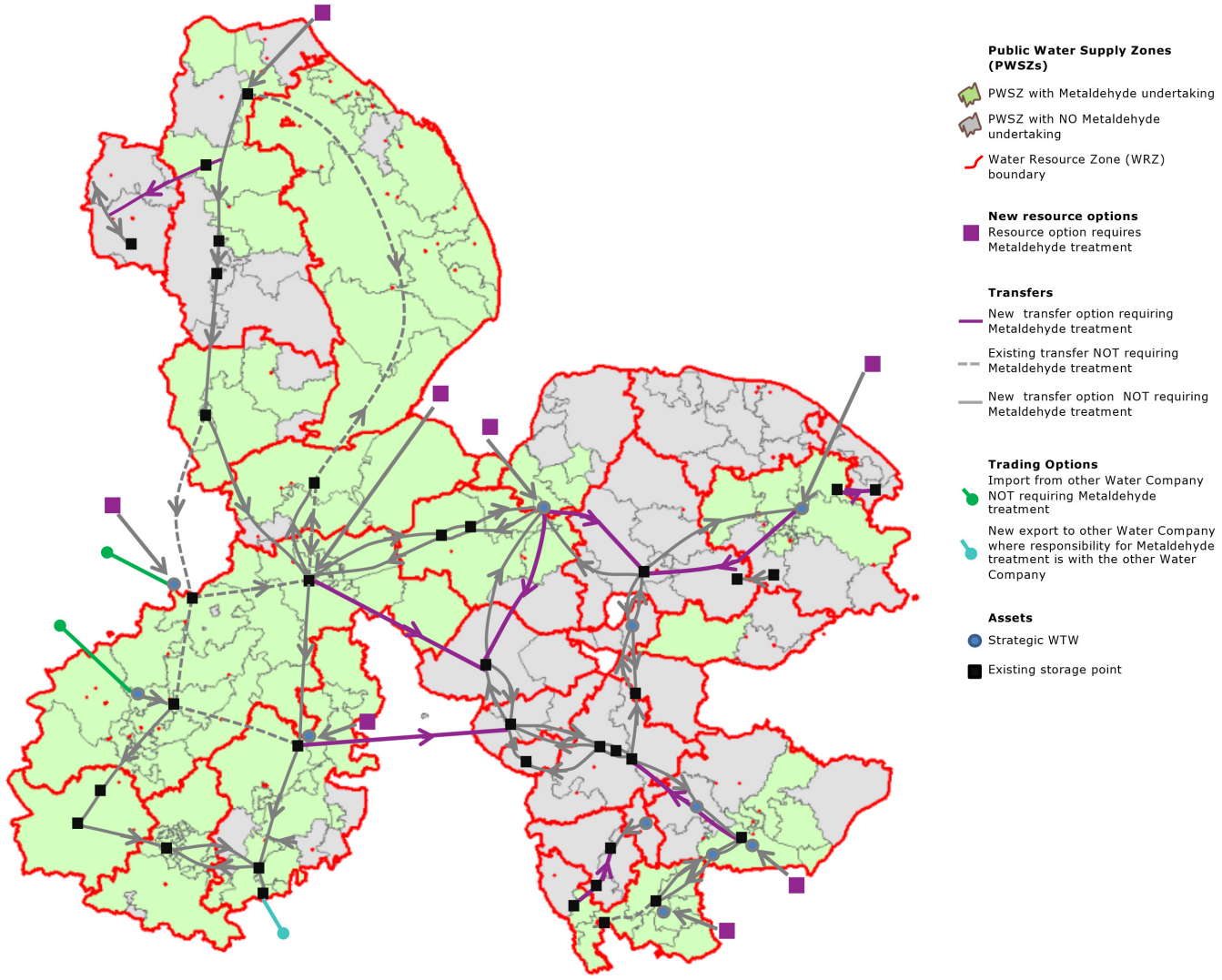
1. Transfers from an existing source with a current Undertaking to an area with no Undertaking

2. New sources with a metaldehyde risk going to an area with no Undertaking, or

3. New sources with a metaldehyde risk going to an area with an existing Undertaking.

Figure 5.2 shows all the areas with Undertakings and the transfer options that require treatment to remove Metaldehyde as part of the scope.

Figure 5.2: Transfer options requiring treatment for Metaldehyde



For the options that require treatment to remove metaldehyde we have based the process used at one of the WTWs in Central Lincolnshire WRZ. Anglian Water developed this treatment process to treat water from the River Trent which required metaldehyde removal. This utilises the following processes:

- Raw water screens – initial screening to avoid damage to pumps downstream in the process.
- Coagulation/Flocculation and clarification – removal of suspended solids, turbidity, and algae. Clarification process type is dependent on raw water source type and specific water quality risks, for this scheme lamella settlement has been selected.
- Roughing GAC Filtration – to removal of suspended solids and total organic carbon.
- Ultrafiltration – further reduction in turbidity, suspended solids and organic carbon.
- Hydrogen Peroxide / UV Advanced Oxidation Process – metaldehyde and other pesticides and organics removal through advanced oxidation.
- GAC Filtration – to remove bio-degradable organic matter to reduce risk of disinfection by-product formation and bio-regrowth in the distribution system.
- UV Disinfection – Disinfection using UV light.
- Chemical Dosing – chlorination and ammoniation to produce chloramines and plumbosolvency control by ortho-phosphoric acid addition.
- Washwater and sludge treatment – sludge from the clarification process and dirty backwash water from the rapid gravity filters and ultrafiltration membranes is treated using lamella thickeners and the thickened sludge is centrifuged to produce a sludge cake for disposal to landfill.

Section 6 has more details about the options requiring treatment to prevent water quality impacts from mixing water types and removal of Metaldehyde.

5.3 Invasive non-native species

Table 5.4: WRMP 2019 – Water company checklist: 4.5 Invasive Non-Native Species (INNS)

Number	Action
114	You have considered whether/how any current or future abstractions or operations might cause the spread of INNS and have determined measures to reduce the risk of this. You have liaised with Environment Agency and/or Natural Resources Wales to discuss the risk of INNS and reflected the outcomes of this in your plan.

We have assessed all new supply-side options to understand the risks of spreading Invasive Non Native Species (INNS) through transfers of water.

Following discussion with the Environment Agency, the assessment has focused on the potential pathways created by the option. We have included all options that:

- Create a hydrological connection between locations not already connected, and
- Where new schemes provides a pathway between locations that have an existing hydrological connection.

We have identified the potential INNS pathways for each of the supply-side options and assessed the frequency and severity of impact of these. Where required we have included robust mitigation that is completely effective for removal of all life stages.

The risk of spreading INNS from our existing raw water transfers will be investigated and options appraised in AMP7 as per Environment Agency guidance[10]: more details are described in Sustainable abstraction technical document[11].

[10] *Environment Agency, PR19 Driver Guidance – Invasive Non-Native Species v2, 2017*
[11] *Anglian Water, Draft WRMP 2019: Sustainable abstraction technical document. December 2017*

5.3.1 INNS risk assessments

We have completed a risk assessment for all supply-side options to identify potential pathways for INNS. The risk assessment is based upon:

- Magnitude of risk
- Frequency of impact, and
- Severity of impact

Factors affecting the risk levels are option specific and include:

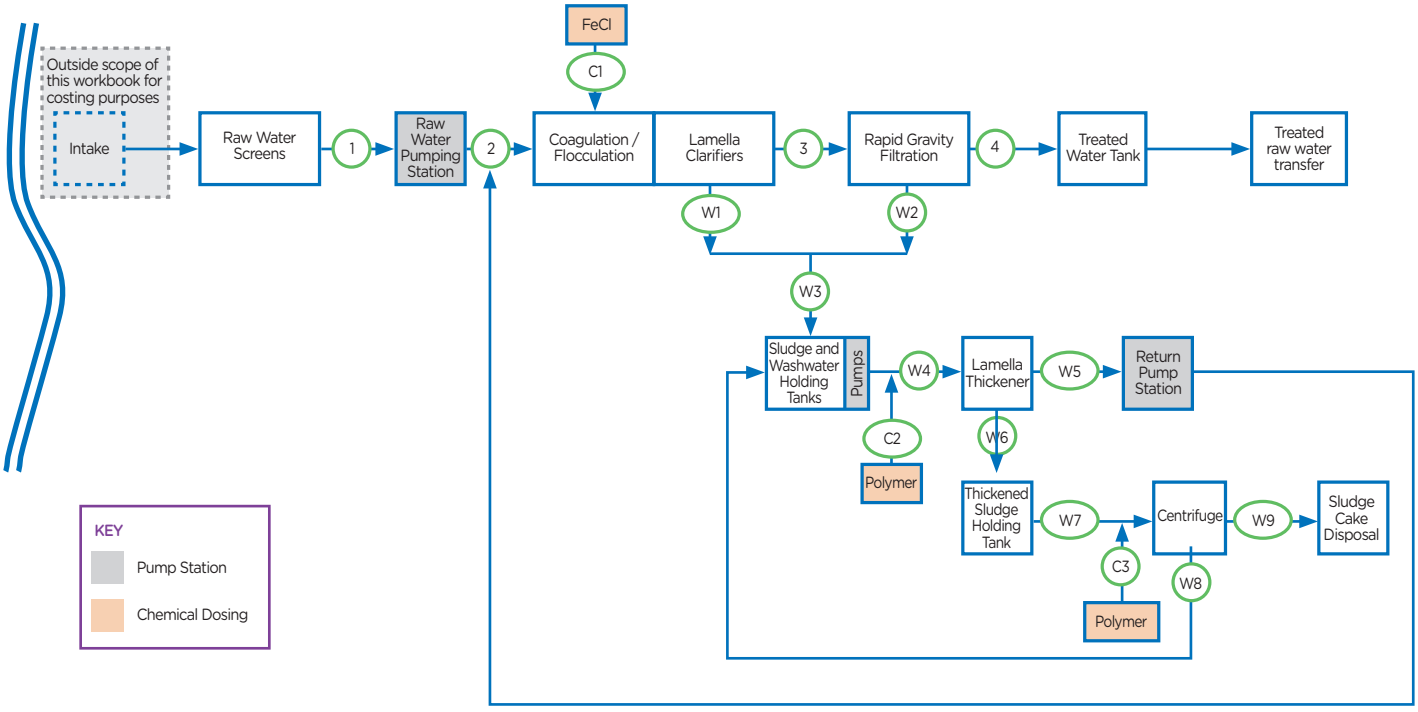
- Type connection: pipeline/canal/sea tanker
- Location of intakes and outfalls
- Length of the transfer
- Transfer time and capacity
- Frequency of operation
- Natural or artificial barriers to passage
- Presence of existing connections to be upgraded or new infrastructure
- Proximity to SSSI/HD sites

The assessment records the risk without mitigation, proposed mitigation and the risk after mitigation. Appendix D contains the option type INNS risk assessments for each option. The specific option risks are also listed in the WRZ summaries in section 6.

5.3.2 INNS treatment process

For some supply-side options the only mitigation is treatment processes to remove all life stages of potential INNS. The treatment stream is shown in Figure 5.3.

Figure 5.3: Treatment process to remove potential INNS



5.4 Environmental assessments

Table 5.5: WRMP 2019 – Water company checklist: 6.7 Feasible list

Number	Action
235	You have assessed the environmental impacts of the option, including implications for RBMP objectives, and have undertaken and reported the outcomes of a Habitats Regulations Assessment (HRA) if the option has been found to potentially affect any designated site.

Options assessed as technically feasible have been subject to further environmental assessments, which built on the high-level environmental screening of the constrained options list:

- Strategic Environmental Assessment (SEA)
- Habitats Regulation Assessment (HRA)
- Water Framework Directive (WFD) Assessment
- Qualitative Ecosystems Services Assessment (ESA)

In some instances, it is possible to avoid adverse environmental impacts by incorporating 'mitigation measures' (for example, re-routing pipelines away from sensitive sites, or using directional drilling to lay pipelines without excavating). Where the SEA, HRA and WFD assessments have recommended mitigation measures, these have been included in the option design and costing as far as possible.

5.4.1 Strategic Environmental Assessment

We have carried out a Strategic Environmental Assessment (SEA) for all feasible supply–side options. The objective of SEA, according to Article I of the SEA Directive is: 'to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans with a view to promoting sustainable development'.

In order to do this, the SEA Directive requires plans and programmes to undergo environmental assessment, and suggests that among other factors human health, population and water should be considered as criteria. The findings from the SEA report[12] are recorded against all the feasible options in the WRZ summaries in section 6.

5.4.2 Habitats Regulations Assessment

A Habitats Regulation Assessment (HRA) is required to assess the potential impact of plans and programmes to ensure that there will not be any 'likely significant effects' (LSE) on sites of European nature conservation importance. European sites of nature conservation importance include Special Protection Areas (SPAs), Special Areas for Conservation (SACs), candidate SACs and proposed SPAs, as well as Sites of Community Importance (SCIs) which have been adopted by the EC, but not yet formally designated by the government of a Member State. In the UK, Ramsar wetland sites of international importance are also required to undergo an assessment when a plan is considered likely to have a significant effect upon them.

The HRA first assessed all of the options on the constrained options list for LSE. Where no LSE were identified there is no requirement to undertake further assessment. However, where LSE were identified those options were subject to a 'Task 2' assessment (also known as an appropriate assessment) to understand the potential adverse impacts and, if possible, recommend mitigation measures. If the adverse impacts cannot be addressed through mitigation then alternative options must be considered. The findings from the HRA report[13] are recorded against all the feasible options in the WRZ summaries in section 6.

5.4.3 Water Framework Directive (WFD) assessment

The WRP Guidance states that we must ensure that feasible options do not pose a risk of deterioration, or prevent the achievement of 'good' status (or potential). As a result we have undertaken a WFD assessment on options in accordance with the guidance.

The assessment consisted of an initial screening, followed by a detailed assessment that investigated both operational and construction impacts. For the finding of the WFD assessment is recorded against all the feasible options in the WRZ summaries in section 6.

[12] *Anglian Water – WRMP 2019 Strategic Environmental Assessment – Environmental Report, Main Report, September 2018*
[13] *Anglian Water – WRMP 2019 Habitats Regulations Assessment – Task 1: Screening, September 2018*

5.4.4 Qualitative Ecosystems Services Assessment (ESA)

Ecosystem services are defined as the benefits provided by ecosystems that contribute to human well-being. A qualitative ecosystem services assessment considers the effects of development on natural capital, and its ability to provide ecosystem services.

Our ESA assesses the potential impacts of options on the provision of ecosystem services. In order to compare the impacts of different options, we developed a scoring methodology that was used to produce an ecosystem score. Each option's score has been weighted by option yield (ES score / Ml/d) to allow for a fair comparison.

Table 5.6: WRMP 2019 - Water company checklist: 6.11 Water Framework Directive

Number	Action
261	You have described any intended actions that may cause deterioration of status/potential or prevent good status/potential being achieved. You have discussed this with the Environment Agency or Natural Resources Wales and made a clear statement in the plan of any potential impacts of any intended actions.

Table 5.7: Water company checklist: 6.1 Considerations when choosing future solutions

Number	Action
208	You evaluated the environmental impacts of all possible and discarded options that could have unacceptable impacts that could not be overcome. You have further considered only those options that support achievement of RBMP objectives and would not result in deterioration.
235	You have assessed the environmental impacts of the option, including implications for RBMP objectives, and have undertaken and reported the outcomes of a Habitats Regulations Assessment (HRA) if the option has been found to potentially affect any designated site.

Table 5.8: Water company checklist: 6.8 Environmental and social impacts

Number	Action
240	You have considered the environmental and social impact of each option of the feasible list.
241	You have assessed impacts using a method that is proportionate to the scale of the problem and have fully justified your approach.
242	You have applied an Ecosystem Services approach to environmental evaluation, if appropriate, and your method gives accountable and transparent outcomes that consider stakeholder needs.
243	You demonstrate that you have used the best available evidence and data in your assessment, and the conclusions you draw are robust, locally valid and justifiable.
244	You provide a clear audit trail of your appraisal of environmental and social impacts and explain the data you use, the results and recommendations from the appraisal.
257	You have described the steps you have taken to carry out a Strategic Environment Assessment and Habitat Regulations Assessment for your chosen solution, or demonstrated why this is not needed. Where relevant, you have incorporated any outcomes from the SEA and/or HRA into your final plan.

5.4.5 Guidance

The evaluation of social and environmental impacts is a key theme of Defra's Guiding Principles, which state:

'You should demonstrate how you value nature in your decisions and consider where you can provide new and innovative opportunities for investment in our natural assets. ... We want to see better informed decisions that reflect the value of the environment, using natural capital as a currency to aid understanding about how to manage our environment. We expect you to thoroughly investigate and report on environmental and social costs and benefits.'[14]

Further detail is provided in the Environment Agency's supplementary guidance note (Nov 2017) entitled 'Environmental Valuation in Water Resources Planning - Additional Information', which is designed to help water companies take account of environment and social costs in water resources planning. The four principles set out in the supplementary guidance note are as follows:

- Principle 1: Use a method that is proportionate to the size of the problem
- Principle 2: Consider using an Ecosystem Services approach to environmental valuation
- Principle 3: Use the best available evidence and develop new evidence if needed
- Principle 4: Your appraisal process should be transparent

Water companies are encouraged to take a risk based approach to the assessment and inclusion of social and environmental impacts in water resource planning and decision making. In order to determine a proportional approach, companies should consider the size of the problem, the size of the deficit, the contentiousness of the option and the 'environmental sensitivity' of the WRZ affected.

5.4.6 Problem characterisation

In our Problem Characterisation assessment, we identified that we were facing some concerns in our region regarding investment in drought resilience.

Problem Characterisation

Drought resilience

As part of the development of dWRMP, we needed to consider what Levels of Service would be appropriate for our customers. We did not have any concerns over our Levels of Service for Temporary Use Bans (including hosepipe bans) and Non-Essential Use Bans, as customer engagement research conducted for PR14 showed that these restrictions were not a concern or a priority area for investment. However, the same research showed that severe restrictions, such as rota-cuts and standpipes, would be an unacceptable service failure and that customers do not expect to experience them in their lifetimes.

In order to determine an appropriate Level of Service, however, more work is required to understand the costs, options required and customer support for this investment.

The assessment also demonstrated that the scale of the challenge is such that it cannot be resolved through demand management alone, and carefully targeted investment in supply-side options will be required. There are different impacts associated with different options, and that these needed to be better understood in order to identify the preferred strategy.

Much of our region is environmentally sensitive: it is home to many internationally important wetland ecosystems that need protecting, including 40 Special Areas of Conservation (SAC), 28 Special Protection Areas (SPA) and 28 Ramsar wetlands. In addition, many unique habitats are located within our area, including reedbeds, inter-tidal mudflats, and grazing marshes. As a company we are facing large sustainability reductions in AMP7.

As a result, we felt that a thorough assessment of environmental and social impacts was required, in addition to the statutory environmental assessments.

[14] *Defra, May 2017, Guiding principles for water resources planning, Page 4*

5.4.7 Our approach to assessing environmental and social impacts

We have completed all statutory assessments, including the Strategic Environmental Assessment, Habitats Regulation Assessment, Water Framework Directive Assessment, Invasive Non Native Species Assessment and Qualitative Ecosystems Services Assessment. More details on these assessments can be found in sections 5.3, 5.4.1, 5.4.2, 5.4.3 and 5.4.4.

We have complemented these assessments with an extensive programme of customer engagement research, including a societal valuation workstream.

In addition, we are also undertaking a substantial programme of work to develop a better understanding of natural capital approaches.

Further details of our approach to assessing environmental and social impacts is provided in Appendix E.

5.4.8 Customer engagement research

Customer engagement is central to both the daily running of our business and our long-term decision making. We have built on the extensive engagement undertaken for PR14 business planning to embed it as a business as usual activity.

Our Customer and Stakeholder Engagement technical document summarises the engagement activities and provides the detailed evidence which underpins the conclusions and influenced our desision making.

5.4.9 Societal Valuation

The overall methodology and approach for delivery of societal valuations required for the PR19 business planning has been underpinned by the development of a valuation strategy[15]. We developed this strategy by prioritising the values required for business planning (including WRMP) by assessing them against the four criteria listed below:

- Customer priority
- Stakeholder importance
- Size of investment programme, and
- Sensitivity to cost benefit assessment.

The results of this assessment showed robust and credible values for investments to reduce the risk of severe restrictions and water resource options.

As a result, the PR19 societal valuation programme looked to ensure there were a range of valuation studies and valuation methods that could inform the customer values for water resilience and water resource options, including:

- Main survey: a stated preference study covering a broad range of service attributes across the business including leakage reduction and water restrictions.
- Second stage resilience study: focusing on customer preferences and valuations for water resource options and water restrictions.
- A macroeconomic assessment of drought impacts study to estimate the loss of economic output from severe water restrictions on non-household customers for the region.

The second stage resilience study[16] used a stated preference approach, which is a survey-based method for eliciting customer priorities and preferences for changes in service levels. A total of 1,008 household customers and 408 non-household customers were interviewed with the survey administered through online interviews. The two samples are representative of their respective customer bases. The study was undertaken in line with latest best practice guidance.

Given the complexity associated with these areas, we placed a large focus on ensuring our surveys were accessible and meaningful. This included a comprehensive design and testing phase, a focus on ensuring the survey was engaging to customers to promote understanding and considered responses, and undertaking detailed analysis and validity testing of the results. To add further assurance and deepen our understanding of the results, we followed up the surveys with customer focus groups that discussed the results and checked our interpretation of them.

In accordance with our Problem Characterisation and valuation strategy, the surveys that we undertook focussed on deriving values for a reduction in the risk of severe restrictions and water resource options. It was not possible to develop a robust value for all of the potential impacts. As

[15] *Informed by work undertaken by NERA for Anglian Water on "Developing a PR19 Valuation Strategy", February 2017.*
[16] *ICS, Eftec, October 2017*

a result, we felt it was not appropriate to include these values in our EBSD options appraisal, as it might have the unintended effect of over-emphasising some impacts at the expense of others. As outlined above we have undertaken an extensive assessment of social and environmental impacts. Much of this work is qualitative. We have used the values:

- To monetise some of the benefits associated with the strategic demand management options. These benefits have been included in the cost-benefit assessment of demand management options.
- To help us strike an appropriate balance between supply-side and demand management options.
- To understand the benefits associated with investment to reduce the risk of severe restrictions. We have also produced a cost benefit assessment[17] to understand the benefits of this investment.
- To provide qualitative insight into customer views and preferences. We have considered the results alongside the conclusions of the qualitative customer engagement research.

[17] *NERA, September 2018*

Table 5.9: Water company checklist: 6.10 Deciding on a solution

Number	Action
257	You have described the steps you have taken to carry out a Strategic Environment Assessment and Habitat Regulations Assessment for your chosen solution, or demonstrated why this is not needed. Where relevant, you have incorporated any outcomes from the SEA and/or HRA into your final plan.

As discussed above, we have completed an SEA and HRA. Information about the methodology and results can be found the SEA and HRA reports.

5.5 Costs estimates

Table 5.10: Water company checklist: 6.7 Feasible list

Number	Action
236	You have undertaken a cost-benefit appraisal of the option, including a cost breakdown over the 80 year period and covering capital, operating and financing costs. Your method is aligned to Ofwat's most recent guidance for PR19 and the WRPG, and gives Average Incremental Costs (AIC) based on maximum capacity costs divided by maximum capacity outputs expressed as net present value (NPV). You have explained how you arrived at your AIC figure.
237	As part of the cost-benefit appraisal, you have evaluated the environmental and social (including carbon) costs and benefits of the options and show either a monetised profile of Average Incremental and Social Costs (AISC), or a non-monetised assessment of impacts. You have stated your approach to calculation of AISC.

5.5.1 C55 Asset Investment Planning and Management tool

Our process for costing of WRMP options is aligned with PR19 cost estimation principles. All options have been entered into our C55 Asset Investment Planning and Management tool, which is the tool we use for the estimation of all Business Plan investments. The cost estimation module within C55 contains a comprehensive asset cost model library covering assets from treatment steps (e.g. pumping station, filter), pipelines and equipment (e.g. starter, pump). The cost models are common for all investments and the cost is driven by the asset attributes entered (i.e. pump kW).

Once the options are developed in C55, they follow a Quality Assurance process, where the Anglian Water Cost Base Team challenges the scope, in order to ensure alignment with current business practice. The cost models in C55 have been updated to 2017 prices using AWS cost data from completed projects.

Where cost models did not exist, we have developed new ones (i.e. surface water intakes, desalination intakes/outfalls, deep boreholes and large diameter pipes). New models are developed using a standard robust methodology that aligns with the corporate cost modelling approach. For the large reservoir cost model, we do not have sufficient historic data available due to lack of recent case studies. The quantities used to develop the cost model have been verified by external cost consultants, and we have reviewed the unit rates used internally.

5.5.2 Cost confidence grades

Cost confidence grades have been allocated to each of the feasible options in WRP Table 5.

Table 5.12 shows the grades allocated to the different types of feasible options, where 1 is the lowest and 5 the highest level of confidence.

We have assigned scope and cost scores below 3 for some options because the scope of works has been developed on limited information or there is a lack of relevant company experience. Where cost information from within the business is unavailable external data has been used.

Table 5.11: Cost confidence grades allocated to different option types

Option Type	Scope Score	Cost Score
Potable Transfer	4	5
Raw Water Transfer	4	5
Desalination	4	2
Water Reuse	4	4
Groundwater Development	5	5
Surface Water Development	5	5
New Reservoir	2	2
Dam raising	1	2

5.5.3 Capital cost estimates

The capital (capex) estimates are based on the scope of works identified in the feasibility reports, see section 4. All costs taken from C55 are based on September 2017 prices.

The capex estimate is based on the maximum capacity of the option. The maximum capacity has been determined by either the size of the deficit in the WRZ to be supplied by the option or limited by the availability of the resource. The initial capex associated with the planning, design and construction has been automatically profiled within C55 over a 5 year period, see section 5.5.1. This is the value used in WRP Table 5 for fixed capex.

Some options require a significant planning and implementation period that would span over multiple AMPs (e.g. winter storage reservoirs) for these we have ensured that the 'Earliest Potential Start Date' used in the WRP Table 5 is relevant (e.g. 2029/30) despite the 'Fixed capex' shown as it is profiled in C55 within the 5 year period. This has the effect of over estimating the 'Capex NPV', 'AIC' and 'AISC' which are automatically calculated with WRP Table 5. In the EBSD economic model the initial capex is considered all in 1 year (i.e. not profiled) therefore this assumption does not affect the options selected only the way capex is presented in the WRP tables.

C55 has defined rules for costs and frequency of capital maintenance/replacement of assets (e.g. instrumental scope replaced every 7 years, mechanical & electrical every 15 years). This data has been used for variable capex in WRP Table 5.

5.5.4 Operational cost estimates

The operational (opex) estimate is based on the maximum capacity of the option. Opex estimates are based September 2012 prices. All costs taken from C55 are based on September 2017 prices.

The opex estimate has been split into fixed and variable opex. The fixed opex is based on the following C55 categories:

- Labour
- Replacement parts
- Licences
- Insurance
- Scientific services

For variable opex the following categories have been used:

- Power
- Chemical

The figures used for variable opex in WRP Table 5 are based on the maximum capacity of the option and not the utilisation.

5.5.5 Carbon cost estimates

C55 has been used to develop capital and operational carbon quantity estimates for each feasible option in terms of tonnes of carbon dioxide equivalent (tCO2e).

The costs are based on the published Department for Business, Energy & Industrial Strategy (BEIS) values for traded and non-traded carbon, December 2017.

For capital carbon the market based approach is built into the price of materials and products used in the C55 cost models. The BEIS values are social costs in addition to those captured in the C55 models. For the economic modelling we have used the central estimate from the traded sector value from Data Table 3 for the year the option is available from (i.e. 2024/25 for most options).

The Carbon reduction commitment tax which was used for operational carbon for WRMP14 will cease in 2019. The power costs used in C55 include for carbon and therefore we have not included additional societal costs for operational carbon in the WRP tables or economic modelling.

5.5.6 Financing costs

We have included the financing costs needed to deliver each option in WRP Table 5. As set out in the WRPG[18] and WRP Table instructions[19] we have followed the Spackman approach to discounting. This includes the cost of capital as a stream of annual costs over the life of the options, alongside the other project costs such as capex and opex.

We have used 3.6% as the average cost of capital. The fixed amount of interest each year is paid against the total amount of capex.

5.5.7 Average Incremental Costs and Average Incremental and Social Costs

We have used WRP Table 5 to calculate the Average Incremental Costs (AIC) and Average Incremental and Social Costs (AISC) for each of the options, using the cost data described in sections Capital cost estimates 5.5.3 to 5.5.6. The appraisal period is 80 years. WRP Table 5 also provides the Net Present Value (NPV) for each option. Both the NPV, AIC and AISC are based on the maximum capacity of the option.

The WRZ Option details in Section 6 include an analysis ranking the options by lowest-highest AIC and AISC.

5.6 Implementation periods

Table 5.12: WRMP 2019 - Water company checklist: 6.7 Feasible list

Number	Action
231	You have appropriately estimated the amount of time needed to investigate and implement the option and have proposed an earliest start date based on your review.

For all feasible options we have estimated the time needed to investigate, plan, design and implement the option based on the option type, see Table 5.14.

[18] *Environmental Agency & Natural Resources Wales, April 2017, 'Water Resources Planning Guideline: Interim update'*
[19] *Environment Agency, WRMP19 Table instructions REVISED May 2017 v16*

Table 5.13: Supply-side option implementation periods

Option Type	Time to investigate, plan, design and implement option (years)	Earliest start date	Notes
Desalination	4	2024/25	It has been assumed that design and construction of the treatment process could be completed within 4 years.
Raw Water Transfer	5	2025/26	Due to the length and capacity of the raw water transfers these have been estimated to require 5 years to deliver.
New Reservoir	15	2035/36	As the reservoirs options are >30Mm3 they are considered as Nationally significant infrastructure projects[20] (NSIPs) and would be subject to the Development Consent Order (DCO) process that accelerates the planning process.
New Reservoir (with raw water transfer)	15	2035/36	See above.
Water Reuse for potable water use	5	2025/26	Delivery would be 4-5 years. As none of the feasible options are direct reuse we do not envisage major stakeholder engagement issues.
Water reuse for non- potable use	4	2024/25	The stakeholder engagement would be less complex as a non-potable supply option.
Dam Raising	15	2035/36	Complex planning due to environmental and operational issues.
Aquifer Recharge	7	2027/28	Complex planning issues and includes time to recharge the Aquifer.
Canal Transfer	10	2030/31	Complex planning, environmental (INNS) and engineering considerations plus winter only working on some elements.
Potable Water Transfer	3-4	2023/24 -2024/25	Due to the planning, enabling works, environmental issues and large number of land owners the pipelines above have been assumed to be delivered within 3-4 years depending on the complexity and length of the pipeline.

5.7 Customer support for options

Table 5.14: WRMP 2019 – Water company checklist: 6.7 Feasible list

Number	Action
230	You have assessed the level of customer support for each option.

[20] *Planning Act 2008*

Given the scale of the challenge we face, we have collaborated and engaged extensively in the development of our dWRMP. Customer engagement is central to both the daily running of our business and our long-term decision making. We have built on the extensive engagement undertaken for PR14 business planning to embed it as a business as usual activity. Further details are provided in the supporting Customer and Stakeholder Engagement technical document.

5.7.1 General conclusions

Customers do not want a deterioration in service and all water resource options (including both demand management and supply-side) were preferable to an increase in restrictions. The one exception being sea-tankering, which customers did not perceive to be a credible option.

Generally, customers prefer options that make best use of existing resource and infrastructure, as opposed to options that involve developing new resources. This explains a clear preference for demand management, particularly leakage reduction. Even when customers understood that our leakage performance is industry leading, and that reducing leakage does not reduce bills, it remains an emblematic issue and a priority for investment. In addition, this principle explains a preference for supply-side options that make use of existing infrastructure, such as dam raising and aquifer storage and recovery.

Although customers express a preference for demand management, they also want to see a cost-effective balance of supply and demand options. When it was explained to customers that there are cheaper alternatives to leakage reduction, many felt that while leakage reduction is important, affordability should also be a key consideration.

In addition, the reliability[21] of water resources options is an additional important consideration to customers, and generally they prefer options that are described as having 'higher' reliability, as opposed to 'medium' or 'lower' reliability. For example, in the Water Resources stated preference survey all options were defined as either 'higher', 'medium' and 'lower' reliability. Overall, leakage reduction was the highest ranked option. However, when leakage was described as 'lower' reliability, it was less preferable to some supply-side options described as 'medium' or 'higher' reliability (including water reuse and reservoir extensions).

5.7.2 Option ranking

The stated preference survey results rank water resource options according to customer preferences. The ranking is set out below; the highest ranked being those at the top[22]:

- Leakage reduction
- Aquifer storage and recovery
- Canal transfer
- NEP mitigation options
- Dam raising
- Water reuse
- Water efficiency: retrofitting water saving devices
- Water efficiency: behavioural change
- Compulsory metering
- Non-compulsory metering
- New reservoir
- Conjunctive use options
- Desalination
- Raw water transfers

[21]The term 'reliability' refers to the certainty over option yield or saving. For example, how confident are we that a reservoir option will achieve the expected 100Ml/d yield, or a water efficiency option will deliver 10 Ml/d of water savings.
[22]ICS and Eftec, 2017, 'Anglian Water, Water Resources Second Stage Research, Stated Preference Report v2', Page 111

5.8 Resource sharing options and third party options

Table 5.15: WRMP 2019 – Water company checklist: 6.3 Third party options

Number	Action
216	You have considered options, where appropriate, that involve engaging with third parties to help deliver solutions at lower cost, such as upstream services, leakage detection and demand management. You have used the Market Information Platform to assess third party bids (when available).
217	You have subjected options involving third parties to the same scrutiny and testing as other options.
218	Where relevant, your plans clearly sets out which options within the final planning scenario are third party options.

We considered third party and resource sharing options identified through,

- Unconstrained options workshops
- Collaborative water resource planning projects/ groups (see section 4.3)
- Market information platform

Table 5.17 describes the process of developing third party options and number of options identified by the methods listed above.

Table 5.16: Third Party Options – process for developing and number of options

	Process for developing options	Number of options taken through to dWRMP EBSD modelling	Number of options taken through to final EBSD modelling
Unconstrained options workshops	• For WRZ identified the major water users/ industries that may have supplies to trade. • These would be further assessed if 3rd parties chose to bid via the Market information Platform.	No options were taken forward in dWRMP as waiting to see if options emerged from market Information platform	No options from market Information Platform
Collaborative water resource planning projects/ groups	• These groups included WRLTPF, WRE and the Trent and Ouse Working Groups. • From these options were developed with Severn Trent Water, Affinity Water, Canal and River Trust and other third parties. • For all these options we requested the data in the following table to ensure that the 3rd party options were assessed using the same methodologies as our own supply-side options. • For the water company trades we received this information where relevant. • However for the non-water company trades we received partial information. • For the sea tankering options the risks associated with INNS were considered too great to be included in the feasible options set without further investigation and so were not included in the dWRMP. • There are risks associated with water quality and resource availability in the planning scenario with the CRT options, for the dWRMP we included these in the feasible option set to test their economic value but there were not selected. • For the non-water company options we did not receive any further information through the market information platform so did not take these into the feasible options set in the revised dWRMP. • We will continue working with all 3rd parties through the collaborative water resource planning projects/groups to further develop options.	3 Severn Trent Water 2 Affinity Water 2 Canal & River Trust	5 Severn Trent Water 1 Affinity Water
Market information platform	• Our market information tables were published on our website with our dWRMP to allow 3rd parties to bid against our supply-side and demand management options. • The bidders were required to complete the same assessment criteria as the 3rd parties identified through the collaborative water resource planning projects/groups • No 3rd parties bid into our plan via the market information platform.	N/A	0

The feasible third party options taken forward to economic modelling are shown in Table 5.18.

Table 5.17: Feasible third party options

Option Type	Third Party	Option Ref	Option Name
Transfer of water between water companies	Severn Trent Water	RTN6	Severn Trent Water import (18Mld)
		RTN7	Severn Trent Water import (36Mld)
		RTN26	Severn Trent Water Raw Water Import (115Ml/d)
		RTN29	Severn Trent Water Leicester Water Reuse Transfer (36Ml/d)
		RTN30	Severn Trent Water Leicester Water Reuse Transfer (50Ml/d)
	Affinity Water	RTS13	Affinity Water Ruthamford South WRZ Reverse Trade

The Affinity Water reverse trade is a feasible option but was not taken through to economic modeling as it is time limited and did not provide a benefit when it would have been required in Ruthamford South WRZ within the planning horizon. Therefore this option is not included in the WRP Table 5.

All third party options have been appraised following the same method for all other supply-side options, see section 6. Third party options that have been discounted are recorded in the rejection register, see Appendix B.

These have been appraised following the same method for other supply-side options as set out in this report, see section 4.3. Table 5.19 shows the bidder assessment criteria used to assess the third party options.

Table 5.18: Bidder Assessment Criteria

Data Type	Data Required
Option Details	Donor Company
	Option Name
	Option Reference
	Resource type (Raw/potable)
	Deployable Output (Ml/d) for dry year annual average (DYAA) and dry year critical period (CP) conditions
	Option earliest start date
	Proposed connection point to AW system
	Connection point coordinates
	Option Description
Security and Resilience	An assessment of the risks and uncertainty associated with the option, including the likelihood and impact of reduced yield due to climate change, environmental constraints.
	An assessment of the flexibility of the option to adapt to future uncertainty
	An explanation of whether the option depends on an existing scheme, or is mutually exclusive with another scheme
	Any factors or constraints specific to the option
Water Quality	Water quality data to be provided by Donor Water Company to allow an assessment of risk of discolouration, nitrates, pesticides, fluoridation, pH impacts and control of disinfection by-products.
	An assessment of the environmental impacts of the option, including the impacts on RBMP objectives
	A Habitats Regulations Assessment (HRA) if an option could affect any designated European site
	An assessment of the risk of transfer of Invasive non-native species (INNS). This should cover options that, • Create a hydrological connection between locations not already connected, and • Where new schemes provides a pathway between locations that have an existing hydrological connection. Options that risk spreading INNS should include proposed measures to manage that risk which must be completely effective for removal of all life stages.
	An assessment of Water Framework Directive No- deterioration to ensure that options do not pose a risk of deterioration, or prevent the achievement of 'good' status (or potential).
Operational regime	Description of how the option will be utilised. E.g. Is the bulk export to be a 365 days a year, or is only required in drought etc. Enough information on how it will be operated to allow the WRP tables to be completed.
Cost Information	Bulk Export cost £/Ml
	The environmental and social impacts of the option. Including carbon.

5.9 Relevance to final planning problem

The final screening stage of the feasible options is to ensure that they are relevant to the planning problem to be modelled in EBSD. At this stage the following have been finalised:

- Supply forecast – the driver for reductions in WAFU in each WRZ is known (e.g. drought, climate change)
- Demand management programme
- Solutions driven by changes to existing abstraction licences.

We have ensured that we are not taking options forward that would not be available in the scenario modelled, for example if the one of the drivers for WAFU reduction is more extreme drought we have checked that all the options in that WRZ are available in that drought. One example of this is in Central Lincolnshire WRZ where drought is impacting DO for our direct intake on the river Trent; we have an option to develop a second abstraction at this location. However in the final planning problem this option would not be able to provide any additional DO and therefore has been excluded from the economic modelling.

Once the demand management programme was finalised this showed that the benefits of demand management exceed the predicted demand increase for growth. This means that we do not need to increase additional treatment capacity (to cater for additional demand, growth) we just need new resources to meet the residual deficits driven by a reduction in available resource (WAFU) as a result of drought, climate change and sustainability reductions.

The supply demand graph in Figure 5.4 shows the WAFU reduction and deficits met by demand management and those to be met by supply-side options.

We have developed options to export resources from all WRZ in surplus to those in deficit, to allow the model to assess whether it is economical to implement long transfers of small surpluses verses developing new resources. However some of these surpluses are small (<5Ml/d) and are in isolated locations that would not form part of a strategic transfer. Due to the uncertainty about the available resources in the future due to WFD no-deterioration we have not taken forward any transfer of less than 5Ml/d in locations that are not part of a strategic transfer route forward to avoid the risk of stranded assets.

Figure 5.4: WRZ supply demand graph showing the deficit met by demand management and supply-side options

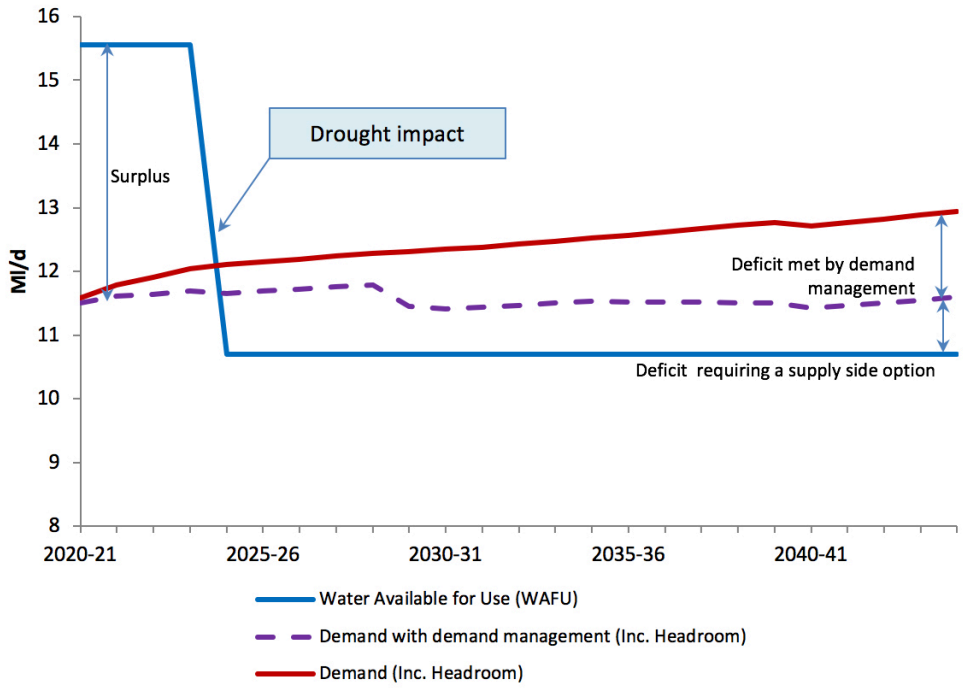
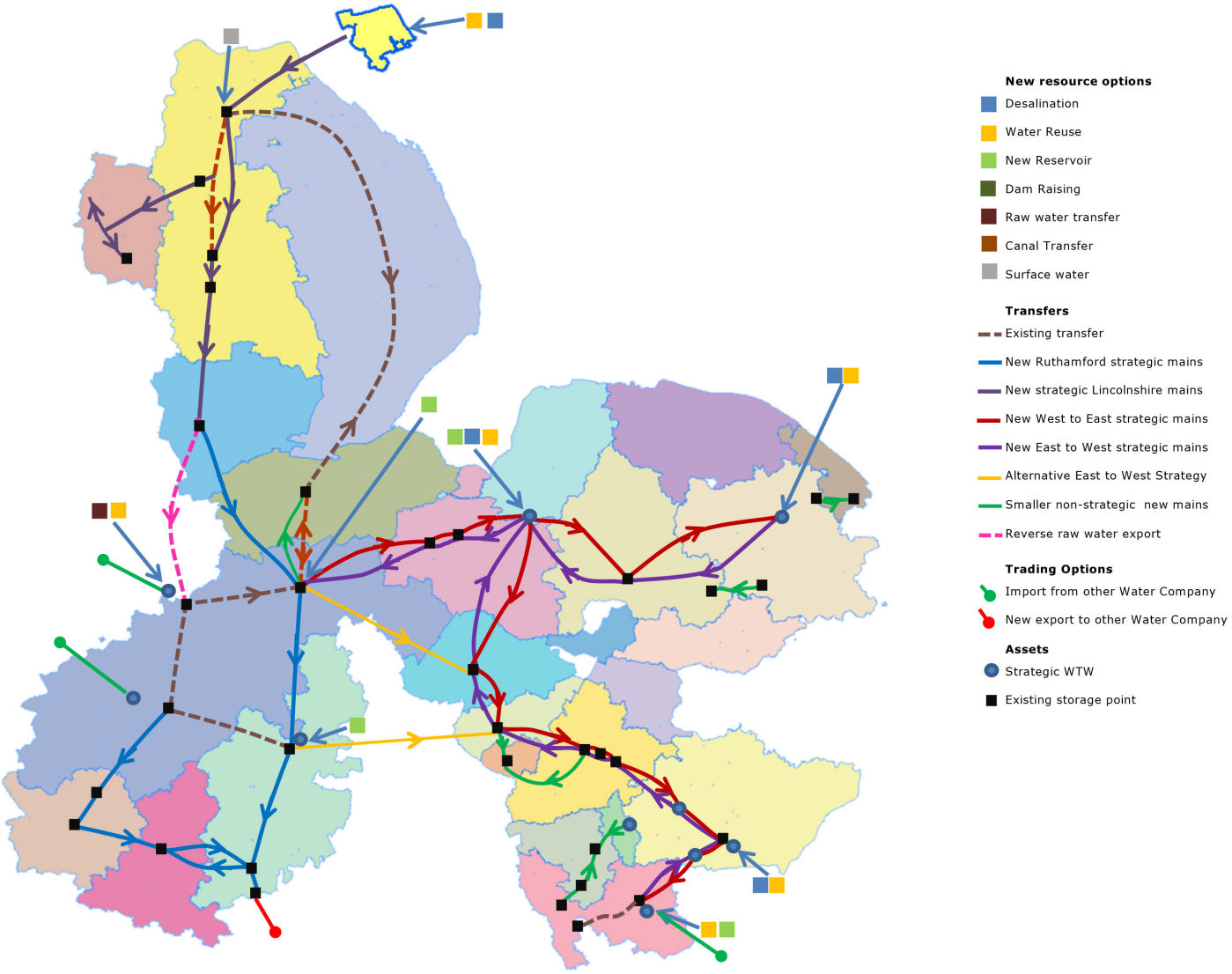


Figure 5.5: Supply-side options taken forward to economic modelling



6 WATER RESOURCE ZONE OPTIONS

The following sub-sections provide details of the unconstrained and feasible options for each Water Resource Zone (WRZ).

Table 6.1: WRMP 2019 - Water company checklist: 6.7 Feasible list

Number	Action
227	You have provided a full description of all feasible options that you have considered, including main operational features, expected implementation extent, conceptual diagram etc.
228	You have compared each feasible option to the baseline case, and provided a profile of the extra water available over the 80 years from initial investment in the option.
232	You have appropriately assessed and reported the risks and uncertainties associated with each option, including the likelihood of reduced yield due to factors such as climate change, environmental constraints and customer behaviour. You have considered the flexibility of the option to adapt to future uncertainty.
233	You have explained any factors or constraints specific to the option, and have highlighted any links or dependencies on other existing schemes, other options and any mutual exclusivity with another option.
234	You have described how the option will be utilised and the impact on costs.
236	You have undertaken a cost-benefit appraisal of the option, including a cost breakdown over the 80 year period and covering capital, operating and financing costs. Your method is aligned to Ofwat's most recent guidance for PR19 and the WRPG, and gives Average Incremental Costs (AIC) based on maximum capacity costs divided by maximum capacity outputs expressed as net present value (NPV). You have explained how you arrived at your AIC figure.
237	As part of the cost-benefit appraisal, you have evaluated the environmental and social (including carbon) costs and benefits of the options and show either a monetised profile of Average Incremental and Social Costs (AISC), or a non-monetised assessment of impacts. You have stated your approach to calculation of AISC. We're not doing AISCs but will need to bring together the qual. information on environmental impacts with the conclusions from the societal valuation
238	For supply options, as part of your cost-benefit appraisal you have determined supplementary costs required to distribute the new supply (e.g. service reservoirs, pumping stations, mains upgrades), excluding costs associated with local infrastructure enhancements.
239	You have evaluated whole-life costs that include treatment, pumping, network, storage, maintenance and operation costs (the latter included control measures relating to water quality optimisation, fluoridation, chemical stabilisation, aesthetic impacts on consumers and control of disinfection by-products.

6.1 Bourne Water Resource Zone

6.1.1 Constrained Options

The table below contains the list of constrained options considered for Bourne WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.2: Bourne WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Tallington Lakes	N
Bulk transfers	BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	Y
Improved/sophisticated conjunctive management	BRN3	Ruthamford conjunctive use	N

6.1.2 Feasible options

The table below provides details of the options for Bourne WRZ taken forward for economic modelling.

Table 6.3: Bourne WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	10	2	4	I010121

6.1.3 Transfer Option Details

Table 6.4: Transfer options for Bourne WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	25	409	1	22

6.1.4 Resource Option Details

There are no feasible new resource options identified for Bourne WRZ.

6.1.5 Environmental considerations

Table 6.5: Climate change impacts of Bourne WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	N/A	N/A	N/A

Table 6.6: Water quality considerations for Bourne WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	Not required	Not required

Table 6.7: INNS risks for Bourne WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	Low	Low	Refer to detailed risk assessment

Table 6.8: Other environmental considerations for Bourne WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	Not Assessed	Not Assessed	Not Assessed

6.1.6 Costs

Table 6.9: Bourne WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	10	13,124	222	3,317	313

6.1.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.10: Bourne WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
BRN1	Ruthamford North WRZ to Bourne WRZ Transfer	None	None

The options assessed for Bourne WRZ have the following synergies and links to other programmes,

- There is a NEP mitigation option for Bourne WRZ, more details are described in the Sustainable abstraction technical document.

6.2 Bury Haverhill Water Resource Zone

6.2.1 Constrained Options

The table below contains the list of constrained options considered for Bury Haverhill WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.11: Bury Haverhill WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Increasing storage at private lakes e.g. Livermere Lakes	
Groundwater wells (boreholes)		Ampton Lake waterbody as a source of water near Bury	
		EOETs & GOGS review	
		Bury St Edmunds groundwater sources	
Reclaimed water		Bury St Edmunds Water reuse	
	BHV3	River Lark Recirculation Scheme	No – included in the feasible NEP options
Bulk transfers	BVH2/ BVH7	East Suffolk WRZ transfer	Yes
		South Essex WRZ Transfer	Yes
		Thetford WRZ Transfer	Yes
	BHV4	Sudbury WRZ Transfer	Yes
		Cheveley WRZ transfer	
	BHV1/ BHV5/ BHV6	Newmarket WRZ transfer	Yes
		Central Essex WRZ Transfer	Yes
Resource Sharing with other Water Companies		Affinity (East and Central)	
		Cambridge WRC reuse pumping to River Stour	
		Cambridge Water	
3rd Party Options		3rd party trade options	
		Sugar beet factory	

6.2.2 Feasible options

The table below provides details of the options for Bury Haverhill WRZ taken forward for economic modelling.

Table 6.12: Bury Haverhill WRZ Feasible Options included in EBSD modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	31	2.7	4	I012774
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	25	3.5	4	I010662
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	20	1.9	4	I015218
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	10	1.2	4	I021906
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	10	1.6	4	I015663

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
	South Essex WRZ Transfer	-	-	Superseded by South Essex to East Suffolk to Bury and Haverhill transfer options
	Thetford WRZ Transfer	-	-	Existing transfer to Bury St Edmunds from Thetford. Surplus in Thetford transferred to Ixworth WRZ to meet deficits there. Any residual surplus could be transferred via existing link.
BHV4	Sudbury WRZ Transfer	3	I015216	Surplus in Sudbury is <5Ml/d. Due to the uncertainty of availability of resources in the future due to WFD we have not taken forward transfers <5Ml/d in locations there are not part of a strategic transfer route to avoid the risk of stranded assets.
	Central Essex WRZ Transfer	-	-	Surplus is <5Ml/d and not part of a strategic transfer route, see above.

6.2.3 Intra-WRZ Transfer Options

Due to the capping of time limited licenses we have found that there are now deficits in discrete parts of some WRZs. These local deficits are not seen at WRZ level and as such would not appear within the WRZ supply demand balances in the WRP Tables. We have completed smaller scale supply demand balances for discrete Planning Zones (PZs) and developed intra-WRZ transfer options to resolve these deficits. The options have been costed and evaluated in the same way as all the other feasible options and the costs details have been included in WRP Table 5. However as the deficits are within a WRZ these options have not been included in the economic modelling and so do not appear in WRP Table 6. Table 6 14 and subsequent tables contain the supporting information for the Intra-WRZ options for this WRZ.

Table 6.14: Intra-Water Resource Zone Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	8	2	4	I010950

6.2.4 Transfer Option Details

Table 6.15: Transfer options for Bury Haverhill WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	33.0	600	1	4
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	43.5	600	1	0
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	33.0	500	1	4
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	33.0	409	1	4
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	43.5	409	1	0
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	17.7	441	4	10

6.2.5 Resource Option Details

There are no feasible new resource options identified for Bury Haverhill WRZ.

6.2.6 Environmental considerations

Table 6.16: Climate change impacts of Bury Haverhill WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	N/A	N/A	N/A
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	N/A	N/A	N/A
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	N/A	N/A	N/A
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	N/A	N/A	N/A
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	N/A	N/A	N/A

Table 6.17: Water quality considerations for Bury Haverhill WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	Not required	Not required
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	Required	Required
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	Not required	Not required
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	Not required	Not required
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	Required	Required
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	Not required	Not required

Table 6.18: INNS risks for Bury Haverhill WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	Low	Low	N/A
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	Low	Low	N/A
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	Low	Low	N/A
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	Low	Low	N/A
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	Low	Low	N/A
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	Low	Low	N/A

Table 6.19: Other environmental considerations for Bury Haverhill WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.2.7 Costs

Table 6.20: Bury Haverhill WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	31	26,288	559	17,417	1,743
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	25	69,664	874	26,898	2,488
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	20	19,778	388	13,509	1,199
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	10	14,117	155	4,285	454
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	10	38,680	438	7,631	1,079
BHV Intra1	Intra WRZ - Bury Haverhill WRZ Transfer to Haverhill PZ	8	14,764	166	3,095	382

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.21: Bury Haverhill WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	1	1
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25 Ml/d)	4	4
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	2	2
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	3	3
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	5	5

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.2.8 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.22: Bury Haverhill WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
BHV1	Newmarket WRZ to Bury Haverhill WRZ Transfer (31 Ml/d)	None	NWM2, NWM7, BHV5, BHV6
BHV2	East Suffolk WRZ to Bury Haverhill WRZ Transfer (25Ml/d)	None	ESU5, ESU8, BHV7, ESU9
BHV5	Newmarket WRZ to Bury Haverhill WRZ Transfer (20 Ml/d)	None	NWM2, NWM7, BHV1, BHV6
BHV6	Newmarket WRZ to Bury Haverhill WRZ Transfer (10 Ml/d)	None	NWM2, NWM7, BHV1, BHV5
BHV7	East Suffolk WRZ to Bury Haverhill WRZ Transfer (10Ml/d)	None	ESU5, ESU8, BHV2, ESU9

The options assessed for Bury Haverhill WRZ have the following synergies and links to other programmes,

- There are NEP mitigation options for Bury Haverhill WRZ, more details are described in the Sustainable abstraction technical document.
- The strategic transfer options would provide supply system resilience to a number of WTWs within the Bury Haverhill WRZ.

6.3 Central Essex WRZ

6.3.1 Constrained Options

The table below contains the list of constrained options considered for Central Essex WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.23: Central Essex WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Review groundwater group licences	
		Central Essex groundwater sources	
		Abandoned Central Essex WRZ sources back to supply	
Bulk transfers	CEX2	South Essex WRZ Transfer	Yes
	CEX3	Bury and Haverhill WRZ transfer	
	CEX1	Sudbury WRZ Transfer	Yes
3rd Party Options		3rd party trade options	
		EOETs & GOGS review	

6.3.2 Feasible options

The table below provides details of the options for Central Essex WRZ taken forward for economic modelling.

Table 6.24 Central Essex WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
CEX1	Sudbury WRZ Central Essex WRZ Transfer	1	0.1	3	I015222
CEX2	South Essex WRZ to Central Essex WRZ Transfer	1	0.3	3	I000273

6.3.3 Transfer Option Details

Table 6.25: Transfer options for Central Essex WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
CEX1	Sudbury WRZ Central Essex WRZ Transfer	10	147	1	8
CEX2	South Essex WRZ to Central Essex WRZ Transfer	15	184	1	9

6.3.4 Resource Option Details

There are no feasible new resource options identified for Central Essex WRZ.

6.3.5 Environmental considerations

Table 6.26: Climate change impacts of Central Essex WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
CEX1	Sudbury WRZ Central Essex WRZ Transfer	N/A	N/A	N/A
CEX2	South Essex WRZ to Central Essex WRZ Transfer	N/A	N/A	N/A

Table 6.27: Water quality considerations for Central Essex WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
CEX1	Sudbury WRZ Central Essex WRZ Transfer	Not required	Not required
CEX2	South Essex WRZ to Central Essex WRZ Transfer	Not required	Not required

Table 6.28: INNS risks for Central Essex WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
CEX1	Sudbury WRZ Central Essex WRZ Transfer	Low	Low	N/A
CEX2	South Essex WRZ to Central Essex WRZ Transfer	Low	Low	N/A

Table 6.29: Other environmental considerations for Central Essex WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
CEX1	Sudbury WRZ Central Essex WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
CEX2	South Essex WRZ to Central Essex WRZ Transfer	Assessed at Phase 1 only - moderate level of impact	Risks can be mitigated	No likely significant effects determined at screening

6.3.6 Costs

Table 6.30: Central Essex WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
CEX1	Sudbury WRZ Central Essex WRZ Transfer	1	2,268	14	513	13
CEX2	South Essex WRZ to Central Essex WRZ Transfer	1	4,653	75	1,078	199

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.31: Central Essex WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
CEX1	Sudbury WRZ Central Essex WRZ Transfer	1	1
CEX2	South Essex WRZ to Central Essex WRZ Transfer	2	2

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.3.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.32: Central Essex WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
CEX2	South Essex WRZ to Central Essex WRZ Transfer	None	None

The options assessed for Central Essex WRZ do not have any synergies and links to other programmes.

6.4 Central Lincolnshire Water Resource Zone

6.4.1 Constrained Options

The table below contains the list of constrained options considered for Central Lincolnshire WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

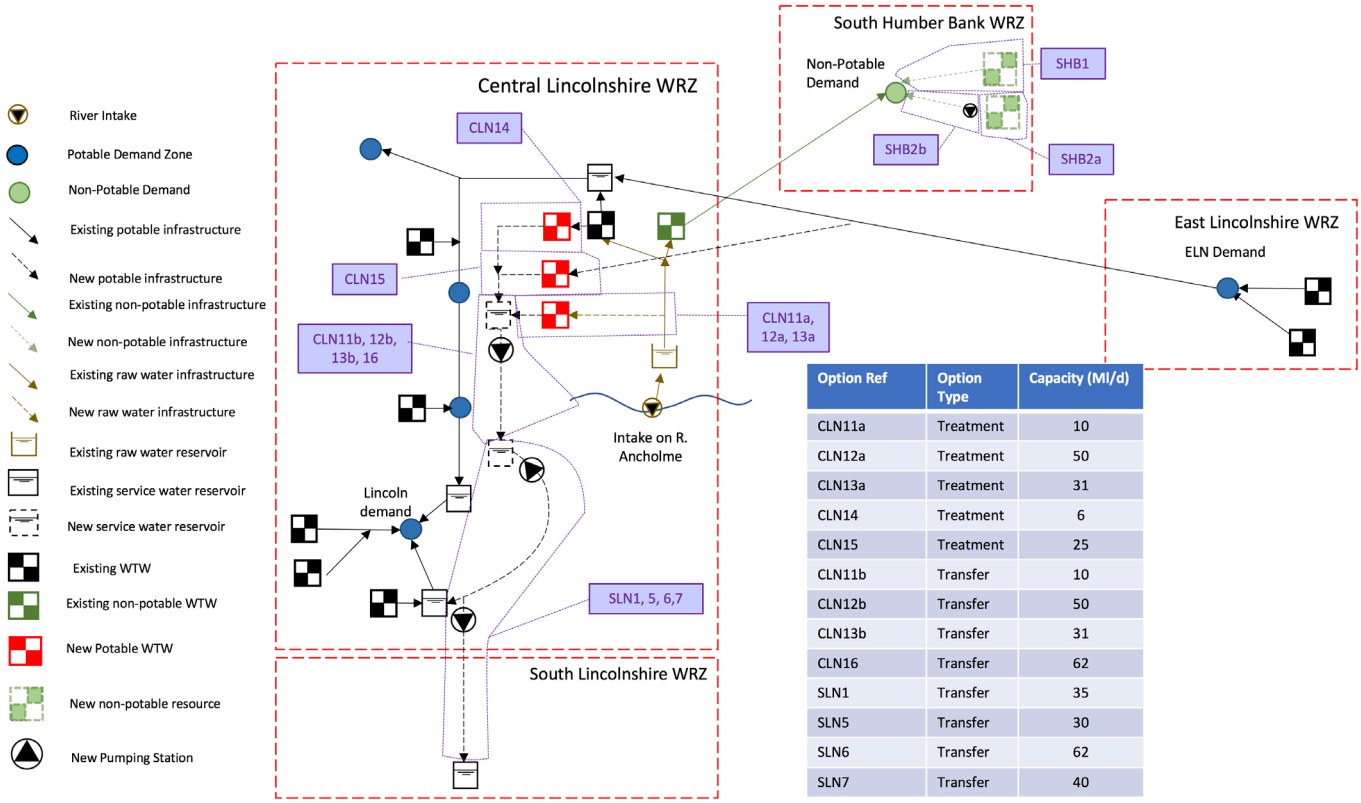
Table 6.33: Central Lincolnshire WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage	CLN2	Additional storage at Trent WTW	
		Cadney extension	
		Toft Newton Extension	
		Gravel pits south of Hykeham	
		Trent gravels	
Increase reservoir yield		Cadney	
		Trent WTW bankside storage	
		Cadney	
Groundwater wells (boreholes)		Review group licences	
		Blending sources licence review	
		New sources	
Reclaimed water		Process improvements to reduce losses WTW	
Bulk transfers	CLN11/CLN12/ CLN13/CLN16	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer	Yes
		Severn Trent Water groundwater into Trent	
		Kidby canal	
Resource Sharing with other Water Companies		Severn Trent Water - new and increasing existing	
		Yorkshire via Humber bridge	
		Yorkshire Water- new	
Tankering of water	CLN1	Sea Tanker to Immingham Port transfer to Central Lincolnshire WTW	Yes
Improved/ sophisticated conjunctive management	CLN4	Increase surface water treatment capacity to utilise high river flows	Yes
	CLN6/CLN8	Optimise conjunctive use of surface water and groundwater resources.	Yes

6.4.2 Feasible options

For the revised dWRMP we updated the way we represented the existing system in Central Lincolnshire WRZ which led to the development of some additional options. These options ensure we have the correct level of treatment (principally Metaldehyde removal) when combined with transfer options. The treatment element of some options (CLN11-13) was split and modelled separately from the transfers, this allowed the economic model to select the most beneficial combination of treatment and transfers. These options are described in Figure 6 1, there are more details of the options in following sections.

Figure 6.1: Schematic showing the options modelled for the Lincolnshire WRZs



Option Ref	Option Type	Capacity (Ml/d)
CLN11a	Treatment	10
CLN12a	Treatment	50
CLN13a	Treatment	31
CLN14	Treatment	6
CLN15	Treatment	25
CLN11b	Transfer	10
CLN12b	Transfer	50
CLN13b	Transfer	31
CLN16	Transfer	62
SLN1	Transfer	35
SLN5	Transfer	30
SLN6	Transfer	62
SLN7	Transfer	40

The table below provides details of the options for Central Lincolnshire WRZ taken forward for economic modelling.

Table 6.34: Central Lincolnshire WRZ Feasible Options taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	10	3.0	4	I013509
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	50	10.0	4	I013286
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	31	10.0	4	I015470
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	10	2.1	4	I013508

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	50	10.2	4	I013320
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	31	8.0	4	I015378
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	6	3.0	4	I022124
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	25	5.0	4	I021602
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	62	10.2	4	I021597

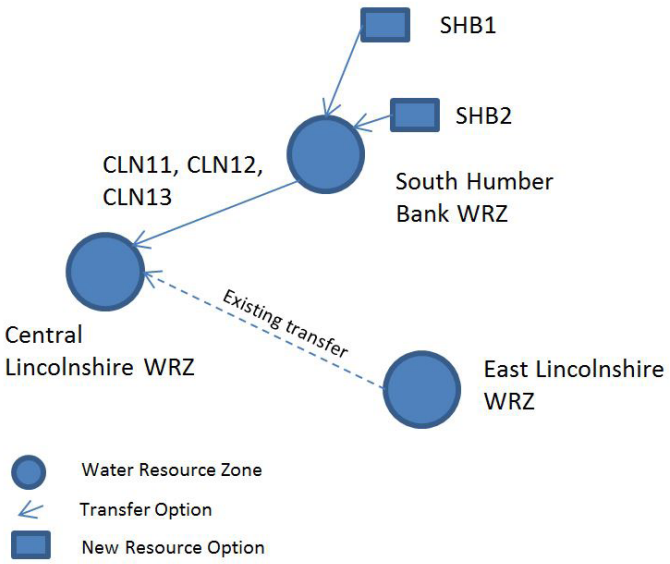
Table 6.35: Central Lincolnshire WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
CLN1	Sea Tanker to Immingham Port transfer to Central Lincolnshire WTW	-	I010544 I010549	Technically feasible but with high INNS risk, water quality and reliability risks which would need more investigation to overcome. Difficult to quantify the DO benefit. Sea tankering was originally included as an option in the Water Resources Options stated preference survey. The results of the pilot survey showed that customers did not believe it to be a realistic option and its inclusion was undermining the credibility of the survey as a whole. As a result it was removed and not included in the final version of the survey.
CLN4	Increase surface water treatment capacity to utilise high river flows	-	I008312 I010780	Option not relevant to the final planning problem in Central Lincolnshire. Does not provide DO required during low flows in more extreme drought than historic.
CLN6/ CLN8	Optimise conjunctive use of surface water and groundwater resources.	-	I010847	Option not relevant to the final planning problem in Central Lincolnshire. Does not provide DO required during low flows in more extreme drought than historic.

6.4.3 Representation of Central Lincolnshire WRZ Options

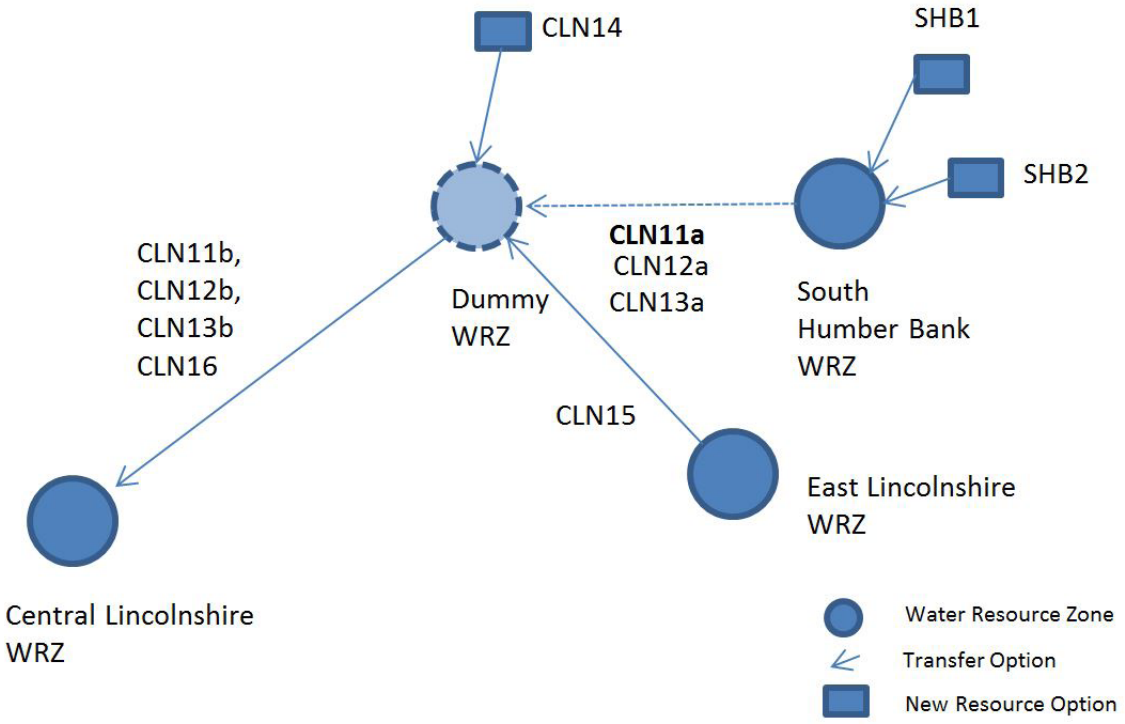
The representation of Central Lincolnshire options in EBSD has been amended between the draft and revised dWRMP. For the dWRMP Central Lincolnshire WRZ and South Humber Bank WRZ were represented as shown in Figure 6 2.

Figure 6.2: Representation in ESBD for Central Lincolnshire WRZ used in draft WRMP



Within Central Lincolnshire WRZ there are Planning Zones not covered by a Metaldehyde undertaking (see Section 5.2). This initial representation of the options meant that the existing transfer from East Lincolnshire (with a Metaldehyde undertaking) could be assumed to be transferred into areas without an undertaking. We amended the representation of the WRZ to ensure these water quality issues were accounted for correctly. We agreed with the Environmental Agency not to split the WRZ into smaller elements but to create a 'dummy WRZ' which would allow the model to select the optimal combination of treatment and transfer options. Figure 6 3 shows the representation of Central Lincolnshire WRZ used in the revised dWRMP.

Figure 6.3: Representation in ESBD for Central Lincolnshire WRZ used in revised dWRMP



The treatment options (CLN11a-13a, CLN14 and CLN15) are separated from the transfer options (CLN11b-13b, CLN16). The 'dummy WRZ' has no demand so acts as a node within EBSD where all the treatment options connect into. This allows the model to choose the optimal combination of resource option and transfer option ensuring water quality constraints are met. Table 6 36 below shows the details of the infrastructure requirements of each option. The treatment elements are described in section 6.4.4, which has a schematic showing how the elements of the options interact.

6.4.4 Treatment Option Details

Options CLN11a, CLN12a and CLN13a all require a new potable WTW to treat the raw water which currently goes to the existing non-potable WTW in Central Lincolnshire WRZ. For Options CLN12a and CLN13a the demand from the existing non- potable WTW is off-set by new resources in the South Humber Bank WRZ.

Option CLN11a utilises the surplus in South Humber Bank WRZ, whereas CLN12a and CLN13a are dependent on options SHB1 and/or SHB2 being selected to off-set the non-potable demand.

Options CLN11a, CLN12a and CLN13a all include treatment to remove Metaldehyde, see section 5.2 for details of the treatment process.

The existing transfer from East Lincolnshire WRZ has been modelled as a treatment option for the revised dWRMP. The treatment is required to remove Metaldehyde so that the resource can be transferred further south via a transfer option to areas without Metaldehyde Undertakings.

The addition of a transfer within Central Lincolnshire WRZ (CLN11b-13b, CLN16) provide a conjunctive use benefit to the WRZ DO when modelled in Aquator. CLN14 represents the 'locked-in' DO that is freed up by improving connectivity within the WRZ. However as the 'locked-in' DO is from existing sources with Metaldehyde undertakings it has been assumed treatment would be required if this is to be conveyed further south via a transfer option.

6.4.5 Transfer Option Details

Table 6 36 below shows the details of the infrastructure requirements of each option. The treatment elements are described in section 6.4.6, which has a schematic showing how the elements of the options interact.

Table 6.36: Transfer options for Central Lincolnshire WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	55.9	409	2	37
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	55.9	900	2	37
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	55.9	800	2	37
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	55.9	900	2	37

6.4.6 Resource Option Details

There are no new feasible resource options for Central Lincolnshire WRZ.

Option CLN11a utilises the surplus in South Humber Bank WRZ, whereas CLN12a and CLN13a are dependent on new resource options SHB1 and/or SHB2 being selected to off-set the non-potable demand.

Options CLN11a, CLN12a, CLN13a, CLN14 and CLN15 all require treatment to remove Metaldehyde (see section 6.4.4) from either off-set or existing sources, they are not new resources.

6.4.7 Environmental considerations

Table 6.37: Climate change impacts of Central Lincolnshire WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	10	10	-
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	50	50	-
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	31	31	-
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	N/A	N/A	N/A
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	N/A	N/A	N/A
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	N/A	N/A	N/A
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	10	6	4
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for existing transfer	25	25	-
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	N/A	N/A	N/A

Table 6.38: Water quality considerations for Central Lincolnshire WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	Required	Not required
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	Required	Not required
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	Required	Not required
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	Not required	Not required

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	Not required	Not required
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	Not required	Not required
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	Required	Not required
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	Required	Not required
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	Not required	Not required

Table 6.39: INNS risks for Central Lincolnshire WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	Low	Low	None
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	Low	Low	None
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	Low	Low	None
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	Low	Low	None
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	Low	Low	None
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	Low	Low	None
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	Low	Low	None
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	Low	Low	None
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	Low	Low	None

Table 6.40: Other environmental considerations for Central Lincolnshire WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.4.8 Costs

Table 6.41: Central Lincolnshire WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	10	26,441	313	3,288	476
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	50	60,436	1,020	8,817	2,221
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	31	46,152	685	6,297	1,392
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	10	28,554	164	10,803	478
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	50	100,581	312	81,079	921

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	31	71,296	262	57,633	778
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	6	15,182	152	1,431	238
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	25	28,460	366	3,587	615
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	62	73,162	567	57,740	1,750

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.42: Central Lincolnshire WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	8	8
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	4	4
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	6	6
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	7	7
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	2	2
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	5	5
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	9	9
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	3	3
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	1	1

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.4.9 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.43: Central Lincolnshire WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
CLN11a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Treatment Only	None	CLN12a, CLN13a
CLN12a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Treatment Only	None	CLN11a, CLN13a
CLN13a	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Treatment only	None	CLN11a, CLN12a
CLN11b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (10 Ml/d) - Transfer Only	None	CLN12b, CLN13b, CLN16
CLN12b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (50 Ml/d) - Transfer Only	None	CLN11b, CLN13b, CLN16
CLN13b	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer (31 Ml/d) - Transfer only	None	CLN11b, CLN12b,CLN16
CLN14	Central Lincolnshire locked in DO (6 Ml/d)	None	None
CLN15	East Lincolnshire WRZ to Central Lincolnshire WRZ treatment for Metaldeyhde for exisitng transfer	None	None
CLN16	South Humber Bank WRZ plus East Lincolnshire WRZ to Central Lincolnshire WRZ - transfer only	None	CLN11b, CLN12b, CLN13b

The options assessed for Central Lincolnshire WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for Central Lincolnshire WRZ, more details are described in the Sustainable abstraction technical document.
- The feasible options would provide supply system resilience to a number of WTWs within the Central Lincolnshire WRZ including customers in the city of Lincoln and could support resilience to WTW in South Lincolnshire WRZ if selected transfers south out of Central Lincolnshire were selected.
- The deficits in Central Lincolnshire are partly driven by drought impacts therefore the options selected would link to the Drought Plan.
- The options for Central Lincolnshire WRZ include treatment for Metaldehyde removal; therefore these options would link to the water quality programme.

6.5 Cheveley Water Resource Zone

6.5.1 Constrained Options

The table below contains the list of constrained options considered for Cheveley WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.44: Cheveley WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Bulk transfers	CVY1	Newmarket WRZ transfer	Yes
	CVY2	Bury and Haverhill WRZ transfer	Yes
Resource Sharing with other Water Companies		Cambridge Water	
3rd Party Options		3rd party trade options	
		Review discharge consents	
		EOETs & GOGS review	

6.5.2 Feasible options

The table below provides details of the options for Cheveley WRZ taken forward for economic modelling. All feasible options were taken forward to modelling.

Table 6.45: Cheveley WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	1	0.1	3	I000254
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	1	0.1	3	I022113

6.5.3 Transfer Option Details

Table 6.46: Transfer options for Cheveley WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	9	229	1	1
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	18.4	184	1	5

6.5.4 Resource Option Details

There are no feasible new resource options identified for Cheveley WRZ.

6.5.5 Environmental considerations

Table 6.47: Climate change impacts of Cheveley WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	N/A	N/A	N/A
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	N/A	N/A	N/A

Table 6.48: Water quality considerations for Cheveley WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	Not required	Not required
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	Not required	Not required

Table 6.49: INNS risks for Cheveley WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	Low	Low	None
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	Low	Low	None

Table 6.50: Other environmental considerations for Cheveley WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.5.6 Costs

Table 6.51: Cheveley WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	1	2,505	25	690	49
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	1	3,974	13	1,084	12

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.52: Cheveley WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	1	1
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	2	2

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.5.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.53: Cheveley WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
CVY1	Newmarket WRZ to Cheveley WRZ Transfer	None	None
CVY2	Bury Haverhill WRZ to Cheveley WRZ Transfer	None	None

The options assessed for Cheveley WRZ have the following synergies and links to other programmes,

- The feasible options would provide supply system resilience to the WTW within the Cheveley WRZ.
- The deficits in Cheveley are partly driven by drought impacts therefore the options selected would link to the Drought Plan.

6.6 East Lincolnshire Water Resource Zone

6.6.1 Constrained Options

The table below contains the list of constrained options considered for East Lincolnshire WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.54: East Lincolnshire WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Covenham extension	
		Bains gravels	
Increase reservoir yield		Covenham - Increase reservoir yield through maximising abstraction licences, amending intakes, utilising dead storage etc.	
		Increasing storage at private lakes	
Groundwater wells (boreholes)		Maximising Northern Chalk	
		Review group licences	
		Blending sources licence review	
Reclaimed water		Boston water reuse	
	ELN1	Skegness water reuse	Yes
Bulk transfers		Grantham canal (flow reversal)	
Reclaimed water		Process improvements to reduce losses WTW	

6.6.2 Feasible options

No feasible options were taken forward for economic modelling the table below provides reason for this.

Table 6.55: East Lincolnshire WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
ELN1	Skegness Water Reuse	-	I009988	Transfer treated effluent 18 km by pipeline to the River Great Eau, as a drought option to support WTW. There is not a drought risk in East Lincolnshire WRZ so the option does not address the planning problem.

6.7 East Suffolk Water Resource Zone

6.7.1 Constrained Options

The table below contains the list of constrained options considered for East Suffolk WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.56: East Suffolk WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Balham - Gipping Valley	
		Gravel Pit exploitation (Claydon/Sproughton/ Blakenham) - Gipping Valley	
Increase reservoir yield		Alton Water - Increase reservoir yield through maximising abstraction licences, amending intakes, utilising dead storage etc.	
Groundwater wells (boreholes)		Review group licences	
		Abandoned East Suffolk WRZ sources back to supply	
		Felixstowe peninsula	
		Use of gravel pits along the Gipping valley to support existing abstractions	
Artificial Storage and Recovery wells (or 'Aquifer Storage and Recharge') (ASR)	ESU3	Bucklesham, Woodbridge & screening other locations	Yes
Desalination	ESU1	Felixstowe desalination	Yes
Reclaimed water	ESU2	Ipswich Water Reuse	Yes
		Sizewell	
		Process improvements to reduce losses WTW	
Bulk transfers		EOETs optimisation (+ trade with Essex and Suffolk Water)	
	ESU7	Sudbury WRZ Transfer	Yes
	ESU6	South Essex WRZ Transfer	Yes
	ESU5/ ESU8/ ESU9	Bury and Haverhill WRZ Transfer	Yes

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Resource Sharing with other Water Companies		Affinity East	
		Essex and Suffolk - Abberton Trilogy	
3rd Party Options		EOETs & GOGS review	
Tankering of water	ESU4	Felixstowe Sea Tankering - pipelines to East Suffolk WRZ	Yes
Improved/ sophisticated conjunctive management		Optimise use of Alton resources and back off Colchester Chalk)	
		Increase surface water treatment capacity to utilise high river flows	Yes

6.7.2 Feasible options

The table below provides details of the options for East Suffolk WRZ taken forward for economic modelling.

Table 6.57: East Suffolk WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
ESU1	Felixstowe Desalination	25	7.0	4	I008276
ESU2	Ipswich water reuse	10.7	3.2	9	I010843
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	25	3.5	4	I012665
ESU6	South Essex WRZ to East Suffolk WRZ transfer	15	1.7	4	I015223
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	20	2.4	4	I015226
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	10	1.6	4	I021399

Table 6.58: East Suffolk WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
ESU3	East Suffolk WRZ Aquifer Storage & Recharge	2.3	I008437	There is high uncertainty around the DO benefits as a supply demand scheme and the likely DO would be small.
ESU4	Felixstowe Sea Tankering - pipelines to East Suffolk WRZ	-	I010554 I010555	Technically feasible but with high INNS risk, which would need more investigation to overcome this risk. Difficult to quantify the DO benefit. Sea tankering was originally included as an option in the Water Resources Options stated preference survey. The results of the pilot survey showed that customers did not believe it to be a realistic option and its inclusion was undermining the credibility of the survey as a whole. As a result it was removed and not included in the final version of the survey.
ESU7	Sudbury WRZ Transfer to East Suffolk WRZ	3	I000277	Final planning scenario - transfer would be <5Ml/d and not part of a strategic route therefore rejected.
	Increase surface water treatment capacity to utilise high river flows	-	I008329	Option is feasible but benefits are complex to assess within the final planning scenario and future scenarios. The benefits in DO are small scale.

6.7.3 Transfer Option Details

Table 6.59: Transfer options for East Suffolk WRZ

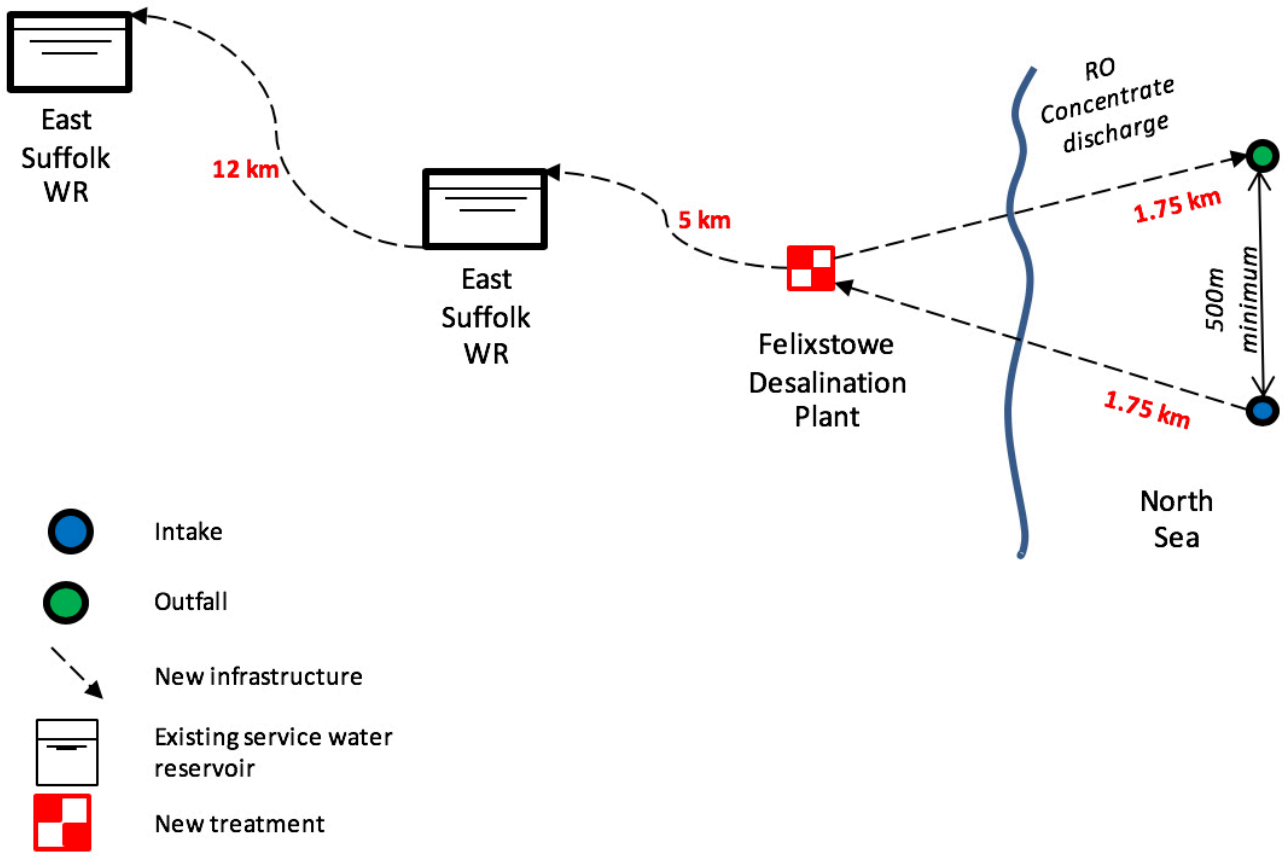
Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	43.5	600	1	0
ESU6	South Essex WRZ to East Suffolk WRZ transfer	35.7	458	1	0
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	43.5	500	1	16
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	43.5	409	1	16

6.7.4 Resource Option Details

6.7.4.1 ESU1 Felixstowe desalination

This option abstracts water from the sea and treated at a new reverse osmosis desalination plant at Felixstowe. The option includes abstraction pipelines from the sea and brine discharge pipelines back into the sea.

Figure 6.4: Schematic for Option ESU1 Felixstowe desalination



The proposed pre-treatment comprises lamella clarifiers and Ultrafiltration (UF). The UF product will be pumped into the desalination plant. The sludge is dewatered and sent to landfill. The backwash waste will be discharged with the brine to sea via a new long sea outfall. The product water will be remineralised and pumped into the treated water network via a new pipeline.

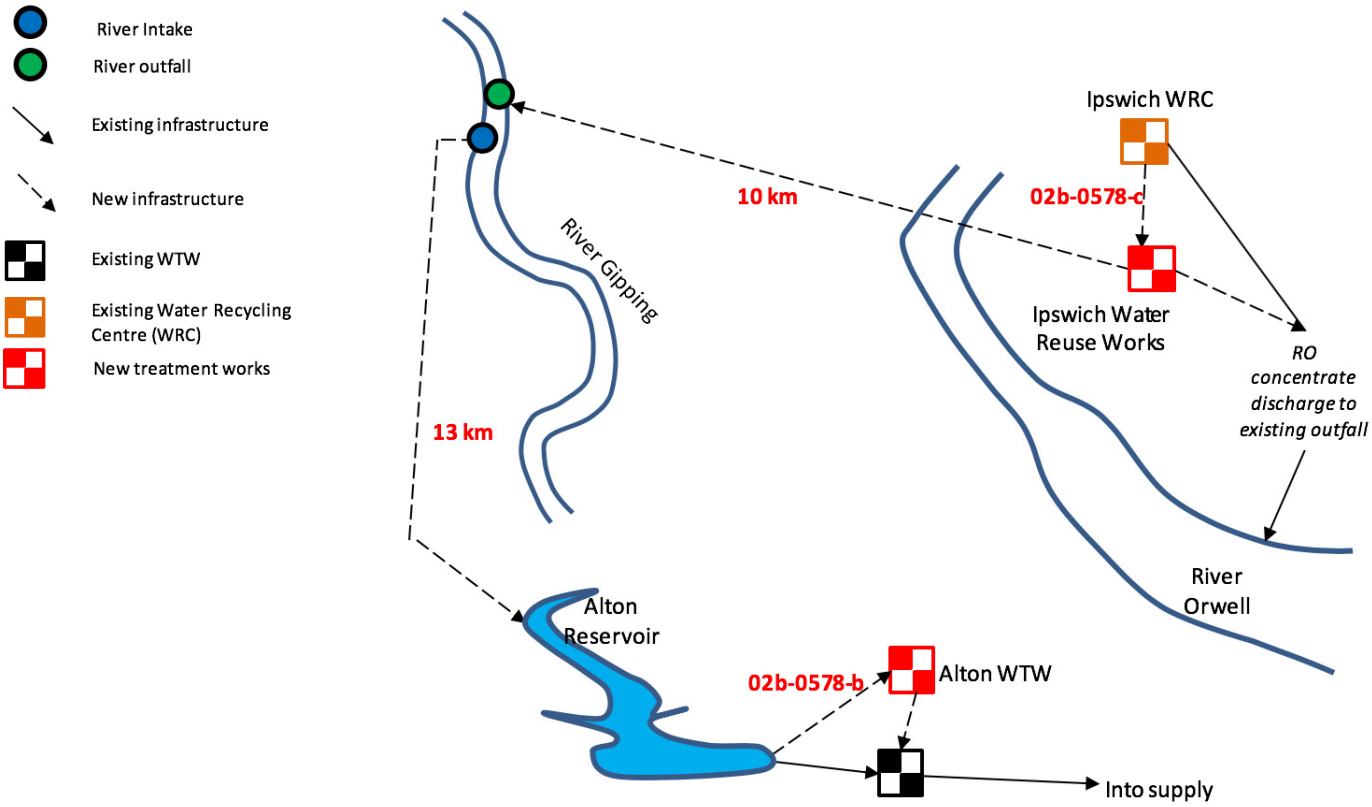
Identified Risks:

- Cost Risk: The intake and brine discharge pipes will have to be laid through the town and out to the sea. There could be delays installing sub-sea pipelines in the event of bad weather. The intake and discharge pipes could be damaged by ships at anchor. The desalination plant will have large power requirements and a new electrical supply will be needed. The length of intake and discharge mains could increase at detailed design.
- Quality Risk: the addition of large quantities of lime and carbon dioxide to achieve alkalinity concentrations prevalent in current water supply may result in higher levels of turbidity. The possibility of oil discharge at the port area is high and this may result in permanent damage to the reverse osmosis membranes. The pre – treatment should reduce the risk, but will not completely eliminate it.
- Environmental Risk: impacts of brine discharge unknown at this stage.
- Programme Risk: Detailed consultation with key stakeholders such as the Environment Agency (EA) and the Drinking Water Inspectorate (DWI) could have an impact on the programme.
- Public Relations Risk: There may be objections on environmental grounds due to the high power usage and brine discharge.
- Licencing and consenting risks.

6.7.4.2 ESU2 Ipswich Water Reuse

The option requires additional treatment process to be added at the end of the Ipswich WRC. A new pipeline is required to divert the treated effluent upstream of the abstraction on the River Gipping. This recycling of water is assumed to be available for abstraction for Alton Water using a put and take licence. Additional intake, pipeline and WTW capacity is included in the costs.

Figure 6.5: Schematic for Option ESU2 Ipswich Water Reuse



The new Ipswich Water Reuse Treatment Works (WRTW) includes a Nitrifying and Denitrifying

BAFF, fine screening, ultrafiltration, reverse osmosis, UV disinfection and remineralisation. This is then discharge 2 km upstream of the existing reservoir intake via a new 10km main. A new raw water intake is required and 13km raw water pipeline to reservoir. The existing WTW would require additional treatment capacity.

Identified Risks:

- Cost Risk: There is limited space available to construct additional treatment at the WRC. Site layouts should be prepared to establish whether additional land should be purchased. The abstraction point in the River Gipping is in an urban area and could result in considerable planning delays.
- Quality Risk: The water reuse plant should have the level of redundancy and design robustness as detailed in the Guidelines for Water Reuse (USEPA, 2012) in order to ensure that the water being pumped into the River Gipping meets the quality requirements.
- Programme Risk: Detailed consultation with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in South East England for many years, this scheme would differ as it would deliberately reuse the effluent. Consequently public perception issues must be carefully managed to minimise objections.
- Environmental Risk: The discharge and re-abstraction of re-used water into the River Gipping would require approval from the Environment Agency and abstraction may be limited to the requirement to maintain the "hands-off" river flows.

6.7.5 Environmental considerations

Table 6.60: Climate change impacts of East Suffolk WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
ESU1	Felixstowe Desalination	25	25	0
ESU2	Ipswich water reuse	10.7	10.7	0
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	N/A	N/A	N/A
ESU6	South Essex WRZ to East Suffolk WRZ transfer	N/A	N/A	N/A
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	N/A	N/A	N/A
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	N/A	N/A	N/A

Table 6.61: Water quality considerations for East Suffolk WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
ESU1	Felixstowe Desalination	Not required	Included in the scope of the option
ESU2	Ipswich water reuse	Not required	Not required
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	Not required	Not required
ESU6	South Essex WRZ to East Suffolk WRZ transfer	Not required	Not required
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	Not required	Not required
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	Not required	Not required

Table 6.62: INNS risks for East Suffolk WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
ESU1	Felixstowe Desalination	Low	Low	None
ESU2	Ipswich water reuse	Low	Low	None
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	Low	Low	None
ESU6	South Essex WRZ to East Suffolk WRZ transfer	Low	Low	None
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	Low	Low	None
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	Low	Low	None

Table 6.63: Other environmental considerations for East Suffolk WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
ESU1	Felixstowe Desalination	Moderate level of impacts. Further assessment required at project level.	Effects on WFD and ecology to be further investigated through a project level WFD Phase 3 assessment and HRA. Other risks can be mitigated	Appropriate assessment concluded potential adverse effects on site integrity, however further assessment is required at lower tier or project-level
ESU2	Ipswich water reuse	Assessed at Phase 1 only - moderate level of impact	Effects on WFD to be further investigated through WFD Phase 2 assessment. Other risks can be mitigated	Appropriate assessment concluded no adverse effects on site integrity
ESU3	East Suffolk WRZ Aquifer Storage & Recharge	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ESU6	South Essex WRZ to East Suffolk WRZ transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	Moderate level of impacts	Effects on WFD and ecology to be further investigated through WFD Phase 3 assessment and project level HRA. Other risks can be mitigated	Appropriate assessment concluded potential adverse effects on site integrity, however further assessment is required at lower tier or project-level

6.7.6 Costs

Table 6.64: East Suffolk WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
ESU1	Felixstowe Desalination	25	61,325	4,140	8,487	12,854
ESU2	Ipswich water reuse	10.7	80,178	1,732	9,777	4,442
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	25	31,731	197	22,749	583
ESU6	South Essex WRZ to East Suffolk WRZ transfer	15	19,001	268	5,410	811
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	20	25,598	333	17,730	1,018
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	10	18,072	113	13,635	318

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.65: East Suffolk WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
ESU1	Felixstowe Desalination	5	5
ESU2	Ipswich water reuse	6	6
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	1	1
ESU6	South Essex WRZ to East Suffolk WRZ transfer	3	3
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	2	2
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	4	4

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.7.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.66: East Suffolk WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
ESU1	Felixstowe Desalination	None	None
ESU2	Ipswich water reuse	None	None
ESU5	Bury Haverhill WRZ to East Suffolk WRZ transfer (25Ml/d)	None	BHV2, ESU8, BHV7, ESU9
ESU6	South Essex WRZ to East Suffolk WRZ transfer	None	SEX4, SEX8
ESU8	Bury Haverhill WRZ to East Suffolk WRZ transfer (20Ml/d)	None	BHV2, ESU5, BHV7, ESU9
ESU9	Bury Haverhill WRZ to East Suffolk WRZ transfer (10Ml/d)	None	BHV2, ESU5, BHV7, ESU8

The options assessed for East Suffolk WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for East Suffolk WRZ, more details are described in the Sustainable abstraction technical document.
- The strategic transfer options from Bury Haverhill would provide supply system resilience to WTWs within the East Suffolk WRZ.

6.8 Ely Water Resource Zone

6.8.1 Constrained Options

The table below contains the list of constrained options considered for Ely WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.67: Ely WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Review group licences	
		Ministry of Defence sites	
Bulk transfers	ELY1/ELY9/ELY10	North Fenland WRZ Transfer	Yes
	ELY2	Newmarket WRZ transfer	Yes
	ELY3/ELY11/ELY12	Ruthamford North WRZ Transfer	Yes
Resource Sharing with other Water Companies		Cambridge Water	
3rd Party Options		3rd party trade options	

6.8.2 Feasible options

The table below provides details of the options for Ely WRZ taken forward for economic modelling. All feasible options were taken through to economic modelling. To enable correct function of the ESBD model, 'dummy options' with constraint data were required. These dummy options were referenced ELY4-8 and had no costs or benefits associated with them, these are described in the EBSD modelling report[1].

Table 6.68: Ely WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	39	3.8	4	I010687
ELY2	Newmarket WRZ to Ely WRZ Transfer	4	0.2	4	I000252
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	40	6.7	4	I012662
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	20	2.8	4	I015900
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	10	1.3	4	I015364
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	20	3.4	4	I015595
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	10	2.3	4	I010028

[1] *Anglian Water, Draft WRMP 2019: EBSD Modelling report, January 2018*

6.8.3 Transfer Option Details

Table 6.69: Transfer options for Ely WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	34.3	700	1	7
ELY2	Newmarket WRZ to Ely WRZ Transfer	16.1	229	1	0
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	60.6	700	1	0
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	34.3	600	1	7
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	34.3	409	1	7
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	60.6	500	1	0
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	60.6	409	1	0

Options that transfer water from North Fenland WRZ or Ruthamford North WRZ into Ely WRZ all Include treatment to remove Metaldehyde, see Error! Reference source not found. for details of the treatment process.

6.8.4 Resource Option Details

There are no feasible new resource options identified for Ely WRZ.

6.8.5 Environmental considerations

Table 6.70: Climate change impacts of Ely WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	N/A	N/A	N/A
ELY2	Newmarket WRZ to Ely WRZ Transfer	N/A	N/A	N/A
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	N/A	N/A	N/A
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	N/A	N/A	N/A
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	N/A	N/A	N/A
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	N/A	N/A	N/A

Table 6.71: Water quality considerations for Ely WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	Required	Required
ELY2	Newmarket WRZ to Ely WRZ Transfer	Not required	Not required
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	Required	Required
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	Required	Required
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	Required	Required
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	Required	Required
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	Required	Required

Table 6.72: INNS risks for Ely WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	Low	Low	None
ELY2	Newmarket WRZ to Ely WRZ Transfer	Low	Low	None
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	Low	Low	None
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	Low	Low	None
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	Low	Low	None
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	Low	Low	None
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	Low	Low	None

Table 6.73: Other environmental considerations for Ely WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ELY2	Newmarket WRZ to Ely WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan

Table 6.74: Ely WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	39	74,693	930	27,528	2,641
ELY2	Newmarket WRZ to Ely WRZ Transfer	4	4,501	37	1,211	86
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	40	106,816	997	43,690	2,774
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	20	61,557	696	22,205	1,470
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	10	31,305	304	5,492	718
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	20	75,381	720	28,073	1,997
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	10	47,555	310	9,274	726

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.75: Ely WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	2	2
ELY2	Newmarket WRZ to Ely WRZ Transfer	1	1
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	3	3
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	4	4
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	5	5
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	6	6
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	7	7

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.8.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.76: Ely WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
ELY1	North Fenland WRZ to Ely WRZ Transfer (39Ml/d)	None	NFN6, ELY9, ELY10
ELY2	Newmarket WRZ to Ely WRZ Transfer	None	NWM1, NWM6, NWM10
ELY3	Ruthamford North WRZ to Ely WRZ Transfer (40 Ml/d)	None	ELY11, ELY12
ELY9	North Fenland WRZ to Ely WRZ Transfer (20Ml/d)	None	NFN6, ELY1, ELY10
ELY10	North Fenland WRZ to Ely WRZ Transfer (10Ml/d)	None	ELY1, ELY9, NFN6
ELY11	Ruthamford North WRZ to Ely WRZ Transfer (20 Ml/d)	None	ELY12, ELY3
ELY12	Ruthamford North WRZ to Ely WRZ Transfer (10 Ml/d)	None	ELY11, ELY3

The options assessed for Ely WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for Ely WRZ, more details are described in the Sustainable abstraction technical document.
- The options for Ely WRZ that include treatment for Metaldehyde removal would link to the water quality programme.

6.9 Happisburgh Water Resource Zone

6.9.1 Constrained Options

The table below contains the list of constrained options considered for Happisburgh WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.77: Happisburgh WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Bulk transfers		Dilham Canal	
	HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	Yes

6.9.2 Feasible options

The table below provides details of the options for Happisburgh WRZ taken forward for economic modelling.

Table 6.78: Happisburgh WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	1.5	0.1	4	I009936

6.9.3 Transfer Option Details

Table 6.79: Transfer options for Happisburgh WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	4.6	291	1	4

Option HPB1 transfers water from Norwich and the Boards WRZ to Happisburgh WRZ and includes treatment to remove Metaldehyde, see Error! Reference source not found. for details of the treatment process.

6.9.4 Resource Option Details

There are no feasible new resource options identified for Happisburgh WRZ.

6.9.5 Environmental considerations

Table 6.80: Climate change impacts of Happisburgh WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	N/A	N/A	N/A

Table 6.81: Water quality considerations for Happisburgh WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	Required	Required

Table 6.82: INNS risks for Happisburgh WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	Low	Low	None

Table 6.83: Other environmental considerations for Happisburgh WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.9.6 Costs

Table 6.84: Happisburgh WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	1.5	12,375	103	2,970	130

6.9.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.85: Happisburgh WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer	None	None

The options assessed for Happisburgh WRZ have the following synergies and links to other programmes,

- The deficit in Happisburgh is driven by the sustainability reduction for the WTW within the WRZ; more details are described in the Sustainable abstraction technical document.
- HPB1 includes treatment for Metaldehyde removal and would link to the water quality programme.

6.10 Hartlepool Water Resource Zone

6.10.1 Unconstrained Options

The table below contains the list of constrained options unconsidered for Hartlepool WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.86: Hartlepool WRZ Unconstrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Direct river abstraction		Skerne	
New reservoir storage		Purchase existing assets	
		On Skerne	
		SUDS	
		New reservoir	
		Private lakes and gravel pits	
Increase reservoir yield		Hartlepool reservoirs	
Groundwater wells (boreholes)		Teeside boreholes	
		Mine dewatering	
		Secondary groundwater	
		Mag limestone	
Desalination		Hartlepool harbour	
		Secondary groundwater	
Reclaimed water		Northumbrian Water WRCs (trade)	
		Teeside industrial effluent	
Bulk transfers		Northumbrian Water	
Resource Sharing with other Water Companies		Northumbrian Water	
3rd Party Options		Agriculture	
		Coal Authorities (Sulphate plume management)	
Tankering of water		Sea - Nordic water	
		Road	
		rail	
Improved/sophisticated conjunctive management		Conjunctive use with Northumbrian Water	
Other		Rainwater harvesting	
		Innovative options (international examples e.g. sea clouding)	

6.10.2 Feasible options

No options have been developed further for the Hartlepool WRZ because the forecast for Hartlepool WRZ shows a surplus at the end of the planning horizon, therefore options are not required within the WRZ.

6.11 Ixworth Water Resource Zone

6.11.1 Constrained Options

The table below contains the list of constrained options considered for Ixworth WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.87: Ixworth WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Ixworth unused borehole	
Bulk transfers	IXW1	Thetford WRZ Transfer	Yes
	IXW2	Bury and Haverhill WRZ Transfer	Yes

6.11.2 Feasible options

The revised dWRMP shows deficits within the Ixworth and Thetford WRZs driven by sustainability reductions. These two WRZs are already connected by an existing main that currently delivers surpluses from Thetford and Ixworth into Bury Haverhill WRZ, these existing transfers have been represented in EBSD as shown in Figure 6 6 a). As both Ixworth and Thetford WRZs go into deficit there will be nothing to transfer to Bury Haverhill WRZ via these existing mains. Therefore we have developed options that reverse the flow through the existing mains, these have been modelled as shown in Figure 6 6 b). These options differ from those shown in Table 6 88 (IXW1, IXW2) which involve laying new mains.

The actual configuration of the mains between WRZs is shown in Figure 6 6 c) which led to the development of one investment in C55 to cover the engineering requirements to reverse the main, see Figure 6 6 d). Therefore the costs associated with the reverse transfer have all been applied to the transfer between Bury Haverhill WRX and Ixworth WRZ (THT1b) in EBSD and the WRP tables. The transfer between Ixworth WRZ and Thetford WRZ (Option THT1a) has no costs associated with it in EBSD or the WRP Tables, as the costs are all included in THT1b.

Figure 6.6: Schematics describing how the existing transfers and options have been represented in the revised dWRMP

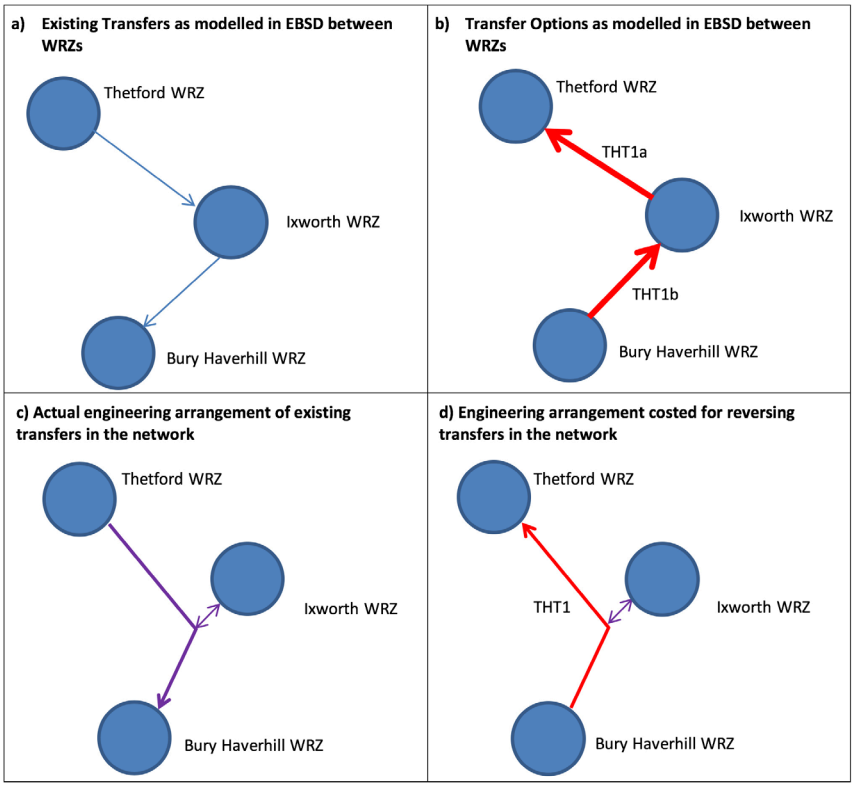


Table 6.88: Ixworth WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
IXW1	Thetford WRZ Transfer	-	I010891	There is no surplus in Thetford to transfer to Ixworth so this option was taken through to EBSD modelling.
IXW2	Bury and Haverhill WRZ Transfer	-	I010893	The deficits are small enough to allow the existing main to be reversed. This will be significantly less expensive than laying a new main, therefore this option was not taken through to economic modelling.

Table 6.89: Ixworth WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	3	0	3	N021959

6.11.3 Transfer Option Details

Table 6.90: Transfer options for Ixworth WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	0	0	2	0

6.11.4 Resource Option Details

There are no feasible new resource options identified for Ixworth WRZ.

6.11.5 Environmental considerations

Table 6.91: Climate change impacts of Ixworth WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	N/A	N/A	N/A

Table 6.92: Water quality considerations for Ixworth WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	Not required	Not required

Table 6.93: INNS risks for Ixworth WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	Low	Low	None

Table 6.94: Other environmental considerations for Ixworth WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	No or Minimal Impact Expected	No impacts	No likely significant effects determined at screening

6.11.6 Costs

Table 6.95: Ixworth WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	3	652	18	108	22

6.11.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.96: Ixworth WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
THT1b	Bury Haverhill WRZ to Ixworth WRZ Transfer via existing infrastructure	None	BHV8

The options assessed for Ixworth WRZ have the following synergies and links to other programmes,

- There is a NEP mitigation options for Ixworth WRZ, more details are described in the Sustainable abstraction technical document.
- The feasible option would provide supply system resilience to the WTW within Ixworth WRZ.

6.12 Newmarket Water Resource Zone

6.12.1 Constrained Options

The table below contains the list of constrained options considered for Newmarket WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.97: Newmarket WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Private reservoirs / lakes	
Increase reservoir yield		Increasing storage at private lakes	
Bulk transfers	NWM1/NWM6/ NWM10	Ely WRZ transfer	Yes
	NWM2/NWM7	Bury and Haverhill WRZ Transfer	Yes
		Cheveley WRZ transfer	
	NWM3/NWM8/ NWM9	Ruthamford South WRZ transfer	Yes
Resource Sharing with other Water Companies		Cambridge Water	
3rd Party Options		3rd party trade options	
		EOETs & GOGS review	

6.12.2 Feasible options

The table below provides details of the options for Newmarket WRZ taken forward for economic modelling.

Table 6.98: Newmarket WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	35	1.8	4	I014035
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	10	1.2	4	I015256
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	35	5.5	4	I010030
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	20	1.3	4	I015211
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	20	1.9	4	I013519
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	20	3.8	4	I015585
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	10	3.2	4	I015634
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	10	0.6	4	I016361

6.12.3 Transfer Option Details

Table 6.99: Transfer options for Newmarket WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	16.1	700	1	5
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	33.0	409	1	6
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	68.1	600	1	23
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	16.1	600	1	5
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	33.0	500	1	6
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	68.1	500	1	23
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	68.1	458	1	23
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	16.1	409	1	5

Options that transfer water from Ruthamford South WRZ to Newmarket WRZ and includes treatment to remove Metaldehyde, see section 5.2 for details of the treatment process.

6.12.4 Resource Option Details

There are no feasible new resource options identified for Newmarket WRZ.

6.12.5 Environmental considerations

Table 6.100: Climate change impacts of Newmarket WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	N/A	N/A	N/A
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	N/A	N/A	N/A
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	N/A	N/A	N/A
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	N/A	N/A	N/A
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	N/A	N/A	N/A
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	N/A	N/A	N/A
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	N/A	N/A	N/A

Table 6.101: Water quality considerations for Newmarket WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	Not required	Not required
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	Not required	Not required
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	Required	Required
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	Not required	Not required
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	Not required	Not required
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	Required	Required
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	Required	Required
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	Not required	Not required

Table 6.102: INNS risks for Newmarket WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	Low	Low	None
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	Low	Low	None
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	Low	Low	None
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	Low	Low	None
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	Low	Low	None
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	Low	Low	None
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	Low	Low	None
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	Low	Low	None

Table 6.103: Other environmental considerations for Newmarket WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.12.6 Costs

Table 6.104: Newmarket WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	35	18,342	630	10,821	2,210
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	10	13,794	116	4,272	329
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	35	114,626	2,078	39,387	6,244
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	20	14,782	387	8,573	1,195
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	20	20,016	377	13,505	1,575
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	20	83,226	1,105	30,592	3,224
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	10	59,722	384	12,078	972
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	10	8,292	224	2,191	679

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.105: Newmarket WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
Ranking	AISC	2	2
Ranking	Newmarket WRZ to Ely WRZ Transfer	1	1
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	1	1
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	5	5
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	6	6
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	2	2
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	4	4
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	7	7
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	8	8
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	3	3

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.12.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.106: Newmarket WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
NWM1	Ely WRZ to Newmarket WRZ Transfer (35Ml/d)	None	ELY2, NWM6, NWM10
NWM2	Bury Haverhill WRZ to Newmarket WRZ Transfer (10 Ml/d)	None	BHV1, NWM7, BHV5, BHV6
NWM3	Ruthamford South WRZ to Newmarket WRZ Transfer (35Ml/d)	None	NWM9, NWM8
NWM6	Ely WRZ to Newmarket WRZ Transfer (20Ml/d)	None	ELY2, NWM1, NWM10
NWM7	Bury Haverhill WRZ to Newmarket WRZ Transfer (20 Ml/d)	None	NWM2, BHV1, BHV5, BHV6
NWM8	Ruthamford South WRZ to Newmarket WRZ Transfer (20Ml/d)	None	NWM9, NWM3
NWM9	Ruthamford South WRZ to Newmarket WRZ Transfer (10Ml/d)	None	NWM8, NWM3
NWM10	Ely WRZ to Newmarket WRZ Transfer (10Ml/d)	None	NWM6, ELY2, NWM1

The options assessed for Newmarket WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for Newmarket WRZ, more details are described in the Sustainable abstraction technical document.
- The deficits in Newmarket WRZ are partly driven by drought impacts therefore the options selected would link to the Drought Plan.
- The options for Newmarket WRZ include treatment for Metaldehyde removal; therefore these options would link to the water quality programme.

6.13 North Fenland Water Resource Zone

6.13.1 Constrained Options

The table below contains the list of constrained options considered for North Fenland WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.107: North Fenland WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage	NFN3	Fenland Reservoir	Yes
		Increasing storage at private lakes e.g. Bawsey Lakes	
		Sands and Gravel extraction locations e.g. Pentney Lakes	
Groundwater wells (boreholes)		Abandoned boreholes	
		Review group licences	
		Nitrate removal/revised blending regime	
Desalination	NFN1	Kings Lynn Desalination	Yes
		Hunstanton (Wash) Desalination	
Reclaimed water	NFN2	Kings Lynn & Wisbech Water Reuse	Yes
		Heacham/Downham Mkt Water Reuse	
Bulk transfers		North Norfolk Coast WRZ transfer	
	NFN4/NFN7/ NFN8	South Fenland WRZ Transfer	Yes
	NFN6	Ely WRZ Transfer	Yes
	NFN5	North Norfolk Rural WRZ transfer	Yes
3rd Party Options		3rd party trade options (surface water)	
		3rd party trade options	

6.13.2 Feasible options

The table below provides details of the options for North Fenland WRZ taken forward for economic modelling.

Table 6.108: North Fenland WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
NFN1	Kings Lynn Desalination	11	3.6	4	I000150
NFN2	Kings Lynn water reuse	15.8	4.7	9	I010499
NFN3	Fenland Reservoir	41.6	25.0	9	I022123 /I022125 /I022233
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	20	1.0	4	I015255
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	20	2.2	4	I000276
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	22	2.8	4	I000250
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	60	3.2	4	I015233
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	11	0.7	4	I000245

6.13.3 Transfer Option Details

Table 6.109: Transfer options for North Fenland WRZ

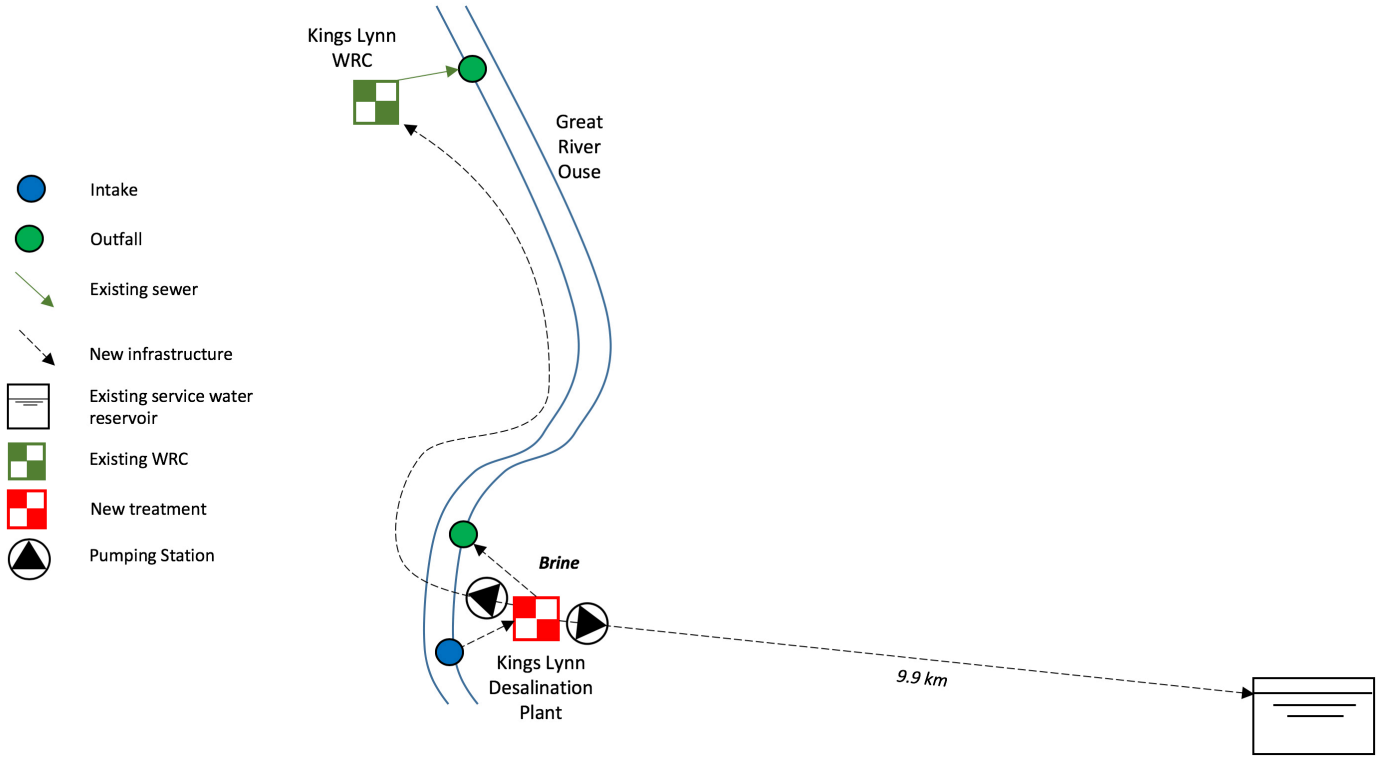
Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	22.0	459	1	6
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	27.8	600	1	0
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	34.3	600	1	7
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	22.0	800	1	0
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	22.0	368	1	0

6.13.4 Resource Option Details

6.13.4.1 NFN1 Kings Lynn Desalination

This option is an estuarine desalination option and abstracts water from a sea river intake south of King's Lynn, on the River Great Ouse, and treated at a new reverse osmosis desalination plant in Kings Lynn. The option includes abstraction pipelines from the Great River Ouse and brine discharge pipelines and a pipeline back into the Kings Lynn WRC for the other wastestreams.

Figure 6.7: Schematic for NFN1 Kings Lynn Desalination



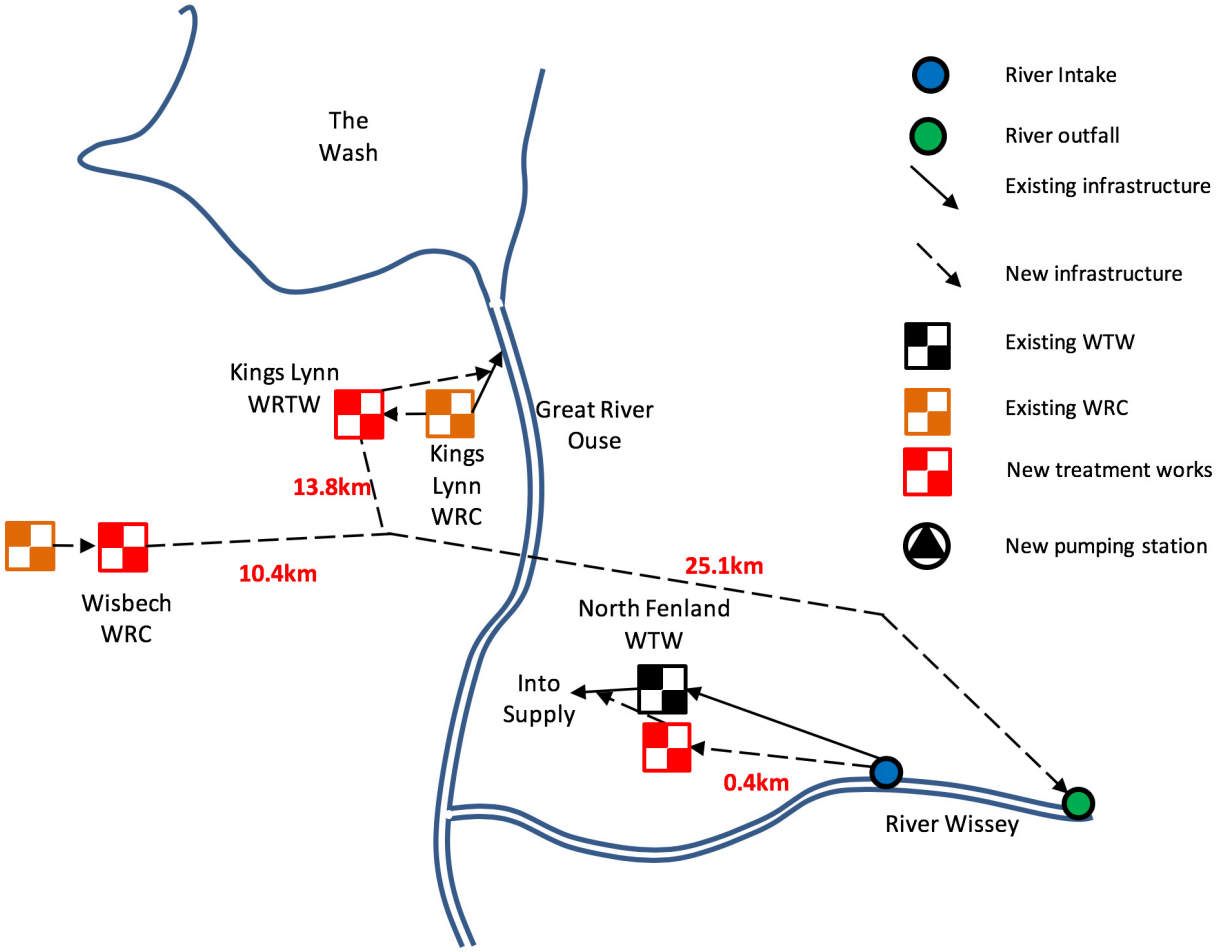
Identified Risks:

- Cost Risk: The waste stream discharge would be at King's Lynn WRC, therefore the pipe would have to cross the River Great Ouse, thus leading to possible cost escalations. Moreover, the desalination plant will have large power requirements and a new electrical supply will be needed. Additional dirty washwater handling plant may be required at Kings Lynn if the WRC cannot handle the additional flow. The cost of the scheme may increase if bank side storage cannot be provided.
- Quality Risk: the addition of large quantities of lime and carbon dioxide to achieve alkalinity concentrations prevalent in current water supply may result in higher levels of turbidity. Also, since the River Great Ouse is navigable, there is a possibility of oil spills which might result in permanent damage to the RO membranes. The pre-treatment will reduce the risk but not eliminate it completely. Discharges will be subject to the Permitting Regulations which may impose strict discharge consents to waste streams.
- Programme Risk: Detailed consultations and engagements with key stakeholders such as the Environment Agency (EA) and the Drinking Water Inspectorate (DWI) could have an impact on the programme.
- Public Relations Risk: There may be objections on environmental grounds due to the high power usage and brine discharge.
- Technical Risk: Locating a desalination plant with an intake on a navigable river is problematic with significant construction risks and operation risks of damage due to collision with vessels. Complex licence. Furthermore, any oil discharges may result in irreversible RO membrane fouling and loss of output.
- Licencing and consenting risks.

6.13.4.2 NFN2 Kings Lynn Water Reuse

The option requires additional treatment process to be added at the end of both Kings Lynn and Wisbech WRC. A new pipeline is required to divert the treated effluent upstream of the abstraction point on the River Wissey. This recycling of water is assumed to be available for abstraction at the existing abstraction point using a put and take licence. Upgrades to the intake, pipelines and WTW are included in the cost.

Figure 6.8: Schematic for NFN2 Kings Lynn Water Reuse



The new Water Reuse Treatment Works (WRTW) include Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis, UV disinfection and remineralisation. This is then discharge 2 km upstream of the existing surface water intake via a new main. The existing WTW would require additional treatment capacity.

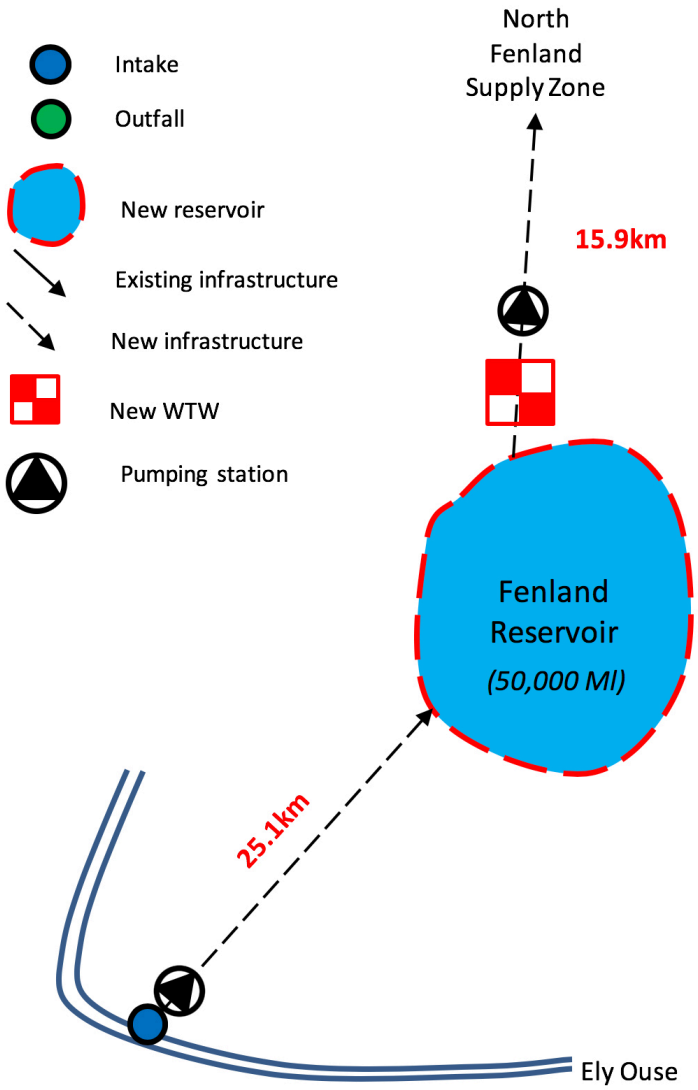
Identified Risks:

- Cost Risk: There are a number of river crossings on the pipe route to the River Wissey which could impact on the design and construction programme. It would appear that there is insufficient space at the existing Wisbech WRC to build the new treatment works and additional land may be required. However, there is sufficient space at the King's Lynn WRC to build the new plant. Poor ground conditions may affect construction and due to the local topography around King's Lynn and the Fenland area, the works may be at risk from flooding. Moreover, a Biological Aerated Flooded Filter (BAFF) may be required to remove the ammonia subject to modelling at a later design stage.
- Programme Risk: Detailed consultations and engagements with key stakeholders such as the Environment Agency (EA) and the Drinking Water Inspectorate (DWI) could have an impact on the programme.
- Environmental Risk: The discharge and re-abstraction of re-use water into the River Wissey would require approval from the Environment Agency and abstraction may be limited to the requirement to maintain the "hands-off" river flows.
- Quality: Raw water salinity is unknown, which affects output of WRTW.

6.13.4.3 NFN3 Fenland Reservoir

New 50,000Ml bunded pumped storage reservoir fed by a new abstraction taking water at high flows from the Ely Ouse. The scheme includes new intake and pipeline to the reservoir site, a new WTWs and pumping station and supply pipeline into the supply system.

Figure 6.9: Schematic for NFN3 Fenland Reservoir



The new WTW will require treatment to remove Metaldehyde, see section 5.2 for details of the treatment process.

Identified Risks:

- Cost Risk: Required site investigations may identify unforeseen ground conditions that have a significant impact on the engineering design. Following a detailed topographic survey, a drainage system needs to be designed for the surrounding areas taking account of local flood risks.
- Environmental Risks: Further studies will be required for the environmental assessment of the scheme and this study may identify significant risks for project implementation.
- Programme Risks: There are risks associated with the overall Planning Application process: there will be a need for a public consultation and, subject to the level of objections received, the scheme is: likely to be subject to a Public Inquiry. There is a risk of delays or failure to gain planning permissions

6.13.5 Environmental considerations

Table 6.110: Climate change impacts of North Fenland WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d	Climate Change impact on WAFU (Ml/d)
NFN1	Kings Lynn desalination	11	11	0
NFN2	Kings Lynn water reuse	15.8	15.8	0
NFN3	Fenland Reservoir	47.4	41.6	5.8
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	N/A	N/A	N/A
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	N/A	N/A	N/A
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	N/A	N/A	N/A

Table 6.111: Water quality considerations for North Fenland WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
NFN1	Kings Lynn desalination	Not required	Not required
NFN2	Kings Lynn water reuse	Not required	Not required
NFN3	Fenland Reservoir	Required	Not required
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	Not required	Not required
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	Not required	Not required
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	Not required	Not required
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	Not required	Not required
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	Not required	Not required

Table 6.112: INNS risks for North Fenland WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
NFN1	Kings Lynn desalination	Low	Low	
NFN2	Kings Lynn water reuse	Low	Low	
NFN3	Fenland Reservoir	High	Low	The Fenland reservoir would be located relativity close to the raw water source. Therefore the INNS risks associated with reservoir overflows are low compared to some of the other reservoir options.
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	Low	Low	
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	Low	Low	
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	Low	Low	
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	Low	Low	
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	Low	Low	

Table 6.113: Other environmental considerations for North Fenland WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
NFN1	Kings Lynn desalination	Minor level of impact following Phase 2.	Effects on WFD and ecology to be further investigated through WFD Phase 3 assessment and project level HRA. Other risks can be mitigated	Appropriate assessment concluded potential adverse effects on site integrity, however further assessment is required at lower tier or project-level
NFN2	Kings Lynn water reuse	Minor level of impact following Phase 2.	Risks can be mitigated	Appropriate assessment concluded no adverse effects on site integrity
NFN3	Fenland Reservoir	Moderate level of impacts. Further assessment required at project level.	Effects on WFD and ecology to be further investigated through a project level WFD Phase 3 assessment and HRA. Other risks can be mitigated	Appropriate assessment concluded potential adverse effects on site integrity, however further assessment is required at lower tier or project-level

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.13.6 Costs

Table 6.114: North Fenland WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
NFN1	Kings Lynn desalination	11	53,135	1,497	8,034	2,968
NFN2	Kings Lynn water reuse	15.8	119,154	3,232	16,160	5,914
NFN3	Fenland Reservoir	41.6	561,767	5,691	-	-
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	20	13,664	396	3,436	1,225
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	20	25,756	509	14,754	1,532
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	22	26,149	223	17,754	669
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	60	28,329	872	17,774	2,747
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	11	27,697	349	4,518	932

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.115: North Fenland WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC	AISC Ranking
Ranking	AISC	2	2
Ranking	Newmarket WRZ to Ely WRZ Transfer	1	1
NFN1	Kings Lynn desalination	6	6
NFN2	Kings Lynn water reuse	7	7
NFN3	Fenland Reservoir	8	8
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	2	2
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	4	4
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	3	3
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	1	1
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	5	5

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.13.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.116: North Fenland WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
NFN1	Kings Lynn desalination	None	None
NFN2	Kings Lynn water reuse	None	None
NFN3	Fenland Reservoir	None	None
NFN4	South Fenland WRZ to North Fenland WRZ Transfer (20 Ml/d)	None	SFN2, NFN7, NFN8
NFN5	Norfolk Rural North WRZ to North Fenland WRZ Transfer (20 Ml/d)	None	NNR2, NNR6
NFN6	Ely WRZ to North Fenland WRZ Transfer (22Ml/d)	None	ELY1, ELY9, ELY10
NFN7	South Fenland WRZ to North Fenland WRZ Transfer (60 Ml/d)	None	SFN2, NFN4, NFN8
NFN8	South Fenland WRZ to North Fenland WRZ Transfer (11 Ml/d)	None	SFN2, NFN7, NFN4

The options assessed for North Fenland WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for North Fenland WRZ, more details are described in the Sustainable abstraction technical document.
- The deficits in North Fenland WRZ are partly driven by drought impacts therefore the options selected would link to the Drought Plan.
- Option NFN3 includes treatment for Metaldehyde removal; therefore this option would link to the water quality programme if selected.

6.14 North Norfolk Coast Water Resource Zone

6.14.1 Constrained Options

The table below contains the list of constrained options considered for North Norfolk Coast WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.117: North Norfolk Coast WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Private reservoirs / lakes e.g. Blickling, Thorpe Market Antingham	
		Private reservoirs / lakes e.g. storage on the River Glaven	
		Sands and Gravel extraction locations e.g. Beetley/ Middleton Lakes on the River Wensum	
Groundwater wells (boreholes)		Review group licences	
		Extend Chalk abstraction	
Reclaimed water		Cromer water reuse	
Bulk transfers		Fenland WRZ transfer	
		Norfolk Rural WRZ transfer	
		Norwich and the Broads WRZ Transfer	
Resource Sharing with other Water Companies		Essex and Suffolk Water trade	
		Essex and Suffolk River abstractions	

6.14.2 Feasible options

No options have been developed further for the North Norfolk Coast WRZ for the following reasons,

- A supply demand deficit has not been forecast for the North Norfolk Coast WRZ, therefore options are not required within the WRZ.
- Supply meets demand at the end of the forecast so there are no suitable surpluses to transfer out of the WRZ.
- None of the new resource options identified in the constrained list would produce a reliable quantity of resource to meet deficits in neighbouring WRZs.

6.15 North Norfolk Rural Resource Zone

6.15.1 Constrained Options

The table below contains the list of constrained options considered for North Norfolk Rural WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.118: North Norfolk Rural WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Existing borehole optimisation	
		Review group licences	
		Ministry of Defence boreholes	
Artificial Storage and Recovery wells (or 'Aquifer Storage and Recharge') (ASR)	NNR5	North Norfolk Rural WRZ ASR	
Bulk transfers		North Norfolk Coast WRZ transfer	
	NNR2/ NNR6	North Fenland WRZ Transfer	Yes
	NNR1/ NNR7/ NNR8	Norwich and the Broads WRZ Transfer	Yes
	NNR3	Thetford WRZ Transfer	Yes
Resource Sharing with other Water Companies		Cambridge Water	

6.15.2 Feasible options

The table below provides details of the options for North Norfolk Rural WRZ taken forward for economic modelling.

Table 6.119: North Norfolk Rural WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	20	20	4	I010689
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	20	20	4	I014862
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	11	11	4	I010688
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	10	10	4	I019973
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	5	5	4	I015640

6.15.3 Intra-WRZ Transfer Options

Due to the capping of time limited licenses we have found that there are now deficits in discrete parts of some WRZs. These local deficits are not seen at WRZ level and as such would not appear within the WRZ supply demand balances in the WRP Tables. We have completed smaller scale supply demand balances for discrete Planning Zones (PZs) and developed intra-WRZ transfer options to resolve these deficits. The options have been costed and evaluated in the same way as all the other feasible options and the costs details have been included in WRP Table 5. However as the deficits are within a WRZ these options have not been included in the economic modelling and so do not appear in WRP Table 6. Table 6 120 and subsequent tables contain the supporting information for the Intra-WRZ options for this WRZ.

Table 6.120: Intra-Water Resource Zone Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	1.5	0.1	4	N9033635

Table 6.121: North Norfolk Rural WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
NNR3	Thetford WRZ to North Norfolk Rural WRZ	-	I000272	Final planning problem - no surplus in Thetford WRZ to transfer

6.15.4 Transfer Option Details

Table 6.122: Transfer options for North Norfolk Rural WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	35.8	600	1	14
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer 20 Ml/d)	27.8	500	0	0
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	27.8	458	0	0
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	35.8	458	1	14
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	12.3	291	1	6
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	11.5	125	1	2

Options that transfer water from Norwich and the Boards or North Fenland WRZs to North Norfolk Rural WRZ and includes treatment to remove Metaldehyde, see section 5.2Error! Reference source not found. for details of the treatment process. The exception is NNR8, see section 6.15.6.

6.15.5 Resource Option Details

There are no feasible new resource options identified for North Norfolk Rural WRZ.

6.15.6 Environmental considerations

Table 6.123: Climate change impacts of North Norfolk Rural WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	N/A	N/A	N/A
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	N/A	N/A	N/A
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	N/A	N/A	N/A
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	N/A	N/A	N/A

Table 6.124: Water quality considerations for North Norfolk Rural WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	Required	Required
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	Required	Required
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	Required	Required
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	Required	Required
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	Not required	Not required
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	Not required	Not required

Option NNR8 is a local scheme which transfers Norwich and The Broads WRZ groundwater which is not part of a Metaldehyde Undertaking into North Norfolk Rural WRZ, this is why treatment for Metaldehyde is not included in this option.

Table 6.125: INNS risks for North Norfolk Rural WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	Low	Low	None
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	Low	Low	None
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	Low	Low	None
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	Low	Low	None
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	Low	Low	None
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	Low	Low	None

Table 6.126: Other environmental considerations for North Norfolk Rural WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no ap-propriate assessment undertaken as not in least cost plan or Preferred Plan
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no ap-propriate assessment undertaken as not in least cost plan or Preferred Plan
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.15.7 Costs

Table 6.127: North Norfolk Rural WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	20	65,948	712	22,341	2,059
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	20	42,223	234	14,362	467
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	11	31,115	152	5,599	261
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	10	41,848	417	7,362	1,054
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	5	3,966	26	1,097	52
NNR Intra1	Intra WRZ Norfolk Rural North WRZ Transfer to Didlington PZ	1.5	2,215	11	557	8

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.128: North Norfolk Rural WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	4	4
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	2	2
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	3	3
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	5	5
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	1	1

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.15.8 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.129: North Norfolk Rural WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
NNR1	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	None	NTB6, NTB8, NNR7
NNR2	North Fenland WRZ to Norfolk Rural North WRZ Transfer (20 Ml/d)	None	NFN5,NNR6
NNR6	North Fenland WRZ to Norfolk Rural North WRZ Transfer (11 Ml/d)	None	NNR2, NFN5
NNR7	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (10 Ml/d)	None	NNR1, NTB6, NTB8
NNR8	Norwich & the Boards WRZ to Norfolk Rural North WRZ Transfer (5 Ml/d)	None	None

The options assessed for North Norfolk Rural WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for North Norfolk Rural WRZ, more details are described in the Sustainable abstraction technical document.
- Most options include treatment for Metaldehyde removal; therefore there would be a link to the water quality programme if one were selected.

6.16 Norwich and the Boards Water Resource Zone

6.16.1 Constrained Options

The table below contains the list of constrained options considered for Norwich and the Boards WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.130: Norwich and the Boards WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Bowthorpe Lakes	
		Taverham Lakes - Wensum	
Groundwater wells (boreholes)		Extend Chalk abstraction	
		Tas Valley boreholes (winter option)	
Desalination	NTB5	Bacton Desalination	Yes
Reclaimed water	NTB3	Lowestoft Water Reuse	Yes
	NTB2/ NTB7	Norwich Water Reuse	Yes
	NTB4	Great Yarmouth water reuse	Yes
		Sizewell	
		Process improvements to reduce losses WTW	Yes

Bulk transfers		North Norfolk Coast transfer	
	NTB6/ NTB8	North Norfolk Rural WRZ transfer	Yes
Resource Sharing with other		Sizewell with or without Essex and Suf-folk Water	
3rd Party Options		3rd party trade options	
		Essex and Suffolk Water transfer from the Broads	
Tankering of water	NTB1	Great Yarmouth Sea tankering	Yes
Improved/sophisticated con-junctive management		Norwich system conjunctive use	Yes

6.16.2 Feasible options

The table below provides details of the options for Norwich and the Boards WRZ taken forward for economic modelling.

Table 6.131: Norwich and the Boards WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
NTB2	Norwich water reuse (22 Ml/d)	22	6	5	I009966
NTB3	Lowestoft water reuse	10	3	5	I009970
NTB4	Great Yarmouth water reuse	15.3	5.1	5	I010845
NTB5	Bacton Desalination	46	14	4	I010846
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	20	1.7	4	I000246
NTB7	Norwich water reuse (11 Ml/d)	11	6	5	I012470
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	10	1.3	4	I020025

Table 6.132: Norwich and the Boards WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
NTB1	Great Yarmouth Sea tankering	–	I010551	Technically feasible but with high INNS risk, which would need more investigation to overcome this risk. Difficult to quantify the DO benefit. Sea tankering was originally included as an option in the Water Resources Options stated preference survey. The results of the pilot survey showed that customers did not believe it to be a realistic option and its inclusion was undermining the credibility of the survey as a whole. As a result it was removed and not included in the final version of the survey.
	Process improvements to reduce losses WTW	0.15	I009975	DO gains of only 0.15 Ml/d as the filters are being upgraded at the moment reducing the amount of back-wash able to be recirculated. Not modelled as DO benefit too small to be transferred to a neighbouring WRZ.
	Norwich system conjunctive use	–	I008324	Final planning problem - no deficit in Norwich and the Broads WRZ.

6.16.3 Transfer Option Details

Table 6.133: Transfer options for Norwich and the Boards WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	35.8	458	1	14
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	35.8	409	1	14

6.16.4 Resource Option Details

6.16.4.1 NTB2/NTB7 Norwich water reuse

The option requires additional treatment process to be added at the end of the Norwich WRC. A new pipeline is required to divert the treated effluent upstream of the water supply abstraction on the River Wensum. This recycling of water is assumed to be available for abstraction at the WTW using a put and take licence.

Option NTB2 is sized to utilise the full flow available from the water recycling centre. For Option NTB7 the capacity was reduced to give the model a greater selection of options to meet a range of deficits for difference planning scenarios. The components of both options are the same, see Figure 6 10.

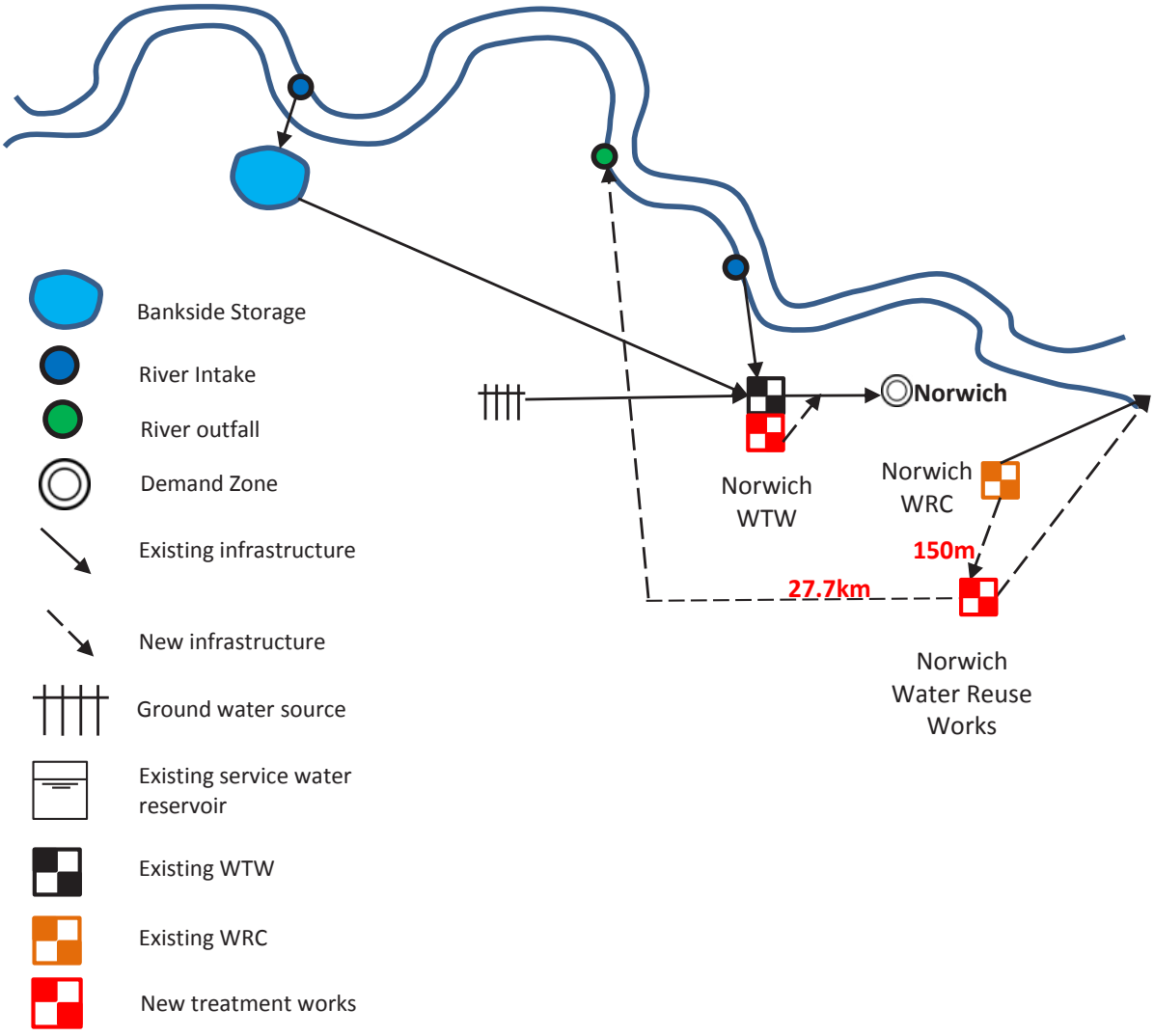


Figure 6.10: Schematic for options NTB2/NTB7 Norwich water reuse

The effluent from the WRC would require treatment by Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis and UV disinfection.

Identified Risks:

- Cost Risk: It would appear that there is sufficient space at the existing WRC to build the new treatment works. However, site layouts should be prepared after verifying the space requirements and space availability at site. Raw water salinity is unknown, which affects output of WRTW. The length of intake and discharge mains could increase at detailed design.
- Programme Risk: Detailed stakeholder engagement with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in the South and East of England over many years, public perception issues will need to be carefully managed.
- Environmental Risk: The discharge and re-abstraction would require approval from the Environment Agency. Reduction in discharge volume, which may be significant in dry weather conditions, could impact WFD status of River Wensum. Difference in water chemistry between recycled water and discharge waterbody may have environmental impact.

6.16.4.2 NTB3 Lowestoft water reuse

The option requires additional treatment process to be added at the end of the Lowestoft WRC. A new pipeline is required to divert the treated effluent upstream of the WTW abstraction on the River Wensum in Norwich. This recycling of water is assumed to be available for abstraction at the WTW using a put and take licence.

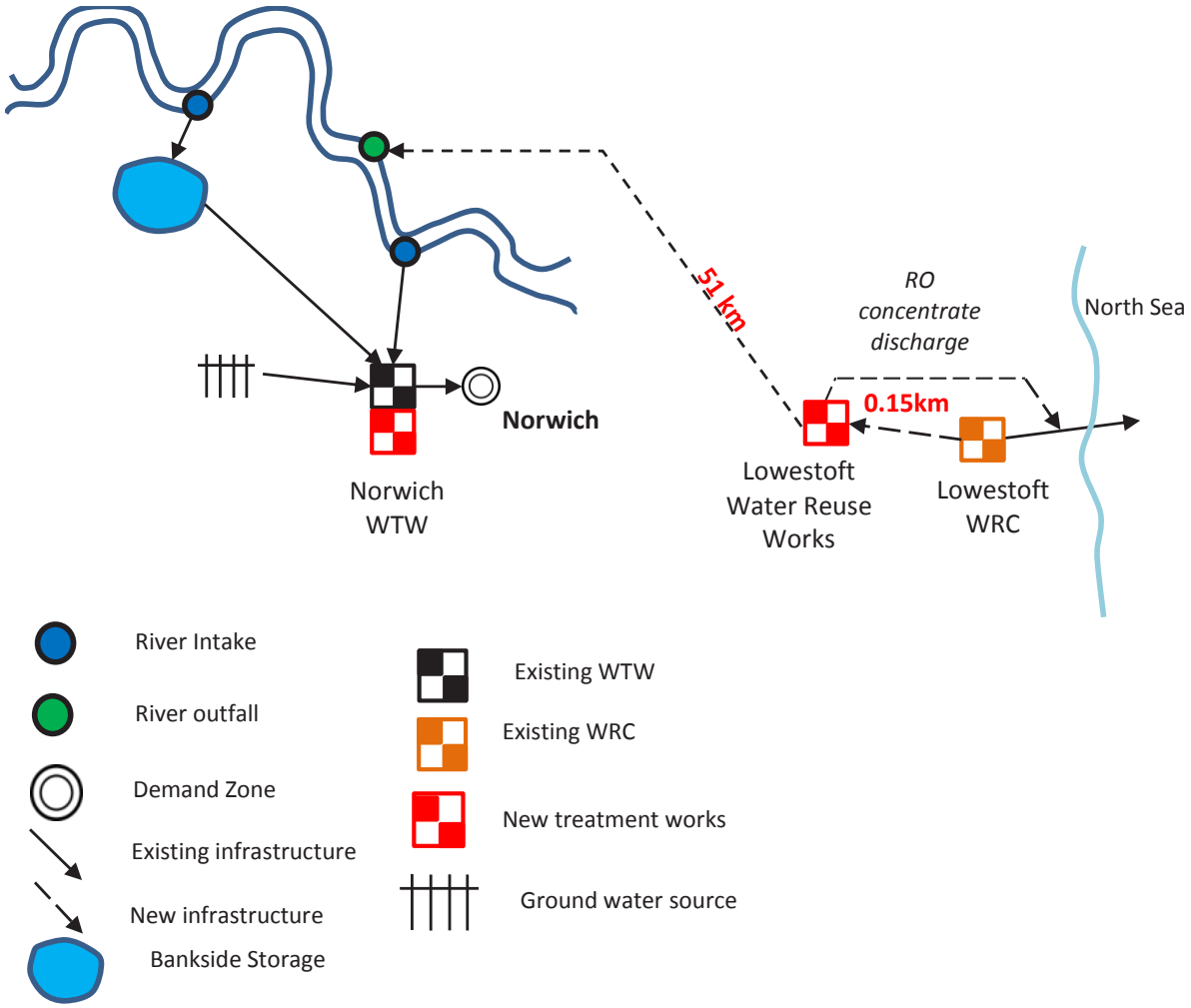


Figure 6.11: Schematic for Option NTB3 Lowestoft water reuse

The effluent from the WRC would require treatment by Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis and UV disinfection.

Identified Risks:

- Cost Risk: It would appear that there is sufficient space at the existing WRC to build the new treatment works. However, site layouts should be prepared after verifying the space requirements and space availability at site. Raw water salinity is unknown, which affects output of WRTW
- Programme Risk: Detailed stakeholder engagement with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in the South and East of England over many years, public perception issues will need to be carefully managed.
- Environmental Risk: The discharge and re-abstraction would require approval from the Environment Agency. Difference in water chemistry between recycled water and discharge waterbody may have environmental impact.

6.16.4.3 NTB4 Great Yarmouth Water Reuse

The option requires additional treatment process to be added at the end of the Great Yarmouth WRC. A new pipeline is required to divert the treated effluent upstream of the WTW abstraction on the River Wensum in Norwich. This recycling of water is assumed to be available for abstraction at the WTW using a put and take licence.

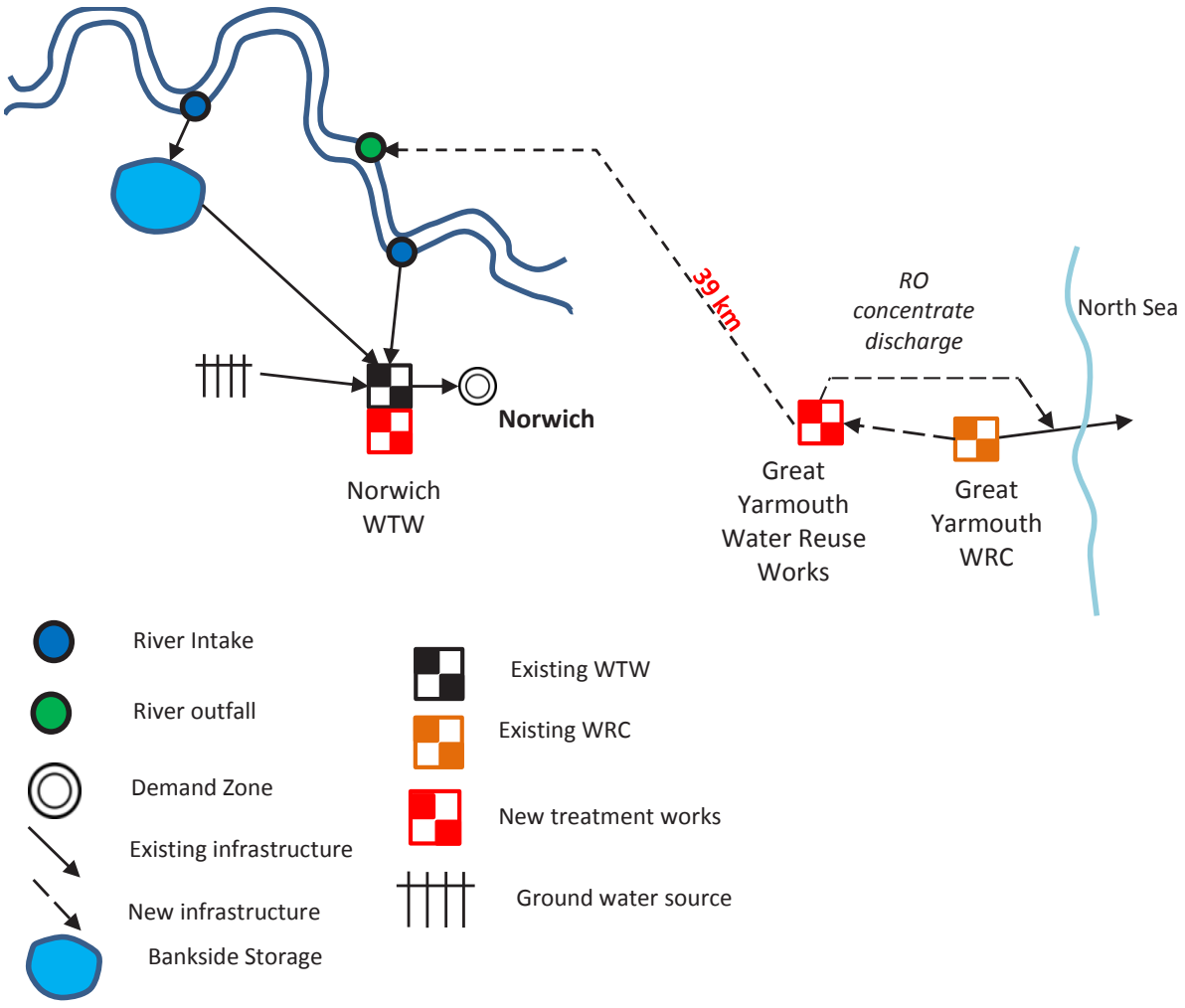


Figure 6.12: Schematic for Option NTB4 Great Yarmouth Water Reuse

The effluent from the WRC would require treatment by Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis and UV disinfection.

Identified Risks:

- Cost Risk: It would appear that there is sufficient space at the existing WRC to build the new treatment works. However, site layouts should be prepared after verifying the space requirements and space availability at site. Raw water salinity is unknown, which affects output of WRTW
- Programme Risk: Detailed stakeholder engagement with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in the South and East of England over many years, public perception issues will need to be carefully managed.
- Environmental Risk: The discharge and re-abstraction would require approval from the Environment Agency. Difference in water chemistry between recycled water and discharge waterbody may have environmental impact.

6.16.4.4 NTB5 Bacton Desalination

This option abstracts water from the sea and treated at a new reverse osmosis desalination plant at Bacton. The option includes abstraction pipelines from the sea and brine discharge pipelines back into the sea.

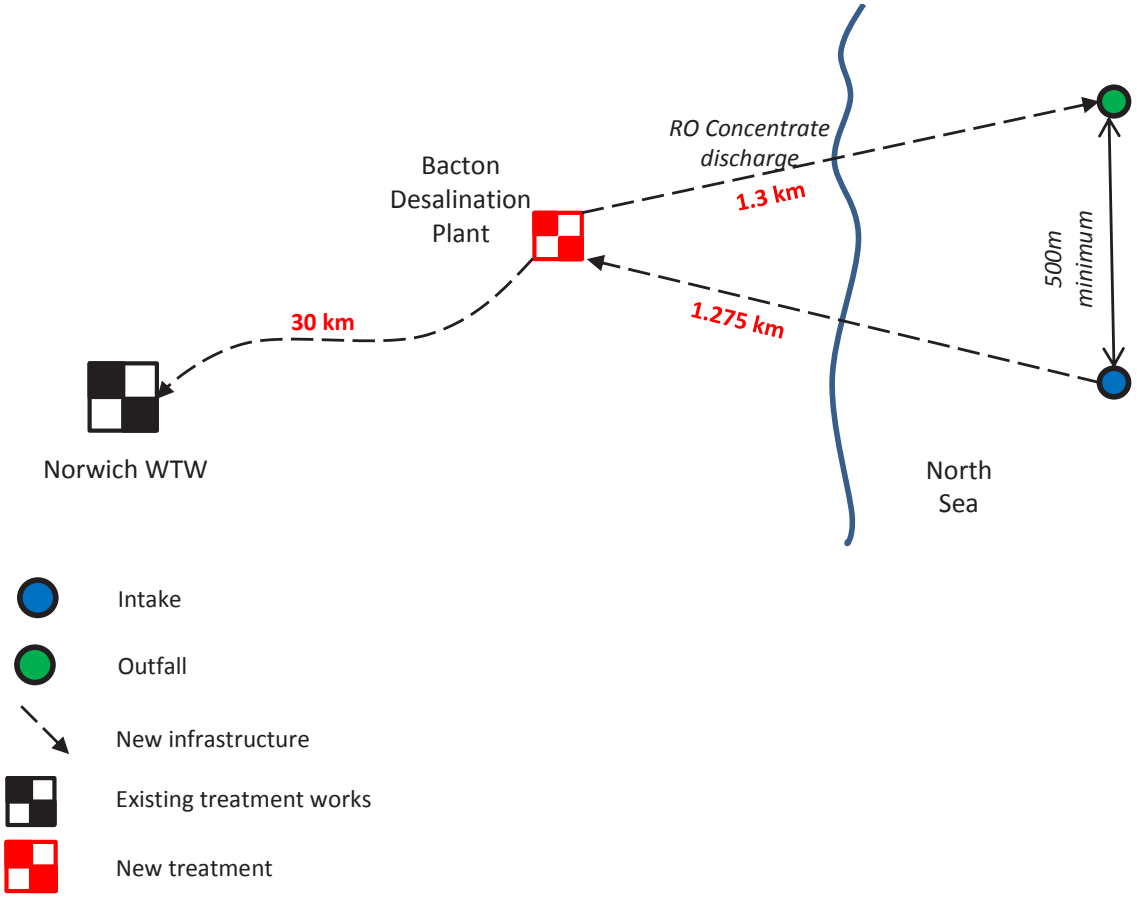


Figure 6.13: Schematic for Option NTB5 Bacton Desalination

The proposed pre-treatment comprises lamella clarifiers and Ultrafiltration (UF). The UF product will be pumped into the desalination plant. The sludge is dewatered and sent to landfill. The backwash waste will be discharged with the brine to sea via a new long sea outfall. The product water will be remineralised and pumped into the treated water network via a new pipeline.

Identified Risks:

- Cost Risk: The intake and brine discharge pipes will have to be laid through the town, coastal road and out to the sea. There could be delays installing sub-sea pipelines in the event of bad weather. The desalination plant will have high energy requirements and a new electrical supply will be needed.

- Quality Risk: The addition of large quantities of lime and carbon dioxide to achieve a similar alkalinity concentration to the current water supply may result in higher levels of turbidity. Moreover, major oil spills at the intake location may result in plant shutdown.
- Environmental Risk: Impacts of brine discharge.
- Licencing and consenting risks.

6.16.5 Environmental considerations

Table 6.134: Climate change impacts of Norwich and the Boards WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
NTB2	Norwich water reuse (22 Ml/d)	22	22	0
NTB3	Lowestoft water reuse	10	10	0
NTB4	Great Yarmouth water reuse	15.3	15.3	0
NTB5	Bacton Desalination	46	46	0
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	N/A	N/A	N/A
NTB7	Norwich water reuse (11 Ml/d)	10	10	0
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	N/A	N/A	N/A

Table 6.135: Water quality considerations for Norwich and the Boards WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
NTB2	Norwich water reuse (22 Ml/d)	Not required	Not required
NTB3	Lowestoft water reuse	Not required	Not required
NTB4	Great Yarmouth water reuse	Not required	Not required
NTB5	Bacton Desalination	Not required	Included in the scope of the option
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	Not required	Not required
NTB7	Norwich water reuse (11 Ml/d)	Not required	Not required
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	Not required	Not required

Table 6.136: INNS risks for Norwich and the Boards WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
NTB2	Norwich water reuse (22 Ml/d)	Low	Low	None
NTB3	Lowestoft water reuse	Low	Low	None
NTB4	Great Yarmouth water reuse	Low	Low	None
NTB5	Bacton Desalination	Low	Low	None
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	Low	Low	None
NTB7	Norwich water reuse (11 Ml/d)	Low	Low	None
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	Low	Low	None

Table 6.137: Other environmental considerations for Norwich and the Boards WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
NTB2	Norwich water reuse (22 Ml/d)	Assessed at Phase 1 only - moderate level of impact	Effects on WFD to be further investigated through WFD Phase 2 assessment. Other risks can be mitigated	No likely significant effects determined at screening
NTB3	Lowestoft water reuse	Minor at Phase 2	Effects on WFD to be further investigated through WFD Phase 2 assessment. Other risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
NTB4	Great Yarmouth water reuse	Assessed at Phase 1 only - moderate level of impact	Effects on WFD and ecology to be further investigated through WFD Phase 2 assessment and Task II Appropriate Assessment if option taken forward in the future. Other risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
NTB5	Bacton Desalination	Assessed at Phase 1 only - moderate level of impact	Effects on WFD and ecology to be further investigated through WFD Phase 2 assessment and Task II Appropriate Assessment if option taken forward in the future. Other risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no ap-propriate assessment undertaken as not in least cost plan or Preferred Plan

NTB7	Norwich water reuse (11 Ml/d)	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan

6.16.6 Costs

Table 6.138: Norwich and the Boards WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
NTB2	Norwich water reuse(22 Ml/d)	22	121,991	4,888	22,156	4,969
NTB3	Lowestoft water reuse	10	83,677	2,115	12,929	4,392
NTB4	Great Yarmouth water reuse	10	92,165	1,273	13,582	6,213
NTB5	Bacton Desalination	46	115,393	20,338	33,699	62,260
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	20	19,383	292	5,463	890
NTB7	Norwich water reuse (11 Ml/d)	11	72,300	1,687	9,674	2,484
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	10	15,375	92	4,640	254

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.139: Norwich and the Boards WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
NTB2	Norwich water reuse (22 Ml/d)	5	5
NTB3	Lowestoft water reuse	7	7
NTB4	Great Yarmouth water reuse	4	4
NTB5	Bacton Desalination	3	3
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	1	1
NTB7	Norwich water reuse (11 Ml/d)	6	6
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	2	2

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.16.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.140: Norwich and the Boards WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
NTB2	Norwich water reuse (22 Ml/d)	None	NTB7
NTB3	Lowestoft water reuse	None	None
NTB4	Great Yarmouth water reuse	None	None
NTB5	Bacton Desalination	None	None
NTB6	Norfolk Rural North WRZ to Norwich & the Boards WRZ Transfer (20 Ml/d)	None	NNR1, NTB8, NNR7
NTB7	Norwich water reuse (11 Ml/d)	None	NTB2
NTB8	Norfolk Rural North WRZ Norwich & the Boards WRZ Transfer (10 Ml/d)	None	NNR1, NTB6, NNR7

There are no synergies with other programmes for the options in Norwich and the Broads WRZ.

6.17 Nottinghamshire Water Resource Zone

6.17.1 Constrained Options

The table below contains the list of constrained options considered for Nottinghamshire WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.141: Nottinghamshire WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Gravel pits north of Retford Idle Valley	
Groundwater wells (boreholes)		Review group licences	
		Existing borehole not in use	
		Recommission abandoned WTW	
		Existing polluted groundwater source	
		New sources	
Bulk transfers		Chesterfield canal	
		Central Lincolnshire WRZ (Lincoln) transfer	
	NTM1	Central Lincolnshire WRZ Transfer	Yes
Resource Sharing with other Water Companies		Severn Trent Water - new and increasing existing	
		Yorkshire Water- new	

3rd Party Options		Gainsborough Water reuse (Severn Trent WRC)	
		Coal mine dewatering	
		Sugar beet (Newark)	
Improved/ sophisticated conjunctive management	NTM4	Increase surface water treatment capacity to utilise high river flows	

6.17.2 Feasible options

The table below provides details of the options for Nottinghamshire WRZ taken forward for economic modelling.

Table 6.142: Nottinghamshire WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	3.5	2	4	I010667

6.17.3 Transfer Option Details

Table 6.143: Transfer options for Nottinghamshire WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	41.1	291	2	41

Option NTM1 transfers water from Central Lincolnshire WRZ to Nottinghamshire WRZ and includes treatment to remove Metaldehyde, see section 5.2Error! Reference source not found. for details of the treatment process.

6.17.4 Resource Option Details

There are no feasible new resource options identified for Nottinghamshire WRZ.

6.17.5 Environmental considerations

Table 6.144: Climate change impacts of Nottinghamshire WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	N/A	N/A	N/A

Table 6.145: Water quality considerations for Nottinghamshire WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	Required	Required

Table 6.146: INNS risks for Nottinghamshire WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	Low	Low	None

Table 6.147: Other environmental considerations for Nottinghamshire WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.17.6 Costs

Table 6.148: Nottinghamshire WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Capital Carbon TCo2e	Operational carbon TCO2e per yr	Operational carbon TCO2e per yr
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	3.5	23,717	93	4,747	89

6.17.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.149: Nottinghamshire WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
NTM1	Central Lincolnshire WRZ to Nottinghamshire WRZ transfer	None	None

Option NTM1 has been modelled as an independent option however if selected in a scenario in conjunction with one of the transfer options from South Humber Bank WRZ to Central Lincolnshire WRZ there maybe an opportunity to remove the need for Metaldehyde treatment. The new potable WTW includes Metaldehyde treatment and if the NTM1 was taken off the new main there would be no need for further treatment.

The options assessed for Nottinghamshire WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for Nottinghamshire WRZ, more details are described in the Sustainable abstraction technical document.
- The transfer options would provide supply system resilience to WTWs within the Nottinghamshire WRZ.
- Option NTM1 includes treatment for Metaldehyde removal; therefore there would be a link to the water quality programme if selected.

6.18 Ruthamford Central Water Resource Zone

6.18.1 Constrained Options

The table below contains the list of constrained options considered for Ruthamford Central WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.150: Ruthamford Central WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage		Private lakes and gravel pits	
		Milton Keynes balancing lakes	
Bulk transfers	RTC2	Ruthamford South WRZ transfer	Yes
	RTC1	Ruthamford West WRZ Transfer	Yes

6.18.2 Feasible options

The table below provides details of the options for Ruthamford Central WRZ taken forward for economic modelling.

Table 6.151: Ruthamford Central WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	70	6.2	4	I010050
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	12	0.8	4	I013359

6.18.4 Resource Option Details

There are no feasible new resource options identified for Ruthamford Central WRZ.

6.18.5 Environmental considerations

Table 6.153: Climate change impacts of Ruthamford Central WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	N/A	N/A	N/A
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	N/A	N/A	N/A

Table 6.154: Water quality considerations for Ruthamford Central WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	Not required	Not required
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	Not required	Not required

Table 6.155: INNS risks for Ruthamford Central WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	Low	Low	None
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	Low	Low	None

Table 6.156: Other environmental considerations for Ruthamford Central WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.18.6 Costs

Table 6.157: Ruthamford Central WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	70	48,323	1,178	35,265	3,723
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	12	10,242	282	2,797	861

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.158: Ruthamford Central WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	1	1
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	2	2

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.18.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.159: Ruthamford Central WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
RTC1	Ruthamford West WRZ to Ruthamford Central WRZ Transfer	None	
RTC2	Ruthamford South WRZ to Ruthamford Central WRZ Transfer	None	RTS5

There are no synergies with other programmes for the options in Ruthamford Central WRZ.

6.19 Ruthamford North Water Resource Zone

6.19.1 Constrained Options

The table below contains the list of constrained options considered for Ruthamford North WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.160: Ruthamford North WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Direct river abstraction		Nene	
New reservoir storage	RTN1	South Lincolnshire reservoir (unsupported)	Yes
	RTN2	South Lincolnshire reservoir (supported via TWA scheme)	Yes
	RTN14	South Lincolnshire reservoir (supported with Trent Transfer)	Yes
		Gravel pits - Northampton	
		Private Reservoirs / Lakes e.g. Mepal	

Increase reservoir yield		Reduces the Gwash Glen transfer and releases from Rutland	
		Maximise refill opportunity for Pitsford	
	RTN11	Pitsford reservoir dam raising	Yes
		Ravensthorpe & Hollowell Reservoir dam raising	
		Rutland Water dam raising	
Groundwater wells (boreholes)		Limestone - recommission sources	
		Existing source	
		Leicester groundwater	
Artificial Storage and Recovery wells (or 'Aquifer Storage and Recharge') (ASR)	RTN12	Sherwood sandstone ASR	Yes
Reclaimed water	RTN3	Peterborough Water reuse	Yes
		Pitsford WTW - backwash water reuse	
		Rutland WTW - backwash water reuse	
Bulk transfers	RTN9	Canal transfer via Grand Union to R. Nene for abstraction to Pitsford	Yes
	RTN10	Canal transfer via Grand Union to R. Nene for abstraction to Pitsford with Severn Trent Water Reuse	Yes
	RTN18/ RTN24/ RTN28	South Lincolnshire WRZ Transfer	Yes
		Pitsford supply option from Ruthamford North network improvements	
	RTN17	South Fenland WRZ Transfer	Yes
	RTN5	River Trent-Rutland Water	Yes
	RTN4	River Trent - Rutland WTW	Yes
		Grafham reservoir - Pitsford reservoir	
		Rutland Reservoir - South Lincolnshire Reservoir	
Resource Sharing with other Water Companies		Cambridge Water	
	RTN6/ RTN7/	Severn Trent Water– potable trades	Yes
	RTN26/ RTN27/ RTN28	Severn Trent Water – raw water trades	Yes
	RTN29/ RTN30	Severn Trent Water's WRCs - Leicester, Rugby, Melton Mowbray	
3rd Party Options		3rd party trade options	
Improved/sophisticated conjunctive management	RTN19/ RTN21	Cease exporting raw water from Rutland Water to Grantham. Treat water at Rutland. Grantham would need another resource to support this option.	Yes

6.19.2 Feasible options

The table below provides details of the options for Ruthamford North WRZ taken forward for economic modelling.

Table 6.161: Ruthamford North WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	76.7	31.6	15	I022132 I022133 I022134
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	116	44	15	I022136 I022137 I022138
RTN3	Peterborough water reuse	20	5	5	I010844
RTN4	Raw water transfer from Trent to Rutland WTW	18	0.5	5	I008377
RTN5	Raw water transfer from Trent to Rutland Reservoir	18	0.5	5	I022366
RTN6	Severn Trent Water import (18Mld)	18	0.1	14	-
RTN7	Severn Trent Water import (36Mld)	36	0.1	14	-
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	147.6	50	15	I022242, I022245, I022244
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	10	2.6	4	I015669
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	30	3.7	4	I010116
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	17	0	4	I012888
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	10	0	4	I012842
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	25	4	4	I015257
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	4.6	0.1	14	-
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	67	7.1	4	I021599
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ transfer (35 Ml/d)	35	8.1	4	I022131

RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	8	0.1	18	-
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	14	0.1	18	-

Table 6.162: Ruthamford North WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
RTN9	Canal transfer without Severn Trent Water Reuse	4.6	I010136	Whilst technically feasible we would require assurances about the reliability of the yields offered, particularly with reference to severe droughts. Therefore this option has not been included in the economic modelling but will be developed further with the Canals & Rivers Trust through collaborative working groups/ projects as a potential future resource option.
RTN10	Canal transfer with Severn Trent Water Reuse	4.6	I009902	See above.
RTN11	Pitsford Dam Raising	4.6	I010503	Reservoir water levels would have to be reduced temporarily during the construction period for dam raising options. This will reduce yield/ DO for the construction duration (3-4 years). As the WRZ is already in deficit a scheme would have to be implemented to off-set the temporary reduction in DO therefore reduc-ing/ removing the need to raise the dam to provide additional DO.
RTN12	Sherwood sandstone ASR	-	I008475	Two options considered for ASR, one as a drought scheme and the other as a supply demand option. There is no drought impact in Ruthamford North WRZ and so the option is not relevant to the final Planning problem. There is high uncertainty around the DO benefits as a supply demand scheme and the likely DO would be small.
RTN27	Severn Trent Water – raw water trade (ANG6d)	-	-	Option is for 189 Ml/d of raw water delivered to the River Nene upstream of the Pitsford and Rutland abstraction points. The raw water is a combination of diverted final effluent and river water. This will have a higher INNS risk than option RTN26 (effluent only). The option also requires Severn Trent to increase capacity of one of their existing reservoirs Therefore this op-tion was not included in the economic modelling.

RTN28	Severn Trent Water – raw water trade (ANG7c)	-	-	Option is for 160 Ml/d of raw water delivered to Rutland Water. The raw water is a combination of River Soar water and diverted final effluent. The raw water would need treatment to remove INNS prior to discharge to Rutland Water. Final planning prob-lem - Ruthamford North WRZ does not have a drought risk greater than his-toric: the benefit of this option would be small compared to the large capex and opex compared to other options available for the WRZ.

6.19.3 Transfer Option Details

Currently raw water from Ruthamford North WRZ is transferred to South Lincolnshire WRZ for treatment. Options RTN19 and RTN21 involves retaining the raw water in Ruthamford North WRZ and providing additional treatment capacity so it can be utilised locally. However the lost raw water resource in South Lincolnshire has to be replaced by a new option. These options have been modelled as transfers in the EBSD model so that the model can optimise the least cost combination of treating raw water in Ruthamford North and providing a new resource/transfer into South Lincolnshire WRZ. Therefore options RTN19 and RTN21 are listed in the table below but there are no new pipelines required for the schemes. Details of the treatment requirements of these options are described in section 6.19.4.

Table 6.163: Transfer options for Ruthamford North WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	55510	55.5	458.4	1
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	46375	46.4	600	1
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	-	-	-	-
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	-	-	-	-
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	49404	49.4	600	1
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	49404	49.4	800	1
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ trans-fer (35 Ml/d)	49404	49.4	700	1

6.19.4 Resource Option Details

6.19.4.1 RTN1 South Lincolnshire Reservoir (unsupported by the Trent)
New bunded pumped storage reservoir of 50,000Ml capacity. The reservoir will be supplied from a new abstraction on the Witham at Boston or South Forty Foot drain. The option includes the intake and intake pipelines, as well as a new WTW which includes for Metaldehyde treatment and a supply pipeline to Ruthamford North WRZ potable network.

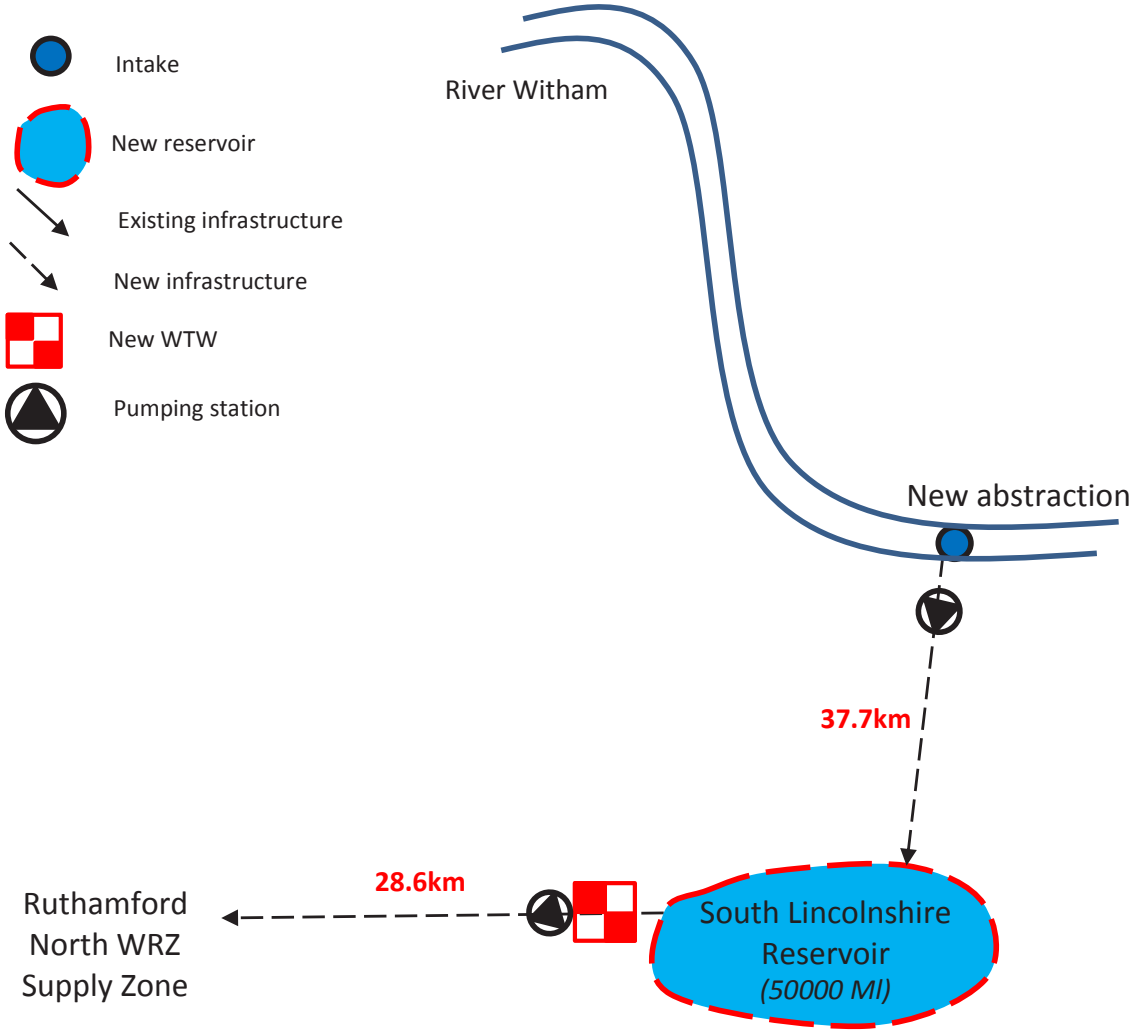


Figure 6.14: Schematic for RTN1 South Lincolnshire Reservoir (unsupported by the Trent)

Identified risks for all South Lincolnshire Options (RTN1, RTN2 and RTN14):

- General licence conditions such as daily maximum and annual quantities.
- A key consideration in the feasibility of a South Lincolnshire reservoir is the assumptions regarding "hands-off" flows in the Trent, at the Witham at Boston.
- Other limitations relate to potential water quality / ecology issues arising from river basin transfers, see Table 6 166 for more details and Appendix D.
- The choice of reservoir sites has been based on a desk study and available geological information. Further site selection work needs to be finalised with more site investigations required to confirm the availability and engineering properties of material for construction of embankments. This may have an impact on cost and delivery programme.
- Potential bird-strike issues in South Lincolnshire and consultations required with the Ministry of Defence.
- Significant risks associated with the planning application for a new reservoir.

6.19.4.2 RTN2 South Lincolnshire Reservoir (supported 160ML Trent)

New bunded pumped storage reservoir of 50,000Ml capacity. The reservoir will be supplied from a new abstraction on the Witham at Boston. The option includes the intake and intake pipelines, as well as a new WTW which includes for Metaldehyde treatment and a supply pipeline to Ruthamford North WRZ. In addition, it is assumed that the abstraction can be supplemented by 160Ml transfer from the River Trent using the existing Trent-Witham-Ancholme scheme, therefore no new infrastructure is included for this.

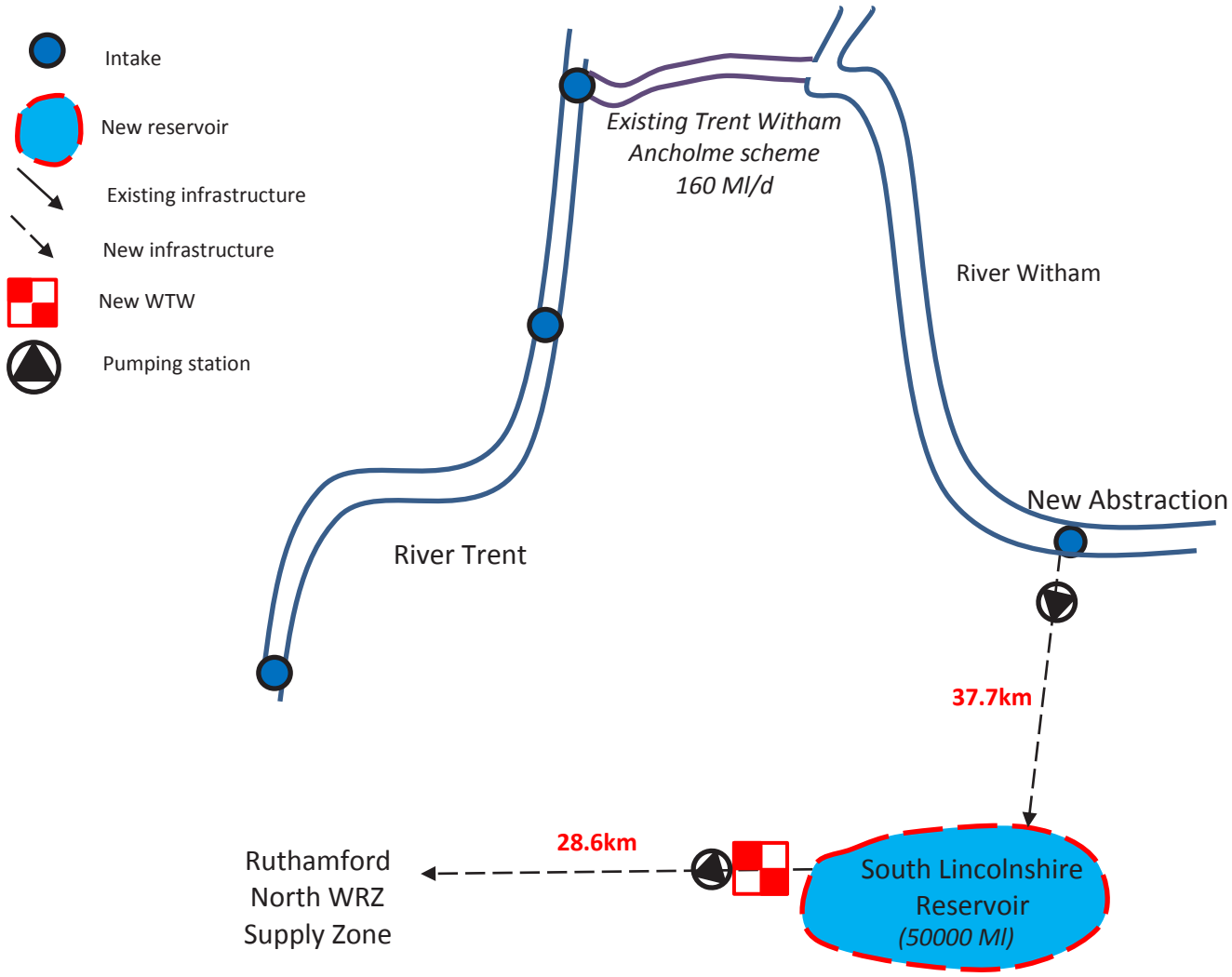


Figure 6.15:Schematic for RTN2 South Lincolnshire Reservoir (supported 160ML Trent)

The identified risks for RTN2 are described in section 6.19.4.1.

6.19.4.3 RTN3 Peterborough water reuse

The option requires additional treatment process to be added at the end of the Peterborough WRC. A new pipeline is required to divert the treated effluent upstream of the abstraction on the River Nene. This recycling of water is assumed to be available for abstraction using a put and take licence. The option includes for an upgrade of the WTW capacity to achieve the benefits of the scheme.

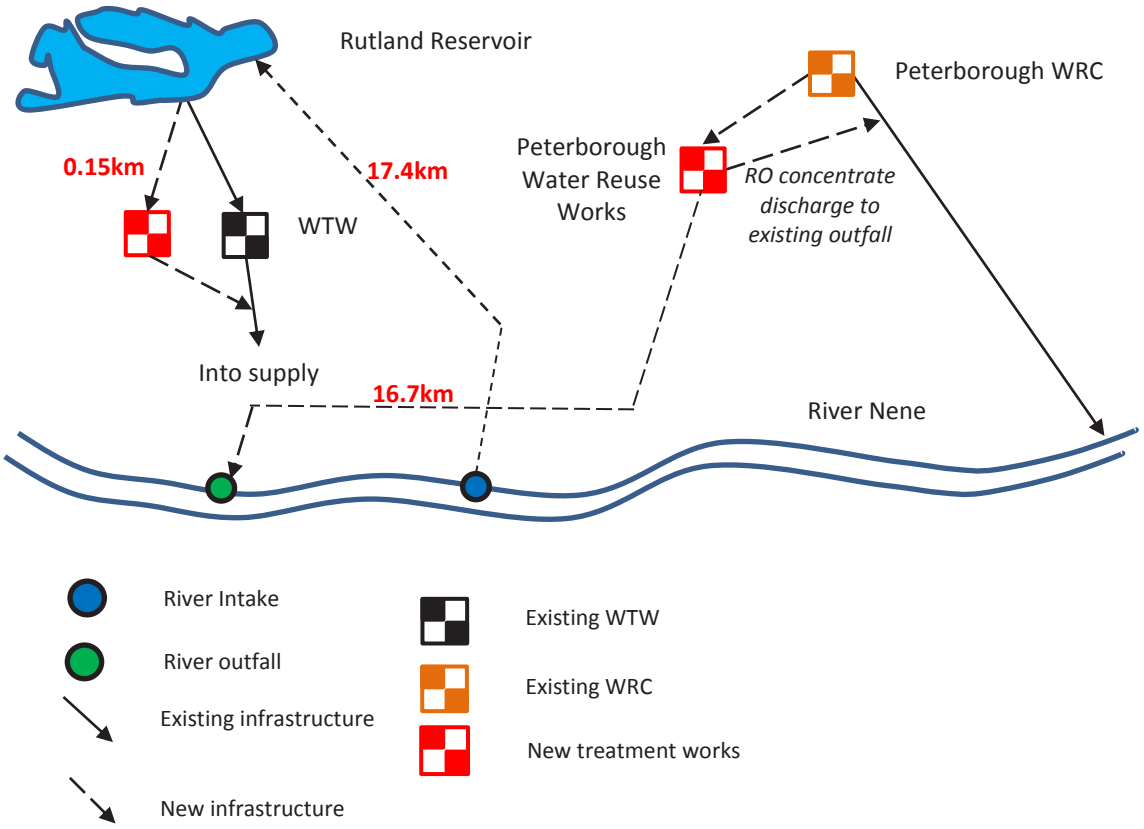


Figure 6.16: Schematic for RTN3 Peterborough Reuse

The effluent from the WRC would require treatment by Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis and UV disinfection.

Identified Risks:

- Cost Risk: It would appear that there is sufficient space at the existing WRC to build the new treatment works. However, site layouts should be prepared after verifying the space requirements and space availability at site. Raw water salinity is unknown, which affects output of WRTW
- Programme Risk: Detailed stakeholder engagement with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in the South and East of England over many years, public perception issues will need to be carefully managed.
- Environmental Risk: The discharge and re-abstraction would require approval from the Environment Agency. Reduction in discharge volume, which may be significant in dry weather conditions, could impact WFD status of River Wensum. Difference in water chemistry between recycled water and discharge waterbody may have environmental impact.

6.19.4.4 RTN4 Raw water transfer from Trent to Rutland WTW

This option involves a new raw water transfer pipeline from the River Trent directly to the WTW at Rutland Water. It includes treatment for invasive and non-native species at the intake on the Trent. There are two pumping stations and a pipeline to transfer the raw water. Abstraction from the Trent would only be available at certain periods of the year and would be used to reduce the demand on Rutland Water and allow for water that would normally need to be abstracted from Rutland Water to be retained in the reservoir.

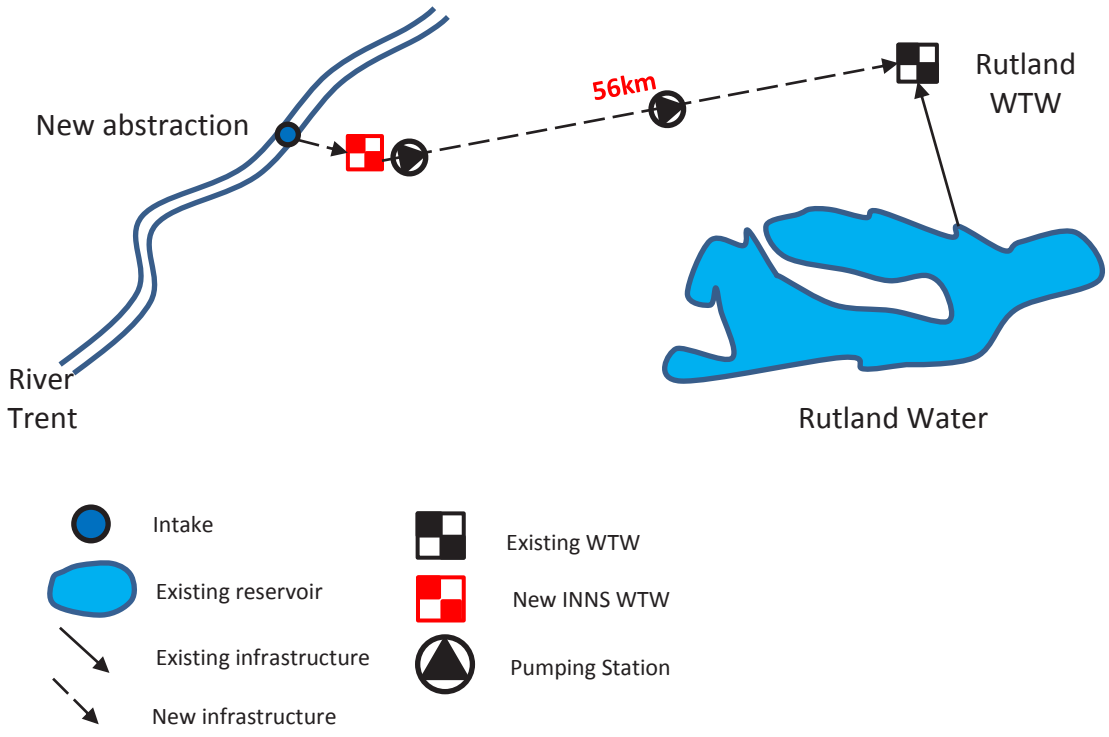


Figure 6.17: Schematic for RTN4 Raw water transfer from Trent to Rutland WTW

Identified risks:

- Cost risk: Pipeline routes are indicative and not fully validated. This may have an impact on the capex and opex costs for the option.
- Programme risks: Obtaining planning permission for the pipeline and new WTW could result in a significant increase in costs and timescales. The new abstraction would require a new licence to be confirmed with the Environment Agency which could result in increase in timescales, and programme.

6.19.4.5 RTN5 Raw water transfer from Trent to Rutland Water

This option involves a new raw water transfer from the River Trent to Rutland Water. Treatment is required for the removal of invasive and non-native species at the intake on the Trent. There are two pumping stations and a 56km pipeline to transfer the raw water to Rutland Water. Abstraction from the Trent would only available at certain periods of the year and when available would be used to refill Rutland Water at periods when the reservoir cannot be filled from its existing sources on the River Nene and Welland. This will ensure that the optimal abstraction and refill regime will be used to maximise storage at Rutland Water.

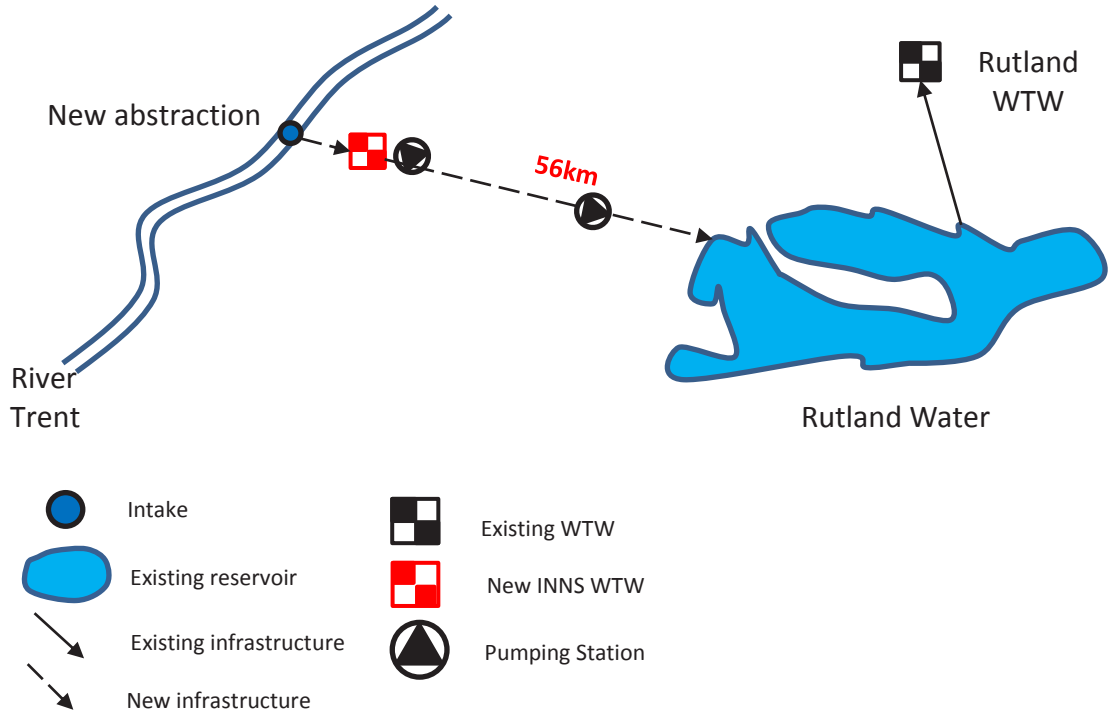


Figure 6.18: Schematic for RTN5 Raw water transfer from Trent to Rutland Water

Identified risks:

- Cost risk: Pipeline routes are indicative and not fully validated. This may have an impact on the capex and opex costs for the option.
- Programme risks: Obtaining planning permission for the pipeline and new WTW could result in a significant increase in costs and timescales. The new abstraction would require a new licence to be confirmed with the Environment Agency which could result in increase in timescales, and programme

6.19.4.6 RTN6 Severn Trent Water import (18Mld)
Anglian Water currently exports 18 Ml/d to Severn Trent Water from our Rutland WTW. Option RTN6 involves Severn Trent Water developing a new option to supply their customers currently supplied from the export so that Anglian Water can retain the 18 Ml/d at our Rutland Water WTW and supply our customers in Ruthamford North WRZ. This option has been offered to Anglian Water as a trade by Severn Trent Water (Severn Trent Water Option Reference ANG5a).

The solution requires Severn Trent Water to connect their Rutland WRZ to their Strategic Grid WRZ and requires the development of a new raw water source in the Derwent Valley to maintain their current level of service to customers (1 in 200.) Severn Trent Water have confirmed that the new source will meet future climate change and environmental constraints.

This is an opex only option, using the cost data provided by Severn Trent Water.

6.19.4.7 RTN7 Severn Trent Water import (36Mld)
Anglian Water currently exports 18 Ml/d to Severn Trent Water from our Rutland WTW. Option RTN7 involves Severn Trent Water developing a new option to supply their customers currently supplied from the export so that Anglian Water can retain the 18 Ml/d plus they will supply an additional 18 Ml/d. This will provide an additional 36 Ml/d to our customers in Ruthamford North WRZ. This option has been offered to Anglian Water as a trade by Severn Trent Water (Severn Trent Water Option Reference ANG5b).

The solution requires Severn Trent Water to connect their Rutland WRZ to their Strategic Grid WRZ and requires the development of a new raw water source in the Derwent Valley to maintain their current level of service to customers (1 in 200.) Severn Trent Water have confirmed that the new source will meet future climate change and environmental constraints.

This is an opex only option, using the cost data provided by Severn Trent Water.

6.19.4.8RTN14 South Lincolnshire Reservoir (supported 300Ml Trent)
New bunded pumped storage reservoir of 50,000Ml capacity. The reservoir will be supplied from a new abstraction on the Witham at Boston. The option includes the intake and intake pipelines, as well as a new WTW which includes for Metaldehyde treatment and a supply pipeline to Ruthamford North WRZ. In addition, there is a new 300Ml raw water transfer scheme from the River Trent to the River Witham for abstraction at Boston.

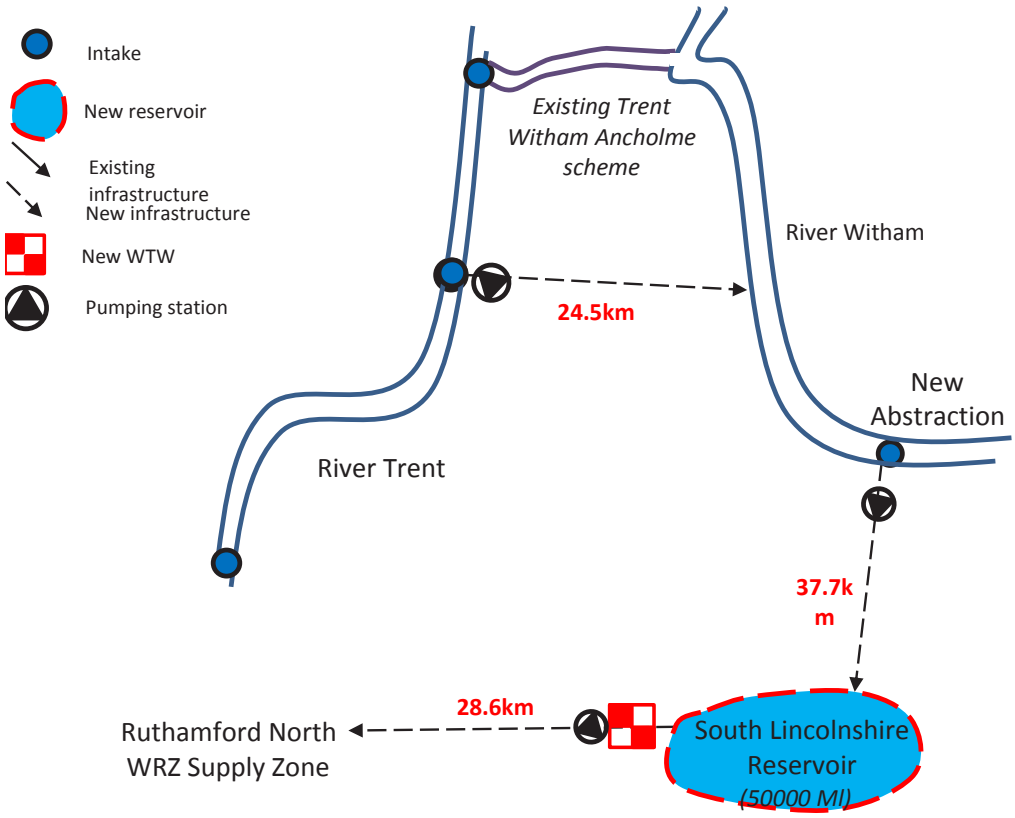


Figure 6.19: Schematic for RTN14 South Lincolnshire Reservoir (supported by the Tent 300Ml)

The identified risks for RTN14 are described in section 6.19.4.1.

6.19.4.9 RTN19 and RTN21 South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer

Currently raw water from Ruthamford North WRZ is transferred to South Lincolnshire WRZ for treatment. Options RTN19 and RTN21 involves retaining either all (RTN19) or some of (RTN21) the raw water in Ruthamford North WRZ and providing additional treatment capacity so it can be utilised locally. However the lost raw water resource in South Lincolnshire will need to be replaced by a new option.

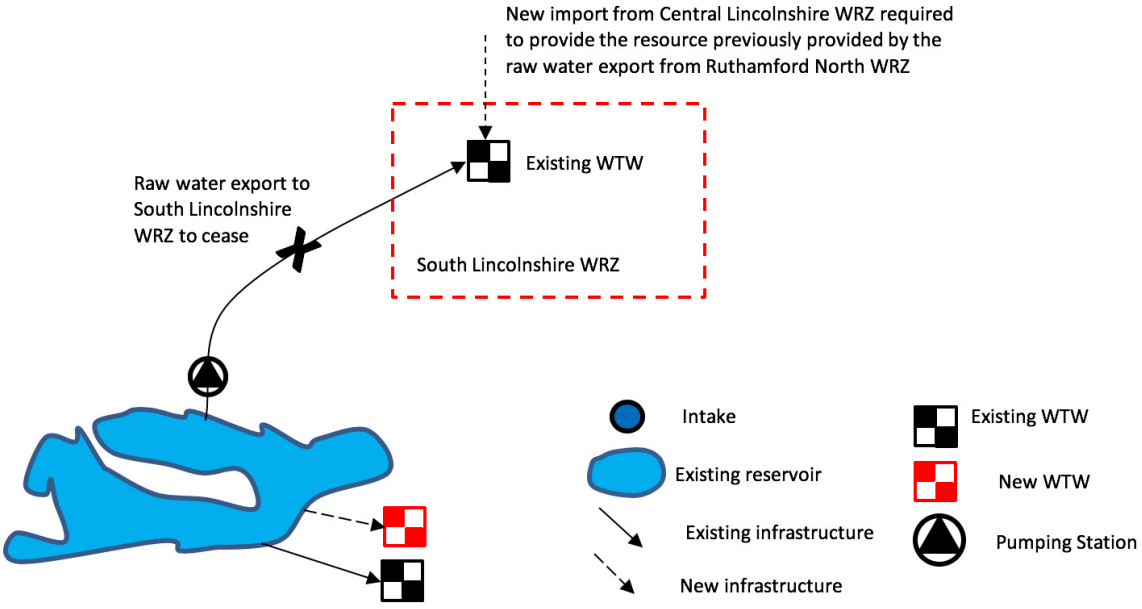


Figure 6.20: Schematic for RTN19 and RTN21 Ruthamford North WRZ Reverse Transfer

Identified Risks:

- Cost risk: Location of new WTW and whether a new intake is required will have impact on cost.
- Programme risk: Delays in obtaining planning permission for the new WTW would impact costs and programme.

6.19.4.10 RTN26 Severn Trent Water Raw Water Import (115 Ml/d)

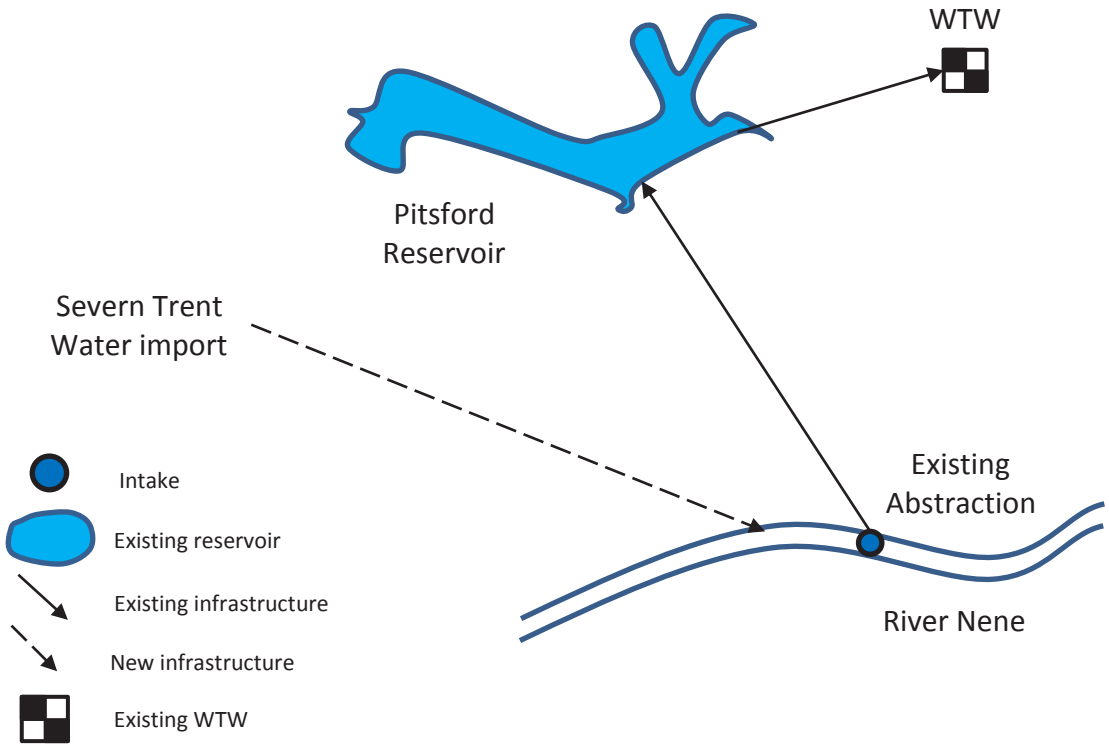


Figure 6.21: Schematic for RTN26 Severn Trent Raw Water Import (115 Ml/d)

The option involves Severn Trent Water providing a new raw water transfer into the River Nene upstream of the existing intake for Pitsford reservoir. The source of the transferred raw water would be the Birmingham WRC. This option has been offered to Anglian Water as a trade by Severn Trent Water (Severn Trent Water Option Reference ANG6c).

Severn Trent Water would provide improved tertiary treatment of a proportion of the final effluent (to meet the relevant water quality standards of the receiving water) and transfer by pump and pipeline. Therefore, this is an opex only option, using the cost data provided by Severn Trent Water.

The discharge point is assumed to be the river Nene at Northampton though the pipeline could go direct to Pitsford reservoir or elsewhere.

6.19.4.11 RTN29 Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)

The option involves Severn Trent Water providing a new raw water transfer from their Leicester sewage treatment works to our Rutland reservoir. We have modelled the benefit to DO at Rutland Water if the maximum daily transfer volume of 36 Ml/d was received at the reservoir as 8 Ml/d.

6.19.4.12 RTN30 Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)

The option involves Severn Trent Water providing a new raw water transfer from their Leicester sewage treatment works to our Rutland reservoir. We have modelled the benefit to DO at Rutland Water if the maximum daily transfer volume of 50 Ml/d was received at the reservoir as 14 Ml/d.

6.19.5 Environmental considerations

Table 6.164: Climate change impacts of Ruthamford North WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on his-toric with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	102.2	76.7	25.5
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	148	116	32
RTN3	Peterborough water reuse	20	20	0
RTN4	Raw water transfer from Trent to Rutland WTW	11.5	11.5	0
RTN5	Raw water transfer from Trent to Rutland Reservoir	11.5	11.5	0
RTN6	Severn Trent Water import (18 Ml/d)	18	18.0	0.0
RTN7	Severn Trent Water import (36 Ml/d)	36	36	0
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	180.4	147.6	32.8
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	N/A	N/A	N/A
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	N/A	N/A	N/A
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	N/A	N/A	N/A
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	N/A	N/A	N/A
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	N/A	N/A	N/A
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	N/A	N/A	N/A
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ trans-fer (67 Ml/d)	N/A	N/A	N/A
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ trans-fer (35 Ml/d)	N/A	N/A	N/A
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	8	8	0
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	14	14	0

Table 6.165: Water quality considerations for Ruthamford North WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	Required	Not required
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	Required	Not required
RTN3	Peterborough water reuse	Not required	Not required
RTN4	Raw water transfer from Trent to Rutland WTW	Required	Not required
RTN5	Raw water transfer from Trent to Rutland Reservoir	Required	Not required
RTN6	Severn Trent Water import (18 Ml/d)	Not required	Not required
RTN7	Severn Trent Water import (36 Ml/d)	Not required	Not required
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	Required	Not required
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	Not required	Not required
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	Not required	Not required
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	Required	Not required
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	Required	Not required
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	Not required	Not required
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	Not required	Not required
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	Not required	Not required
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ transfer (35 Ml/d)	Not required	Not required
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	Not required	Not required
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	Not required	Not required

All options that require a new source of raw water (e.g. South Lincolnshire reservoir, canal transfer) have been assumed that they require treatment to remove Metaldehyde even though they are supplying an area with an existing Undertaking, see section 5.2.

Table 6.166: INNS risks for Ruthamford North WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	Medium	Medium	RTN1 has a lower INNS risk after mitigation than the other South Lincolnshire reservoir options because it does not require a transfer from the River Trent. However there is still a risk from the reservoir overflow as the reservoir is likely to be located some distance from the raw water intake. This would need to be investigated further.
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	Medium	Medium	RTN2 involves increasing the volume of Trent water via an existing transfer route. It would be difficult to separate and treat the Trent water to remove INNS. There would also be an INNS risk from the reservoir overflow as described above. This would need to be investigated further.
RTN3	Peterborough water reuse	Low	Low	None
RTN4	Raw water transfer from Trent to Rutland WTW	High	Low	INNS treatment of the raw water close to the source removes the INNS risk.
RTN5	Raw water transfer from Trent to Rutland Reservoir	High	Low	INNS treatment of the raw water close to the source removes the INNS risk.
RTN6	Severn Trent Water import (18Mld)	Low	Low	None
RTN7	Severn Trent Water import (36Mld)	Low	Low	None
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	Medium	Medium	For this option the additional Trent water is conveyed via a pipeline reducing the INNS risk associated with the transfer. However the risks associated with reservoir overflows as described for RTN1 and RTN2 still remain. Therefore this would need to be investigated further
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	Low	Low	None
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	Low	Low	None
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	Low	Low	None

RTN21	South Lincolnshire WRZ to Ruthamford North WRZ R-verse Transfer (10 Ml/d)	Low	Low	None
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ trans-fer (25 Ml/d)	Low	Low	None
RTN26	Severn Trent Water Raw Wa-ter Import (115 Ml/d)	Low	Low	None
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ trans-fer (67 Ml/d)	Low	Low	None
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ trans-fer (35 Ml/d)	Low	Low	None
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	Low	Low	None
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	Low	Low	None

Table 6.167: Other environmental considerations for Ruthamford North WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	Moderate level of impacts	Effects on WFD to be further investigated through WFD Phase 3 assessment. Other risks can be mitigated	No likely significant effects determined at screening
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	Moderate level of impacts	Effects on WFD to be further investigated through WFD Phase 3 assessment. Other risks can be mitigated	No likely significant effects determined at screening
RTN3	Peterborough water reuse	Assessed at Phase 1 only - moderate level of impact	Effects on WFD and ecology to be further investigated through WFD Phase 2 assessment and Task II Appropriate Assessment if option taken forward in the future. Other risks can be mitigated.	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
RTN4	Raw water transfer from Trent to Rutland WTW	Assessed at Phase 1 only - moderate level of impact	Effects on WFD to be further investigated through WFD Phase 2 assessment. Other risks can be mitigated	No likely significant effects determined at screening
RTN5	Raw water transfer from Trent to Rutland Reservoir	Assessed at Phase 1 only - moderate level of impact	Effects on WFD and ecology to be further investigated through WFD Phase 2 assessment and Task II Appropriate Assessment if option taken forward in the future. Other risks can be mitigated.	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
RTN6	Severn Trent Water import (18Mld)	No or minimal impact	No impacts	No likely significant effects determined at screening
RTN7	Severn Trent Water import (36Mld)	No or minimal impact	No impacts	No likely significant effects determined at screening
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	Assessed at Phase 1 only - moderate level of impact	Effects on WFD and ecology to be further investigated through WFD Phase 2 assessment and Task II Appropriate Assessment if option taken forward in the future. Other risks can be mitigated.	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	Not assessed	Risks can be mitigated	No likely significant effects determined at screening
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	Not assessed	Risks can be mitigated	No likely significant effects determined at screening

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	Not assessed	No impacts	Not assessed
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ transfer (35 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	Not assessed	Not assessed	Not assessed
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	Not assessed	Not assessed	Not assessed

Table 6.168: Ruthamford North WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	76.7	647,572	3,957	215,066	10,372
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	116	736,767	6,615	240,593	17,394
RTN3	Peterborough water reuse	20	128,847	5,327	17,456	9,037
RTN4	Raw water transfer from Trent to Rutland WTW	18	151,756	1,940	62,209	4,319
RTN5	Raw water transfer from Trent to Rutland Reservoir	18	163,842	4,615	64,459	13,949
RTN6	Severn Trent Water import (18Mld)	18	-	9,281	-	-
RTN7	Severn Trent Water import (36Mld)	36	-	11,382	-	-
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	147.6	826,167	11,265	244,959	22,706

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	10	29,772	219	8,354	735
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	30	36,438	653	24,288	2,041
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	17	21,717	354	2,828	549
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	10	18,410	224	2,163	339
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	25	36,159	137	25,661	388
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	4.6	-	16,292	-	-
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	67	55,240	935	39,786	2,940
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ transfer (35 Ml/d)	35	43,413	124	32,176	341
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	8	10	8,010	-	-
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	14	10	10,010	-	-

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.169: Ruthamford North WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	12	12
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	10	10
RTN3	Peterborough water reuse	15	15
RTN4	Raw water transfer from Trent to Rutland WTW	16	16
RTN5	Raw water transfer from Trent to Rutland Reservoir	17	17
RTN6	Severn Trent Water import (18Mld)	9	9
RTN7	Severn Trent Water import (36Mld)	8	8
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	13	13
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	6	6
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	4	4
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	5	5
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	7	7
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	3	3
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	18	18
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	1	1
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ transfer (35 Ml/d)	2	2
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	14	14
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	11	11

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.19.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.170: Ruthamford North WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
RTN1	South Lincolnshire Reservoir (unsupported by the Trent)	None	RTN14, RTN2
RTN2	South Lincolnshire Reservoir (supported 160ML Trent)	None	RTN14, RTN1, RTN4, RTN5
RTN3	Peterborough water reuse	None	None
RTN4	Raw water transfer from Trent to Rutland WTW	None	RTN5, RTN2, RTN14
RTN5	Raw water transfer from Trent to Rutland Reservoir	None	RTN4, RTN2, RTN14
RTN6	Severn Trent Water import (18Mld)	None	RTN7
RTN7	Severn Trent Water import (36Mld)	None	RTN6
RTN14	South Lincolnshire Reservoir (supported 300ML Trent)	None	RTN2, RTN1, RTN4, RTN5
RTN17	South Fenland WRZ to Ruthamford North WRZ transfer	None	SFN1, SFN3, SFN4
RTN18	South Lincolnshire WRZ to Ruthamford North WRZ transfer (30 Ml/d)	None	RTN24, RTN27, RTN28
RTN19	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (17 Ml/d)	None	RTN21
RTN21	South Lincolnshire WRZ to Ruthamford North WRZ Reverse Transfer (10 Ml/d)	None	RTN19
RTN24	South Lincolnshire WRZ to Ruthamford North WRZ transfer (25 Ml/d)	None	RTN18, RTN27, RTN28
RTN26	Severn Trent Water Raw Water Import (115 Ml/d)	None	None
RTN27	South Lincolnshire WRZ to Ruthamford North WRZ transfer (67 Ml/d)	None	RTN24, RTN18, RTN28
RTN28	South Lincolnshire WRZ to Ruthamford North WRZ transfer (35 Ml/d)	None	RTN24, RTN18, RTN27
RTN29	Severn Trent Water Leicester Water Reuse Transfer (36 Ml/d)	None	RTN30
RTN30	Severn Trent Water Leicester Water Reuse Transfer (50 Ml/d)	None	RTN29

The options assessed for Ruthamford North WRZ have the following synergies and links to other programmes,

- The options that provide additional WTW capacity would improve supply system resilience within Ruthamford North WRZ.

6.20 Ruthamford South Water Resource Zone

6.20.1 Constrained Options

The table below contains the list of constrained options considered for Ruthamford South WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.171: Ruthamford South WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage	RTS1	Ruthamford South New Reservoir	Yes
		Existing direct river intake WTW - bankside storage	Yes
		Wyboston Lakes	
Increase reservoir yield	RTS2	Grafham Water dam raising	Yes
Groundwater wells (boreholes)		Existing sources	
		Maximising licences	
		Abandoned boreholes	
Reclaimed water		Grafham WTW - backwash water reuse	
	RTS9/ RTS10/ RTS11	Ruthamford North WRZ Transfer	Yes
	RTS5	Ruthamford Central WRZ Transfer	Yes
	RTS3	Rutland Reservoir - Grafham Reservoir	
		Pitsford reservoir - Grafham reservoir	
		Rutland to Ouse, (for subsequent partial transfer to Grafham and remainder to flow to Fenland)	
		Ouse, Offord - Grafham	
Resource Sharing with other Water Companies		Cambridge Water- to St Ives/Huntingdon	
		Thames Water	
		Thames Water reservoir	
	RTS13	Affinity reverse transfer to Ruthamford South WRZ	Yes
3rd Party Options		3rd party trade options	
Improved/sophisticated conjunctive management		Great Ouse Water Act (GOWA) operating rules - review	

6.20.2 Feasible options

The table below provides details of the options for Ruthamford South WRZ taken forward for economic modelling.

Table 6.172: Ruthamford South WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
RTS1	New Ruthamford South WRZ reservoir	17.2	10.0	15	I010072
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	70	4.1	4	I015206
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	80	10.2	4	I000239
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	55	8.0	4	I015670
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	10	2.1	4	I015672

Table 6.173: Ruthamford South WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
RTS2	Grafham Dam Raising	17.2	I012671	Reservoir water levels would have to be reduced temporarily during the construction period for dam raising options. This will reduce yield/ DO for the construction duration (3-4 years). As the WRZ is already in deficit a scheme would have to be implemented to off-set the temporary reduction in DO therefore reducing/removing the need to raise the dam to provide additional DO.
RTS13	Affinity Water Ruthamford South WRZ Reverse Trade	18	–	The Affinity Water reverse trade is a feasible option but was not taken through to economic modelling as it is time limited and did not provide a benefit when it would have been required in Ruthamford South WRZ within the planning horizon
–	Existing direct river intake WTW - bankside storage	4	I010471	A low DO benefit (4Ml/d), which does not make it a very cost effective solution. It is mutually exclusive to other Ouse abstraction options (RTS1, RTS2 and RTW2) which are much more cost effective so this option was not taken through to economic modelling.
–	Great Ouse Water Act (GOWA) operating rules - review	–	–	Trade from GOWA to Grafham included in feasible options (RTS13)

6.20.4 Transfer Option Details

Due to the capping of time limited licenses we have found that there are now deficits in discrete parts of some WRZs. These local deficits are not seen at WRZ level and as such would not appear within the WRZ supply demand balances in the WRP Tables. We have completed smaller scale supply demand balances for discrete Planning Zones (PZs) and developed intra-WRZ transfer options to resolve these deficits. The options have been costed and evaluated in the same way as all the other feasible options and the costs details have been included in WRP Table 5. However as the deficits are within a WRZ these options have not been included in the economic modelling and so do not appear in WRP Table 6. Table 6 174 and subsequent tables contain the supporting information for the Intra-WRZ options for this WRZ.

Table 6.174: Intra-Water Resource Zone Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	5	0.1	4	N9033714
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	5	0.1	4	N9033716
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	80	10.2	4	I000239
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	55	8.0	4	I015670
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	10	2.1	4	I015672

6.20.4 Transfer Option Details

Table 6.175: Transfer options for Ruthamford South WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	22.3	900	1	0
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	55.9	900	1	33
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	55.9	800	1	33
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	55.9	409	1	33
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	2.2	300	1	1
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	9.6	300	1	3

6.20.5 Resource Option Details

This option is for a new bunded pumped storage reservoir and includes new pipelines from the existing intake on the Great River Ouse and to supply the existing WTW. This option provides Ruthamford South WRZ more winter storage capacity to provide drought and climate change resilience. This option is an alternative to raising Grafham Dam and therefore mutually exclusive to RTS2.

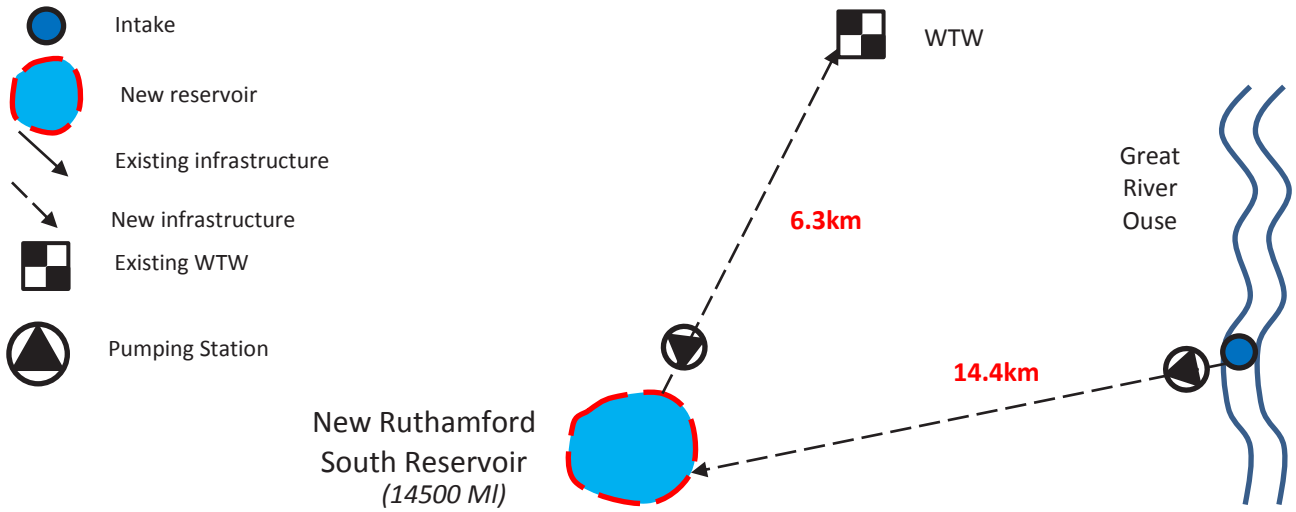


Figure 6.22: Schematic RTS1 New Ruthamford South WRZ reservoir

Identified risks:

- Cost risks: Unforeseen geological conditions, increasing construction costs. Substantial increase in energy costs.
- Programme risks: Substantial delay through the planning and consent process, and possibly refusal of permission. Changes to the abstraction licence from the Great Ouse are required.
- Environmental risks: Although construction of the pipeline will be temporary it could cause loss of sensitive habitat within the designated site and will directly affect species during construction which may affect them returning to the area or their breeding. No likely significant effect on Nene Washes, Portholme, Rutland Water, or Upper Nene Valley Gravel Pits. The scheme runs through a Site of Special Scientific Interest (SSSI) and is adjacent to a Local Nature Reserve (LNR).

6.20.6 Environmental considerations

Table 6.176: Climate change impacts of Ruthamford South WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
RTS1	New Ruthamford South WRZ reservoir	0	17.2	-
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	N/A	N/A	N/A
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	N/A	N/A	N/A
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	N/A	N/A	N/A
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	N/A	N/A	N/A
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	N/A	N/A	N/A
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	N/A	N/A	N/A

To establish the DO benefit for Option RTS1, we have compared the existing DO for Grafham WTW (i.e. with the current storage) against DO calculated to reflect the additional storage created by building a new reservoir. This was done for both the historic and climate change scenarios. The WAFU in the table above is the difference between the baseline DO and the DO after increasing storage in both scenarios.

For the historic scenario the baseline DO was constrained by the group licence. Therefore even with additional storage this constraint would limit the DO so there is no benefit. For the climate change scenario the baseline DO is less than the historic baseline (i.e. the DO of Grafham with current storage would reduce due to climate change). The additional storage increases the DO back to the maximum which is limited by the group licence. Therefore there would be a DO benefit for increasing storage at in the climate change scenario.

Table 6.177: Water quality considerations for Ruthamford South WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
RTS1	New Ruthamford South WRZ reservoir	Required	Not required
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	Not required	Not required
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	Not required	Not required
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	Not required	Not required
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	Not required	Not required
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	Not required	Not required
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	Required	Required

Option RTS1 requires a new source of raw water and has been assumed that treatment to remove Metaldehyde is required even though it is supplying an area with an existing Undertaking, see section 5.2.

Table 6.179: Other environmental considerations for Ruthamford South WRZ feasible supply-side options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
RTS1	New Ruthamford South WRZ reservoir	Low	Low	The RTS1 reservoir would be located relativity close to the raw water source. Therefore the INNS risks associated with reservoir overflows are low compared to some of the other reservoir options.
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	Low	Low	None
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	Low	Low	None
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	Low	Low	None
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	Low	Low	None
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	Low	Low	None
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	Low	Low	None

Table 6.179: Other environmental considerations for Ruthamford South WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
RTS1	New Ruthamford South WRZ reservoir	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.20.7 Costs

Table 6.180: Ruthamford South WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
RTS1	New Ruthamford South WRZ reservoir	17.2	308,631	873	83,754	1,300
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	70	28,211	170	21,923	499
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	80	71,673	1,033	54,454	3,249
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	55	62,488	551	44,615	1,665
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	10	24,054	124	7,223	354
RTS Intra1	Intra WRZ Ruthamford South WRZ Transfer to Woburn PZ	5	3,568	33	859	71
RTS Intra2	Intra WRZ Ruthamford South WRZ Transfer to Meppershall PZ	5	16,139	98	2,266	131

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.181: Ruthamford South WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
RTS1	New Ruthamford South WRZ reservoir	5	5
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	1	1
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	2	2
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	3	3
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	4	4

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.20.8 Inter-dependencies, links and synergies synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.182: Ruthamford South WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
RTS1	New Ruthamford South WRZ reservoir	None	
RTS5	Ruthamford Central WRZ to Ruthamford South WRZ Transfer	None	RTC2
RTS9	Ruthamford North WRZ to Ruthamford South WRZ Transfer (80 Ml/d)	None	RTN25
RTS11	Ruthamford North WRZ to Ruthamford South WRZ Transfer (55 Ml/d)	None	RTS11, RTS12
RTS12	Ruthamford North WRZ to Ruthamford South WRZ Transfer (10 Ml/d)	None	RTS12, RTS9

There are no synergies with other programmes for the options in Ruthamford South WRZ.

6.21 Ruthamford West Water Resource Zone

6.21.1 Constrained Options

The table below contains the list of constrained options considered for Ruthamford West WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.183: Ruthamford West WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage	RTW2	Recommission Ruthamford West Reservoir WTW	No
Increase reservoir yield		Ruthamford West reservoir dam raising	
Bulk transfers	RTW1/ RTW3	Ruthamford North WRZ Transfer	Yes

6.21.2 Feasible options

The table below provides details of the options for Ruthamford West WRZ taken forward for economic modelling.

Table 6.184: Ruthamford West WRZ Feasible Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage	RTW2	Recommission Ruthamford West Reservoir WTW	No
Increase reservoir yield		Ruthamford West reservoir dam raising	
Bulk transfers	RTW1/ RTW3	Ruthamford North WRZ Transfer	Yes

Table 6.185: Ruthamford West WRZ options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
RTW2	Recommission Ruthamford West Reservoir WTW	6	I015654	Due to the high uncertainty and risks associated with the environmental mitigation measures required to re-commission the reservoir at Foxcote we have removed this option from the feasible options set. These risks could be further assessed if required to develop this option in the future.

6.21.2 Feasible options

The table below provides details of the options for Ruthamford West WRZ taken forward for economic modelling.

Table 6.184: Ruthamford West WRZ Feasible Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
New reservoir storage	RTW2	Recommission Ruthamford West Reservoir WTW	No
Increase reservoir yield		Ruthamford West reservoir dam raising	
Bulk transfers	RTW1/ RTW3	Ruthamford North WRZ Transfer	Yes

6.21.3 Transfer Option Details

Table 6.186: Transfer options for Ruthamford West WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	36.3	409	1	15
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	36.3	900	1	15

6.21.4 Resource Option Details

There are no feasible new resource options identified for Ruthamford West WRZ.

6.21.5 Environmental considerations

Table 6.187: Climate change impacts of Ruthamford West WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	N/A	N/A	N/A
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	N/A	N/A	N/A

Table 6.188: Water quality considerations for Ruthamford West WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	Not required	Not required
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	Not required	Not required

Table 6.189: INNS risks for Ruthamford West WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	Low	Low	None
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	Low	Low	None

Table 6.190: Other environmental considerations for Ruthamford West WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

Table 6.191: Ruthamford West WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	10	15,410	113	4,716	321
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	70	45,647	541	35,006	1,679

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.192: Ruthamford West WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	2	2
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	1	1

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.21.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.193: Ruthamford West WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
RTW1	Ruthamford North WRZ to Ruthamford West WRZ Transfer (10 Ml/d)	None	RTW3
RTW3	Ruthamford North WRZ to Ruthamford West WRZ Transfer (70 Ml/d)	None	RTW1

There are no synergies with other programmes for the options in Ruthamford West WRZ.

6.22 South Essex Water Resource Zone

6.22.1 Constrained Options

The table below contains the list of constrained options considered for South Essex WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.194: South Essex WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Direct river abstraction		Colne - Change the Hands off Flow(HOF)	
New reservoir storage	SEX2	Ardleigh extension	Yes
Increase reservoir yield		Increasing storage at private lakes	

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Review group licences	
		Observation boreholes	
		Braintree boreholes	
		Tiptree boreholes	
Artificial Storage and Recovery wells (or 'Aquifer Storage and Recharge') (ASR)	SEX6/ SEX12	Colchester Water Reuse	Yes
		Southend water reuse	
		Process improvements to reduce losses WTW	
Bulk transfers	SEX10	Sudbury WRZ Transfer	Yes
		Central Essex WRZ Transfer	
	SEX4/ SEX8	East Suffolk WRZ Transfer	Yes
Resource Sharing with other Water Companies	SEX9	Affinity Water - to continue with Colchester WTW agreement at 70:30	No
	SEX5	Affinity Water - to amend Colchester WTW agreement at 80:20	No
		Essex and Suffolk Water	
		Thames Water	
3rd Party Options		3rd party trade options	
Improved/sophisticated conjunctive management	SEX7	Optimise use of Colchester resources	Yes

6.22.2 Feasible options

The table below provides details of the options for South Essex WRZ taken forward for economic modelling.

Table 6.195: South Essex WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
SEX1	Colchester water reuse	15.1	4.5	5	I008461
SEX2	Ardleigh reservoir extension	3.4	0.5	15	I010497
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	15	2.3	4	I015247
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	6.5	1.7	4	I013817

6.22.3 Transfer Option Details

Table 6.197: Transfer options for South Essex WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	41.5	500	1	23
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	35.6	458	1	8

6.22.4 Resource Option Details

6.22.4.1 SEX1 Colchester water reuse

The option requires additional treatment process to be added at the end of the Colchester WRC. A new pipeline is required to divert the treated effluent upstream of the abstraction on the River Colne.

This recycling of water is assumed to be available for abstraction using a put and take licence. The option includes for upgrade of the infrastructure to supply Ardleigh reservoir and an expansion to the WTW to achieve the maximum benefit of the scheme.

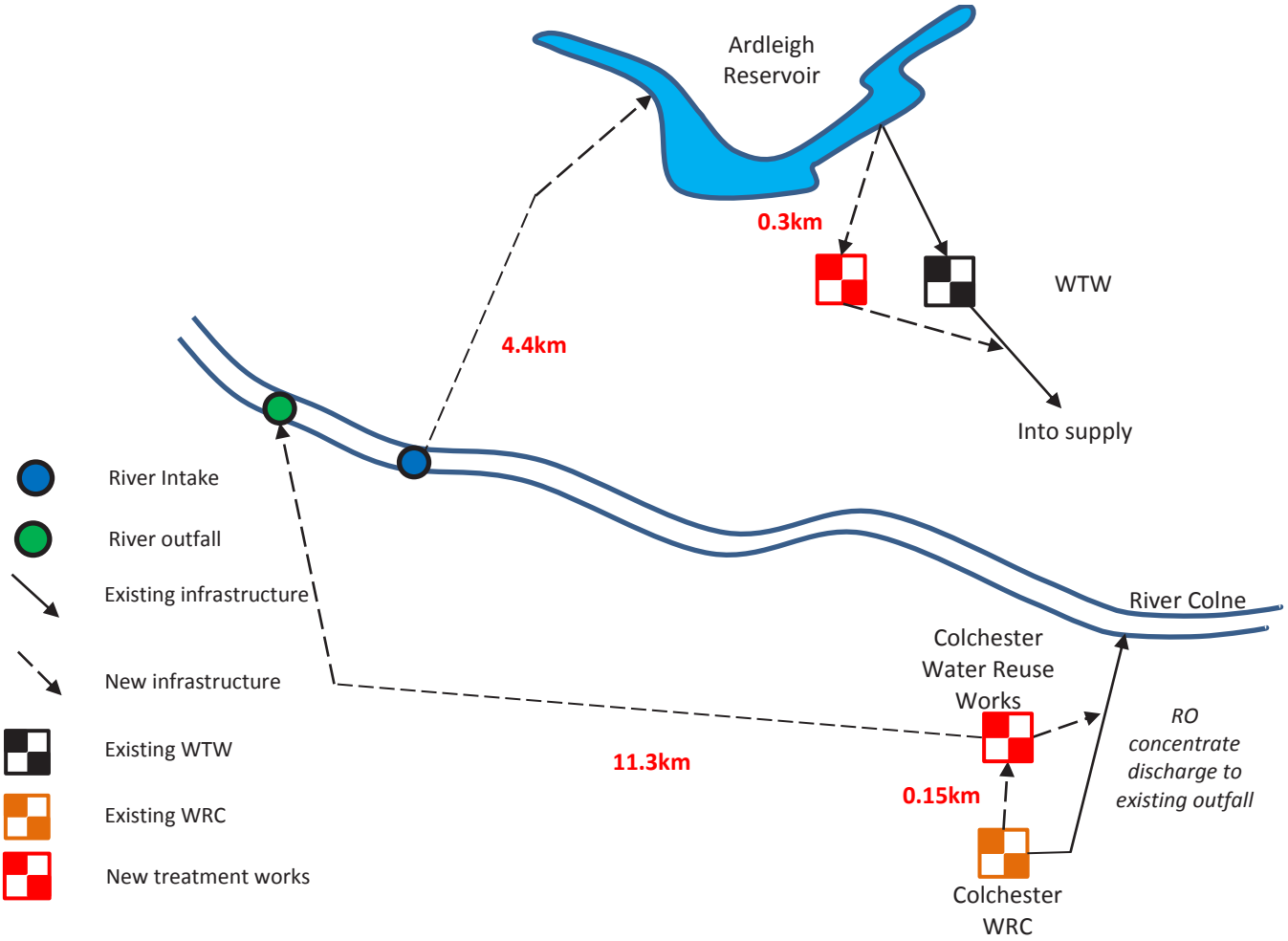


Figure 6.23: Schematic for SEX1 Colchester water reuse

The effluent from the WRC would require treatment by Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis and UV disinfection.

Identified Risks:

- Cost Risk: There is limited space available to construct additional treatment at Colchester WRC. Site layouts should be prepared to establish whether additional land should be purchased. The abstraction point in the River Colne is in the city centre and could result in considerable planning delays.
- Quality Risk: The water reuse plant should have the level of redundancy and design robustness as detailed in the Guidelines for Water Reuse (USEPA, 2012) in order to ensure that the water being pumped into the River Colne meets the quality requirements.
- Programme Risk: Detailed consultation with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in South East England over many years, this scheme would differ as it would deliberately reuse the effluent. Consequently public perception issues must be carefully managed to minimise objections.
- Environmental Risk: The discharge and re-abstraction of re-used water into the River Colne would require approval from the Environment Agency and abstraction may be limited to the requirement to maintain the "hands-off" river flows.

6.22.4.2 SEX2 Ardleigh reservoir extension

This option utilises the gravel pits adjacent to Ardleigh reservoir to provide additional storage. The pits are being created as part of mineral extraction however once this work has been completed these pits would be available to adapt into a reservoir. The reservoir would be filled from the existing abstraction on the River Colne within the existing licence. Additional treatment capacity would be required to treat the additional yield from the new storage volume.

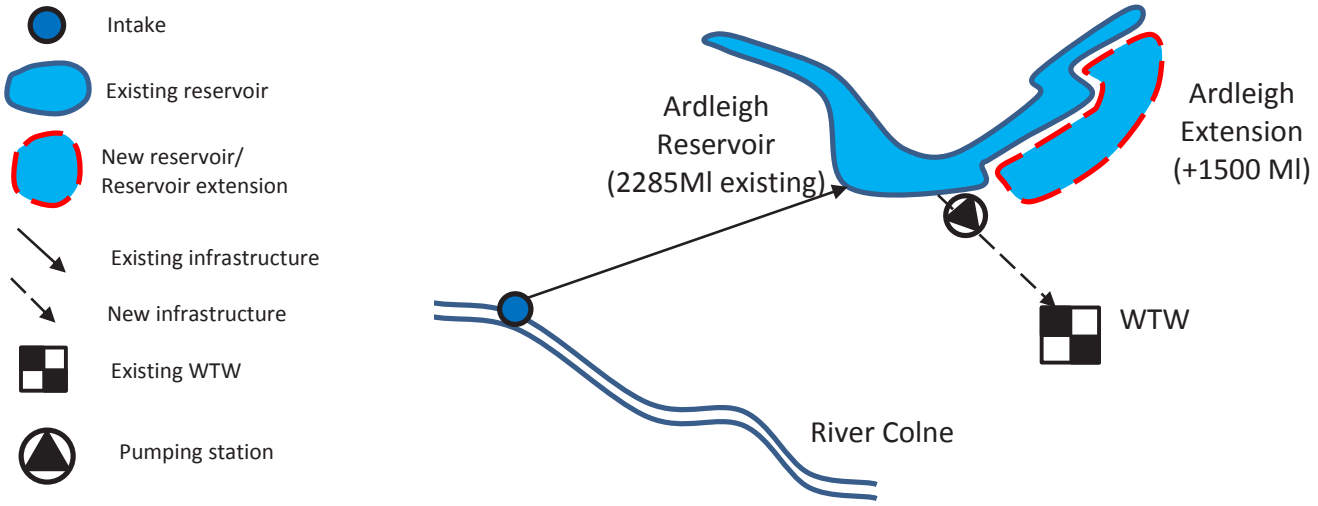


Figure 6.24: Schematic for SEX2 Ardleigh extension

Identified Risks:

- Cost risks: there are number of options for the scope of works carried out by the mineral extraction company in relation to the reservoir ancillary structures prior to hand over to Anglian Water (i.e. inclusion of draw-off works etc. in their scope). A change in scope may have an impact on the capex and opex for this option.
- Programme risks: The scheme is dependent on when the mineral extraction is complete and the gravel pits are available to be converted to a reservoir.

6.22.5 Environmental considerations

Table 6.198: Climate change impacts of South Essex WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
SEX1	Colchester water reuse	15.1	15.1	0
SEX2	Ardleigh reservoir extension	0	3.4	-
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	N/A	N/A	N/A
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	N/A	N/A	N/A

To establish the DO benefit for the Ardleigh extension (SEX2), we have compared the existing DO for Ardleigh (i.e. with the current storage) against DO calculated to reflect the additional storage created by extending reservoir. This was done for both the historic and climate change scenarios. The WAFU in the table above is the difference between the baseline DO and the DO after increasing storage in both scenarios.

For the historic scenario the baseline DO was constrained by the group licence. Therefore even with additional storage this constraint would limit the DO so there is no benefit. For the climate change scenario the baseline DO is less than the historic baseline (i.e. the DO of Ardleigh with current storage would reduce due to climate change). The additional storage increases the DO but it is limited by the extended reservoir yield. Therefore there would be a DO benefit for increasing storage at Ardleigh in the climate change scenario.

Table 6.199: Water quality considerations for South Essex WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
SEX1	Colchester water reuse	Not required	Not required
SEX2	Ardleigh reservoir extension	Not required	Not required
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	Not required	Not required
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	Not required	Not required

Table 6.200: INNS risks for South Essex WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
SEX1	Colchester water reuse	High	Low	None
SEX2	Ardleigh reservoir extension	Low	Low	None
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	Low	Low	None
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	Low	Low	None

Table 6.201: Other environmental considerations for South Essex WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
SEX1	Colchester water reuse	Minor level of impacts	Risks can be mitigated	Appropriate assessment concluded no adverse effects on site integrity
SEX2	Ardleigh reservoir extension	Not assessed	Minor effects on ecology and landscape. Other risks can be mitigated	No likely significant effects determined at screening
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.22.6 Costs

Table 6.202: South Essex WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
SEX1	Colchester water reuse	15.1	92,382	4,217	11,135	5,220
SEX2	Ardleigh reservoir extension	2	19,718	161	1,912	160
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	15	24,467	271	7,102	821
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	6.5	16,094	87	4,753	268

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.203: South Essex WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
SEX1	Colchester water reuse	4	4
SEX2	Ardleigh reservoir extension	3	3
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	1	1
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	2	2

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.22.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.204: South Essex WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
SEX1	Colchester water reuse	None	
SEX2	Ardleigh reservoir extension	None	
SEX4	East Suffolk WRZ to South Essex WRZ transfer (15 Ml/d)	None	ESU6, SEX8
SEX8	East Suffolk WRZ to South Essex WRZ transfer (6.5 Ml/d)	None	ESU6, SEX4

The options assessed for East Suffolk WRZ have the following synergies and links to other programmes,

- The transfer options from East Suffolk would provide supply system resilience to WTWs within the East Suffolk WRZ.

6.23 South Fenland Water Resource Zone

6.23.1 Constrained Options

The table below contains the list of constrained options considered for South Fenland WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.205: South Fenland WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Relocating existing boreholes (away from the River to reduce impact)	
Reclaimed water	SFN6	Process improvements to reduce losses WTW	Yes
Bulk transfers	SFN1/ SFN3/ SFN4	Ruthamford North WRZ Transfer	Yes
	SFN2	North Fenland WRZ Transfer	Yes
Resource Sharing with other Water Companies		Cambridge Water	
3rd Party Options		EOETs & GOGS review	
Tankering of water		Sea tankering (Kings Lynn)	
Improved/sophisticated conjunctive management	SFN7	Kings Lynn/Wisbech conjunctive use - amend existing operation	

6.23.2 Feasible options

The table below provides details of the options for South Fenland WRZ taken forward for economic modelling.

Table 6.206: South Fenland WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	80	12.5	4	I012715
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	22	1.2	4	I010052
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	22	3.1	4	I012750
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	40	6.1	4	I015232

Table 6.207: South Fenland WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
SFN6	Process improvements to reduce losses WTW	0.36	I009977	Process improvements could be implemented to recover wash water from ASG and GAC however it only yields 0.36 Ml/d. As DO benefits are low it has not been modelled.

6.23.3 Transfer Option Details

Table 6.208: Transfer options for South Fenland WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	55.5	1000	1	26
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	22.0	500	1	0
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	55.5	500	1	26
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	55.5	700	1	0

6.23.4 Resource Option Details

There are no feasible new resource options identified for South Fenland WRZ.

6.23.5 Environmental considerations

Table 6.209: Climate change impacts of South Fenland WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	N/A	N/A	N/A
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	N/A	N/A	N/A
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	N/A	N/A	N/A
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	N/A	N/A	N/A

Table 6.210: Water quality considerations for South Fenland WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	Low	Low	None
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	Low	Low	None
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	Low	Low	None
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	Low	Low	None

Table 6.212: Other environmental considerations for South Fenland WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	Minor level of impacts	Risks can be mitigated	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan

6.23.6 Costs

Table 6.213: South Fenland WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	81,014	345	62,892	1,163	81,014
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	14,751	320	8,920	982	14,751
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	35,307	575	22,290	–	35,307
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	50,290	481	36,158	1,485	50,290

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.23.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.215: South Fenland WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
SFN1	Ruthamford North WRZ to South Fenland WRZ Transfer (80 Ml/d)	None	RTN17, SFN3, SFN4
SFN2	North Fenland WRZ to South Fenland WRZ Transfer	None	NFN4, NFN8
SFN3	Ruthamford North WRZ to South Fenland WRZ Transfer (22 Ml/d)	None	RTN17, SFN1, SFN4
SFN4	Ruthamford North WRZ to South Fenland WRZ Transfer (35 Ml/d)	None	RTN17, SFN1, SFN3

The options assessed for South Fenland WRZ have the following synergies and links to other programmes,

- There is a NEP mitigation option for South Fenland WRZ, more details are described in the Sustainable abstraction technical document.
- The deficits in South Fenland WRZ are partly driven by drought impacts therefore the options selected would link to the Drought Plan.

6.24 South Humber Bank Water Resource Zone

6.24.1 Constrained Options

South Humber Bank was not a separate WRZ at the time of developing the unconstrained options set. Unconstrained options for South Humber Bank WRZ were included in the Central Lincolnshire WRZ and East Lincolnshire WRZ.

6.24.2 Feasible options

The table below provides details of the options for South Humber Bank WRZ taken forward for economic modelling.

Table 6.216: South Humber Bank WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
SHB1	South Humber Bank Desalination	23	6.9	4	I008274
SHB2	Pyewipe Water Reuse for non-potable use	20.4	6.2	3	I009985

6.24.3 Transfer Option Details

There are no transfer options for the South Humber Bank WRZ.

6.24.4 Resource Option Details

6.24.4.1 SHB1 South Humber Bank Desalination

Desalination for non-potable demand in the South Humber Bank. The option requires Reverse Osmosis of saline water and remineralisation. New pipelines are required to abstract water from the Humber estuary, discharge the brine into the sea and supply pipe to the non-potable network.

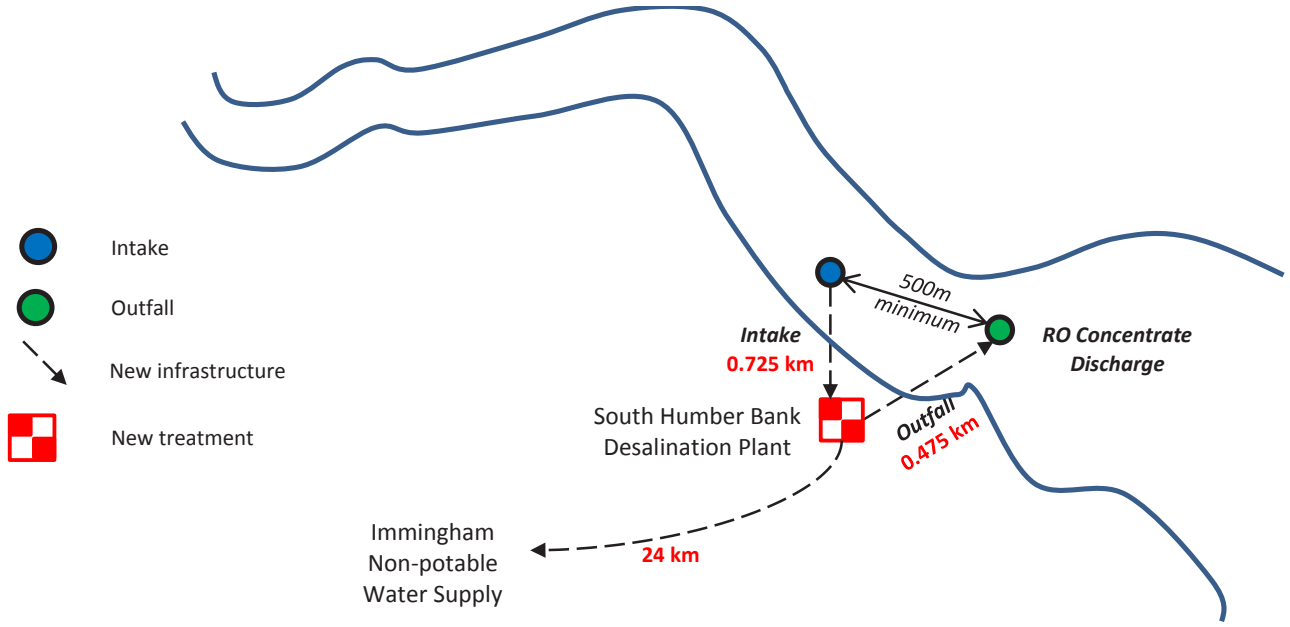


Figure 6.25: Schematic SHB1 South Humber Banks Desalination

The proposed pre-treatment comprises lamella clarifiers and Ultrafiltration (UF). The UF product will be pumped into the desalination plant. The sludge is dewatered and sent to landfill. The backwash waste will be discharged with the brine to sea via a new long sea outfall. The product water will be remineralised and pumped into the treated water network via a new pipeline.

Identified Risks:

- Cost Risk: The intake and brine discharge pipes will have to be laid through the town, coastal road and out to the sea. There could be delays installing sub-sea pipelines in the event of bad weather. The desalination plant will have high energy requirements and a new electrical supply will be needed.
- Quality Risk: The addition of large quantities of lime and carbon dioxide to achieve a similar alkalinity concentration to the current water supply may result in higher levels of turbidity. Moreover, major oil spills at the intake location may result in plant shutdown.
- Environmental Risk: Impacts of brine discharge.
- Licencing and consenting risks.

6.24.4.2 SHB2 Pyewipe Water Reuse for non-potable use

Water reuse for non-potable demand in the South Humber Bank. The option requires additional treatment process to be added at the end of the WRC. A new pipeline is required to divert the treated effluent to the non-potable network.

The effluent from the WRC would require treatment by Nitrifying and Denitrifying BAFF, fine screening, ultrafiltration, reverse osmosis and UV disinfection.

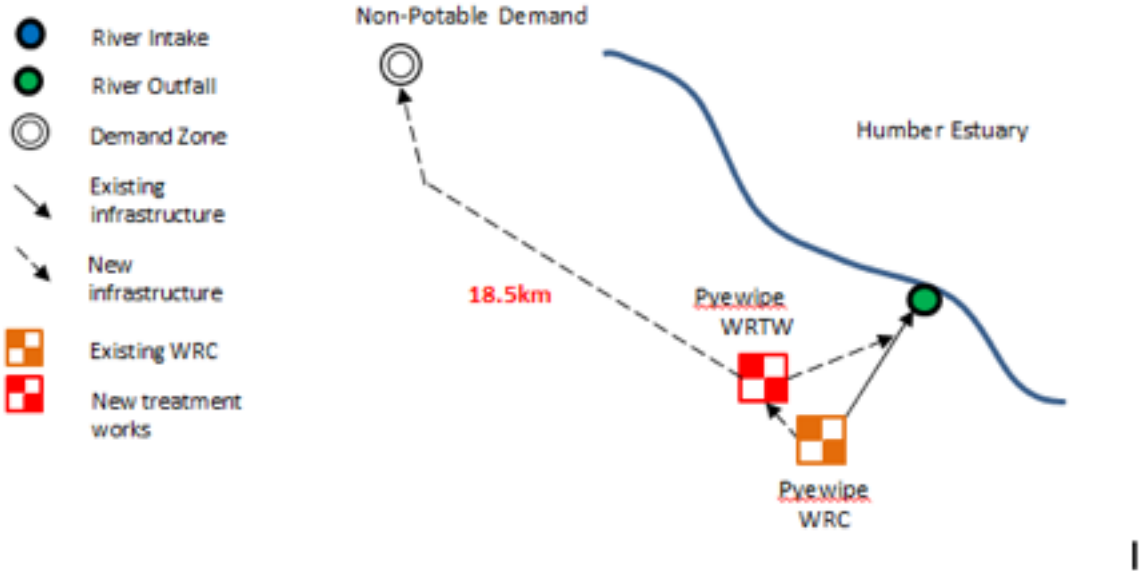


Figure 6.26: Schematic for SHB2 Pyewipe reuse for non-potable use

Identified Risks:

- Cost Risk: Site layouts should be prepared to establish whether additional land should be purchased for the new WRC at the Pyewipe site. The site has known poor ground conditions and is likely to require piling works which could increase the cost of the groundworks for the WRC development.
- Quality Risk: The water reuse plant will discharge directly into the non-potable network and the receiving customers will need to be consulted to ensure the water chemistry is suitable for the industrial processes.
- Programme Risk: Detailed consultation with key stakeholders such as the Environment Agency and the Drinking Water Inspectorate could have an impact on the programme.
- Public Relations Risk: Whilst indirect potable water reuse has been widely practised in South East England for many years, this scheme would differ as it would deliberately reuse the effluent. Consequently, public perception issues must be carefully managed to minimise objections.
- Environmental Risk: The raw water salinity is unknown which will affect the output of the WRTW and the reduction in the current discharge to the South Humber Estuary would require approval from the Environment Agency.

6.24.5 Environmental considerations

Table 6.217: Climate change impacts of South Humber Bank WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
SHB1	South Humber Bank Desalination	23	23	0
SHB2	Pyewipe Water Reuse for non-potable use	20.6	20.6	0

Table 6.218: Water quality considerations for South Humber Bank WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
SHB1	South Humber Bank Desalination	Not required	Not required
SHB2	Pyewipe Water Reuse for non-potable use	Not required	Not required

Table 6.219: INNS risks for South Humber Bank WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
SHB1	South Humber Bank Desalination	Low	Low	None
SHB2	Pyewipe Water Reuse for non-potable use	Low	Low	None

Table 6.220: Other environmental considerations for South Humber Bank WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
SHB1	South Humber Bank Desalination	Moderate level of impact	Effects on WFD and ecology to be further investigated through WFD Phase 3 assessment and Task II Appropriate Assessment if option taken forward in the future. Other risks can be mitigated.	Likely significant effects determined at screening, no appropriate assessment undertaken as not in least cost plan or Preferred Plan
SHB2	Pyewipe Water Reuse for non-potable use	Minor level of impacts	Risks can be mitigated	Appropriate assessment concluded no adverse effects on site integrity

6.24.6 Costs

Table 6.221: South Humber Bank WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
SHB1	South Humber Bank Desalination	23	93,427	10,143	14,730	31,865
SHB2	Pyewipe Water Reuse for non-potable use	20.4	56,194	4,239	9,377	6,824

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

Table 6.222: South Humber Bank WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
SHB1	South Humber Bank Desalination	2	2
SHB2	Pyewipe Water Reuse for non-potable use	1	1

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.24.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.223: South Humber Bank WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
SHB1	South Humber Bank Desalination	None	–
SHB2	Pyewipe Water Reuse for non-potable use	None	–

The options assessed for South Humber Bank WRZ have the following synergies and links to other programmes,

- The new resource development options would provide supply system resilience to WTWs within the South Humber Bank WRZ.

6.25 South Lincolnshire Water Resource Zone

6.25.1 Constrained Options

The table below contains the list of constrained options considered for South Lincolnshire WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.224: South Lincolnshire WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Groundwater wells (boreholes)		Existing unused sources	
Reclaimed water		Process improvements to reduce losses WTW	
Bulk transfers		Grantham canal (flow reversal)	
	SLN2	Bourne WRZ Transfer	Yes
	SLN1/ SLN3/ SLN5/ SLN6 SLN7	Central Lincolnshire WRZ Transfer	Yes (SLN3 – using the existing link between CLN and SLN is no longer feasible)

6.25.2 Feasible options

The table below provides details of the options for South Lincolnshire WRZ taken forward for economic modelling.

Table 6.225: South Lincolnshire WRZ Feasible Options

Opt Ref	Option Name	Average Capacity (Ml/d)	Minimum Capacity (Ml/d)	Implementation Period (yrs)	C55 Investment Code
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	35	4.5	4	I010046
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	30	4.5	4	I015258
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	63	10.1	4	I021932
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	40	12.0	4	I021932

Table 6.226: South Lincolnshire WRZ feasible options not taken through to economic modelling

Opt Ref	Option Name	Average Capacity (Ml/d)	C55 Investment Code	Reason for not including in economic modelling
SLN2	Bourne WRZ Transfer	5	I010037	Final planning scenario – transfer would be <5 Ml/d and not part of a strategic route therefore rejected.

Option SLN3 Central Lincolnshire WRZ to South Lincolnshire WRZ (CLTM) involved using existing infrastructure that was due to be refurbished. The Central Lincolnshire Trunk Main (CLTM)was to become a resilience link which would be used to support South Lincolnshire in a drought. This option is no longer feasible as this existing main is to be taken out of supply.

6.25.3 Transfer Option Details

Table 6.227: Transfer options for South Lincolnshire WRZ

Opt Ref	Option Name	Total Length (km)	Internal Diameter (mm)	No of Pumping Stations	Crossings requiring directional drilling
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	55.8	600	1	23
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	55.8	600	1	23
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	55.8	900	2	26
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	55.8	800	2	26

6.25.4 Resource Option Details

There are no feasible new resource options identified for South Lincolnshire WRZ.

6.25.5 Environmental considerations

Table 6.228: Climate change impacts of South Lincolnshire WRZ supply-side feasible options

Opt Ref	Option Name	WAFU based on historic without climate change (Ml/d)	WAFU based on historic with climate change (Ml/d)	Climate Change impact on WAFU (Ml/d)
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	N/A	N/A	N/A
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	N/A	N/A	N/A
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	N/A	N/A	N/A
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	N/A	N/A	N/A

Table 6.229: Water quality considerations for South Lincolnshire WRZ supply-side feasible options

Opt Ref	Option Name	Metaldehyde Treatment required	Water quality measures associated with mixing surface water and groundwater in the treated water network
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	Not required	Not required
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	Not required	Not required
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	Not required	Not required
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	Not required	Not required

Table 6.230: INNS risks for South Lincolnshire WRZ supply-side feasible options

Opt Ref	Option Name	INNS Risk Before Mitigation	INNS Risk After Mitigation	Notes
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	Low	Low	None
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	Low	Low	None
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	Low	Low	None
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	Low	Low	None

Table 6.231: Other environmental considerations for South Lincolnshire WRZ feasible supply-side options

Opt Ref	Option Name	WFD no deterioration	SEA	HRA
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	Minor level of impacts	Risks can be mitigated	No likely significant effects determined at screening

6.25.6 Costs

Table 6.232: South Lincolnshire WRZ Supply-side feasible option costs and carbon

Opt Ref	Option Name	Average Capacity (Ml/d)	Capex (£k)	Opex (£k/yr)	Capital Carbon TCo2e	Operational carbon TCO2e per yr
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	35	47,098	1,984	30,048	6,308
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	30	45,479	1,451	29,401	4,599
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	63	28,754	2,442	33,320	4,285
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	40	72,175	1,427	49,170	4,474

The options have been ranked based on the Average Incremental Costs (AIC) and Average Incremental Social Cost (AISC) calculated in WRMP table WRP5, these are shown in the table below. The options have been ranked in ascending AIC/AISC i.e. the option ranked 1 has the lowest AIC/AISC.

6.25.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.233: South Lincolnshire WRZ Supply-side feasible option AIC, AISC rankings

Opt Ref	Option Name	AIC Ranking	AISC Ranking
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	2	2
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	3	3
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	1	1
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	4	4

The ranking of AICs and AISCs may vary from the options selected by the EBSD model. The model completes a more sophisticated analysis and takes into account the timing of option availability, utilisation capacity of option and ability for combinations of options to meet deficit.

6.25.7 Inter-dependencies, links and synergies

The table below shows where options were modelled with dependencies or as mutually exclusive.

Table 6.234: South Lincolnshire WRZ feasible supply-side options modelled as mutually exclusive

Opt Ref	Option Name	Dependencies	Exclusivities
SLN1	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (35 Ml/d)	None	SLN5, SLN6, SLN7
SLN5	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (30 Ml/d)	None	SLN1, SLN6, SLN7
SLN6	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (63 Ml/d)	None	SLN1, SLN5, SLN7
SLN7	Central Lincolnshire WRZ to South Lincolnshire WRZ Transfer (40 Ml/d)	None	SLN1, SLN5. SLN6

The options assessed for South Lincolnshire WRZ have the following synergies and links to other programmes,

- There are a number of NEP mitigation options for South Lincolnshire WRZ, more details are described in the Sustainable abstraction technical document.
- The feasible options would provide supply system resilience to a WTW within the South Lincolnshire WRZ including customers in Grantham.

6.26 South Norfolk Rural Water Resource Zone

6.26.1 Constrained Options

The table below contains the list of constrained options considered for South Norfolk Rural WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.235: South Norfolk Rural WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Bulk transfers		Norwich and the Broads WRZ Transfer	
		North Norfolk Rural WRZ transfer	
Resource Sharing with other Water Companies		Essex and Suffolk Water	

6.27.2 Feasible options

No options have been developed further for the Sudbury WRZ because the forecast for Sudbury WRZ shows a surplus at the end of the planning horizon, therefore options are not required within the WRZ.

6.28 Thetford Water Resource Zone

6.28.1 Constrained Options

The table below contains the list of constrained options considered for Thetford WRZ. Details of the full unconstrained list and the reasons for screening and rejecting options can be found in Appendix B.

Table 6.237:Thetford WRZ Constrained Options

Scheme Type	Opt Ref	Option Name	Included in Feasible Option Set
Bulk transfers	THT2	Bury and Haverhill WRZ transfer	
	THT1a	Ixworth WRZ transfer	Yes
	THT3	North Norfolk Rural WRZ transfer	
Resource Sharing with other Water Companies		Cambridge Water	

6.28.2 Feasible options

The feasible option THT1a has been developed with Ixworth WRZ. Section 6.11.2 has full details of how the options have been developed. This also explains why there are no costs associated with this option in WRP table 5.

6.28.3 Resource Option Details

There are no feasible new resource options identified for Thetford WRZ.

SUPPLY SIDE OPTIONS DEVELOPMENT REPORT - APPENDICES

APPENDIX A – ABBREVIATIONS

Abbreviation	
AMP	Asset Management Period
AP	Assessment Point (used in CAMS)
ASR	Aquifer Storage & Recharge
CAMS	Catchment Abstraction Management Strategies
Capex	Capital expenditure
CLTM	Central Lincolnshire Trunk Main
CRT	Canal and Rivers Trust
DO	Deployable Output
dWRMP	Draft WRMP
EBSD	Economics of Balancing Supply and Demand
EOETs	Ely Ouse Essex Transfer Scheme
GOGS	Great Ouse Groundwater Scheme
GWMU	Groundwater Management Unit (used in CAMS)
HOF	Hands off Flow
HRA	Habitats Regulation Assessment
IDBs	Internal Drainage Boards
INNS	Invasive Non-Native Species
LNR	Local Nature Reserves
LSE	Likely significant effects
MoD	Ministry of Defence
MRF	Minimum Residual Flow
NNR	National Nature Reserves
Opex	Operational expenditure
PR19	Price Review 2019
SAC	Special Areas for Conservation
SCI	Sites of Community Importance
SEA	Strategic Environmental Assessment
SPA	Special Protection Areas

Abbreviation	
SSSI	Sites of special scientific interest
SUDS	Sustainable Urban Drainage System
TWA	Trent Witham Ancholme Scheme
WAFU	Water Available for Use
WFD	Water Framework Directive
WINEP	Water Industry National Environment Programme
WRC	Water Recycling Centre
WRE	Water Resources East
WRLTPF	Water UK Water Resources Long-Term Planning Framework
WRMP	Water Resources Management Plan
WRPG	Water Resources Planning Guideline
WRZ	Water Resource Zone
WTW	Water Treatment Works

APPENDIX B – REJECTION REGISTER

Bourne WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Nene						x					CAMS assessment shows no water available	Y	N	N	N
			River Welland						x					CAMS assessment shows N water available	Y	N	N	N
			River Glen						x					CAMS assessment shows N water available	Y	N	N	N
			South Forty foot Drain						x					CAMS assessment shows that water is available at all flow values. See CAMS report, Witham AP7, South Forty Foot Outfall. This option is being included in South Lincolnshire Reservoir	Y	N	N	N
New reservoir storage	Private lakes and gravel pits		Tallington Lakes	x	x	x			x					Abstraction from the pits will affect the availability of water downstream in the River Welland. N water available for licencing.	Y	Y	N	N
			River Welland Washes		x		x		x					CAMS assessment shows that the HOF is as high as 694ML and water is only available on average 31 days per year so using this as a reservoir would Nt be hydrologically reliable.	Y	N	N	N
	Flood storage		Nene washes		x									High risk of failure due to uncertain DO	Y	N	N	N
			Internal Drainage Boards (IDBs) - South Forty Foot Drain						x			x		Uncertainty over any additional DO compared to a Nrmal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
Bulk transfers	By pipeline - potable water transfer	BRN1	Ruthamford Nrth WRZ Transfer												Y	Y	Y	Y
Improved/ sophisticated conjunctive management		BRN3	Ruthamford conjunctive use			x								Ruthamford system already connected to Bourne and systems work conjunctively already.	Y	Y	N	N

Bury Haverhill WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does Not address the problem			Breaches unalterable planning constraints	Option is Not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Lark						x					CAMS assessment shows that water not available in the Lark .	Y	N	N	N
			Little Ouse						x					CAMS assessment indicates that only a small quantity of water is available during winter	Y	N	N	N
New reservoir storage	Private lakes and gravel pits		Increasing storage at private lakes e.g. Livermere Lakes						x			x		The Broad Water and Long Water are fed by groundwater from the Chalk. The lakes are supplied by water from the Broad Water and are also losing to groundwater. CAMS indicates there is no groundwater available for abstraction	Y	Y	N	N
Groundwater wells (boreholes)			Surface water treatment of River Stour near Haverhill						x					CAMS assessment shows no water available	Y	N	N	N
			Ampton Lake waterbody as a source of water near Bury		x	x	x		x					Ampton lake is fed by groundwater from the Chalk and CAMS suggests there is no water available for abstraction.	Y	Y	N	N
			EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
			Bury St Edmunds groundwater sources		x				x					WFD assessment - no additional resource available	Y	Y	N	N
Aquifer Storage and Recharge (ASR)			Bury St Edmunds Scheme		x	x			x			x		Poor hydrogeological setting with significant unconfined features indicate high risk of losing stored water.	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Bury St Edmunds Water reuse		x		x					x		Option to use ASR for storage is not feasible due to hydrogeological risks and constraints.	Y	Y	N	N
	Reclaimed domestic		Haverhill Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint	Y	N	N	N

Bury Haverhill WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does Not address the problem			Breaches unalterable planning constraints	Option is Not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	wastewater													leading to environmental issues				
	Reclaimed domestic wastewater	BHV3	River Lark Recirculation Scheme												Y	Y	Y	Y
Bulk transfers	By pipeline - potable	BVH2/ BVH7	East Suffolk WRZ transfer												Y	Y	Y	Y
			South Essex WRZ Transfer											Superseded by South Essex to East Suffolk to Bury and Haverhill transfer options	Y	Y	Y	N
			Thetford WRZ Transfer											Existing transfer to Bury St Edmunds from Thetford. Surplus in Thetford transferred to Ixworth WRZ to meet deficits there. Any residual surplus could be transferred via existing link. Therefore this option was not modelled.	Y	Y	Y	N
		BHV4	Sudbury WRZ Transfer											Surplus in Sudbury is <5Ml/d. Due to the uncertainty of availability of resources in the future due to WFD we have not taken forward transfers <5Ml/d in locations there are not part of a strategic transfer route to avoid the risk of stranded assets.	Y	Y	Y	N
			Cheveley WRZ transfer		x	x								No resource available to transfer and not part of a strategic route.	Y	Y	N	N
		BHV1/ BHV5/ BHV6	Newmarket WRZ transfer												Y	Y	Y	Y
			Central Essex WRZ Transfer											Surplus is <5Ml/d and not part of a strategic transfer route.	Y	Y	Y	N
Resource Sharing with other Water Companies			Affinity (East and Central)		x	x			x					No resource available, therefore rejected	Y	Y	N	N
			Cambridge WRC reuse pumping to River Stour											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Cambridge Water		x	x			x					As part of the Ouse Working Group options	Y	Y	N	N

Bury Haverhill WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does Not address the problem			Breaches unalterable planning constraints	Option is Not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														were not identified for specific trades in Bury Haverhill however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.				
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Chicken factory											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Forestry commission											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Green King/ Paul's Malt/ British Sugar											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Review discharge consents											Third party options to be developed when published on Ofwat Information Platform in January 2018	Y	N	N	N
			Rougham WRC (Bury sty Edmunds)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Sugar beet factory											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
			Vegetable producers											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Improved/ sophisticated conjunctive management			Conjunctive use combined with a transfer from another WRZ		x	x						x		Maybe an option to optimise use of groundwater sources depending on the selected preferred options for Bury Haverhill. As an option on it's own there are no new resources options within the WRZ so no conjunctive use benefits.	Y	N	N	N
			EOETS plus additional storage	x	x	x	x		x		x		x	Covered by review of EOETS and GOGS	Y	N	N	N

Bury Haverhill WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does Not address the problem			Breaches unalterable planning constraints	Option is Not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Central Essex WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Other rivers identified from CAMS						x					CAMS assessment shows no water available	Y	N	N	N
			River Blackwater						x					CAMS assessment shows no water available	Y	N	N	N
			River Colne (upstream part)						x					CAMS assessment shows no water available	Y	N	N	N
			River Pant						x					CAMS assessment shows no water available	Y	N	N	N
			River Stour-EOETS						x					CAMS assessment shows no water available	Y	N	N	N
New reservoir storage	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Increase reservoir yield	Private lakes and gravel pits		Increasing storage at private lakes,		x	x	x		x	x		x		None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			Review groundwater group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Central Essex groundwater sources		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Abandoned Central Essex WRZ sources back to supply		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			MOD site boreholes											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Infiltration galleries			Halstead										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Halstead Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable	CEX2	South Essex WRZ Transfer												Y	Y	Y	Y

Central Essex WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Bury and Haverhill WRZ transfer			x						x		No longer feasible option due to main from Bury to Haverhill not being delivered in AMP6. Not adequate resource in Haverhill to transfer to Central Essex WRZ.	Y	Y	N	N
		CEX1	Sudbury WRZ Transfer												Y	Y	Y	Y
Resource Sharing with other Water Companies			EOETs optimisation	x	x	x	x		x		x		x	Covered by review of EOETS and GOGS	Y	N	N	N
3rd Party Options			3rd party trade options											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
			EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Fossdyke						x					Not resilient as CAMS assessment shows that water is only available during winter	Y	N	N	N
			Cringlebrook						x					Not resilient as CAMS assessment shows that water is only available during Q50	Y	N	N	N
			River Don						x					CAMS assessment shows no water available	Y	N	N	N
			Humber						x					CAMS assessment shows that no water is available at any point during the year. Less than 1 ML/d is available at one AP during winter only.	Y	N	N	N
			River Trent						x					CAMS assessment shows that it is not feasible as direct river abstraction on it's own. Option included in other supply options using the lower Trent (Trent WTW expansion, Sherwood ASR, Trent transfers, South Lincolnshire reservoir)	Y	N	N	N
			River Slea						x					Not resilient as CAMS assessment shows that water is only available during Q50 and Q30	Y	N	N	N
			River Till						x					CAMS assessment shows that only a small amount water is available during Winter.	Y	N	N	N
			River Witham						x					CAMS assessment shows that it is not feasible as direct river abstraction on it's own. Option to use Witham included within the South Lincolnshire Reservoir options and associated new flow assessments.	Y	N	N	N
			Ancholme						x					CAMS assessment shows that water is not available at any points during the year along the Ancholme. Two APs have a very small amount of water available during winter only.	Y	N	N	N
New reservoir	Pumped-		Additional storage at		x									Option not relevant to the final planning	Y	Y	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
storage	storage reservoirs		Trent WTW											problem in Central Lincolnshire. Does not provide DO required during low flows in more extreme drought than historic.				
			Cadney extension		x	x	x		x				x	Existing reservoir is fed by the river Ancholme which has superficial flows from the Trent Witham Ancholme scheme. Currently the option is modelled in Aquator assuming constant inflows and outflows. Therefore increasing storage would not provide a DO benefit. Further investigation would be required to determine if there was a benefit to increasing storage at existing reservoir with information on the TWA scheme operation to estimate the R. Ancholme flows. Therefore, it is not a reliable option for WRMP19.	Y	Y	N	N
			Pumped storage reservoir (source any river in Central Lincs)		x									CAMS assessment shows no water available	Y	N	N	N
			Toft Newton Extension		x		x						x	EA comments that this option would not be suitable for WRMP due to the nature of how it is operated - only have short storage capacities	Y	Y	N	N
	On-stream reservoirs		Recommission existing reservoir (Stoke Rochford)		x							x		Small yield with significant uncertainty about reliability under future climate change scenarios. Significant water quality risks in Upper Witham catchment	Y	N	N	N
	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
			Flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
			Trent flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel		Increasing storage at private lakes											None identified as part of the Private Lakes and Reservoir study	Y	N	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	pits		Environment Agency's Toft Reservoir						x	x			x	Asset designed for minimal storage to provide resilience. Will not provide further DO benefit	Y	N	N	N
			Gravel pits south of Hykeham	x	x	x								Review suggests the pits are rainwater fed so the yield will be very small.	Y	Y	N	N
			Trent gravels			x			x				x	Supplied by superficial deposits in continuity with the river Trent, option to abstract from Trent is thought as more feasible that from the gravels	Y	Y	N	N
Increase reservoir yield	Amend abstraction regime		Cadney		x	x	x						x	The current pumps meet the licence capacity, so this does not provide and DO benefits.	Y	Y	N	N
			Trent WTW bankside storage		x	x	x						x	Option would require further storage to make use of higher abstractions. See CLN2	Y	Y	N	N
			Stoke Rochford		x				x					Screened out - does not provide DO required in a drought	Y	N	N	N
	Raising/dredging existing reservoirs		Cadney		x	x	x		x				x	Existing reservoir is fed by the river Ancholme which has superficial flows from the Trent Witham Ancholme scheme. Currently the option is modelled in equator assuming constant inflows and outflows. Therefore increasing storage would not provide a DO benefit. Further investigation would be required to determine if there was a benefit to increasing storage at exiting reservoir with information on the TWA scheme operation to estimate the R. Ancholme flows. Therefore, it is not a reliable option for WRMP19.	Y	Y	N	N
			Trent WTW bankside storage			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
			Stoke Rochford			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
Groundwater wells (boreholes)			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Blending sources licence review		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			New sources		x	x	x		x					Lincs Limestone and Chalk fully committed -	Y	Y	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														no new consumptive licences considered. May be opportunity for abstraction from the Sands&Gravels near Lincoln - discussed under Sands&Gravels option. Sherwood Sandstone discussed under other schemes.				
			Decommissioned Power station sources						x					CAMS assessment indicates that the source has the potential for development.	Y	N	N	N
			Lincolnshire limestone (new source)						x					CAMS assessment indicates that no water is available for consumptive abstraction as the existing resources in the Lincs Limestone are fully committed to existing users and the environment.	Y	N	N	N
			Secondary groundwater						x					CAMS assessment shows no water available	Y	N	N	N
			MOD boreholes							x				Generic - significant options raised separately	Y	N	N	N
Infiltration galleries			River Trent			x			x				x	Supplied by superficial deposits in continuity with the River Trent, option to abstract from Trent is thought as more feasible that from the gravels	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Lincolnshire limestone		x	x						x		Limited storage capacity	Y	N	N	N
Aquifer Recharge (AR)			Flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
			Lincolnshire limestone											Limited storage capacity	Y	N	N	N
			Sherwood sandstone											Limited storage capacity	Y	N	N	N
			SUDS (road drainage)		x									High risk of failure due to uncertain DO	Y	N	N	N
Desalination			Secondary groundwater		x									Option dependent on drought order	Y	N	N	N
Desalination			Tidal Trent										x	Water quality envelope would require complex operating regime	Y	N	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Reclaimed water	Reclaimed domestic wastewater		Lincoln Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Scunthorpe water reuse		x	x	x	x						Outside of AWS supply area	Y	N	N	N
	Reduce losses WTW		Process improvements to reduce losses WTW			x								Washwater recovery already in place	Y	Y	N	N
Bulk transfers	By canal		Kidby canal		x	x	x	x	x		x		x	At this stage the scheme is not considered viable, due to the lack of availability of source water. There are also several risks and unknowns including: - Hydraulic capacity of the canal and required bund raising over the length of pound - Cost and feasibility of additional treatment expansion at existing WTW to treat the river water quality - Ecological implications on the canal				
	By pipeline - potable	CLN11/ CLN12/ CLN13	South Humber Bank WRZ to Central Lincolnshire WRZ Transfer												Y	Y	Y	Y
	By pipeline - raw water		Severn Trent Water groundwater into Trent		x	x	x		x					This is considered as part of the Trent working group and trading options but GW is subject to sustainability losses so not an option.	Y	Y	N	N
			Toft newton - Short Ferry						x	x			x	EA comments that this option would not be suitable for WRMP due to the nature of how it is operated.	Y	N	N	N
Resource Sharing with			Severn Trent Water - new and increasing							x				As part of the Trent Work Group options were not identified for specific trades in	Y	Y	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
other Water Companies			existing											Central Lincolnshire however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.				
			Yorkshire via Humber bridge											As part of the Trent Work Group options were not identified for specific trades in Central Lincolnshire however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	Y	N	N
			Yorkshire Water- new											As part of the Trent Work Group options were not identified for specific trades in Central Lincolnshire however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	Y	N	N
3rd Party Options			Lincoln WRC effluent into Trent (Severn Trent WRC)											As part of the Trent Work Group options were not identified for specific trades in Central Lincolnshire however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	N	N	N
			Icebergs			x						x		Unproven technology	Y	N	N	N
			Agriculture Potatoes (groundwater)		x	x						x		Insignificant reliable yield.	Y	N	N	N
			Power stations - cooling water, boiler feed (Brigg) - 3 power stations in Yorkshire		x	x	x		x	x				Not a feasible option. Not a 3rd party option - independent of operation of power station. Change of use from non-consumptive to consumptive	Y	N	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Water region															
			Power stations (Brigg) + 3 power stations in Yorkshire Water region		x	x	x		x	x				Not a feasible option. Not a 3rd party option - independent of operation of power station. Change of use from non-consumptive to consumptive	Y	N	N	N
			Sugar beet (Bardney)		x									Factory closed therefore option rejected	Y	N	N	N
			Tata Steel (groundwater)											Subject to fluctuations in global steel market, and at present unlikely to offer any water. May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
	Shared asset ownership		Agriculture		x	x						x		Insignificant reliable yield.	Y	N	N	N
			Environment Agency's Toft Reservoir						x	x			x	EA comments that this option would not be suitable for WRMP due to the nature of how it is operated - only have short storage capacities	Y	N	N	N
Tankering of water	Sea	CLN1	Sea Tanker to Immingham Port transfer to Central Lincolnshire WTW					x	x		x		x	Technically feasible but with high INNS risk, water quality and reliability risks which would need more investigation to overcome. Difficult to quantify the DO benefit. Sea tankering was originally included as an option in the Water Resources Options stated preference survey. The results of the pilot survey showed that customers did not believe it to be a realistic option and its inclusion was undermining the credibility of the survey as a whole. As a result it was removed and not included in the final version of the survey.	Y	Y	Y	N
			Canal		x	x					x			Small DO. Risk to navigation in drought - reliability issues related to third party	Y	N	N	N
	Rail		Rail						x	x			x	Rejected due to weather and reliability	Y	N	N	N

Central Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														issues, and due to traffic impacts				
	Road		Road tankering		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Improved/sophisticated conjunctive management			Optimise conjunctive use of existing surface water and groundwater resources.			x								System DO modelled in Aquator so the benefits of optimal conjunctive use are already included in supply forecast	Y	N	N	N
			Trent Witham Ancholme enhancements with ASR											Covered by other TWA options	Y	N	N	N
			Increase surface water treatment capacity to utilise high river flows		x									Option not relevant to the final planning problem in Central Lincolnshire. Does not provide DO required during low flows in more extreme drought than historic.	Y	Y	Y	N
		CLN6/CLN8	Optimise conjunctive use of surface water and groundwater resources.		x									Option not relevant to the final planning problem in Central Lincolnshire. Does not provide DO required during low flows in more extreme drought than historic.	Y	Y	Y	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Cheveley WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
New reservoir storage	Flood storage		Environment Agency flood protection scheme (artificial recharge)/Internal Drainage Boards		x									High risk of failure due to uncertain DO	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel pits		Private reservoirs / lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Increase reservoir yield	Private lakes and gravel pits		Increasing storage at private lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			Groundwater source						x					CAMS assessment shows no water available	Y	N	N	N
			GOGS	x	x	x	x		x		x		x	No availability from GOGS	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Cheveley water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable	CVY1	Newmarket WRZ transfer												Y	Y	Y	Y
		CVY2	Bury and Haverhill WRZ transfer												Y	Y	Y	Y
	By pipeline - raw water		River Stour - River Pant/Blackwater		x	x								CAMS assessment shows no water available	Y	N	N	N
Resource Sharing with other Water Companies			Cambridge Water											As part of the Ouse Working Group options were not identified for specific trades in Cheveley however once other company plans are published there may be more third party options to be developed when published on	Y	Y	Y	N

Cheveley WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														Ofwat Information Platform in January.				
			River Colne with a trade with Essex & Suffolk Water via Ely Ouse Essex Transfer Scheme (EOETS)											As part of the Ouse Working Group options were not identified for specific trades in Cheveley however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	N	N	N
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Review discharge consents											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
	Shared asset ownership		Large scale Agricultural reservoirs											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.	Y	N	N	N
	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Other			Innovative options			x		x				x		Unproven technology, cost and yield	Y	N	N	N

Cheveley WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			(international examples e.g. sea clouding)															
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

East Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Chalk streams						x					CAMS assessment shows no water available	Y	N	N	N
			Louth Canal						x					CAMS assessment shows no water available	Y	N	N	N
			River Bain						x					CAMS assessment shows no water available	Y	N	N	N
			River Barlings						x					River Barlings feeds into the Witham so it is part of Witham abstractions which is included in the South Lincolnshire reservoir options. could not abstracted from both locations on the Witham.	Y	N	N	N
			River Great Eau						x					CAMS assessment shows no water available	Y	N	N	N
			River Humber						x					CAMS assessment shows that no water is available at any point during the year. Less than 1 ML/d is available at one AP during winter only.	Y	N	N	N
			River Lud						x					CAMS assessment shows no water available	Y	N	N	N
			River Witham						x					Option to use Witham included within the South Lincolnshire Reservoir options and associated new flow assessments.	Y	N	N	N
New reservoir storage			Covenham extension		x			x						Option is not promotable due to excessive cost for benefit. The option requires a large extension to the reservoir (additional 50% storage) to gain a very small additional yield and DO.	Y	Y	N	N
			New small reservoirs from new sources above (Revesby, Miningsby)					x				x	x	High risk of failure- Reservoirs are river fed but is linked to the Bains gravels where abstraction will not be permitted if there is hydraulic connections with the surface water features in the link limestone, links chalk or spilsby sandstone.	Y	N	N	N
	Flood storage		Internal Drainage Boards (South Forty Foot Drain - Lincs waterway)						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N

East Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
			Flood storage (Lower Witham, Boston Barrier)		x									High risk of failure due to uncertain DO	Y	N	N	N
			Northcoates Lagoons		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel pits		Bains gravels	x	x	x			x				x	Chalk fed river Bain feeds sands and gravels which support the reservoir. The Bain gravel pits supply water to the river Bain. Groundwater yield from the Bains gravels is variable. High risk of failure due to no abstraction allowed if there is no hydraulic connection with surface water features in the Lincs Limestone, Lincs Chalk, or Spilsby Sandstone.	Y	Y	N	N
Increase reservoir yield	Raising/dredging existing reservoirs		Covenham			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
	Amend abstraction regime		Covenham - Increase reservoir yield through maximising abstraction licences, amending intakes, utilising dead storage etc.		x	x	x							Current pumping capacity meets current licence so further capacity is not an option.	Y	Y	N	N
	Private lakes and gravel pits		Increasing storage at private lakes	x	x	x			x				x	Chalk fed river Bain feeds sands and gravels which support the reservoir. The Bain gravel pits supply water to the river Bain. Groundwater yield from the Bains gravels is variable. High risk of failure due to no abstraction allowed if there is no hydraulic connection with surface water features in	Y	Y	N	N

East Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														the Lincs Limestone, Lincs Chalk, or Spilsby Sandstone.				
Groundwater wells (boreholes)			Maximising Northern Chalk		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Blending sources licence review		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Blow wells						x					CAMS assessment shows no water available	Y	N	N	N
			New sources (chalk)						x					CAMS resource availability- No Chalk groundwater available	Y	N	N	N
			Elsham sandstone						x					CAMS assessment shows no water available	Y	N	N	N
			Lincolnshire limestone (new source)						x					CAMS assessment indicates that no water is available for consumptive abstraction as the existing resources in the Lincs Limestone are fully committed to existing users and the environment	Y	N	N	N
			Roach and Carstone,						x					CAMS assessment indicates that no water is available for consumptive abstraction.	Y	N	N	N
			Secondary groundwater						x					CAMS assessment shows no water available	Y	N	N	N
			Spilsby						x					CAMS assessment shows that no water is available for consumptive abstraction	Y	N	N	N
			RAF/MOD boreholes											Generic - significant options raised separately	Y	N	N	N
Infiltration galleries			Bain	x	x	x			x				x	Chalk fed river Bain feeds sands and gravels which support the reservoir. The Bain gravel pits supply water to the river Bain. Groundwater yield from the Bains gravels is variable. High risk of failure as abstraction will not be allowed if there is a hydraulic connection with surface water features in the Lincs Limestone, Lincs Chalk, or Spilsby	Y	N	N	N

East Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														Sandstone.				
			Witham										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
'Aquifer Storage and Recharge (ASR)			Splisby		x		x		x					No water available for consumptive abstraction	Y	N	N	N
Aquifer Recharge (AR)			Flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
			SUDS (road drainage)		x									High risk of failure due to uncertain DO	Y	N	N	N
Desalination			Secondary groundwater		x									Emergency option dependent on drought order, not a supply demand management.	Y	N	N	N
			Multiple Effect Distillation (MED)		x								x	Heat source no longer exists. Also major technical challenge	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Boston water reuse				x	x					x	Option would require an excessively long transfer to stoke ferry to support the TWA scheme, of which the operation details are unknown	Y	Y	N	N
			Horncastle water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Louth water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Skegness water reuse			x								Transfer treated effluent 18 km by pipeline to the River Great Eau, as a drought option to support WTW. There is not a drought risk in East Lincolnshire WRZ so the option does not address the planning problem.	Y	Y	Y	N
			Spalding/Bourne water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint	Y	N	N	N

East Lincolnshire WRZ Rejection Register

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				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														leading to environmental issues				
	Reduce losses WTW		Process improvements to reduce losses WTW			x								Washwater recovery already in place	Y	Y	N	N
Bulk transfers	By canal		Grantham canal (flow reversal)		x	x	x	x	x		x		x	At this stage the scheme is considered not feasible. The screening categories on which this scheme is discounted are summarised below: High risk of failure – Sustainability: The canal is disused and has become valuable wetland habitat. Changes in flow and water chemistry are considered likely to cause habitat damage. High risk of failure – Technical: Rehabilitation of a disused canal to transfer flows is likely to require extensive canal repair. High risk of failure – Technical: Pre-treatment may be required to protect existing habitat along the canal. Option is not promotable – Cost: Large pipeline transfer required, repairs to existing pounds, and pumping bypass around every lock is likely to render the scheme not feasible.	Y	Y	N	N
3rd Party Options			Agriculture (Witham, Blankney estates)		x	x						x		Low yielding, and significant environmental risks	Y	N	N	N
			Batemans brewery											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Butlin's (groundwater, effluent)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Killingholme power station + Sutton											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N

East Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Bridge															
			Killingholme sludge (waste stream from Elsham)									x		Low yielding, and significant environmental risks	Y	N	N	N
			Agriculture Potatoes (groundwater)		x	x						x		Insignificant reliable yield.	Y	N	N	N
			Tata Steel (groundwater)											Subject to fluctuations in global steel market, and at present unlikely to offer any water. May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
	Shared asset ownership		Agriculture		x	x						x		Insignificant reliable yield.	Y	N	N	N
Tankering of water			Rail						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Road tankering		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Improved/sophisticated conjunctive management			Spilbsy chalk		x	x	x		x					Insufficient surface water to generate a benefit	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N
			Reduce evaporation in reservoirs			x		x				x		Unproven technology, cost and yield	Y	N	N	N

East Suffolk WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Mill River - licence maximisation						x					CAMS assessment shows no water available and current operation of licence is only under drought conditions. Increase in abstraction will affect WFD no deterioration	Y	N	N	N
			River Stour - trade with Essex and Suffolk Water via EOETs						x					Essex and Suffolk water state that they will require the full licenced amount from EOETs and a downstream assessment will be required if further abstractions are requested therefore not a current feasible option.	Y	N	N	N
			River Brett						x					CAMS assessment shows no water available	Y	N	N	N
			River Deben						x					CAMS assessment shows that water is only available during winter in small quantities	Y	N	N	N
			River Fynn						x					Not resilient during low flows - CAMS assessment shows that water is only available at higher flows Q50 and Q30 at Martlesham Sluice	Y	N	N	N
			River Orwell						x					CAMS assessment shows no water available	Y	N	N	N
			River Gipping						x					CAMS assessment shows no water available	Y	N	N	N
New reservoir storage			Suffolk Valleys		x									Small yield with significant uncertainty about reliability under future climate change scenarios.	Y	N	N	N
	Flood storage		IDBs-Suffolk Holistic group						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
	Gravel Pits/Lakes		Balham - Gipping Valley		x	x	x		x					No water available for licencing as fed by the groundwater that feeds into the River Gipping	Y	Y	N	N
			Gravel Pit exploitation (Claydon/Sproughton /Blakenham) -		x	x	x		x					No water available for licencing as fed by the groundwater that feeds into the River Gipping	Y	Y	N	N

East Suffolk WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Gipping Valley															
Increase reservoir yield	Amend abstraction regime		Alton Water - Increase reservoir yield through maximising abstraction licences, amending intakes, utilising dead storage etc.		x				x					Maximising the output of existing WTW by increasing pumping capacity by 2Ml/d is not a realistic option. The current licence is obtained but on the understanding that it is only used as it has been historically, i.e. drought periods only. There is a reasonable annual licence (2000 Ml), but WFD no-deterioration risk if start using it every year. Pump sizes on the River Gipping intake are oversized for allowable abstraction due to yearly and 5 yearly licence constraints, therefore not an option unless Environment Agency can relax constraints.	Y	Y	N	N
	Raising/ dredging existing reservoirs		Alton Water dredging			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
			Alton dam raising			x						x	x	Increasing storage at Alton is not a viable method of increasing hydrological yield as the yield is constrained by the current refill licence constraints, not the storage volume as shown in WRMP14 investigations.	Y	N	N	N
			Private lakes and gravel pits identified above			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Abandoned East Suffolk WRZ sources back to supply		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Felixstowe peninsula		x				x			x	x	High risk of saline intrusion in this region.	Y	Y	N	N
			Use of gravel pits		x	x	x		x					Gravel pits fed by groundwater which is	Y	Y	N	N

East Suffolk WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			along the Gipping valley to support existing abstractions											connected to surface water. Downstream surface water AP14 has no water available at any Q value.				
			MOD sites											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Infiltration galleries			Ipswich										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			Woodbridge										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			Felixstowe										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
'Aquifer Storage and Recharge (ASR)		ESU3	Bucklesham, Woodbridge & screening other locations			x						x		There is high uncertainty around the DO benefits as a supply demand scheme and the likely DO would be small.	Y	Y	Y	N
Aquifer Recharge (AR)			Ipswich WRC (Stowmarket, Felixstowe, Woodbridge)										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Desalination		ESU1	Felixstowe desalination												Y	Y	Y	Y
			Other coastal locations				x			x				No other locations identified	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater	ESU2	Ipswich Water Reuse												Y	Y	Y	Y
	Reclaimed industrial and commercial wastewater		Sizewell											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	Y	N
	Reduce losses WTW		Process improvements to			x								Washwater recovery already in place	Y	Y	N	N

East Suffolk WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			reduce losses WTW															
Bulk transfers	By River		EOETs optimisation (+ trade with Essex and Suffolk Water)											As part of the Ouse Working Group options were not identified for specific trades in East Suffolk however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	Y	N	N
	By pipeline - potable	ESU7	Sudbury WRZ Transfer											Final planning scenario - transfer would be <5Ml/d and not part of a strategic route therefore rejected.	Y	Y	Y	N
		ESU6	South Essex WRZ Transfer												Y	Y	Y	Y
		ESU5/ESU8/ESU9	Bury and Haverhill WRZ Transfer												Y	Y	Y	Y
	By pipeline - raw water transfer		Raw water transfer between Alton and Ardleigh		x	x	x		x					Doesn't give resilience. And higher risk than potable South Essex to East Suffolk Transfer	Y	N	N	N
Resource Sharing with other Water Companies			Affinity East											As part of the Ouse Working Group options were not identified for specific trades in East Suffolk WRZ however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	Y	Y	N
			Essex and Suffolk - Abberton Trilogy											As part of the Ouse Working Group options were not identified for specific trades in East Suffolk WRZ however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in	Y	Y	Y	N

East Suffolk WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														January.				
3rd Party Options			Icebergs									x		Unproven technology	Y	N	N	N
			Old sugar beet factory									x		Low yielding, and significant environmental risks	Y	N	N	N
			Suffolk Water Park (A14-Baylham)									x		Low yielding, and significant environmental risks	Y	N	N	N
			Salinity of water is an issue and not proven. Resilience not proven. Can be offered in trading platform.						x					CAMS assessment shows no water available	Y	N	N	N
	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
Tankering of water			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
		ESU4	Felixstowe Sea Tankering - pipelines to East Suffolk WRZ					x	x		x		x	Technically feasible but with high INNS risk, water quality and reliability risks which would need more investigation to overcome. Difficult to quantify the DO benefit. Sea tankering was originally included as an option in the Water Resources Options stated preference survey. The results of the pilot survey showed that customers did not believe it to be a realistic option and its inclusion was undermining the credibility of the survey as a whole. As a result it was removed and not included in the final version of the survey.	Y	Y	Y	N
Improved/sophisticated			Optimise use of Alton resources and back		x	x								Ardleigh with Colchester chalk is favoured over Alton	Y	Y	N	N

East Suffolk WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
conjunctive management			off Colchester Chalk)															
			Increase surface water treatment capacity to utilise high river flows		x	x								Option is feasible but benefits are complex to assess within the final planning scenario and future scenarios. The benefits in DO are small scale.	Y	Y	Y	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Ely WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Bedford drain/Forty foot drain						x					CAMS assessment shows no water available	Y	N	N	N
			Cut-off channel						x					CAMS assessment shows that water is only available during winter months at certain APs. No water is available at any point during the year at some APs. AP17 has a very high HOF of 1040 Ml/d	Y	N	N	N
			Great Ouse (Ely)						x					CAMS assessment indicates that a small quantity of water is only available during winter	Y	N	N	N
			Little Ouse						x					CAMS assessment indicates that only a small quantity of water is available during winter	Y	N	N	N
			River Cam						x					Not a resilient source, CAMS assessment shows that water is available at all flow values at AP1. Downstream, no water is available at any flow value (AP4) and water is only available in small quantities during winter (AP6)	Y	N	N	N
New reservoir storage	Flood storage		Environment Agency flood protection scheme (artificial recharge)/Internal Drainage Boards		x									High risk of failure due to uncertain DO	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel pits		Private reservoirs / lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Increase reservoir yield	Raising/ dredging private lakes and gravel pits		Increasing storage at private lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater			Ely groundwater		x				x					WFD assessment - no additional resource	Y	Y	N	N

Ely WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
wells (boreholes)			sources											available				
			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			MoD sites											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
Infiltration galleries			Little Ouse										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Ely water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable	ELY1/ ELY9/ ELY10	North Fenland WRZ Transfer												Y	Y	Y	Y
		ELY2	Newmarket WRZ transfer												Y	Y	Y	Y
		ELY3/ ELY11/ ELY12	Ruthamford North WRZ Transfer												Y	Y	Y	Y
	By pipeline - raw water transfer		Trent to Rutland to Fenland transfer (and storage)					x						Raw water transfers would require treatment for INNS and so for long large diameter transfers the potable network is more cost effective and resilient option.	Y	N	N	N
Resource Sharing with other Water Companies			Cambridge Water											As part of the Ouse Working Group options were not identified for specific trades in Ely however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	Y	N	N
			EOETS/storage											As part of the Ouse Working Group options	Y	N	N	N

Ely WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														were not identified for specific trades in Ely however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.				
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
	Shared asset ownership		Mepal gravel pit development (Ely)											High risk of failure due to uncertain DO	Y	N	N	N
			Review discharge consents									x		Low yielding, and significant environmental risks	Y	N	N	N
	Shared asset ownership		Large scale Agricultural reservoirs											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.	Y	N	N	N
	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	N	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Tankering (road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Other			Innovative options (international			x		x				x		Unproven technology, cost and yield	Y	N	N	N

Ely WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			examples e.g. sea clouding)															
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Happisburgh WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Groundwater wells (boreholes)			Secondary Groundwater Use						x					Happsiburgh WTW is in the Norfolk Broads. For River Bure and Ant catchments nearby - presumption against new groundwater abstractions.	Y	N	N	N
Bulk transfers	By canal		Dilham Canal		x	x	x	x	x		x		x	At this stage the scheme is considered not feasible. The screening categories on which this scheme is discounted are summarised below: High risk of failure – Technical: Upgrading the existing WTW to treat surface water. Option is not promotable – Cost: This option provides minimal benefit, and does not address the deficit projected in this WRZ. Conversely the cost of the infrastructure required to deliver this scheme is likely to outweigh the benefit gained.	Y	Y	N	N
	By pipeline - potable water transfer	HPB1	Norwich & the Boards WRZ to Happisburgh WRZ Transfer												Y	Y	Y	Y
	By pipeline - raw water transfer		Broads options		x	x						x		Not feasible - no resource options	Y	N	N	N

Hartlepool WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Skerne															
New reservoir storage	On-stream reservoirs		Purchase existing assets															
	Pumped-storage reservoirs		On Skerne															
	Flood storage		SUDS															
			New reservoir															
	Private lakes and gravel pits		Private lakes and gravel pits															
Increase reservoir yield	Raising/dredging existing reservoirs		Hartlepool reservoirs															
Groundwater wells (boreholes)			Teeside boreholes															
			Mine dewatering															
			Secondary groundwater															
			Mag limestone															
Desalination			Hartlepool harbour															
			Secondary groundwater															
Reclaimed water	Reclaimed domestic wastewater		Northumbrian Water WRCs (trade)															
	Reclaimed industrial and commercial wastewater		Teeside industrial effluent															

Hartlepool WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	(for domestic, commercial and industrial users)																	
Bulk transfers	By Pipeline		Northumbrian Water															
Resource Sharing with other water companies	Trade		Northumbrian Water															
3rd Party Options	Trade		Agriculture															
			Coal Authorities (Sulphate plume management)															
Tankering of water			Nordic water															
			Road															
			rail															
Improved/sophisticated conjunctive management			Conjunctive use with Northumbrian Water															
Other			Rainwater harvesting															
			Innovative options (international examples e.g. sea clouding)															

Ixworth WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Sapiston						x					CAMS assessment shows no water available	Y	N	N	N
			River Thet						x					CAMS assessment shows that only a small quantity of water is available during winter.	Y	N	N	N
New reservoir storage	Private lakes and gravel pits		Private reservoirs / lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			GOGS (Thet, Little Ouse)	x	x	x	x		x		x		x	No availability from GOGS	Y	N	N	N
			Ixworth unused borehole		x				x					WFD assessment - no additional resource available	Y	Y	N	N
Infiltration galleries			Floodplain Ixworth										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			Little Ouse										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
Bulk transfers	By pipeline - potable	IXW1	Thetford WRZ Transfer											Existing transfer to Bury St Edmunds from Thetford via Ixworth WRZ to meet deficits there. Any residual surplus could be transferred via existing link. Therefore this option was not modelled.	Y	Y	Y	N
		IXW2	Bury and Haverhill WRZ Transfer											Existing transfer to Bury St Edmunds from Ixworth transfers surplus in Thetford and Ixworth WRZ to meet deficits there. Any residual surplus could be transferred via existing link. Therefore this option was not modelled.	Y	Y	Y	N
3rd Party Options	Shared asset ownership		Large scale Agricultural reservoirs											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities	Y	N	N	N

Ixworth WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.				

Newmarket WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Cam						x					Not a resilient source, CAMS assessment shows that water is available at all flow values at AP1. Downstream, no water is available at any flow value (AP4) and water is only available in small quantities during winter (AP6)	Y	N	N	N
Direct river abstraction			River Kennett (Newmarket)						x					CAMS assessment shows no water available	Y	N	N	N
New reservoir storage	Flood storage		Environment Agency flood protection scheme (artificial recharge)/Internal Drainage Boards						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
New reservoir storage	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
New reservoir storage	Private lakes and gravel pits		Private reservoirs / lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	Y	N	N
Increase reservoir yield	Raising/dredging private lakes and gravel pits		Increasing storage at private lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	Y	N	N
Groundwater wells (boreholes)			New groundwater source						x					CAMS assessment shows no water available	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Newmarket Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline -		Kennet											EOETS-related links that were in WRE but are	Y	N	N	N

Newmarket WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	potable water transfer													not in scope of WRMP RWT section				
Bulk transfers	By pipeline - potable water transfer	NWM1/ NWM6/ NWM10	Ely WRZ transfer												Y	Y	Y	Y
Bulk transfers	By pipeline - potable water transfer	NWM2/ NWM7	Bury and Haverhill WRZ Transfer												Y	Y	Y	Y
Bulk transfers	By pipeline - potable water transfer		Cheveley WRZ transfer		x									Final planning problem - no surplus in Cheveley to transfer	Y	Y	N	N
Bulk transfers	By pipeline - potable water transfer	NWM3/ NWM8/ NWM9	Ruthamford South WRZ transfer												Y	Y	Y	Y
Resource Sharing with other Water Companies			Cambridge Water											As part of the Ouse Working Group options potential options for trades into Newmarket were identified but these were not modelled. Once other company plans are published these third party options may be developed via the Ofwat Information Platform in January.	Y	Y	Y	N
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
3rd Party Options			Internal Drainage Boards											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
3rd Party Options			Jockey club									x		Low yielding, and significant environmental risks	Y	N	N	N
3rd Party Options			Review discharge consents											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
3rd Party	Shared asset		Large scale											The WRE Black Sluice study has indicated the	Y	N	N	N

Newmarket WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Options	ownership		Agricultural reservoirs											key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.				
3rd Party Options	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
Tankering of water			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
Other			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N
3rd Party Options	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
Tankering of water			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Other			Innovative options			x		x				x		Unproven technology, cost and yield	Y	N	N	N

Newmarket WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			(international examples e.g. sea clouding)															
Other			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

North Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Extend Chalk abstraction						x					No water available for new consumptive abstractions. Trading of recent actual quantities within GWMUs may be possible.	Y	N	N	N
			Gaywood River						x					CAMS assessment shows that a small amount of water is only available during winter at the lower part of the river only. No deficit predicted in this region.	Y	N	N	N
			North Norfolk Rivers (other)						x					CAMS assessment shows that small amounts of water are available at many APs between Q70 and Q30. This quantity is between 4 and 10 Ml/d	Y	N	N	N
			River Heach						x					CAMS assessment shows no water available	Y	N	N	N
			River Ingol						x					CAMS assessment shows that a small amount of water is available throughout the year (up to 1Ml/d in summer) which is not reliable.	Y	N	N	N
			River Nar						x					CAMS assessment shows that a small amount of water is only available during winter	Y	N	N	N
			River Wissey						x					CAMS assessment shows that only a small amount of water is available during the winter months.	Y	N	N	N
			North Norfolk Rivers						x					CAMS assessment shows that small amounts of water are available at many APs between Q70 and Q30. This quantity is between 4 and 10 Ml/d	Y	N	N	N
			River Heach						x					CAMS assessment shows no water available	Y	N	N	N
			River Ouse						x					Not resilient as CAMS assessment shows that water is only available during winter	Y	N	N	N
New reservoir storage		NFN3	Fenland Reservoir												Y	Y	Y	Y
			Wash Reservoirs			x	x		x		x			Wash reservoir study in 1976 reviewed -	Y	N	N	N

North Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														yield predictions decreased by approx. 60% and environmental concerns are greater than previously reported.				
			Any other reservoir identified through CAMS assessment			x			x	x			x	No reliable source found in CAMS assessment	Y	N	N	N
	Flood storage		New Internal Drainage Board structure						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
			SUDS - recharge lagoons		x									High risk of failure due to uncertain DO	Y	N	N	N
			Wash Barrage		x									Planning risks due to environmental status of the Wash.	Y	Y	N	N
	Private lakes and gravel pits		Increasing storage at private lakes e.g. Bawsey Lakes		x				x					Groundwater supplies the lakes through the Sandringham Sands. CAMS indicates groundwater is not available for licencing.	Y	Y	N	N
			Sands and Gravel extraction locations e.g. Pentney Lakes		x				x					Groundwater supplies both rivers and lakes in this area through the sandstone aquifer and conductive superficial deposits. CAMS indicates that neither groundwater or surface water is available for abstraction in this area.	Y	Y	N	N
Groundwater wells (boreholes)			Abandoned boreholes		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Nitrate removal/revised blending regime		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			New groundwater source						x					CAMS resource availability- No water available or only minor localised sources	Y	N	N	N
			Extend Sandringham Sands						x					CAMS assessment indicates that no water is available for consumptive abstraction	Y	N	N	N

North Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Secondary groundwater						x					CAMS resource availability- No water available or only minor localised sources	Y	N	N	N
			New groundwater source						x					CAMS resource availability (North Norfolk) - No groundwater available at Q95 for surface water, and restricted at Q70. North West Norfolk - no water available	Y	N	N	N
			MoD site boreholes											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Chalk		x	x			x			x		Hydrology is unsuitable	Y	N	N	N
			Sandringham Sands		x	x			x			x		Water not available in many years in low flow/drought conditions in the River Babingley and similar situation expected in the River Gaywood. No scheme is viable on this basis. Hydrogeological setting also poor with potential for rapid loss of stored water.	Y	N	N	N
Desalination		NFN1	Kings Lynn Desalination												Y	Y	N	N
			Hunstanton (Wash) Desalination				x	x	x					Intake not feasible due to shallow nature of the wash. Abstraction from groundwater will also be limited due to the risk of GW intrusion and impacts on the wash	Y	Y	N	N
			Small scale desalination		x									Option does not provide the required DO	Y	N	N	N
			Secondary Groundwater		x	x						x		Option not appropriate - no secondary groundwater available	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater	NFN2	Kings Lynn & Wisbech Water Reuse												Y	Y	Y	Y
			Heacham/Downham Mkt Water Reuse		x	x		x						Downham Market has available flow of <1.5 Ml/d – not feasible.	Y	Y	N	N
			In combination with aquifer recharge		x	x						x		Hydrogeological setting poor with potential for rapid loss of stored water.	Y	N	N	N

North Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			options															
			Effluent reuse - small scale other		x	x						x		Hydrogeological setting poor with potential for rapid loss of stored water.	Y	N	N	N
			River augmentation options											Covered by NEP options	Y	N	N	N
Bulk transfers	By River		Transfer from Lincolnshire (Trent, Witham) via river system		x	x								This option is included as part of the South Lincolnshire Reservoir options (RTN2, RTN14) supported by Trent Transfer via the Trent Witham Ancholme river transfers scheme.	Y	N	N	N
	By pipeline - potable		North Norfolk Coast WRZ transfer		x									Final planning problem - no surplus in North Norfolk Coast WRZ to transfer	Y	Y	N	N
			Wash Pipeline from Lincolnshire			x	x		x			x		Complex installation and material planning issues (environmental and conservation)	Y	N	N	N
		NFN4/ NFN7/ NFN8	South Fenland WRZ Transfer												Y	Y	Y	Y
		NFN6	Ely WRZ Transfer												Y	Y	Y	Y
		NFN5	North Norfolk Rural WRZ transfer												Y	Y	Y	Y
3rd Party Options			3rd party trade options (surface water)											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			European interconnector (pipeline from Europe)									x		Significant risks with pipeline	Y	N	N	N
			Icebergs			x						x		Unproven technology	Y	N	N	N
			Industrial reclaimed water - Palm Paper									x		Low yielding, and significant environmental risks	Y	N	N	N
			Industrial reclaimed water - British Sugar sites, including closed ones									x		Low yielding, and significant environmental risks	Y	N	N	N

North Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Trading options - private groundwater abstractions (food processing, paper industry)									x		Low yielding, and significant environmental risks	Y	N	N	N
			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			European interconnector (pipeline from Europe)									x		Significant risks with pipeline	Y	N	N	N
			Icebergs									x		Unproven technology	Y	N	N	N
	Shared asset ownership		Multi use reservoir (agriculture)											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.	Y	N	N	N
Improved/ sophisticated conjunctive management			Increase surface water treatment capacity to utilise high river flows			x						x	x	Option has high risk of significant outage	Y	N	N	N

North Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

North Norfolk Coast WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Tidal waters (brackish) North Norfolk Rivers						x					CAMS assessment shows no water available	Y	N	N	N
			River Bure						x					CAMS assessment shows that a small amount of water is available but not at low flows.	Y	N	N	N
			River Glaven						x					Not resilient as CAMS assessment shows that water is not available at low flows	Y	N	N	N
			River Stiffkey						x					Not resilient as CAMS assessment shows that water is not available at low flows	Y	N	N	N
			River Wensum						x					Not resilient as CAMS assessment shows that water is only available during Q50 and Q30	Y	N	N	N
			The Broads - Hickling, Barton, Horning (Ant, Bure, Thurn)						x					CAMS assessment shows that water is not available during lower flows but availability at higher flows, but there is no deficit predicted in this region.	Y	N	N	N
New reservoir storage			North Norfolk Rivers (winter storage)		x									Private lakes and gravel pits assessment concluded this was not a suitable local option	Y	N	N	N
			North Norfolk Rivers (winter storage)		x									Private lakes and gravel pits assessment concluded this was not a suitable local option	Y	N	N	N
			Norfolk Valleys options		x									Small yield with significant uncertainty about reliability under future climate change scenarios.	Y	N	N	N
			Winter storage reservoir		x									Small yield with significant uncertainty about reliability under future climate change scenarios.	Y	N	N	N
	Flood storage		SUDS type local schemes - with artificial recharge		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel		Sands and Gravel extraction locations		x		x							No others identified as part of the Private Lakes and Reservoir study	Y	N	N	N

North Norfolk Coast WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	pits		Private reservoirs / lakes e.g. Blickling, Thorpe Market Antingham		x	x			x					Small drainage catchment fed by recharge in agricultural setting, low storage and potentially poor quality water.	Y	Y	N	N
			Private reservoirs / lakes e.g. storage on the River Glaven		x	x	x		x					Storage fed by River Glaven is a chalk spring fed river. Clay superficial deposits in area of option may impede direct hydraulic connection between surface water and groundwater. It has unreliable yield and high environment risks.	Y	Y	N	N
			Sands and Gravel extraction locations e.g. Beetley/ Middleton Lakes on the River Wensum		x	x	x		x					"The gravel pits are fed by water from the Chalk aquifer through the conductive sand and gravel deposits. Abstraction from the gravel pits directly affects the availability of water from the Wensum. It has unreliable yield and high environment risks.	Y	Y	N	N
Increase reservoir yield	Private lakes and gravel pits		Increasing storage at private lakes		x		x							None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Extend Chalk abstraction		x	x						x		North Norfolk groundwater may be available, but screened out due to risk of saline intrusion.	Y	Y	N	N
			Extend Crag abstraction						x					CAMS assessment indicates that there is no identifiable recharge so abstraction cannot be permitted.	Y	N	N	N
			Ministry of Defence site boreholes											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Source from effluent re-use		x				x					Rejected due to water quality issues - WFD no deterioration	Y	N	N	N
			Small schemes		x				x					None identified	Y	N	N	N

North Norfolk Coast WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Aquifer Recharge (AR)			Local recharge/flood management systems e.g. Glaven to support Sheringham abstraction		x				x					CAMS indicates 39Ml/d available to store and abstract but no deficit predicted in this region	Y	N	N	N
Desalination			Coastal desalination network (small scale)		x									Option does not provide the required DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Aylsham water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Cromer water reuse			x	x	x						No suitable waterbodies nearby and dry weather flows are too small to warrant a transfer to the nearest demand centre of Norwich, 30 km away.	Y	Y	N	N
			Fakenham/North Walsham WRC reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable		Fenland WRZ transfer											Final planning problem - no deficit in North Norfolk Coast requiring a transfer	Y	Y	Y	N
			Norfolk Rural WRZ transfer											Final planning problem - no deficit in North Norfolk Coast requiring a transfer	Y	Y	Y	N
			Norwich and the Broads WRZ Transfer											Final planning problem - no deficit in North Norfolk Coast requiring a transfer	Y	Y	Y	N
Resource Sharing with other Water Companies			Essex and Suffolk Water trade											Final planning problem - no deficit in North Norfolk Coast requiring a transfer. May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
			Essex and Suffolk River abstractions											Final planning problem - no deficit in North Norfolk Coast requiring a trade	Y	Y	Y	N
3rd Party Options			Bacton Gasworks									x		Low yielding, and significant environmental risks	Y	N	N	N

North Norfolk Coast WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			European interconnector (pipeline from Europe)									x		Significant risks with pipeline	Y	N	N	N
			Fakenham Laundries borehole									x		Low yielding, and significant environmental risks	Y	N	N	N
			Food processing in Fakenham and North Walsham									x		Low yielding, and significant environmental risks	Y	N	N	N
			Heinz (North Walsham)									x		Low yielding, and significant environmental risks	Y	N	N	N
			Icebergs									x		Unproven technology	Y	N	N	N
			McCartneys borehole									x		Low yielding, and significant environmental risks	Y	N	N	N
			Other industrial reclaimed water (see 3rd party options)											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
			Other private abstractors											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
	Shared asset ownership		Management of Broads resource		x		x		x					WFD risk	Y	N	N	N
			Multi-use reservoirs (agriculture)											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work	Y	N	N	N

North Norfolk Coast WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														in WRE will continue to explore the opportunities available for multi-sector water storage.				
Tankering of water			Inland (road / rail) tankering		x	x			x	x	x			Weather related reliability issues. Traffic impact	Y	N	N	N
			Sea tankering					x	x		x	x	x	Insufficient draught to accept sea tankers of reasonable size.	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

North Norfolk Rural WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Wensum						x					Not resilient as CAMS assessment shows that water is only available during Q50 and Q30	Y	N	N	N
			River Wissey						x					CAMS assessment shows that only a small amount of water is available during the winter months.	Y	N	N	N
New reservoir storage			West Bradenham (Wissey feeder streams)		x									Small yield with significant uncertainty about reliability under future climate change scenarios.	Y	N	N	N
Groundwater wells (boreholes)			Existing borehole optimisation		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Ministry of Defence boreholes											No specific options identified	Y	Y	N	N
Aquifer Storage and Recharge (ASR)		NNR5	North Norfolk Rural WRZ ASR		x	x						x		Leaky groundwater system connected to sensitive environmental receptors.	Y	Y	N	N
Aquifer Recharge (AR)			Bradenham/ Pickenham										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Attleborough, Wymondham, Dereham, Swaffham water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable		North Norfolk Coast WRZ transfer											Final planning problem - no surplus available to export	Y	Y	N	N
		NNR2/ NNR6	North Fenland WRZ Transfer												Y	Y	Y	Y
		NNR1/ NNR7 NNR8	Norwich and the Broads WRZ Transfer												Y	Y	Y	Y
		NNR3	Thetford WRZ											Final planning problem - no surplus in	Y	Y	Y	N

North Norfolk Rural WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Transfer											Thetford WRZ to transfer				
Resource Sharing with other Water Companies			Cambridge Water											As part of the Ouse Working Group options potential options for trades into North Norfolk Rural were identified but these were not modelled. Once other company plans are published these third party options may be developed via the Ofwat Information Platform in January.	Y	Y	N	N
3rd Party Options			Banham Zoo									x		Low yielding, and significant environmental risks	Y	N	N	N
			Norfolk Rural Industry									x		Low yielding, and significant environmental risks	Y	N	N	N
			Thetford/Eye Power Stations reuse									x		Low yielding, and significant environmental risks	Y	N	N	N
			Trade effluent review									x		Low yielding, and significant environmental risks	Y	N	N	N
	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS	Y	N	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Tankering (road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Tas						x					CAMS assessment shows that water is not available at low flows and at high flows only a small quantity is available for abstraction	Y	N	N	N
			River Tud						x					CAMS assessment shows that only a small quantity of water is available for half of the year.	Y	N	N	N
			River Wensum						x					Not resilient as CAMS assessment shows that water is only available during Q50 and Q30	Y	N	N	N
			River Yare (tidal and non-tidal)						x					Not resilient as CAMS assessment shows that water is only available during Q50 and Q30	Y	N	N	N
			River Tas						x					CAMS assessment shows that water is not available at low flows and at high flows only a small quantity is available for abstraction	Y	N	N	N
New reservoir storage			Costessey Pits extension (dredging / deepen)		x	x						x		Costessey Pits are connected to the chalk aquifer creating a risk of effecting the groundwater abstractions by extending/deepening the pits.	Y	N	N	N
			New Reservoir		x	x						x		Private Lakes and Gravel Pits study indicates that Bowthorpe is mainly groundwater fed and feeds into the River Yare. Therefore it would be more beneficial for quality and treatment to exploit the groundwater rather than using the lake.	Y	N	N	N
			Essex Reservoir		x		x		x					Option superseded by Fenland Reservoir options	Y	N	N	N
			Excess winter groundwater option				x							Strumpshaw Fen is a designated site	Y	N	N	N
			Costessey Pits extension		x									Continuity between Pits and river likely to constrain yield. Groundwater source.	Y	N	N	N
			Waveney Valley		x									Small yield with significant uncertainty about reliability under future climate change scenarios.	Y	N	N	N
			Wensum		x									Small yield with significant uncertainty about	Y	N	N	N

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														reliability under future climate change scenarios. Potential for unacceptable impact on Wensum SSSI and Broads				
	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
			Yare / Gt. Yarmouth flood options		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel pits		Gravel Pit development (Lyng Forge) - Wensum		x	x	x		x					Gravel pits are fed by water from the Chalk aquifer through the conductive sand and gravel deposits. Abstraction from the gravel pits directly affects the availability of water from the Wensum. Nearest abstraction point indicates that water is only available at Q50 and Q30 with a small allowance of 4 and 32Ml/d respectively.	Y	N	N	N
			Bowthorpe Lakes		x		x	x	x					May impact downstream flows. Option to exploit the groundwater directly would be more beneficial for quality and treatment costs.	Y	Y	N	N
			Taverham Lakes - Wensum		x	x	x		x					The gravel pits are fed by water from the Chalk aquifer through the conductive sand and gravel deposits. Abstraction from the gravel pits directly affects the availability of water from the Wensum. CAMS Water Availability The nearest assessment points indicate water is available at Q50 and Q30.	Y	Y	N	N
			Private lakes		x	x	x		x					Groundwater fed and option to exploit groundwater directly would be beneficial for quality and treatment purposes	Y	N	N	N
			Whitlingham Broad		x	x	x		x					Unreliable yield, high environment risks	Y	N	N	N
Increase reservoir yield	Amend abstraction		Costessey Pits development (lining)		x	x						x		Yield would be insignificant. Purpose of pits is bankside storage for pre-treatment	Y	N	N	N

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	regime																	
	Amend abstraction regime		Increase reservoir yield through maximising abstraction licences, amending intakes, utilising dead storage etc.			x						x		Reservoir built for managing water quality risk - not suitable for resource development	Y	N	N	N
	Raising/ dredging existing reservoirs		Costessey reservoirs			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
	Private lakes and gravel pits		Private lakes and gravel pits identified above.			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			Extend Chalk abstraction		x		x		x					For all assessment points (APs) in CAMS - presumption against new groundwater abstractions. Groundwater may be available near Loddon, south east of Norwich (Crag overlying Chalk) but it is Environmentally sensitive requires investigation, would be very difficult to increase abstraction.	Y	Y	N	N
			Existing borehole optimisation						x					River Yare catchment - presumption against new groundwater abstractions.	Y	N	N	N
			Extend Sands and Gravels / Crag abstraction						x					CAMS assessment indicates that there is no identifiable recharge so abstraction cannot be permitted.	Y	N	N	N
			Norwich WTW boreholes						x					CAMS assessment indicates that abstraction is not permitted as there is no identifiable recharge	Y	N	N	N
			Ringland perched ponds						x					No water available. Presumption against new groundwater abstractions	Y	N	N	N
			Strumpshaw (winter						x					CAMS assessment shows that no water is	Y	N	N	N

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			option)											available for recharge and therefore abstraction cannot be permitted				
			Tas Valley boreholes (winter option)		x									Presumption against new groundwater abstractions and there is no deficit predicated in this region.	Y	Y	N	N
Infiltration galleries			Wensum gravels		x	x							x	Highly productive aquifer that is in connection with the River Wensum, storage here is likely to fail and seep into the river system.	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Water reuse		x				x					Rejected due to water quality issues - WFD no deterioration	Y	N	N	N
			Chalk option (e.g. at Costessey Pits)			x								Hydrology is unsuitable	Y	N	N	N
Aquifer Recharge (AR)			Flood water management		x									High risk of failure due to uncertain DO	Y	N	N	N
			Existing sources with aquifer recharge										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
Desalination		NTB5	Bacton Desalination												Y	Y	Y	Y
			Cantley (brackish river water or groundwater)				x							Breaches unalterable planning constraint for SEA	Y	N	N	N
			Small schemes		x				x			x		No sustainable source available, therefore rejected	Y	N	N	N
			Bungay Desal		x				x			x		No sustainable source available, therefore rejected	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater	NTB3	Lowestoft Water Reuse												Y	Y	Y	Y
		NTB2/NTB7	Norwich Water Reuse												Y	Y	Y	Y
		NTB4	Great Yarmouth water reuse					x							Y	Y	Y	Y

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	Reclaimed industrial and commercial wastewater		Sizewell											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	Y	N
	Reduce losses WTW		Process improvements to reduce losses WTW		x	x		x				x		DO gains of only 0.15 Ml/d as the filters are being upgraded at the moment reducing the amount of backwash able to be recirculated. Not modelled as DO benefit too small to be transferred to a neighbouring WRZ.	Y	Y	Y	N
Bulk transfers	By pipeline - potable		North Norfolk Coast transfer		x									Final planning problem - no surplus in North Norfolk Coast WRZ to transfer	Y	Y	N	N
		NTB6/ NTB8	North Norfolk Rural WRZ transfer												Y	Y	Y	Y
	By pipeline - raw water		Great Ouse - Wensum transfer (pipeline),		x				x					Significant INNS risk of these river transfers. Potable transfers would be preferable.	Y	N	N	N
			Fenland (new reservoir) - Norwich and the Broads		x				x				x	Final planning problem - no deficit in Norwich and the Broads WRZ to require such a large transfer	Y	N	N	N
			Fenland (new reservoir) - River Wensum		x				x				x	Final planning problem - no deficit in Norwich and the Broads WRZ to require such a large transfer	Y	N	N	N
Resource Sharing with other	Shared asset ownership		Sizewell with or without Essex and Suffolk Water											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	Y	N
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Review discharge consents											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
			Essex and Suffolk Water transfer from the Broads											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Cambridge Water											As part of the Ouse Working Group options were not identified for specific trades in Norwich & the Boards however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	N	N	N
			Cantley (British Sugar)									x		Low yielding, and significant environmental risks	Y	N	N	N
	Shared asset ownership		Agricultural reservoirs											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.	Y	N	N	N
Tankering of water			Road / rail tankers		x	x			x	x	x			Weather related reliability issues. Traffic impact	Y	N	N	N
		NTB1	Great Yarmouth Sea tankering					x	x		x		x	Technically feasible but with high INNS risk, water quality and reliability risks which would need more investigation to overcome. Difficult to quantify the DO benefit. Sea tankering was originally included as an option in the Water Resources Options	Y	Y	Y	N

Norwich and the Broads WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														stated preference survey. The results of the pilot survey showed that customers did not believe it to be a realistic option and its inclusion was undermining the credibility of the survey as a whole. As a result it was removed and not included in the final version of the survey.				
Improved/ sophisticated conjunctive management			Norwich system conjunctive use											Final planning problem - no deficit in Norwich and the Broads WRZ	Y	Y	Y	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Nottinghamshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Idle		x	x	x		x					Groundwater availability is dependent upon surface water availability. No water available for licencing.	Y	N	N	N
			River Poulter										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			River Trent			x			x				x	Supplied by superficial deposits in continuity with the river Trent, option to abstract from Trent is thought as more feasible that from the gravels	Y	N	N	N
New reservoir storage	Flood storage		Flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel pits		Gravel pits north of Retford Idle Valley		x				x					Groundwater availability is dependent upon surface water availability. No water available for licencing.	Y	Y	N	N
Groundwater wells (boreholes)			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Existing borehole not in use		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Recommission abandoned WTW		x				x					WFD assessment - no additional resource available. Existing source to abandoned WTW is transferred utilised in Central Lincolnshire WRZ WTW.	Y	Y	N	N
			Existing polluted groundwater source		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			New sources		x							x		Groundwater not available from the unconfined Sherwood Sandstone. However, available as described for WL21 in the confined Sherwood Sandstone along the River Trent.	Y	Y	N	N
			Secondary groundwater		x							x		Secondary groundwater in Nottinghamshire not considered. HOF of 2,650 Ml/d will be applied to abstractions from superficial	Y	N	N	N

Nottinghamshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														deposits found to be in continuity with the river Trent and included within options using Trent as a source				
			Sherwood sandstone (new source)									x		Groundwater availability is guided by the surface water resource availability. The reach of the Trent along the power station boreholes has water available for licensing during Q70 flows, and restricted availability during Q95 flows. included within options using Trent as a source	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Sherwood sandstone		x							x		Considered more viable Sherwood sandstone option to supply Ruthamford North WRZ rather than Nottinghamshire WRZ (see option RTN12)	Y	N	N	N
Aquifer Recharge (AR)			Flood storage		x									High risk of failure due to uncertain DO	Y	N	N	N
			Sherwood sandstone		x							x		Considered more viable Sherwood sandstone option to supply Ruthamford North WRZ rather than Nottinghamshire WRZ (see option RTN12)	Y	N	N	N
			SUDS (road drainage)		x									High risk of failure due to uncertain DO	Y	N	N	N
Desalination			Tidal Trent at Gainsborough				x		x	x			x	Abstraction and treatment of the tidal Trent would be complicated as the existing Trent WTW license is affected on levels downstream in the River Trent, therefore considered too risking for licencing purposes.	Y	N	N	N
			Secondary groundwater		x							x		Option not appropriate - no secondary groundwater available	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Newark water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Retford water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N

Nottinghamshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Bulk transfers	By canal		Chesterfield canal		x	x	x	x	x		x		x	High risk of failure – Sustainability: The Chesterfield Canal is an SSSI for the entire area of interest (Retford to River Trent). The ecosystem supports a nationally uncommon aquatic plant, and therefore changes in flows and water quality may impact on these features. The aquatic plant thrives in the brackish, eutrophic water in the canal, and mixing with River Trent water chemistry and increased flows are likely to impact. High risk of failure – Sustainability: Spread of invasive species (signal crayfish, zebra mussels, and non-native pondweeds) is also considered a risk as the water chemistry in the River Trent is likely different than that of the canal. High risk of failure – Technical: Whether the existing WTW could be upgraded to cope with the new water chemistry is considered a high risk due to the brackish nature of the water in the canal. Whilst this may be possible, it may render the scheme financially unviable for the benefit (increased water supply) it provides. Further work is required to assess the feasibility of this option.	Y	Y	N	N
Bulk transfers	By pipeline - potable		Central Lincolnshire WRZ (Lincoln) transfer											Final planning problem - new option development is in the north of the WRZ so more efficient to transfer from the north of the WRZ rather than Lincoln.	Y	Y	Y	N
		NTM1	Central Lincolnshire WRZ Transfer												Y	Y	Y	Y

Nottinghamshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	By pipeline - raw water		Severn Trent Water - groundwater into Trent											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Severn Trent Water WRCs into Trent (Scunthorpe WRC)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Resource Sharing with other Water Companies			Opportunity with all options											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Severn Trent Water - new and increasing existing											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	Y	N
			Yorkshire Water- new											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	Y	N
3rd Party Options			Gainsborough Water reuse (Severn Trent WRC)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
			Coal mine dewatering											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
			Decommissioned Power station sources				x					x		Licences likely to be clawed back	Y	N	N	N
			Power stations - cooling water, boiler feed											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Sugar beet (Newark)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	Y	N	N
	Shared asset ownership		Agriculture		x	x						x		Insignificant reliable yield.	Y	N	N	N
Tankering of water			Boat on Trent (Gainsborough)						x	x		x	x	Preliminary analysis has determined that the tankers are too large to be transported to Gainsborough.	Y	N	N	N
			Canal						x	x			x	Small DO. Risk to navigation in drought - reliability issues related to third party	Y	N	N	N
			Rail						x	x			x	Rejected due to weather and reliability	Y	N	N	N

Nottinghamshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														issues, and due to traffic impacts				
			Road tankering		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Improved/sophisticated conjunctive management		NTM4	Increase surface water treatment capacity to utilise high river flows		x				x					Option not relevant to the final planning problem in Central Lincolnshire which would be the source of the surface water. Does not provide DO required during low flows in more extreme drought than historic.	Y	Y	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Ruthamford Central WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
New reservoir storage	Private lakes and gravel pits		Private lakes and gravel pits		x	x			x					Potential risk of impacting downstream licences and storage (Grafham Reservoir). Low DO and potentially not cost effective. Lake has limited storage potential as water only available 30% of the time.	Y	Y	N	N
			Milton Keynes balancing lakes		x		x		x				x	May impact downstream flows into Grafham Reservoir and direct intake WTW. Low DO scheme. AP12 downstream has no water availability and may be impacted from abstraction at the balancing lake.		Y	Y	N	N
Bulk transfers	By pipeline - potable	RTC2	Ruthamford South WRZ transfer												Y	Y	Y	Y
		RTC1	Ruthamford West WRZ Transfer												Y	Y	Y	Y

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Grand union canal						x					CAMS assessment shows no water available	Y	N	N	N
			River Gwash						x					CAMS assessment shows no water available	Y	N	N	N
			River Nene						x					CAMS assessment shows that flow is not available at any point during the year	Y	Y	N	N
			River Welland						x					CAMS assessment shows no water available	Y	N	N	N
			Lower Welland Nene (Brackish)						x					CAMS assessment shows no water available	Y	N	N	N
New reservoir storage		RTN1	South Lincs reservoir (unsupported)				x								Y	Y	Y	Y
		RTN2	South Lincs reservoir (supported via TWA scheme)												Y	Y	Y	Y
		RTN14	South Lincs reservoir (supported with Trent Transfer)												Y	Y	Y	Y
			Manton Valley Reservoir					x		x				Not feasible as it would involve diversion of the railway	Y	N	N	N
			New reservoir from new sources identified in direct river abstraction						x					CAMS assessment shows no water available	Y	N	N	N
			Canal reservoirs (Naseby, Silby)											Potential option that needs to be considered under trading platform when available	Y	N	N	N
			Acquiring Eye brook reservoir		x	x			x					Potential issues about reliability of yield and availability of resource under WFD no-deterioration requirements	Y	N	N	N
	Flood storage		Internal Drainage Boards						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
	Private lakes and gravel pits		Private lakes and gravel pits											None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
			Gravel pits - Northampton		x	x	x		x					No water available for licencing in the CAMS area (Idle and Tome).	Y	Y	N	N
			Private Reservoirs / Lakes e.g. Mepal	x	x	x		x				x		Fed by drainage from the surrounding area and seasonal recharge storage in superficial deposits so will have an unreliable yield. CAMS indicates that groundwater is only available for abstraction in the winter.	Y	Y	N	N
Increase reservoir yield	Amend abstraction regime		Maximise refill opportunity for Ravensthorpe & Hollowell		x	x						x		100% natural catchments - no significant additional resource available	Y	N	N	N
			Reduces the Gwash Glen transfer and releases from Rutland				x		x				x	EA transfer to Gwash Glen is not considered to be available for reducing the transfer without other viable options to replace the water. The actual transfer volume cannot change because it is an EA licence and determined by flows in the Glen. However there has been the Gwash Flows Project where we have been working with the EA to reduce the MRF at Belmesthope (the location of the transfer on the Gwash) that is required whenever the transfer is operational. This is being trialled at a rate of 21.6 Ml/d reduced from 27 Ml/d for this AMP. So far there have not been any negative impacts so it's expected that the change will continue. There are no plans to change the compensation release but technically we do release significantly more than we are required to (the licence requires us to release 52.6 l/s (4.5 Ml/d) but	Y	Y	N	N

Ruthamford North WRZ Rejection Register

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				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														historically we release ~8 Ml/d) so this is a possible option – however it would need extensive engagement as it would dramatically reduce flows in the Gwash all year round, and may not even be possible now due to WFD no deterioration.				
			Maximise refill opportunity for Pitsford		x	x		x						Increasing the pump capacities to meet the current licence only increases yield of reservoir by 1.2ML/d so is not considered feasible as the pump capacity would need to increase by 47.5ML/d.	Y	Y	N	N
			Reduce dead storage - Pitsford			x						x		High risk of failure, and potential DO from reduction in dead storage not thought to be significant.	Y	N	N	N
			Reduce dead storage - Ravensthorpe & Hollowell			x						x		High risk of failure, and potential DO from reduction in dead storage not thought to be significant.	Y	N	N	N
			Reduce dead storage - Rutland Water			x						x		High risk of failure, and potential DO from reduction in dead storage not thought to be significant.	Y	N	N	N
			Existing Nene pumps to Rutland Water - maximise refill opportunities		x	x		x						Increasing the pump capacities to meet the current licence only increases yield of reservoir by 1.5ML/d so is not considered feasible as the pump capacity would need to increase by +500ML/d.	Y	N	N	N
	Raising/dredging existing reservoirs		Reservoir raising plus deepening of options above			x						x		Dredging of existing reservoirs not feasible due to results of bathymetric surveys	Y	N	N	N
			Dredging - Pitsford			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
		RTN11	Pitsford reservoir				x		x		x			Raising by 3m is technically feasible but	Y	Y	Y	N

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			dam raising											requires mitigation of environmental impacts.				
			Dredging - Ravenshtorpe & Hollowell			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
			Ravensthorpe & Hollowell Reservoir dam raising	x	x	x		x			x			Raising these reservoirs only gains small <1ML/d gain in yield which would create an excessive cost for the option per ML of water gained. In addition, drawdowns for the reservoirs would prevent the asset being able to be used fully during construction est. at 3 years.	Y	Y	N	N
			Dredging - Rutland Water			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
			Rutland Water dam raising				x	x	x		x	x		Option does not provide a much greater yield for the cost of raising the reservoir. In addition, the bird ponds would need relocation along with a number of other mitigation measures required due to the impacts of raising the dam by 0.5m.	Y	Y	N	N
Groundwater wells (boreholes)			Limestone - recommission sources		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Existing source		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Leicester groundwater		x							x	x	Yield unlikely from secondary aquifer - water quality issues.	Y	Y	N	N
Infiltration galleries			Upper Nene gravels		x	x	x		x				x	No or very limited water available for licencing in the CAMS area.	Y	N	N	N
Aquifer Storage and Recharge (ASR)		RTN12	Sherwood sandstone ASR			x						x		Two options considered for ASR, one as a drought scheme and the other as a supply demand option. There is no drought impact in Ruthamford North WRZ and so the option is not relevant to the final Planning problem.	Y	Y	Y	N

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														There is high uncertainty around the DO benefits as a supply demand scheme and the likely DO would be small.				
			Potential locations		x				x					Rejected due unsuitable geology, on SUDS basis	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater	RTN3	Peterborough Water reuse				x		x						Y	Y	Y	Y
	Reclaimed industrial and commercial wastewater		Industrial reclaimed water											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
			Tata											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
	Reduce losses WTW		Pitsford WTW - backwash water reuse			x								Washwater recovery already in place	Y	Y	N	N
			Rutland WTW - backwash water reuse			x								Washwater recovery already in place	Y	Y	N	N
Bulk transfers	By canal	RTN9	Canal transfer via Grand Union to R. Nene for abstraction to Pitsford												Y	Y	Y	N
		RTN10	Canal transfer via Grand Union to R. Nene for abstraction to Pitsford with Severn Trent Water												Y	Y	Y	N

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Reuse															
			Leicester groundwater via Grand Union canal		x		x						x	Option from Canal and Rivers Trust - needs further water quality and drought resilience investigations prior to being included in the plan	Y	N	N	N
Bulk transfers	By pipeline - potable	RTN18/ RTN24/ RTN28	South Lincolnshire WRZ Transfer												Y	Y	Y	Y
			Pitsford supply option from Ruthamford North network improvements		x	x		x				x	x	option is already being built	Y	Y	N	N
		RTN17	South Fenland WRZ Transfer												Y	Y	Y	Y
	By pipeline - raw water		River Welland, River Nene for Rutland abstraction						x					CAMS assessment shows that flow is not available at any point during the year	Y	N	N	N
		RTN5	River Trent-Rutland Water												Y	Y	Y	Y
		RTN4	River Trent - Rutland WTW												Y	Y	Y	Y
			Grafham reservoir - Pitsford reservoir				x		x					Water is connected via potable network and proposed transfers that provide further resilience	Y	Y	N	N
			Rutland Reservoir - South Lincolnshire Reservoir				x		x					As part of the South Lincolnshire Reservoir options there is a potable transfer to Ruthamford North WRZ. This could support Rutland water superseding the need for a raw water transfer.	Y	Y	N	N
Resource Sharing with other Water Companies			Cambridge Water											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	N
		RTN6/	Severn Trent Water–												Y	Y	Y	Y

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
		RTN7/	potable trades															
		RTN26	Severn Trent Water – raw water trades (ANG6c)												Y	Y	Y	Y
		RTN27	Severn Trent Water – raw water trades (ANG6d)											Option is for 189Ml/d of raw water delivered to the River Nene upstream of the Pitsford and Rutland abstraction points. The raw water is a combination of diverted final effluent and river water. This will have a higher INNS risk than option RTN26 (effluent only). The option also requires Severn Trent to increase capacity of one of their existing reservoirs Therefore this option was not included in the economic modelling.	Y	Y	Y	N
		RTN28	Severn Trent Water – raw water trades (ANG7c)											Option is for 160 Ml/d of raw water delivered to Rutland Water. The raw water is a combination of River Soar water and diverted final effluent. The raw water would need treatment to remove INNS prior to discharge to Rutland Water. Final planning problem - Ruthamford North WRZ does not have a drought risk greater than historic: the benefit of this option would be small compared to the large capex and opex compared to other options available for the WRZ.	Y	Y	Y	N
		RTN29/ RTN30	Severn Trent Water's WRCs - Leicester, Rugby, Melton Mowbray											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	Y

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Carlsberg									x		Low yielding, and significant environmental risks	Y	N	N	N
			Canal River Trust (CRT)	x									x	Included in bulk transfer via canal options	Y	N	N	N
			Tata steel											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
			Weetabix											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
Tankering of water			Rail						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Road		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Improved/sophisticated conjunctive management		RTN19/ RTN21	Cease exporting raw water from Rutland Water to Grantham. Treat water at Rutland. Grantham would need another resource to support this option.												Y	Y	Y	Y
			Increase surface water treatment capacity to utilise high river flows						x					No significant groundwater resources are available	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N

Ruthamford North WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Ruthamford South WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Grafham/Offord Group Licence (peak only)						x					CAMS assessment shows no water available	Y	N	N	N
			River Ouse - existing intake						x					CAMS assessment shows only a small amount of water is available in winter only.	Y	N	N	N
			River Flit						x					CAMS assessment shows no water available	Y	N	N	N
			River Ivel						x					CAMS assessment shows that only a small amount of water is available during the winter months at certain APs. Some APs have no water available at any point during the year	Y	N	N	N
			River Ouzel						x					CAMS assessment shows that only a small amount of water is available during the winter months at certain APs. Some APs have no water available at any point during the year	Y	N	N	N
New reservoir		RTS1	Ruthamford South				x								Y	Y	Y	Y

Ruthamford South WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
storage			New Reservoir															
	Flood storage		Internal Drainage Boards						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
			Existing direct river intake WTW - bankside storage					x						A low DO benefit (4Ml/d), which does not make it a very cost effective solution. It is mutually exclusive to other Ouse abstraction options (RTS1, RTS2 and RTW2) which are much more cost effective so this option was not taken through to economic modelling.	Y	Y	Y	N
	Private lakes and gravel pits		Wyboston Lakes	x	x	x								Water from the Great Ouse enters the lakes via the river terrace deposits. The Oxford Clay prevents water entering groundwater. Surface water fed and only has availability at Q30 so not a reliable source.	Y	Y	N	N
Increase reservoir yield	Amend abstraction regime		Reduce dead storage Ruthamford South Reservoir		x	x						x		Opportunity addressed by re-commissioning of reservoir option	Y	N	N	N
			Reduce dead storage Grafham Water			x						x		High risk of failure, and potential DO from reduction in dead storage not thought to be significant.	Y	N	N	N
			Maximise refill opportunity for reservoir		x	x								Pumping capacity meets current licence capacities so no further capacity is required. Engineering capacity exists, but no useful severe drought yield. See 2011/12 reservoirs report.	Y	N	N	N
	Raising/dredging existing reservoirs		Dredging - Grafham Water			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
		RTS2	Grafham Water dam raising								x			High yield benefit for raising the dam by 3m, the environmental and constructability issues require mitigation measures.	Y	Y	Y	N
Groundwater			Existing sources		x				x					WFD assessment - no additional resource	Y	Y	N	N

Ruthamford South WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
wells (boreholes)														available				
			Maximising licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Abandoned boreholes		x	x	x		x					Three AWS boreholes not in use. Infrastructure still in place. Water quality issues. Licence expired - presumption against new groundwater abstractions. Environment Agency stated they would not be able to licence an increase in Woburn Sands or Chalk abstraction in this area as there is no new groundwater available.	Y	Y	N	N
			new sources - Greensands, Clophill, Leighton Buzzard, Leighton Linslade						x					No water available for new consumptive abstractions.	Y	N	N	N
Infiltration galleries			Clapham infiltration system										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			Houghton										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			River Gravels - Brampton										x	High risk of failure as DO is uncertain, and there are potential environmental risks. Abstraction from the Brampton gravels are likely to impact on the Bedford Ouse where water in only available at high flows.	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Greensand ASR		x	x			x			x		Limited water availability which is not resilient in low flow periods. The hydrogeological setting is poor for ASR with high risk of losing stored water.	Y	N	N	N
Aquifer Recharge (AR)			SUDS - Greensand - Ampthill/Flitwick		x									High risk of failure due to uncertain DO	Y	N	N	N
			SUDS - Greensand -		x									High risk of failure due to uncertain DO	Y	N	N	N

Ruthamford South WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Biggleswade															
			SUDS - Greensand - Leighton Buzzard		x									High risk of failure due to uncertain DO	Y	N	N	N
			SUDS - Greensand - Shefford		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed Water	Reclaimed domestic wastewater		Huntingdon water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Milton Keynes water reuse		x				x					WRC already discharges upstream of Grafham WTW existing abstraction so no additional benefit.	Y	N	N	N
	Reclaimed industrial and commercial wastewater		Industrial reclaimed water											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
	Reduce losses WTW		Grafham WTW - backwash water reuse			x								Washwater recovery already in place	Y	Y	N	N
Bulk transfers	By canal		Grand Union to Great Ouse											Considered as a part of option RTN10	Y	N	N	N
	By pipeline - potable	RTS9/ RTS10/ RTS11	Ruthamford North WRZ Transfer												Y	Y	Y	Y
		RTS5	Ruthamford Central WRZ Transfer												Y	Y	Y	Y
		RTS8	Ruthamford North WRZ via existing infrastructure											No longer required - superseded by potable transfer	Y	N	N	N
	By pipeline - raw water	RTS3	Rutland Reservoir - Grafham Reservoir				x		x					Superseded by potable transfer to reduce risk of INNS	Y	Y	N	N
			Pitsford reservoir - Grafham reservoir				x		x					Water is connected via potable network and proposed transfers that provide further resilience	Y	Y	N	N

Ruthamford South WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Rutland to Ouse, (for subsequent partial transfer to Grafham and remainder to flow to Fenland)				x		x					Option breaches unalterable planning constraint, and is not promotable on sustainability	Y	Y	N	N
			Ouse, Offord - Grafham				x							This transfer exists and is included within existing licence for the Grafham Raising and New Ruthamford South reservoir options which supersedes the raw water transfer option	Y	Y	N	N
Resource Sharing with other Water Companies			Cambridge Water- to St Ives/Huntingdon											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	N
			Thames Water											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	N
			Thames Water reservoir											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	N
	Trade	RTS13	Affinity reverse transfer to Ruthamford South WRZ												Y	Y	Y	N
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Eon, Little Barford											Third party options to be developed when published on Ofwat Information Platform in January	Y	N	N	N
Tankering of water			Rail						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N

Ruthamford South WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			Road		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Improved/sophisticated conjunctive management			Great Ouse Water Act (GOWA) operating rules - review											Trade from GOWA to Grafham included in feasible options (RTS13)	Y	Y	Y	N
			River support - conjunctive use		x	x	x		x					Not feasible due to lack of surface water available in low flows	Y	N	N	N
			Increase surface water treatment capacity to utilise high river flows		x									No significant groundwater resources are available	Y	N	N	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Ruthamford West WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Ouse - existing abstraction						x					Scheme is part of the RTW2 recommissioning option	Y	N	N	N
New reservoir storage		RTW2	Recommission Ruthamford West Reservoir WTW												Y	Y	Y	Y
			Ruthamford West Reservoir extension	x										Subject to unalterable planning conditions and environmentally sensitive area	Y	N	N	N
Increase reservoir yield	Raising/dredging existing reservoirs		Dredging - Ruthamford West reservoir			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
			Ruthamford West reservoir dam raising		x	x	x		x					Ruthamford West reservoir is within an environmentally sensitive area - high risk of failure due to WFD deterioration from recommissioning reservoir	Y	Y	N	N
Bulk transfers	By pipeline - potable water transfer	RTW1/ RTW3	Ruthamford North WRZ Transfer												Y	Y	Y	Y

South Essex WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Blackwater						x					CAMS assessment shows no water available	Y	N	N	N
			River Colne						x					CAMS assessment shows no water available	Y	N	N	N
			River Pant						x					CAMS assessment shows no water available	Y	N	N	N
			River Stour -						x					CAMS assessment shows no water available	Y	N	N	N
			Colne - Change the Hands off Flow				x			x				Abstractions to Ardleigh Reservoir currently do not have an MRF. However, there is a requirement to pass at least 316 l/s for four hours for up to 100 days per year when requested to do so by Colchester Borough Council. Elsewhere in situations where no MRF exists we have recommended that sources are modelled with a bypass of 3 Ml/d for fish passage. Any variation to this licence could include a similar requirement. The reason for the 5-year aggregate is not known. There is also a summer 5-year aggregate of 34,095,000 m^3. Ardleigh could benefit from relaxing the 5 year constraints to be discussed further with the Environment Agency.	Y	Y	N	N
New reservoir storage		SEX2	Ardleigh extension												Y	Y	Y	Y
			Potential options to be investigated.						x					CAMS assessment shows no water available	Y	N	N	N
	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
			Environment Agency asset		x									High risk of failure due to uncertain DO	Y	N	N	N
Increase reservoir yield	Private lakes and gravel pits		Increasing storage at private lakes											None identified as part of the Private Lakes and Reservoir study	Y	Y	N	N
	Amend abstraction regime		Ardleigh Reservoir - Increase reservoir yield through maximising		x							x		Cannot increase abstraction as licence constrained	Y	N	N	N

South Essex WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			abstraction licences, amending intakes, utilising dead storage etc.															
	Raising/ dredging existing reservoirs		Ardleigh Reservoir				x							Raising Ardleigh breaches unalterable planning constraint	Y	N	N	N
Groundwater wells (boreholes)			Review group licences		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Observation boreholes		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Braintree boreholes		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Tiptree boreholes		x				x					WFD assessment - no additional resource available	Y	Y	N	N
Infiltration galleries			Braintree										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
			Halstead										x	High risk of failure as DO is uncertain, and there are potential environmental risks.	Y	N	N	N
Aquifer Storage and Recharge (ASR)		SEX6/SEX12	South Essex WRZ ASR			x						x		Poor recovered water quality (Potassium)	Y	Y	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Desalination			Bradwell											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater	SEX1	Colchester Water Reuse												Y	Y	Y	Y
			Braintree water reuse				x							Breaches unalterable planning constraint -	Y	N	N	N

South Essex WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														assumes abstraction reform constraint leading to environmental issues				
			Southend water reuse		x			x					x	WRC considerable distance from Anglian Water supply system.	Y	Y	N	N
	Reclaimed industrial and commercial wastewater		Bradwell											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
	Reduce losses WTW		Process improvements to reduce losses WTW			x								Washwater recovery already in place	Y	Y	N	N
Bulk transfers	By pipeline - potable		Sudbury WRZ Transfer											Final planning scenario - transfer would be <5Ml/d and not part of a strategic route therefore rejected.	Y	Y	Y	N
			Central Essex WRZ Transfer		x									Final planning scenario no surplus in Central Essex to transfer	Y	Y	N	N
		SEX4/ SEX8	East Suffolk WRZ Transfer												Y	Y	Y	Y
	By pipeline - raw water transfer		River Pant - Abberton						x					CAMS assessment shows no water available	Y	N	N	N
Resource Sharing with other Water Companies		SEX9	Affinity Water - to continue with Colchester WTW agreement at 70:30	x										Affinity Water require their full entitlement of the Ardleigh WTW to meet their own supply demand balance needs.	Y	Y	N	N
		SEX5	Affinity Water - to amend Colchester WTW agreement at 80:20	x									x	Affinity Water require their full entitlement of the Ardleigh WTW to meet their own supply demand balance needs.	Y	Y	N	N
			Essex and Suffolk Water											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	N
			Thames Water											Third party options to be developed when	Y	Y	Y	N

South Essex WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														published on Ofwat Information Platform in January				
			EOETs optimisation (+ trade with Essex and Suffolk Water)	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	N	N	N
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Bradwell											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Colchester/Ipswich industrial study (discharge consents)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Tilbury/Chelmsford (trades)											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
			Trade high fluoride water											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Tankering of water			Tankering (rail)						x	x			x	Rejected due to weather and reliability issues, and due to traffic impacts	Y	N	N	N
			Tankering (Road)		x	x			x	x	x			Road Tankering rejected due to capacity required would not be feasible via road	Y	N	N	N
Improved/sophisticated conjunctive management		SEX7	Optimise use of Colchester resources											Option is feasible but benefits are complex to assess within the final planning scenario and future scenarios. The benefits in DO are small scale.	Y	Y	Y	N
Other			Innovative options (international examples e.g. sea clouding)			x		x				x		Unproven technology, cost and yield	Y	N	N	N
			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

South Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Cur-off channel						x					CAMS assessment shows that water is only available during winter months at certain APs. No water is available at any point during the year at some APs. AP17 has a very high HOF of 1040 Ml/d	Y	N	N	N
			River Ely Ouse						x					CAMS assessment shows no water available	Y	N	N	N
			River Lark						x					CAMS assessment shows that water not available in the Lark .	Y	N	N	N
			River Nene (Wisbech)						x					CAMS assessment shows no water available	Y	N	N	N
			Cut-off Channel/Stoke Ferry Extension + transfer											CAMS assessment shows that water is only available during winter months at certain APs. No water is available at any point during the year at some APs. AP17 has a very high HOF of 1040 Ml/d	Y	N	N	N
			River Waveney						x					CAMS assessment shows that water is only available in small quantities during summer	Y	N	N	N
New reservoir storage	Flood storage		New Internal Drainage Board structure						x			x		Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice	Y	N	N	N
			SUDS - recharge lagoons		x									High risk of failure due to uncertain DO	Y	N	N	N
			Ely Ouse Washes Expansion and Control		x									High risk of failure due to uncertain DO	Y	N	N	N
			Wash Barrage		x									High risk of failure due to uncertain DO	Y	N	N	N
Increase reservoir yield	Raising/ dredging existing reservoirs		Dredge the cut off channel and use as storage reservoir (weirs at each end) – capture water in the winter period, i.e. storage reservoir			x						x		Option rejected as it is mutually exclusive with Feltwell. The use of flood management weirs interfere with this option.	Y	N	N	N
			Raise the ditches in			x						x		Unproven option, opportunities need further	Y	N	N	N

South Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
			the area (Dyke System) and use as a water storage area											investigation - no data currently available to determine if option could be feasible.				
Groundwater wells (boreholes)			Relocating existing boreholes (away from the River to reduce impact)		x				x					WFD assessment - no additional resource available	Y	Y	N	N
			Existing boreholes expansion						x					CAMS assessment indicates that there is no groundwater available for abstraction.	Y	N	N	N
			Ministry of Defence sites											May be an option, when details published on Ofwat Information Platform in January 2018.	Y	N	N	N
Desalination			Fenland River Outfalls										x	Water quality envelope would require complex operating regime	Y	N	N	N
			Inland (Wisbech) desal										x	Water quality envelope would require complex operating regime	Y	N	N	N
Reclaimed water	Reduce losses WTW	SFN6	Process improvements to reduce losses WTW		x	x						x		Process improvements could be implemented to recover wash water however it only yields 0.36Ml/d. As DO benefits are low it has not been modelled.	Y	Y	Y	N
Bulk transfers	By pipeline - potable	SFN1/ SFN3/ SFN4	Ruthamford North WRZ Transfer												Y	Y	Y	Y
		SFN2	North Fenland WRZ Transfer												Y	Y	Y	Y
Resource Sharing with other Water Companies			Cambridge Water transfer											As part of the Ouse Working Group options were not identified for specific trades in South Fenland however once other company plans are published there may be more third party options to be developed when published on Ofwat Information Platform in January.	Y	Y	Y	N

South Fenland WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
3rd Party Options	Shared asset ownership		Multi use reservoir (agriculture)											The WRE Black Sluice study has indicated the key driver for multi-sector projects is a public water supply (PWS) reservoir. The study showed that multi-sector projects have come together due to local and community groups utilising opportunities that arise from a PWS reservoir. Therefore no specific multi-sector options in addition to the public water supply reservoir options included in the EBSD modelling have been assessed as part of the WRMP. Further work in WRE will continue to explore the opportunities available for multi-sector water storage.	Y	N	N	N
	Trade		EOETs & GOGS review	x	x	x	x		x		x		x	No availability from GOGS or EOETs	Y	Y	N	N
Tankering of water			Inland (road / rail) tankering		x	x			x	x	x			Weather related reliability issues. Traffic impact	Y	N	N	N
			Sea tankering (Kings Lynn)					x	x		x	x	x	Insufficient draught to accept sea tankers of reasonable size.	Y	Y	N	N
Improved/sophisticated conjunctive management		SFN7	Kings Lynn/Marham conjunctive use - amend existing operation		x	x	x		x					Insufficient groundwater.	Y	Y	N	N
Other			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

South Humber Bank WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Desalination		SHB1	Humber Desalination												Y	Y	Y	Y
Reclaimed water	Reclaimed domestic wastewater	SHB2	Pyewipe Water reuse												Y	Y	Y	Y

South Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
New reservoir storage	On-stream reservoirs		Recommission unused reservoir		x							x		Small yield with significant uncertainty about reliability under future climate change scenarios. Significant water quality risks in Upper Witham catchment	Y	N	N	N
Increase reservoir yield	Amend abstraction regime		Unused reservoir		x				x					Does not provide DO required during low flows	Y	N	N	N
	Raising/ dredging existing reservoirs		Unused reservoir			x						x		Not feasible due to results of the bathymetric surveys	Y	N	N	N
Groundwater wells (boreholes)			Existing unused sources		x				x					WFD assessment - no additional resource available	Y	Y	N	N
Reclaimed water	Reclaimed domestic wastewater		Marston Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
			Sleaford Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
	Reduce losses WTW		Process improvements to reduce losses WTW			x								Washwater recovery already in place	Y	Y	N	N
Bulk transfers	By canal		Grantham canal (flow reversal)		x	x	x	x	x		x		x	The canal is disused and has become valuable wetland habitat. Changes in flow and water chemistry are considered likely to cause habitat damage. Rehabilitation of a disused canal to transfer flows is likely to require extensive canal repair. Pre-treatment may be required to protect existing habitat along the canal. Large pipeline transfer required, repairs to existing pounds, and pumping bypass around every	Y	Y	N	N

South Lincolnshire WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
														lock is likely to render the scheme not feasible.				
	By pipeline - potable	SLN2	Bourne WRZ Transfer		x		x		x		x			Final planning scenario - transfer would be <5Ml/d and not part of a strategic route therefore rejected.	Y	Y	Y	N
		SLN1/ SLN3/ SLN5	Central Lincolnshire WRZ Transfer												Y	Y	Y	Y

South Norfolk Rural WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			Little Ouse - subject to CAMS assessment						x					CAMS assessment indicates that only a small quantity of water is available during winter	Y	N	N	N
New reservoir storage	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Groundwater wells (boreholes)			Existing abstraction						x					CAMS assessment shows no water available	Y	N	N	N
			Extend Chalk abstraction						x					No water available for new consumptive abstractions. Trading of recent actual quantities within GWMUs may be possible.	Y	N	N	N
Aquifer Storage and Recharge (ASR)			Effluent reuse		x				x					Rejected due to WQ issues - WFD no deterioration	Y	N	N	N
Bulk transfers	By pipe - potable		Norwich and the Broads WRZ Transfer											Final planning problem - no deficit in South Norfolk Rural requiring a transfer	Y	Y	Y	N
			North Norfolk Rural WRZ transfer											Final planning problem - no deficit in South Norfolk Rural requiring a transfer	Y	Y	Y	N
Resource Sharing with other Water Companies			Essex and Suffolk Water											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	Y	N
Other			Rainwater harvesting			x		x				x		Demand management option	Y	N	N	N

Sudbury WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Stour (Sudbury)						x					CAMS assessment shows that no water is available for abstraction at Sudbury	Y	N	N	N
New reservoir storage	Flood storage		SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
	Private lakes and gravel pits		Private reservoirs / lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Increase reservoir yield	Private lakes and gravel pits		Increasing storage at private lakes			x								None identified as part of the Private Lakes and Reservoir study	Y	N	N	N
Groundwater wells (boreholes)			New groundwater resource						x					CAMS indicates a presumption against new groundwater abstractions.	Y	N	N	N
Aquifer Recharge (AR)			SUDS		x									High risk of failure due to uncertain DO	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Sudbury Water reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable		Bury and Haverhill WRZ transfer											Final planning scenario - no deficit in Sudbury	Y	Y	Y	N
			South Essex WRZ Transfer											Final planning scenario - no deficit in Sudbury	Y	Y	Y	N
			Central Essex WRZ Transfer		x									Final planning scenario - no deficit in Sudbury	Y	Y	N	N
Resource Sharing with other Water Companies			EOETS/storage	x	x	x	x		x		x		x	EOETS only available in short term and storage will be a longer term option.	Y	N	N	N
3rd Party Options			3rd party trade options											Third party options to be developed when published on Ofwat Information Platform in January	Y	Y	N	N
			Review discharge											Third party options to be developed when	Y	N	N	N

Thetford WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Thet						x					CAMS assessment shows that only a small quantity of water is available during winter.	Y	N	N	N
New reservoir storage			Thetford Forest		x									Small yield with significant uncertainty about reliability under future climate change scenarios. Geotechnical issues	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Thetford Water Reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable	THT3	Bury and Haverhill WRZ transfer											Final planning problem - no deficit in Thetford	Y	Y	Y	N
		THT2	North Norfolk Rural WRZ transfer											Final planning problem - no deficit in Thetford	Y	Y	Y	N
Resource Sharing with other Water Companies		THT1	Cambridge Water											As part of the Ouse Working Group options potential options for trades into Thetford were identified but these were not modelled. Once other company plans are published these third party options may be developed via the Ofwat Information Platform in January.	Y	Y	Y	N
			GOGS (Thet/Little Ouse)	x	x	x	x		x		x		x	No availability from GOGS	Y	N	N	N

Thetford WRZ Rejection Register

Scheme Type	Scheme Sub-Categories/ Sub-Components	Opt Ref	Scheme Name	Does not address the problem			Breaches unalterable planning constraints	Option is not promotable			High Risk of Failure			Comments	Unconstrained	Constrained	Feasible	Modelled
				Programme	Sustainability	Technical	Third Party	Cost	Sustainability	Third Party	Programme	Technical	Programme/ Technical					
Direct river abstraction			River Thet						x					CAMS assessment shows that only a small quantity of water is available during winter.	Y	N	N	N
New reservoir storage			Thetford Forest		x									Small yield with significant uncertainty about reliability under future climate change scenarios. Geotechnical issues	Y	N	N	N
Reclaimed water	Reclaimed domestic wastewater		Thetford Water Reuse				x							Breaches unalterable planning constraint - assumes abstraction reform constraint leading to environmental issues	Y	N	N	N
Bulk transfers	By pipeline - potable	THT3	Bury and Haverhill WRZ transfer											Final planning problem - no deficit in Thetford	Y	Y	Y	N
		THT2	North Norfolk Rural WRZ transfer											Final planning problem - no deficit in Thetford	Y	Y	Y	N
Resource Sharing with other Water Companies		THT1	Cambridge Water											As part of the Ouse Working Group options potential options for trades into Thetford were identified but these were not modelled. Once other company plans are published these third party options may be developed via the Ofwat Information Platform in January.	Y	Y	Y	N
			GOGS (Thet/Little Ouse)	x	x	x	x		x		x		x	No availability from GOGS	Y	N	N	N

APPENDIX C – LIST OF SUPPORTING TECHNICAL REPORTS

Task	Report	Report Author
Task 1	Reservoir options appraisal report	Mott MacDonald
	Reservoir Raising Rim-side Impact: Initial Assessment	Mott MacDonald
	Ruthamford Reservoir's Drawdown	Mott MacDonald
	Distributed Hydrological Modelling Witham	Mott MacDonald
	Distributed Hydrological Modelling Ely Ouse	Mott MacDonald
	Wash Storage Scheme Technical Note	Mott MacDonald
Task 2	Transfers option appraisal report	Mott MacDonald
	Potable Water Transfers Water Quality Technical	Mott MacDonald
	Trent Transfer yield and DO memorandum	Mott MacDonald
Task 3	Water re-use option appraisal report	Anglian Water
Task 4	Groundwater review	Mott MacDonald
Task 6	CAMS review	Mott MacDonald
Task 8	Aquifer storage appraisal report	Mott MacDonald
Task 11	Desalination appraisal report	Mott MacDonald
Task 12	Conjunctive use appraisal report	Mott MacDonald
Task 15	Tankering appraisal report	Mott MacDonald
Task 18	Gravel Pits and Lakes study	Mott MacDonald
Task 21	Study 1 – Trent strategic storage report (issued to Trent Working Group)	Mott MacDonald
Other	Treatment philosophy memorandum	Mott MacDonald
	Treatment Report	Mott MacDonald

The referencing of Tasks is based on the same studies produced for WRMP14. The following tasks were not relevant for WRMP19,

- Task 5 Third party options – these are to be assessed as part of the Ofwat Information Platform
- Task 7 Sizewell B – to be assessed as part of Ofwat Information Platform
- Task 9 Trent resources study – superseded by Task 21
- Task 10 Flood management options
- Task 13 Multiple use options – this has been covered by the WRE
- Task 14 Trading transfers – this has been covered by the Trent and Ouse working groups and any other options will be assessed as part of Ofwat Information Platform.
- Task 16 Clapham increased abstraction – AMP6 scheme
- Task 19 Norwich WTW options – an AMP6 scheme
- Task 20 – Innovation

APPENDIX D – INVASIVE NON-NATIVE SPECIES RISK ASSESSMENT

INNS pathways risk assessment

The following document sets out a high level risk assessment of the potential pathways for the movement of invasive non-native species (INNS) which may be created by the different AWS WRMP19 option types.

This document is split into two sections;

- the first section is a generic risk assessment which sets out all the potential pathways which could be created by any new AWS option involving the transfer of water.
- the second section sets out pathway risks by AWS option type. These include reservoir options, raw water transfers, effluent reuse, ASR, tankering, desalination, conjunctive use, potable water transfers and NEP augmentation options.

The risk assessment is based upon a frequency and severity of impact as set out in Table 1 below. The criteria applied for setting out the frequency and severity of an impact as presented in Table 2 & 3 below.

Factors affecting the risk levels are option specific and include:

- Type connection: pipeline/canal/shipping (tankering)
- Location of intakes and outfalls
- Length of the transfer
- Transfer time and capacity
- Frequency of operation
- Natural or artificial barriers to passage
- Presence of existing connections to be upgraded or new infrastructure
- Proximity to SSSI/HD sites

Table 1: Magnitude of Risk

Frequency / Severity	Infrequent	Periodical	Regular
Very Low	1 = Very Low	1 = Very Low	1 = Very Low
Low	2 = Low	2 = Low	3 = Low
Medium	3 = Low	4 = Moderate	4 = Moderate
High	4 = Moderate	5 = High	6 = High

Table 2: Frequency of impact

Frequency	Criteria
Infrequent	Only occurs in emergency or during situations not considered part of the normal running of the scheme
Periodical	Will happen during start up or shutdown, or periodically during routine maintenance or operation of the option
Regular	Will occur throughout the regular operation of the option

Table 3: Severity of impact

Severity	Criteria
Very Low	Treated water, effluent or groundwater
Low	Existing pathway between waterbodies or treated water / groundwater / Effluent with no INNS risk being transferred
Medium	Change in volume of transfer between waterbodies which are already connected.
High	New pathway between waterbodies not current connected or potential to introduce new INNS not currently observed in the UK

Generic risk assessment.

In this risk assessment all possible pathways for the transfer of INNS have been identified, and the risks before mitigation assessed (based on criteria set out above). Possible mitigation is then presented along with the risk after this mitigation has been applied. It should be noted that this potential mitigation may not be viable for all specific options and the risks before mitigation may apply in some specific cases.

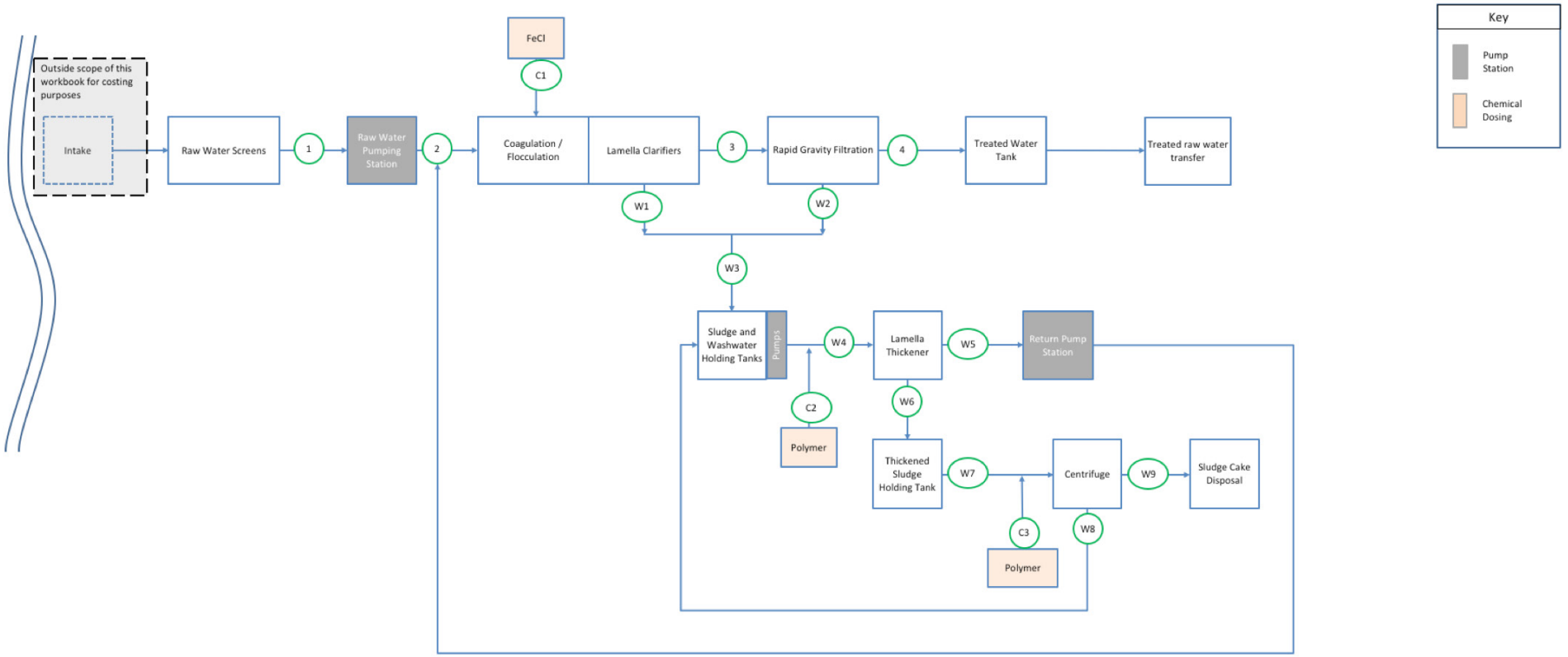
Risk Matrix	Pathway	Potential INNS impact	Frequency	Severity	Risk without mitigation (RWM)	Potential mitigation to be considered	Risk after mitigation (RAM)
A. Raw Water Connection	1. Washouts along the pipe	**A.1.1** The raw water transfers will not be running 100% of year or will be running with a reduced flow during some periods of the year. Washouts will be required along the pipe which will discharge to local water courses for normal maintenance, to avoid the accumulation of sediments in low points and to empty the pipeline during long periods of disuse.	Periodical	High	5	Treatment on all washout points / treat before pipeline / pipe back to abstraction waterbody / tanker for disposal.	
		A.1.2 Washouts from short raw water pipes discharged back to source waterbody (no risk of INNS transfer as no new pathway created).	Periodical	Low	2		
		A.1.3 Treated raw water pipelines (no risk of INNS transfer from washouts, as treated water will be free from INNS).	Periodical	V. Low	1		
	2. Leaks or bursting of the pipe	**A.2.1** Pipe bursts cause water to be released to the environment (creating pathway for the transfer of INNS)	Infrequent	High	4	Treat before pipeline	
		A.2.2 Leak or burst of short raw water pipeline which would discharge back to the source waterbody (no new pathway for the transfer of INNS)	Infrequent	Low	2		
		A.2.3 Leak or burst of treated water pipeline (no risk of INNS transfer as treated water will be free from INNS)	Infrequent	V. Low	1		
	3. Mussels	**A.3.1** Transfer of raw water can lead to the growth of mussels in pipelines which would need to be disposed of.	Infrequent	Low	2		
	4. Physical transfer of water	**A.4.1** Physical transfer of untreated water between two waterbodies currently unconnected	Regular	High	6	Treat water at abstraction point	
		A.4.2 Physical transfer of untreated water between two waterbodies currently already connected in this location	Regular	Medium	4	None practicable	
		A.4.3 Physical transfer of treated water between two waterbodies currently unconnected (no INNS risk as treated water will be free from INNS)	Regular	V. Low	1		
		A.4.4 Physical transfer of treated water between waterbodies currently already connected (treated water will be free of INNS)	Regular	V. Low	1		
B. Water Processing /Storage	1. Backwash discharge from treatment process	**B.1.1** Washwater at treatment works potentially containing INNS species discharged to the original river/estuary	Periodical	Low	3		
		B.1.2 Washwater at treatment works potentially containing INNS species discharging to a different river/estuary	Periodical	High	5	Return washwater to top of works	
		B.1.3 Washwater at treatment works potentially containing INNS species discharged to a reservoir	Periodical	High	5	Return washwater to top of works	
		B.1.4 Washwater at treatment works potentially containing INNS species recycled to the top of the WTW	Periodical	Low	3		
	2. Emergency overflows	**B.2.1** Failure of some processes at the treatment works / overflows from storage tanks in emergency situations (can lead to water potentially containing INNS species being released to original abstraction watercourse or sea)	Infrequent	Low	2		
		B.2.2 Failure of some processes at the treatment works / overflows from storage tanks in emergency situations (can lead to water potentially containing INNS species being released to a different watercourse)	Infrequent	High	4	Treat near source	
	3. Sludge cake disposal	**B.3.1** The disposal of sludge cake as by-product of the treatment process could transfer INNS plant species to wider environment directly or via airborne pathways, if used on land	Periodical	High	5	Dispose to hazardous landfill / sterilise sludge before disposal	
		B.3.2 Disposal of sludge cakes as by-product of the treatment process does not change from existing disposal route	Periodical	Low	2		
C. Other pathways	1. Natural	**C.1.1** New reservoirs represent new natural habitats for birds, who could pick up INNS and transfer to other local waterbodies	Regular	High	6	None practicable	
	2. Recreational	**C.2.1** New reservoirs may form new recreational usage increasing the risk of INNS transfer to other waterbodies via recreational equipment (e.g. kayaking, fishing etc.)	Periodical	High	5	None practicable	
D. Reservoirs	1. Overflows	**D.1.1** Emergency outflow from reservoir/storage will outflow to local watercourse which already has a connection	Infrequent	Medium	3		
		D.1.2 Emergency outflow from reservoir/storage will outflow to new local watercourse with no current connection	Infrequent	High	4	None practicable	

INNS treatment process schematic

Mitigation for the transfer for INNS has already been applied to many of the options by the inclusion of new INNS water treatment works at the abstraction point.

The generic INNS treatment works design is shown below.

Further details can be found in the report 'WRMP19 Supply Option Development – Treatment, Mott MacDonald, 5th July 2017



2- INNS transfer risks by option type

1 -Reservoir options: Increased storage of existing reservoirs

Dam Raising

Existing Reservoir

Existing or upgrade of existing infrastructure

Existing WTW to be upgraded

Existing pumping station that may need to be upgraded

Potable water Demand Zone

Short raw water intake with potential of INNS transfer

Treatment works washwater discharge

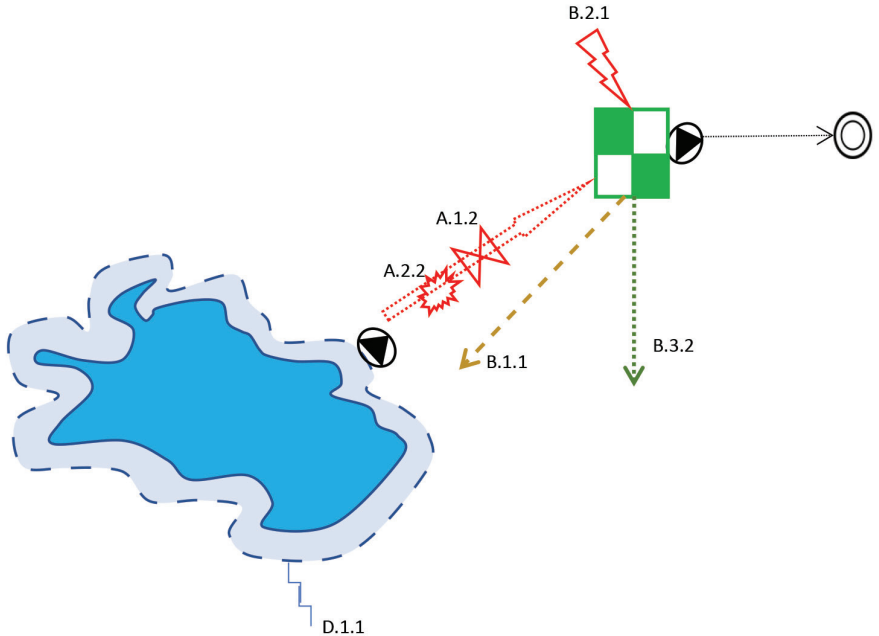
Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of short war water pipeline

Reservoir/storage emergency overflow



Applicable INNS risks – see risk matrix for details

		mitigation	options	mitigation
1.2	Pipeline washout	1		
2.2	Pipeline bursts	2		
1.1	Washwater discharge	3		
2.1	Emergency overflows	2		
3.2	Sludge disposal	2		
1.1	Reservoir overflows	3		

2 - Reservoir options: new reservoirs

New or upgrade of existing River Intake + PS

New reservoir

Existing or upgrade of existing infrastructure

New infrastructure with potential for INNS transfer

Existing WTW to be upgraded

New pumping station

Existing pumping station that may need to be upgraded

Potable water Demand Zone

Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

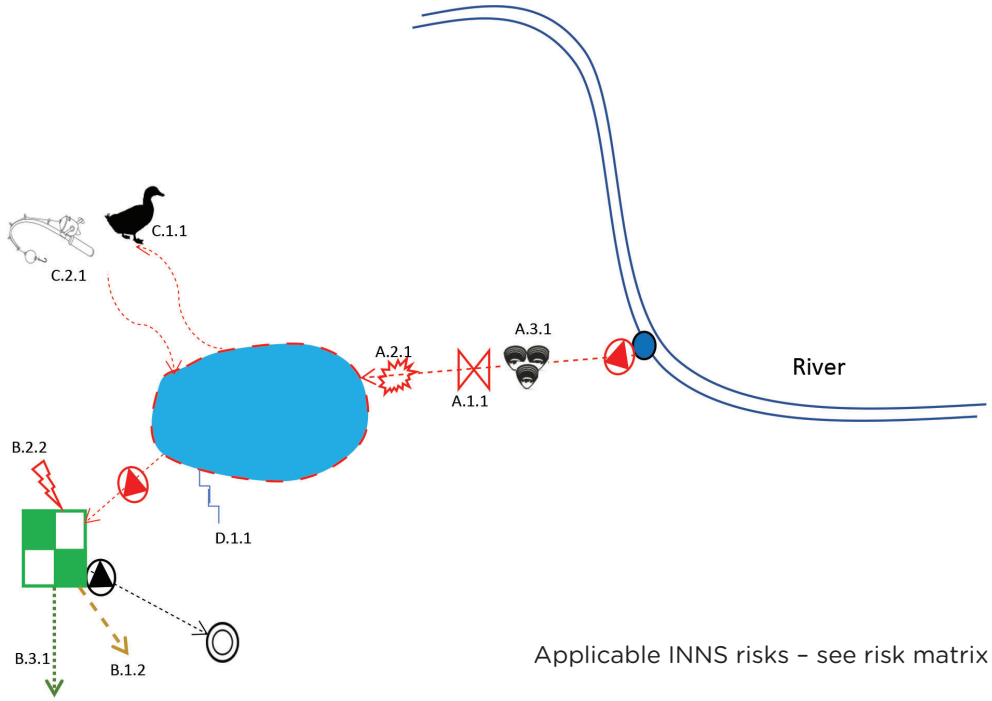
Leak or burst of raw water pipeline

Mussels in pipeline

Reservoir/storage emergency overflow

Transfer via natural pathways

Transfer via recreational equipment



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.1	Pipeline washout	5	Tanker for disposal / treat at washout point (costs not applied in dWRMP)*	
A.2.1	Pipeline bursts	4		
A.3.1	Mussels in pipeline	2		
B.1.2	Washwater discharge	5	Return washwater to top of works	
B.2.2	Emergency overflows	4	Treat near source	
B.3.1	Sludge disposal	5	Dispose to landfill / sterilise sludge before disposal	
C.1.1	Natural (birds etc.)	6	None practicable	
C.2.1	Recreational	5	None practicable	
D.1.2	Reservoir overflows	4	None practicable	

* Mitigation to be applied will be confirmed when reservoir site selection complete

3 - Raw water transfer river to WTW

New or upgrade of existing River Intake + PS

New infrastructure or upgrade of existing infrastructure

New infrastructure with potential of INNS transfer

Existing WTW to be upgraded

Existing pumping station that may need to be upgraded

Demand Zone

Treatment works washwater discharge

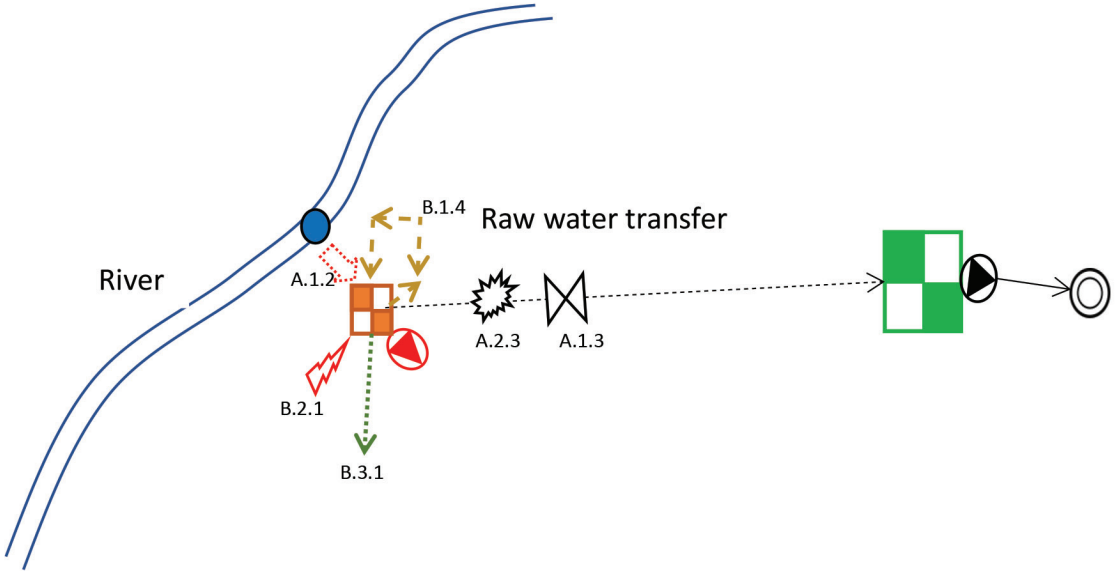
Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline

Mussels in pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.2	Pipeline washout	2		
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	1		
B.1.4	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.1	Sludge disposal	5	Dispose to landfill / sterilise sludge before disposal	

4 - Raw water transfer between existing reservoirs

Existing Reservoir

New INNS WTW

Short raw water intake with potential of INNS transfer

New pumping station

New infrastructure with no potential of INNS transfer

Treatment works washwater discharge

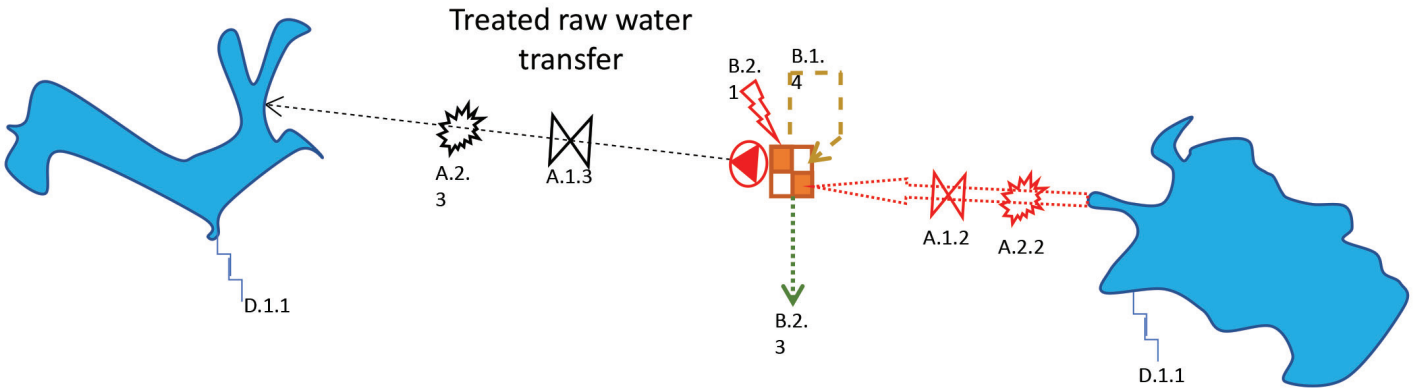
Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline

Reservoir/storage emergency overflow



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.2	Pipeline washout	2		
A.1.3	Pipeline washouts	1		
A.2.2	Pipeline bursts	2		
A.2.3	Pipeline bursts	1		
A.4.4	Physical transfer of water	1		
B.1.4	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.1	Sludge disposal	5	Dispose to landfill / sterilise sludge before disposal	
D.1.1	Reservoir overflows	3		

5 - Raw water transfer river to reservoir

New or upgrade of existing River Intake + PS

Existing Reservoir

New INNS WTW

New infrastructure or upgrade of existing infrastructure

Short raw water intake with potential of INNS transfer

New pumping station

Treatment works washwater discharge

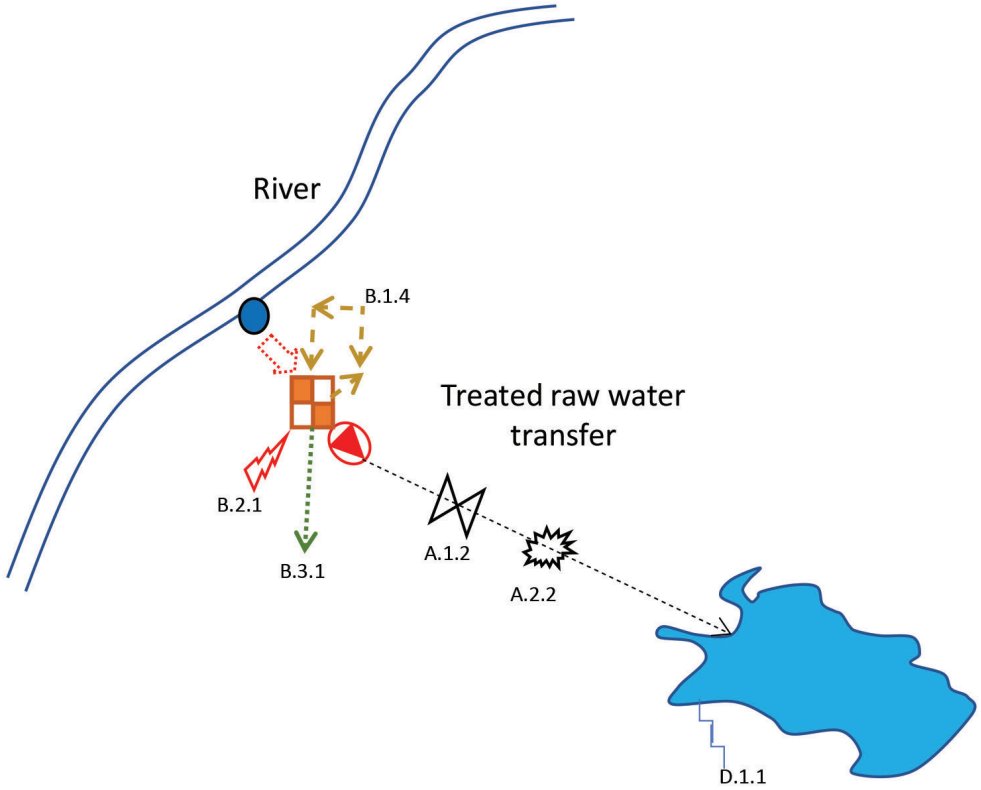
Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline

Reservoir/storage emergency overflow



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.2	Pipeline washout	2		
A.2.2	Pipeline bursts	2		
A.4.3	Physical transfer of water	1		
B.1.4	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.1	Sludge disposal	5	Dispose to landfill / sterilise before disposal	
D.1.1	Reservoir overflows	3		

6 - Raw water transfer via a Canal

Existing canal connection

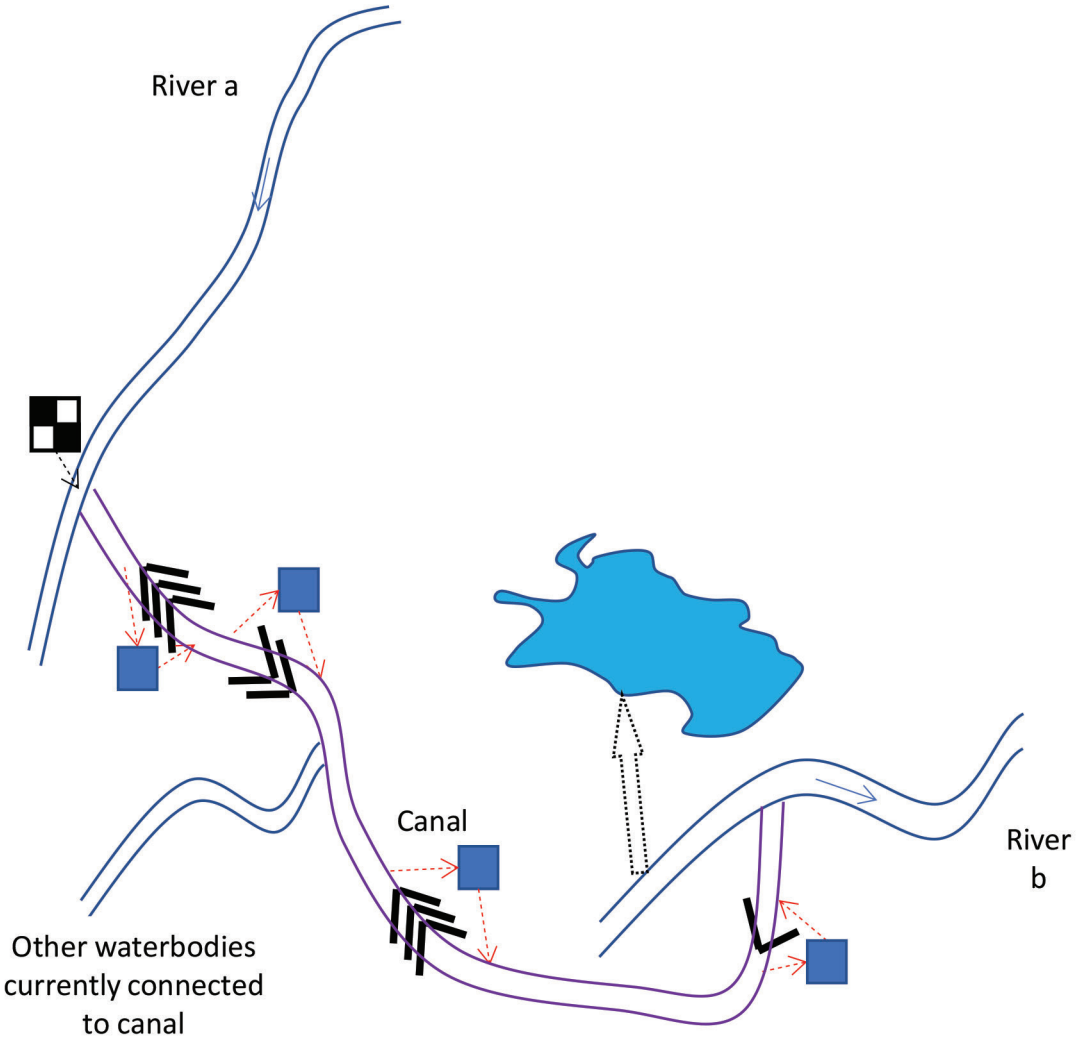
River/canal flow direction

Existing river abstraction to reservoir

Upgraded pumping stations

New infrastructure pipelines for bypassing locks

Existing connection from WwTW to canal



Note: These options will not create any new connections between watercourses or change in flow directions on the canal only the volume of water transfers will change

Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.4.2	Physical transfer of water	4	None practicable	

7 - River to river raw water transfer between already connected waterbodies

New or upgrade of existing River Intake + PS

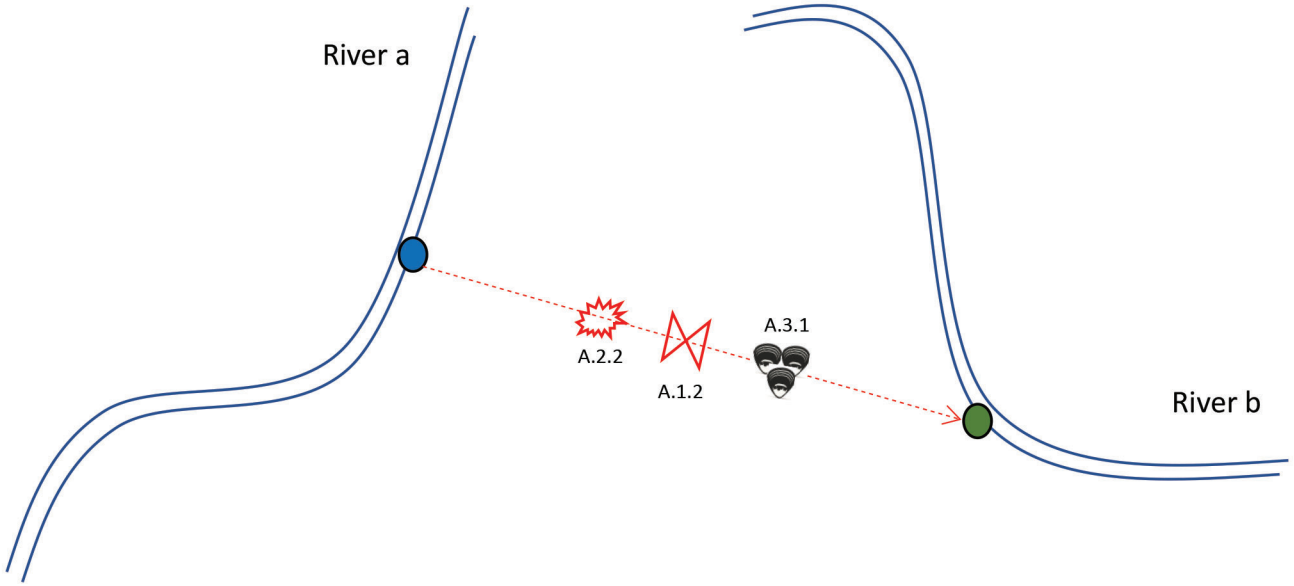
River discharge point

New pipeline with potential of INNS transfer, between two already connected waterbodies

Washout on raw water pipeline

Leak or burst of raw water pipeline

Mussels in pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.2	Pipeline washout	5	Treatment at all washout points / tanker for disposal (costs not applied in dWRMP)	
A.2.2	Pipeline bursts	4	Treat before pipeline (costs no applied in dWRMP)	
A.3.1	Mussels	2		
A.4.2	Physical transfer of water	4	None practicable	

8 - Water reuse WRC to reservoir

New or upgrade of existing River Intake + PS

River discharge point

Sewage Treatment Works

New Water Recycling Centre

Existing WTW to be upgraded

Existing infrastructure

New infrastructure

New or upgrade of existing infrastructure with potential of INNS transfer

New pumping station

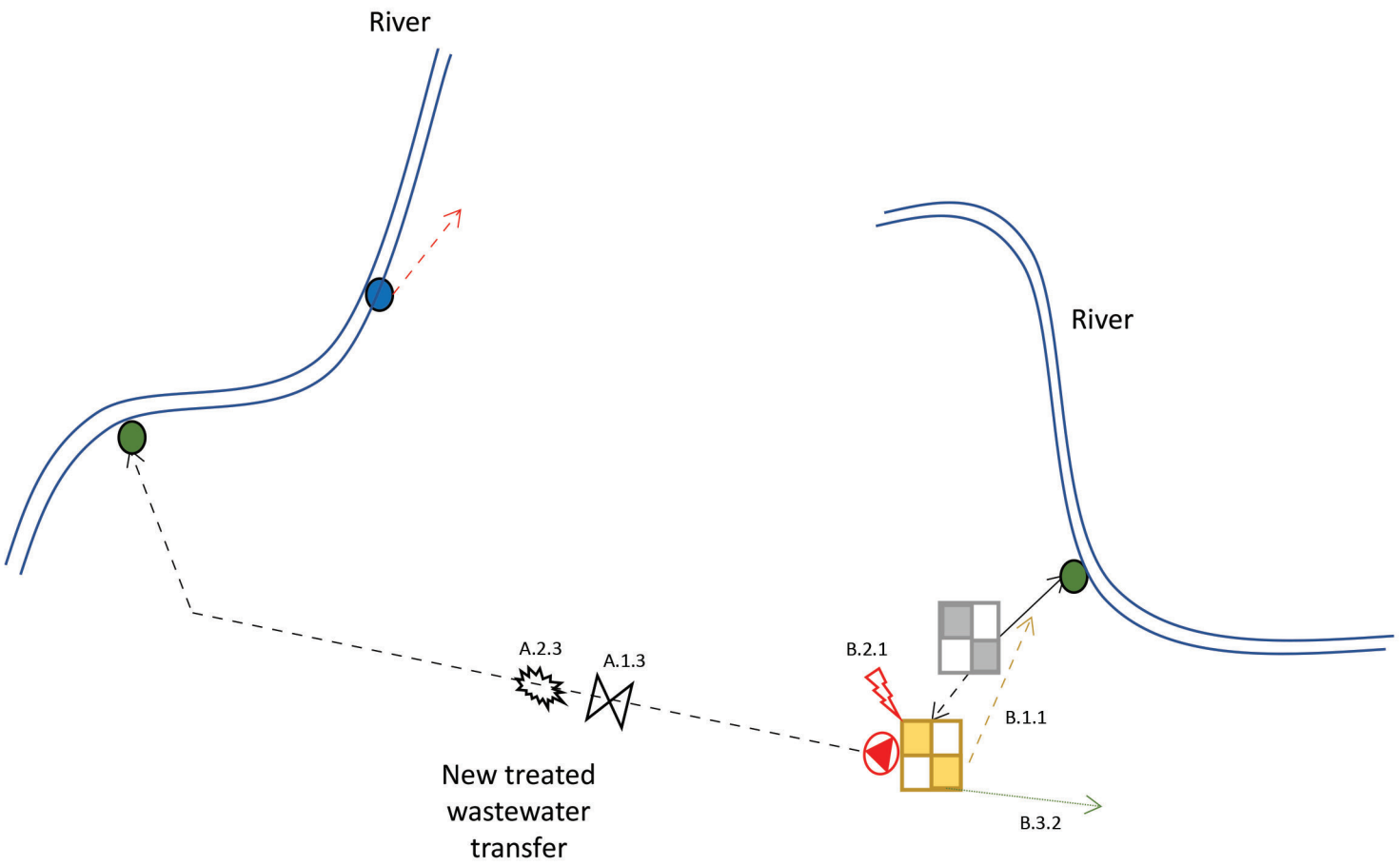
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	2		
A.4.3	Physical transfer of water	1		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.2	Sludge disposal	2		

9 - Water reuse WRC to new river

New or upgrade of existing River Intake + PS

River discharge point

Sewage Treatment Works

New Water Recycling Centre

Existing infrastructure

New infrastructure

New pumping station

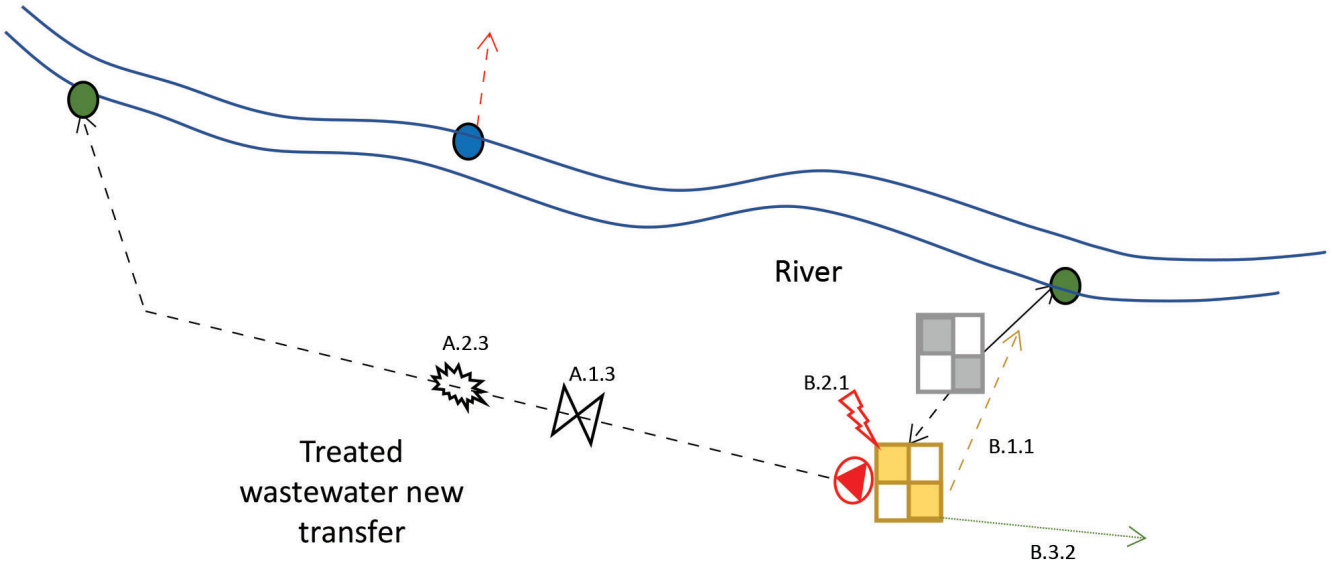
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	2		
A.4.3	Physical transfer of water	1		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.2	Sludge disposal	2		

10 - Water reuse non-potable supply

River discharge point

Sewage Treatment Works

New Water Recycling Centre

Existing infrastructure

New infrastructure or upgrade of existing infrastructure

New or upgrade of existing infrastructure with potential of INNS transfer

New pumping station

Non-Potable Demand Hub

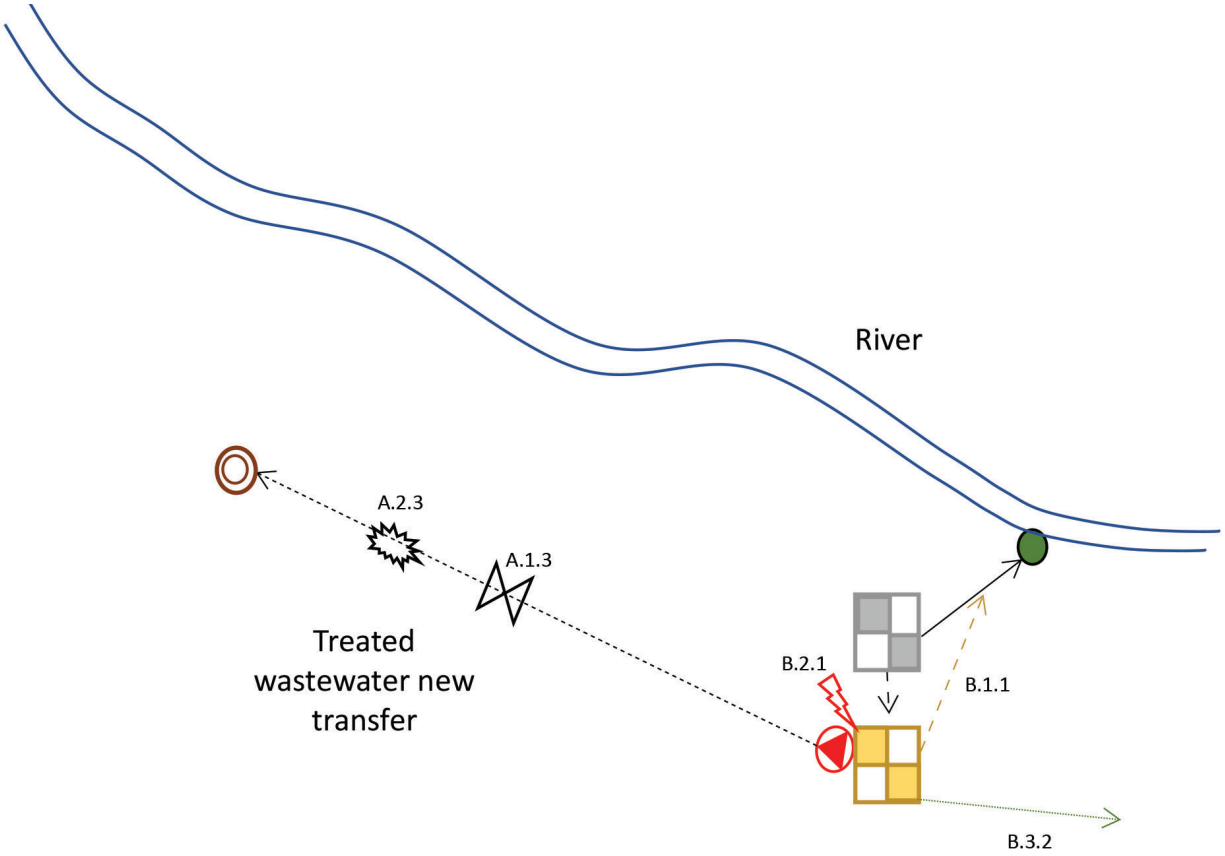
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	2		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.2	Sludge disposal	2		

11 - ASR River abstraction to reservoir to ground

New Borehole

Groundwater treatment

Surface water treatment

Existing reservoir

Existing WTW to be upgraded

Bi-directional trunk mains taking to the boreholes for recharge. Flow is reversed during borehole abstraction

New infrastructure or upgrade of existing infrastructure

Short raw water intake

Existing pumping station that may need to be upgraded

Potable water Demand Zone

Treatment works washwater discharge

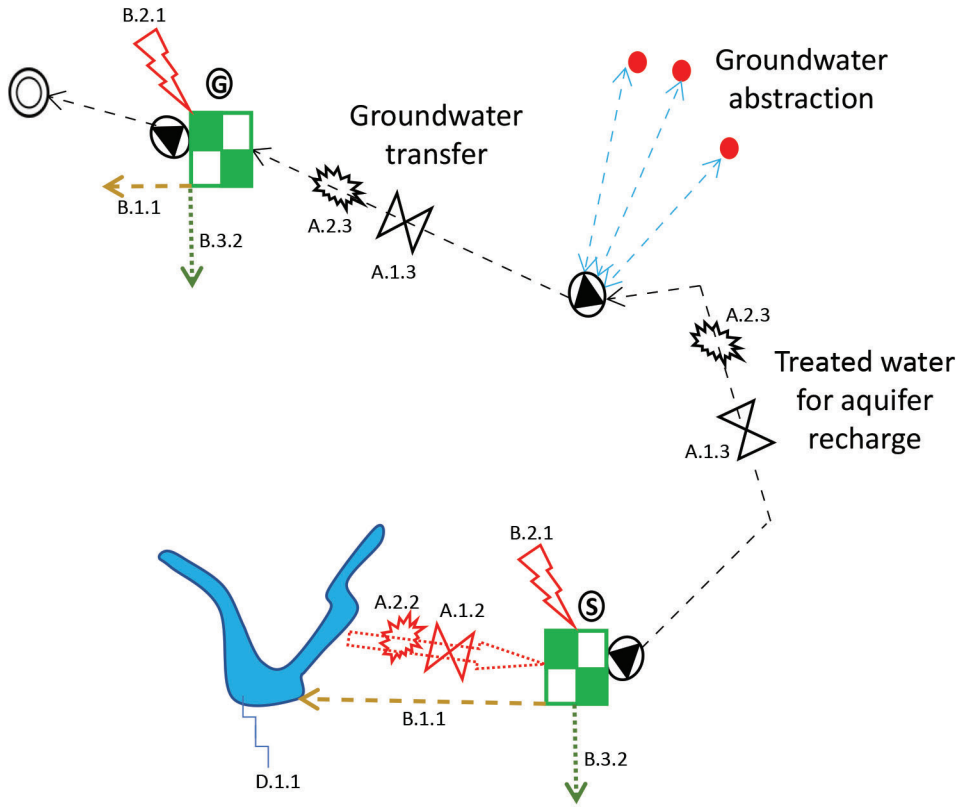
Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline

Reservoir/storage emergency overflow



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.2	Pipeline washout	2		
A.1.3	Pipeline washout	1		
A.2.2	Pipeline bursts	2		
A.2.3	Pipeline bursts	1		
A.4.3	Physical transfer for water	1		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.2	Sludge disposal	2		
D.1.1	Reservoir overflow	3		

12 – Sea Tankering

Generic raw water source with INNS

New infrastructure or upgrade of existing infrastructure with no INNS risk

New infrastructure with potential of INNS transfer

New covered storage

Existing WTW

New pumping station

Existing pumping station that may need to be upgraded

Potable water Demand Zone

Port

Treatment works washwater discharge

Treatment works sludge discharge

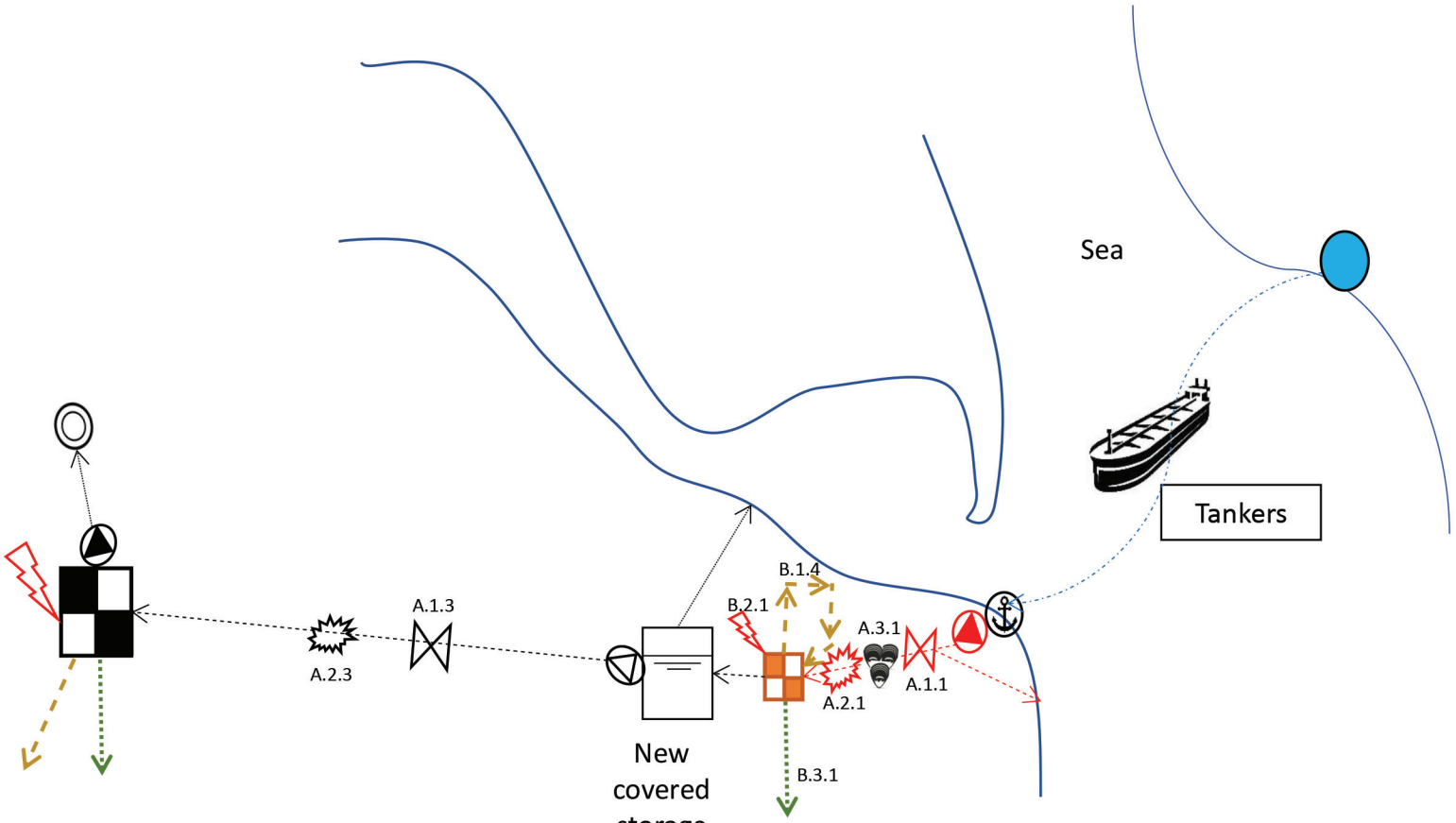
Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline

Mussels in pipeline

New INNS WTW



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.1	Pipeline washout	5	Pipe discharge to sea	
A.1.3	Pipeline washout	2		
A.2.1	Pipeline bursts	4	None practicable	
A.2.3	Pipeline bursts	2		
A.3.1	Mussels	2		
B.1.4	Washwater discharge	3	Return washwater to top of works	
B.2.1	Emergency overflows	2		
B.3.1	Sludge disposal	5	Sterilise sludge before disposal	

13 - ASR River abstraction to treatment to BHs

New Borehole

Groundwater treatment

Surface water treatment

New or upgrade of existing River Intake + PS

New or existing WTW to be upgraded

Bi-directional trunk mains taking to the boreholes for recharge. Flow is reversed during borehole abstraction.

New infrastructure or upgrade of existing infrastructure with no INNS risk

New or upgrade of existing infrastructure with potential of INNS transfer

Existing pumping station that may need to be upgraded

Potable water Demand Zone

Treatment works washwater discharge

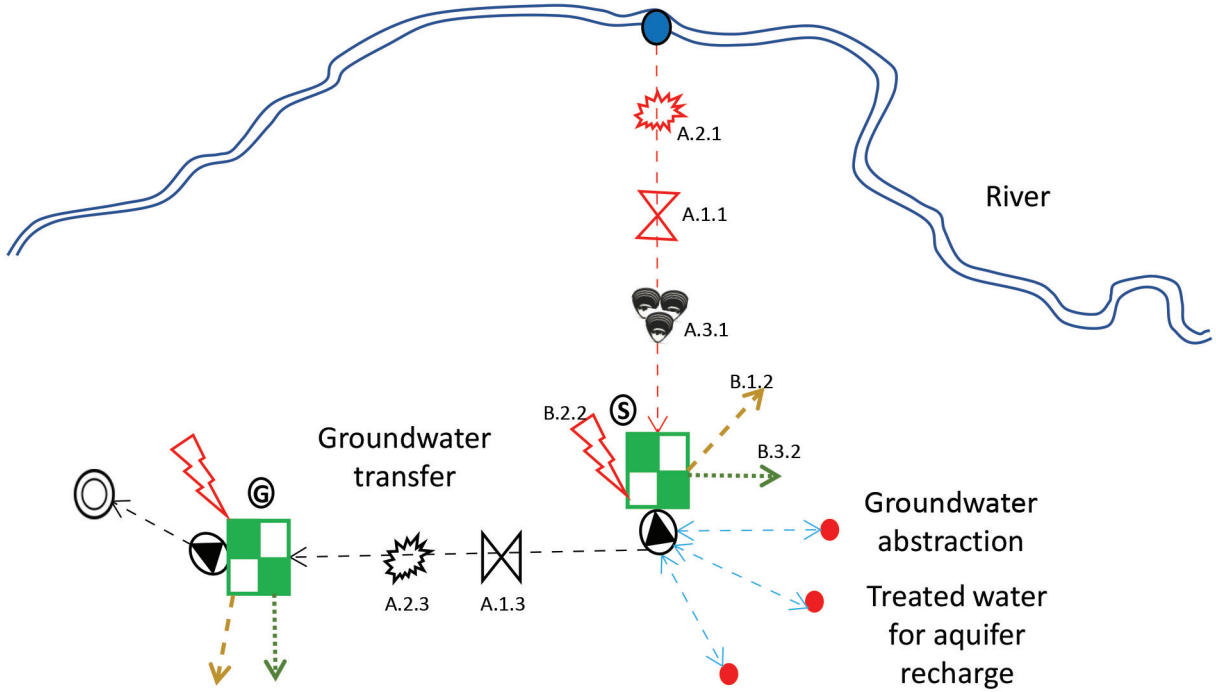
Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline

Mussels in pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.1	Pipeline washout	5	Treatment at all washout points / tanker for disposal (costs not applied in dWRMP)	
A.1.3	Pipeline washout	1		
A.2.1	Pipeline bursts	4	None practicable	
A.2.3	Pipeline bursts	1		
A.3.1	Mussels	2		
A.4.3	Physical transfer for water	1		
B.1.2	Washwater discharge	5	Return washwater to top of works	
B.2.2	Emergency overflows	4	None practicable	
B.3.1	Sludge disposal	5	Dispose of landfill / sterilise sludge before disposal	

14 - Desalination Backwash stream to sea or estuary

Sea intake

Sea outfall

New Desalination plant

New pumping station

Existing or upgrade of existing covered reservoir

Existing or upgrade of existing infrastructure

Potable water Demand Zone

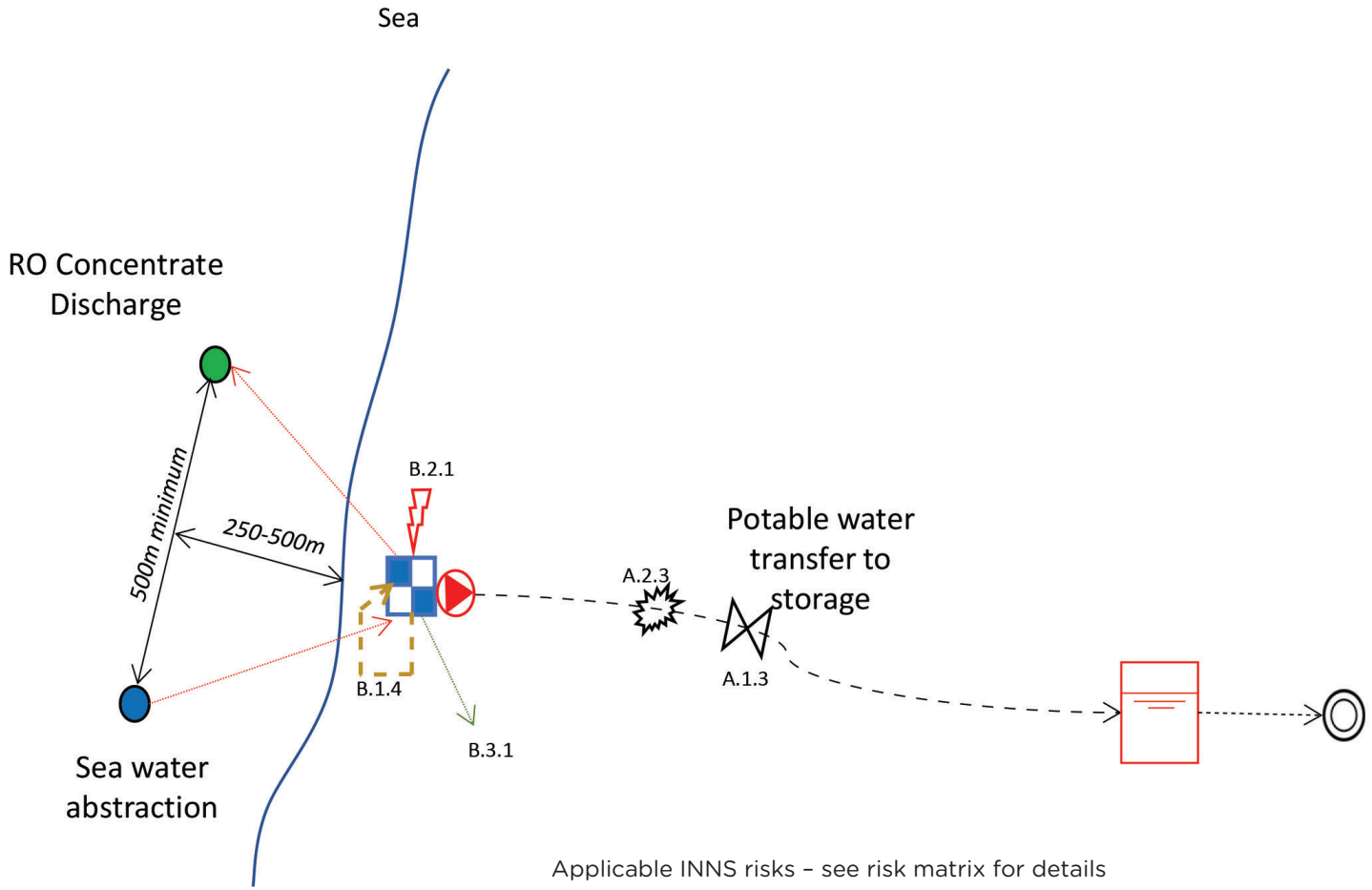
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	1		
B.1.4	Washwater discharge	3		
B.2.1	Emergency overflows	2	None practicable	
B.3.1	Sludge disposal	5	Dispose of landfill / sterilise sludge before disposal	

15 - Conjunctive Use

New or upgrade of existing River Intake + PS

Existing Boreholes

Existing WTW to be upgraded

Existing WTW

Existing infrastructure

New infrastructure or upgrade of existing infrastructure

Short raw water intake with potential of INNS transfer

Existing pumping station that may need to be upgraded

Demand Zone

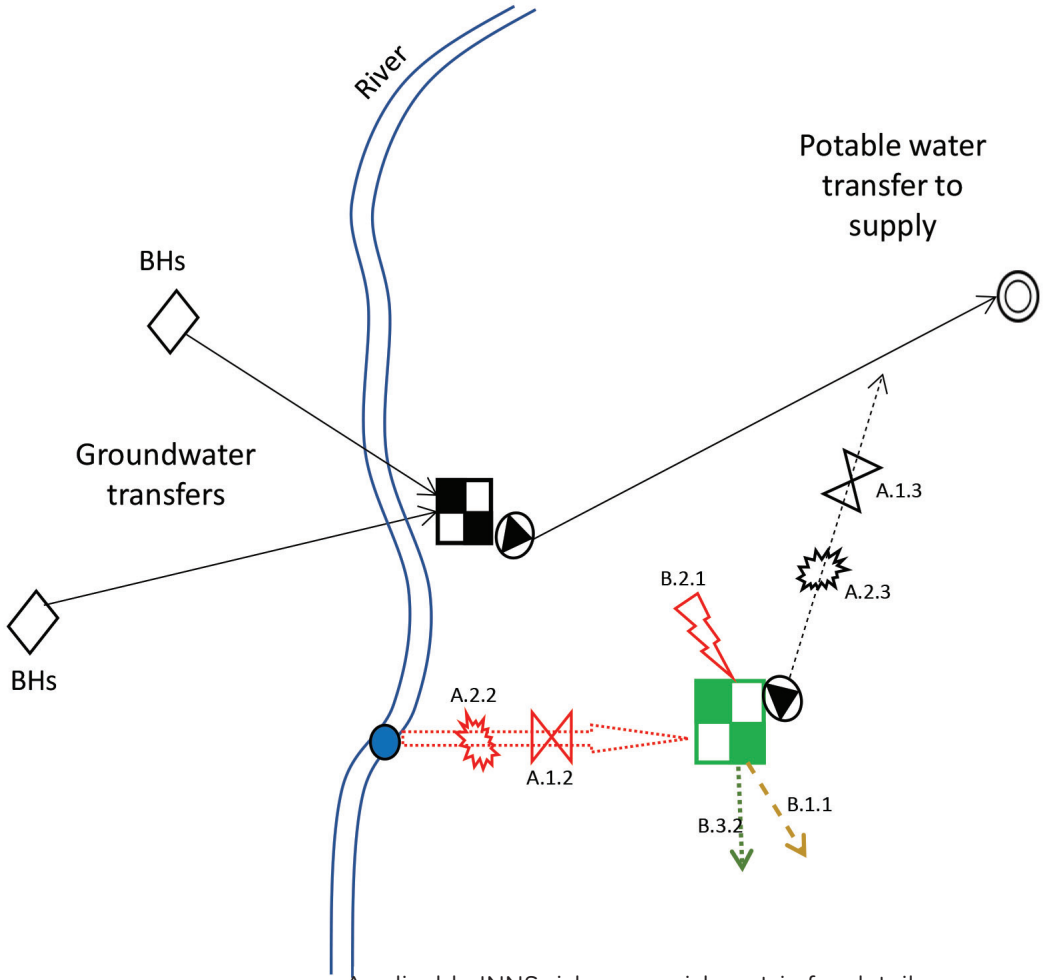
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.2	Pipeline washout	2		
A.1.3	Pipeline washout	1		
A.2.2	Pipeline bursts	2		
A.2.3	Pipeline bursts	1		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2	None practicable	
B.3.2	Sludge disposal	2		

Existing WTW to be upgraded

New infrastructure or upgrade of existing infrastructure

Existing pumping station that may need to be upgraded

Demand Zone

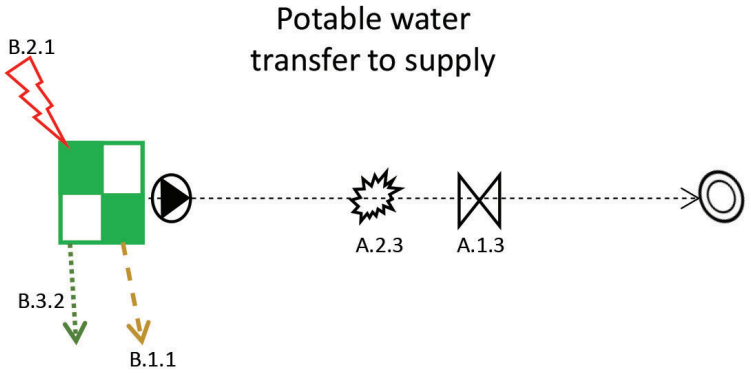
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	1		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.2	Sludge disposal	2		

17 - Potable water transfers from other companies

Other companies

New infrastructure or upgrade of existing infrastructure

New or existing pumping station to be upgraded

Demand Zone

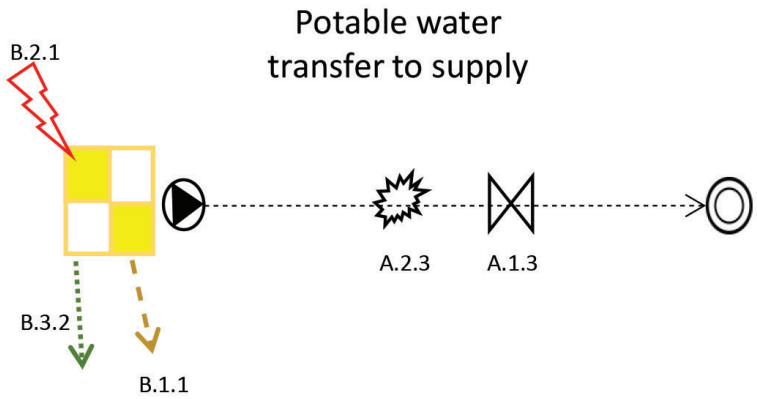
Treatment works washwater discharge

Treatment works sludge discharge

Treatment works emergency overflow

Washout on raw water pipeline

Leak or burst of raw water pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	1		
B.1.1	Washwater discharge	3		
B.2.1	Emergency overflows	2		
B.3.2	Sludge disposal	2		

18 - NEP (Groundwater augmentation)

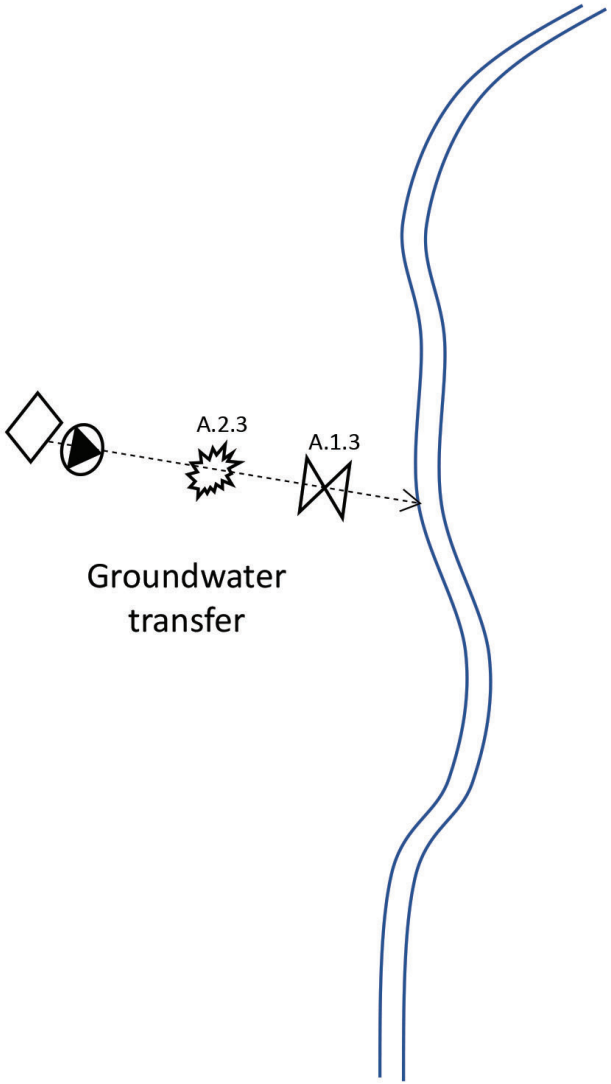
Borehole

New infrastructure or upgrade of existing infrastructure

New or existing pumping station to be upgraded

Washout on groundwater pipeline

Leak or burst of groundwater pipeline



Applicable INNS risks – see risk matrix for details

Applicable risk pathways		Risk without mitigation	Potential mitigation options	Risk after mitigation
A.1.3	Pipeline washout	1		
A.2.3	Pipeline bursts	1		

APPENDIX E – APPRAISAL OF ENVIRONMENTAL AND SOCIAL IMPACTS

Introduction

Water resource options have various associated impacts, or costs and benefits. Environmental and social impacts refer to the costs and benefits that are experienced by the environment and society, rather than by us and our customers directly.

For example, a sympathetically designed new reservoir could provide important new habitats and increase regional biodiversity, and it could also create new recreational opportunities. However, the reservoir would result in increased carbon emissions, particularly during the construction phase. Understanding these impacts helps us to ensure our plans are sustainable and provide best value to society.

Assessing environmental and social impacts is complex. Water resources options can impact upon the environment and society in multiple ways and certain combinations of options can produce additional cumulative effects.

Environmental and social impact appraisals can include qualitative, quantitative and monetised assessments. Once appraisals have been completed, we need to integrate the outputs into our decision-making process, ensuring that there is no double counting.

Our appraisal of environmental and social impacts was informed by the following assessments and reports:

- SEA (informed by the Habitats Regulations Assessment (HRA), WFD assessment and Invasive Non-Native Species (INNS) assessment); and
- Ecosystem Services Assessment (voluntary)

The SEA will be published on Huddle and eventually on our company website. The Ecosystem Services Assessment is available on request.

This appendix sets out our approach to appraising environmental and social impacts. Note that there is a strong link to our customer engagement programme, where we have explored the impacts of options extensively with our customers. Please refer to the supporting Customer and Stakeholder Engagement technical document for more details.

Our approach

Our draft Problem Characterisation assessment highlighted that our dWRMP would require trade-offs between costs and non-monetised 'best value' considerations, particularly in relation to:

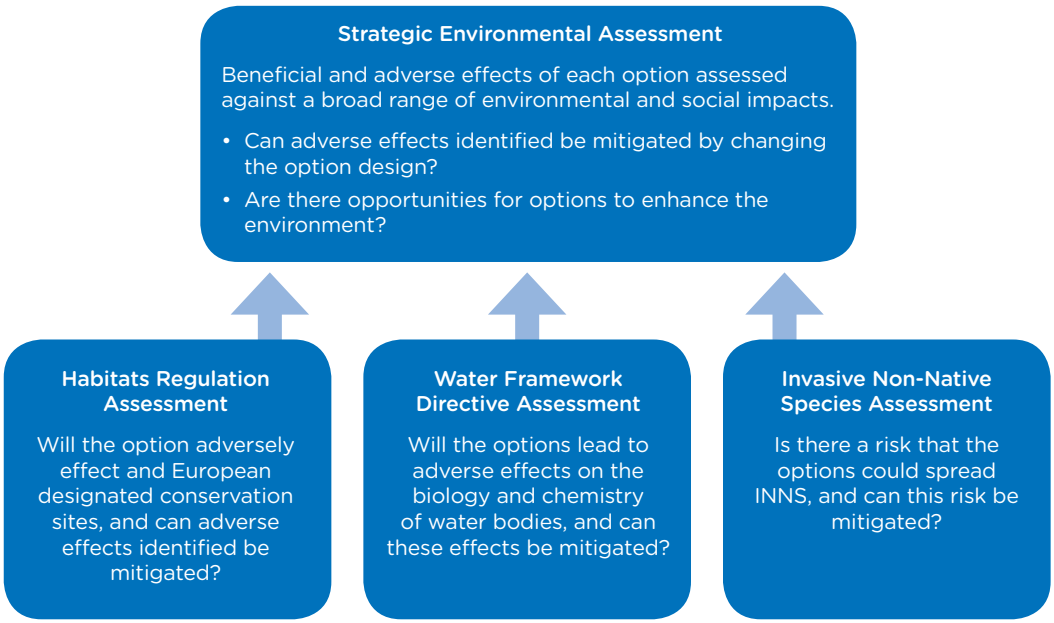
- The scale of the demand management programme
- Identifying an appropriate Level of Service, and,
- The selection of supply-side options.

We concluded that a comprehensive appraisal of environmental and social impacts would be particularly important to the development of our dWRMP, and we developed our appraisal approach accordingly. Our approach is in line with the WRP Guidance, Defra's Guiding Principles and the UKWIR SEA guidance.[1]

We have undertaken a thorough assessment of Environmental and Social impacts followed the 'building blocks' approach proposed in the WRP Guidance[2]. The SEA (informed by the Habitats Regulations Assessment (HRA), WFD assessment and Invasive Non-Native Species (INNS) assessment) provided qualitative and semi-quantitative assessments of the environmental and social effects at a detailed level, as set out in Figure 1.

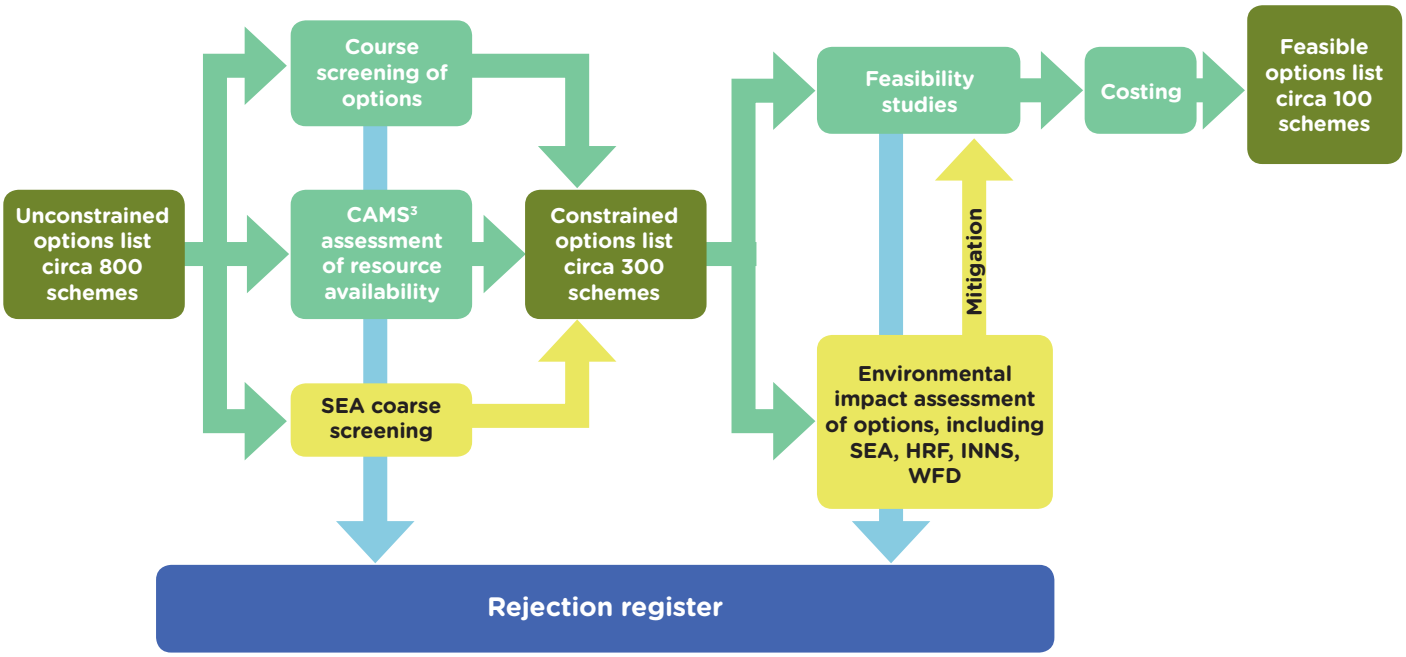
[1] *UKWIR, 2012, Strategic Environmental Assessment and Habitats Regulations Assessment - Guidance for Water Resources Management Plans and Drought Plans*
[2] *Environment Agency, Nov 2017, Environmental Valuation in Water Resources Planning - Additional Information*

Figure 1: Strategic Environmental Assessment



The assessment approach covered all stages of the development of dWRMP, commencing with the 'coarse' screening of a very broad 'unconstrained' list of options, through to a 'fine' screening process, and the final constrained list of options, and assessment of alternative programmes and the plan as a whole (Figure 2). We also assessed the cumulative effects between different environmental and social aspects of a particular programme or plan, as well as between the alternative options and programmes.

Figure 2: Development of supply-side options



[3] CAMS = Catchment Abstraction Management Strategy

We have also voluntarily undertaken a qualitative Ecosystems Service Assessment (ESA) to complement the SEA and reflect the ambition expressed in Defra's Guiding Principles and the WRP Guidance to use natural capital and ecosystems services approaches.

Ecosystem services are defined as the benefits provided by ecosystems that contribute to human well-being. A qualitative ecosystem services assessment considers the effects of development on natural capital, and its ability to provide ecosystem services. Our approach to Natural Capital is described in more detail at the end of this appendix.

We considered the use of environmental valuation (using a monetised Ecosystems Services Approach). However, the absence of an agreed methodology and a lack of data means that currently, only certain environmental and social effects can be costed, thereby leading to a partial assessment. We discussed this with the Environment Agency and Natural England[4], and agreed that there would be little benefit to the decision-making process in calculating environmental and social costs for a partial set of effects. As such, our qualitative ESA assessment produced outcomes were used alongside the SEA and HRA in the multi-criteria assessment to determine the Preferred Plan.

The only exception to this approach was the consideration of carbon impacts, which were included through a quantified assessment as they are commonly monetised using well established techniques. These have been included in the AISC calculations and represent the only difference compared to the AIC values. We have described the emission of greenhouse gases as a result of the Preferred Plan in terms of Tonnes of C02 equivalent in Section 5.8 of the dWRMP. Individual option carbon costs are provided in the updated WRP tables. We have provided the greenhouse gas emissions from our current water operations in chapter 1. We have used the traded central values of the December 2017 version of the BEIS tables.

Our Ecosystem Service Assessment also provides valuable learning to contribute to the development of our Natural Capital approach in future Water Resources Management Plans.

Mitigation and opportunities for environmental enhancement

We are committed to delivering the required mitigation for the options defined in the Preferred Plan. As far as possible, we have ensured that all options are costed to include the mitigation identified as necessary within the HRA. Where negative effects were identified in the options assessment, these have been mitigated through the options design process where practicable, by re-routing pipelines or using directional drilling under sensitive sites and rivers or investigated further through the HRA and WFD processes. The use of best practice construction methods will also be utilised to minimise any effects during the construction phase. Minor negative effects remain for one option (Felixtowe Desalination) due to the predicted moderate effects on WFD objectives. Where effects relating to greenhouse gas emissions were known, all options had minor negative effects apart from three options where major negative effects were identified. Use of renewable energy technologies could help to reduce these effects.

Some options have been flagged for more detailed costing if the option is selected to be taken forward or at the detailed project design stage. In some cases it has not been necessary to cost mitigation options (e.g. when the cost difference for the mitigation option has been assessed as negligible). See Appendix L of the SEA for further details.

We are committed to securing a net benefit to the environment when delivering the options wherever possible. Our supply-side options have been designed at a high level, but detailed design work has still to be completed. We have identified opportunities for environmental enhancement in both the SEA (Appendix C and F-J) and as part of our Ecosystem Services Assessment. Our Natural Capital strategy which is currently being developed will also contribute to this.

[4] *At a methods discussion meeting, held on 6th June 2017*

Planning for improved WRMP decision-making through the Natural Capital approach

Although Natural Capital was not directly used in the current WRMP option selection process, we are developing an approach to integrate Natural Capital thinking within our future decision making.

In 2018 we worked with UEA to undertake a natural capital asset check for the Anglian Water region. We wanted to understand the state and extent of natural capital in our region, so that we could develop our own approach to natural capital decision-making and show how we are contributing to the protection of the region's natural assets.

Natural capital can be defined as the world's stocks of natural assets which include geology, soil, air, water and all living things. Crucially, these assets provide many benefits to society, called ecosystem services. For example soil is vital for food production and water is taken from the environment to supply customers. If natural capital declines in extent or condition then the services they provide may also decline.

The Anglian Water region represents approximately 22% of both the land area and coastline length of England. The asset check for the Anglian Water region showed that our region is vital for food production, having 43% of England's most important farmland. It also showed that our region has only 11% of England's most important biodiversity. Furthermore, a third of all water bodies without capacity for further abstraction are found in our region.

Land cover in the Anglian Water Combines Service Area

Indicator	Km2	% of England Total
Broad Habitat Classes		
Mountains, Moorlands & Heath	23	0.4
Semi Natural Grasslands	54	1.5
Enclosed Farmland	24,217	25.5
Woodlands	969	12.1
Freshwaters	201	37.1
Urban	2,505	15.3
Coastal Margins	144	36.2
Marine	63	27.0

We have extended our natural capital work into our water resource planning by including an assessment of the impact of the portfolio of options on the ecosystem services that are provided by these broad habitats. This was undertaken by mapping these habitats and, for each ecosystem service, scoring the importance, direction and magnitude of change that results from the implementation of each option.

We are developing a six-capitals approach to decision-making. In AMP7, we will take account of natural capital alongside the other capitals (social, financial, manufactured, human and intellectual). This will improve decision-making and help us, where appropriate, select options that better protect the environment. We will be reporting our performance using a set of natural capital metrics, which will include a metric for water resources.