
love every drop
anglianwater
WRMP24 Technical Document
Supply-side option development
September 2024
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Supply-side option development

1 WRMP24 Introduction

1.1 About our company

Anglian Water is the largest water and wastewater company in England and Wales geographically, covering 20% of the land area.

We operate in the East of England, the driest region in the UK, receiving two-thirds of the national average rainfall each year; that's approximately 600mm.

Our region has over 3,300km of rivers and is home to the UK's only wetland national park, the Norfolk Broads.

Between 2011 and 2021, our region experienced the highest population increase in England. Despite this, we are still putting less water into our network than we did in 1989.

1.2 Planning for the long term

Our company Purpose is "to bring environmental and social prosperity to the region we serve through our commitment to Love Every Drop". This purpose is at the heart of our business, having been enshrined in our Articles of Association in 2019.

Central to delivering this purpose is planning for the long term; one of the strategic planning frameworks we use to achieve this is the Water Resources Management Plan (WRMP), which details how we will ensure resilient water supplies to our customers over the next 25 years.

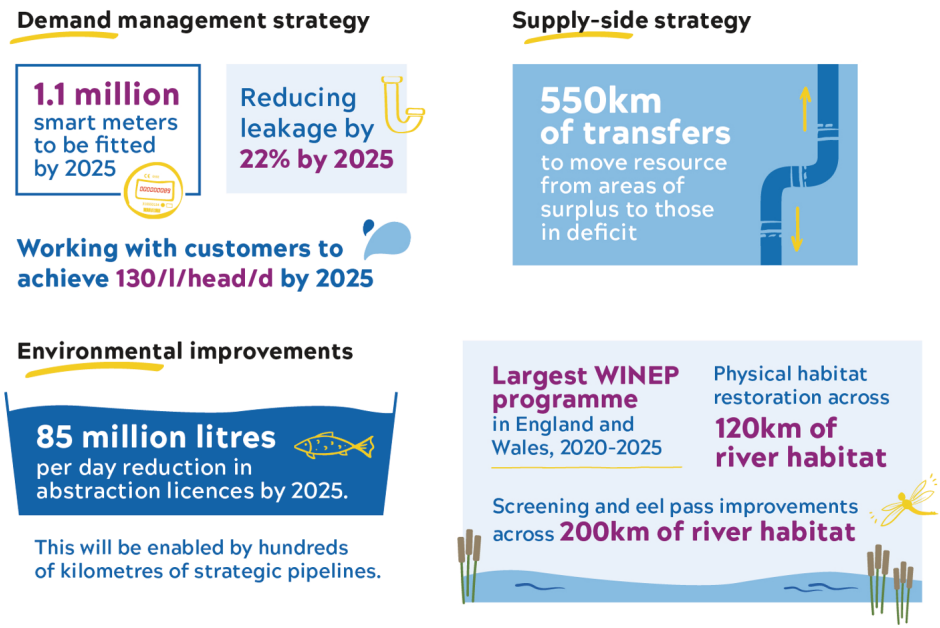
A WRMP looks for low regret investments[1] for our region, giving flexibility to adapt to future challenges and opportunities such as technological advances, climate change, demand variations, and abstraction reductions.

1.3 Water Resources Management Plan

We produce a WRMP every five years. It is a statutory document that sets out how a sustainable and secure supply of clean drinking water will be maintained for our customers. Crucially it takes a long-term view over 25 years, allowing us to plan an affordable, sustainable pathway that provides benefit to our customers, society and the environment.

Our previous WRMP, WRMP19, had an ambitious twin track strategy, combining an industry leading smart meter roll out and leakage ambition with a strategic pipeline across our region, bringing water from areas of surplus to areas of deficit. An overview of the WRMP19 strategy can be seen in Figure 1 below.

Figure 1 Our WRMP19 strategy



This WRMP focusses on the period 2025 to 2050, and is known as WRMP24. We have developed it by following the Water Resources Planning Guideline (WRPG)[2], as well as other relevant guidance, in order to meet our statutory requirements. This has ensured our WRMP24:

- Provides a sustainable and secure supply of clean drinking water for our customers.

1 Investments that are likely to deliver outcomes efficiently under a wide range of plausible scenarios
2 https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline

- Demonstrates a long-term vision for reducing the amount of water taken from the environment, and shows how we will protect and improve it.
- Is affordable.
- Maintains flexibility by being able to respond to new challenges.
- Complies with its legal duties.
- Incorporates national and regional planning; and
- Provides best value for the region and its customers.

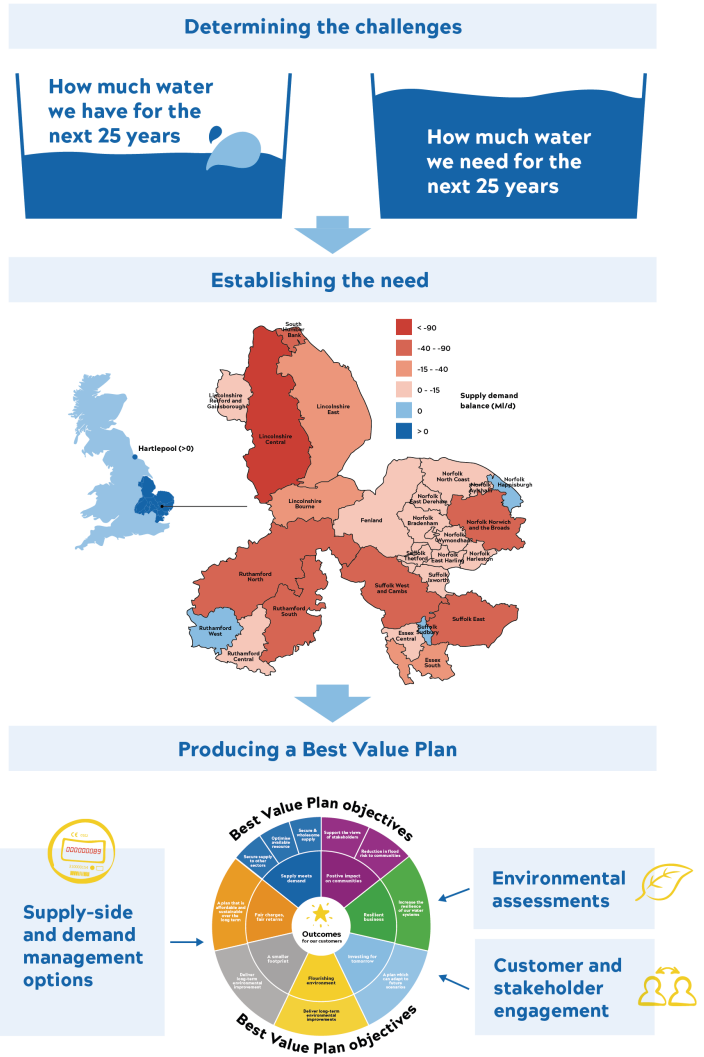
1.4 Developing our WRMP

Our WRMP24 has been progressed following the processes detailed in the WRPG, as shown in Figure 2.

We start by determining the extent of the challenges we face between 2025 and 2050. We achieve this by developing forecasts to establish the amount of water available to use (supply forecast) and the amount of water needed (demand forecast) in our region. When these forecasts are combined, a baseline supply-demand balance is created. This tells us whether we have a surplus of water or a deficit, establishing our water needs for the planning period.

An appraisal for both demand management options and supply-side options is undertaken, starting with an unconstrained list of possible options which progresses through various assessments until a final constrained list is determined.

Figure 2 A high level overview of our WRMP24 planning process



Demand management options aim to reduce the amount of water being used by our customers and lost in our water network. Examples of these options include smart metering and the promotion of water efficiency measures, such as reducing shower times. Supply-side options are also developed; these provide additional water to supply to customers. Examples of these options include new raw water storage reservoirs or water reuse treatment works.

We environmentally assess both demand management and supply-side options so we can understand their potential environmental impacts and what could be put in place to mitigate these impacts; in some cases we exclude options from further consideration.

The next step is for the water savings associated with the chosen demand management option to be added into our baseline supply-demand balance to determine if our region's water needs are met. If the demand management options savings do not solve the need, supply-side options are added into the modelling process. This is undertaken in our Economics of Balancing Supply and Demand (EBSD) model which conducts numerous modelling runs, creating a range of plans that meet our objectives. These plans are also environmentally assessed.

We develop a best value plan from these different model runs and environmental assessments, encompassing the views of our customers and stakeholders who have been consulted throughout the plan's development.

1.5 Best value planning

To ensure we develop the right solution for our region's water needs, we have focused on 'best value'. To us, best value is looking beyond cost and seeking to deliver a benefit to customers and society, as well as the environment, whilst listening and acting on the views of our customers and stakeholders.

These views, from our customers and stakeholders, have helped build our best value framework, shown in Figure 3, which has been used as the basis for our decision making.

Figure 3 Our best value planning objectives

1.6 Our WRMP24

Our best value plan, has been produced following a public consultation on our draft WRMP24. This consultation ran from December 2022 to March 2023. Taking into account consultation feedback and our revised forecasts, we:

- Increased our leakage ambition from 24% to 38%.
- Included projected non-household demand for the South Humber Bank, in north Lincolnshire.
- Developed non-household demand management options.
- Recognised further opportunities to utilise the existing resource we have; and
- Removed abstractions from the supply forecast that are likely to be closed due to Habitats Regulations.

1.7 Strategic context of the WRMP24

Our WRMP24 aligns with our Purpose, as well as internal and external strategic plans and initiatives. We have worked collaboratively with internal and external stakeholders, regulators and other water abstractors to achieve this.

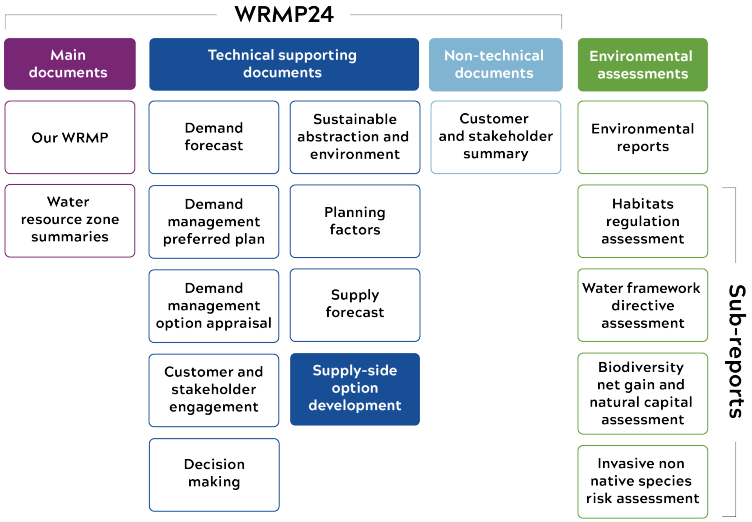
These interactions are highlighted throughout our WRMP24, showing the importance of collaborative planning. For instance, Regional Plans led by Water Resources East (WRE) and Water Resources North (WReN) have been significant in shaping our investment priorities and requirements, with WRE demonstrating the valve of the strategic regional options (SROs) at the regional, multi-sectoral level.

Our WRMP24 has helped to shape our company investment strategy for the Price Review (PR24), as well as our Long Term Delivery Strategy. We have also maintained close links with the Drainage Wastewater Management Plan and our Drought Plan.

1.8 Guide to our WRMP24 submission

Our submission comprises a non-technical customer and stakeholder summary, our main report and nine technical supporting documents, shown in Figure 4 below. These technical documents are supported by a suite of independent environmental assessments.

Figure 4 Our WRMP24 reports



This is the WRMP24 Supply-side option development technical supporting document.

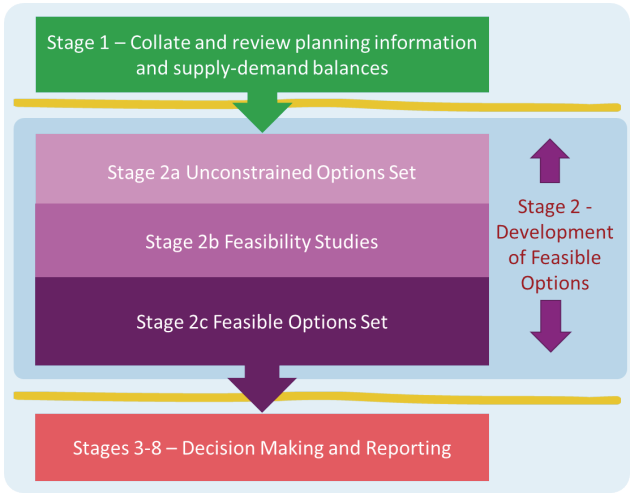
2 Supply-side option development process

2.1 Supply-side option development process

The supply-side options have been developed following the 8-stage framework set out in the UKWIR Guidance on decision making processes; this is shown in Figure 5 and includes:

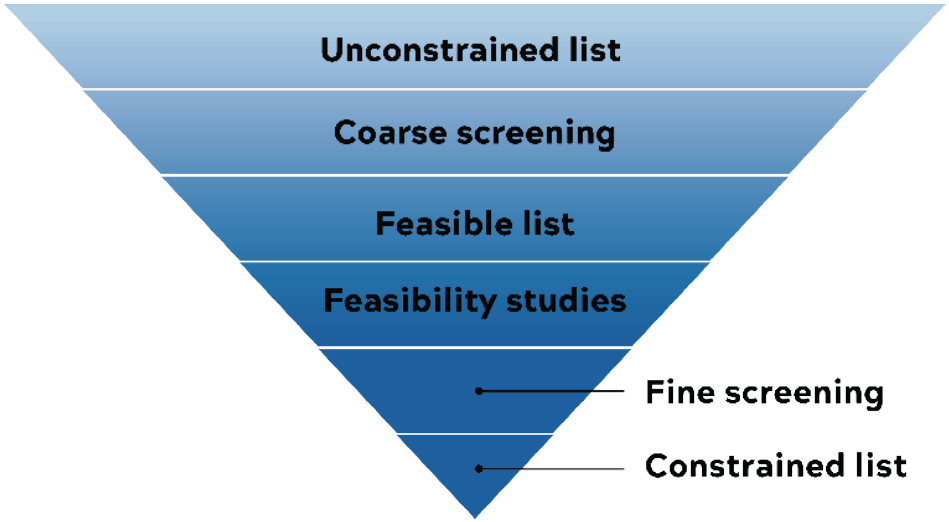
- Stage 1 - Prepare supply-demand balance information
- Stage 2 - Develop a list of unconstrained options that takes account of government policy and aspirations
- Stage 3 - Undertake a problem characterisation and evaluate strategic needs and complexity
- Stage 4 - Decide on a modelling method
- Stage 5 - Identify and define data inputs to model(s)
- Stage 6 - Undertake decision making (options appraisal) modelling
- Stage 7 - Stress testing and sensitivity analysis
- Stage 8 - Produce a final planning forecast

Figure 5 The 8-stage option appraisal process



For the development of the options we have expanded Stage 2 of the decision making framework, which is the focus of this report. Figure 6 shows the high level process for the screening stages and feasibility studies, illustrating how the option set is reduced to a constrained feasible list to be used for modelling and decision making. As part of this process we have also followed the guidance in the WRPG.

Figure 6 The outline process from the unconstrained list of options to the constrained list



This technical supporting document describes our options appraisal process for developing the constrained supply-side options set; this helps us develop our best value plan. The objectives for the option appraisal process are to:

- Complete a clear and transparent appraisal of options. This will include equal consideration to all new resource options, demand management, water trading, and third-party options.

- Demonstrate compliance with legislation and Government policy/aspirations, including the Strategic Environment Assessment Regulations and Habitats Regulations.
- Ensure that customers, regulators and other stakeholders have been involved throughout the process and that their preferences are taken into account.
- Provide evidence to fully justify the selection of the preferred solutions and be able to demonstrate long-term best-value for customers whilst protecting the environment.
- Align with, and support the WRE option appraisal process, identifying options that can support the region as a whole and developing options in a way that supports and enables regional processes.

3 Unconstrained options

3.1 Stage 2a Unconstrained options set

The WRPG Section 8.1 guided our approach to developing the unconstrained list; this meant we:

- Compiled a list of all possible options that could reasonably be used in our plan. We developed this unconstrained list from a generic list of option types[3].
- Included all the options considered in the previous planning round, as well as any options identified since.
- Explored options presented by regional groups, including regionally scaled and joint-company options. We also identified potential transfers from neighbouring water companies and engaged with third party options.
- Developed an unconstrained option list not completely free from restrictions, such as environmental or planning issues, but the options within it were technically feasible. We also ascertained an indicative deployable output, or range of deployable output, for these unconstrained options.

Table 1 provides further detail on how we used the UKWIR process and WRPG to develop our unconstrained list.

We developed a template based on the list of generic options provided in the Economics of Balancing Supply and Demand (EBSD) Guidelines[4] and in the UKWIR WR27[5] report.

This template was populated at a series of workshops, with key internal staff covering the regional areas of Anglian Water, as follows:

- North and West, covering Lincolnshire and the Ruthamford system;
- East which looked at the Norfolk area; and
- The South, which covered Essex and Suffolk.

Table 1 Unconstrained list development summary

Unconstrained list development	
UKWIR generic option type	The list of generic options was consulted with a view to openly considering options that had previously discounted. This didn't identify any new option types suitable for inclusion in the unconstrained list.
WRMP19	All options considered at WRMP19 were reviewed; those that met the pre-screening criteria have been included in the unconstrained list.
Regional and sharing opportunities	Through a series of workshops all options identified by Water Resources East (WRE) have been considered and those that are appropriate have been included in our WRMP unconstrained list. Furthermore all unconstrained options identified by us and other WRE Water Company members have been included in the regional option list. Initially options with a DO benefit greater than 10 Ml/d were considered for the Regional Plan. Following WRE's Emerging Regional Plan feedback, supply-side options with greater than 1 Ml/d benefit were progressed in the WRE modelling processes, along with options that: could benefit the region or another water company, are multi-sector, and/or supports the regional environmental ambition. In addition, we have regular meetings with neighbouring water companies to discuss our WRMPs, seeking opportunities to manage a 'borderless' supply-demand balance and consider options collaboratively.
Technical feasibility studies	Feasibility studies have been carried out for each option type. A summary of this can be found in Section 6 of this report.

3 We used the *UKWIR Water Resources Planning Tools 2012: summary report* to aid with this process.
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

The workshops were attended by representatives from Water Services, the Water Resources Management Team and Asset Delivery Planning. These attendees 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.

3.1.1 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.

3.2 Screening the unconstrained options

A series of screening stages were then used to refine the unconstrained list to a feasible list. The criteria used to screen the unconstrained options is described in the rest of this section. Any options discounted at this stage were recorded in the rejection register, along with the reasons why they were not considered suitable to investigate further, please refer to Section 7 Appendix C.

3.2.1 Pre-screening quality checks

The refinement process started with a pre-screening check, detailed in Table 2. This check aimed to remove duplicates, ensure previous rejection reasons were still valid and were sensible options to move forward into the options appraisal process.

Table 2 Pre-screening quality checks

Criteria	Quality check
Option description	Could a third party understand it easily? Does it describe the water source adequately in terms of the opportunity and location? If an option cannot be described, it will be rejected. Similarly, generic options used to aid the option identification process will also be rejected.
Deployable output (DO)	Is there a reported DO figure for the option? If it is not a DO driven option is the wider benefit clearly described? If the DO or the benefit cannot be defined, the option will be rejected as it does not address the problem.
Is the option categorisation correct	Is the correct UKWIR category applied to the option?
GIS data	Does the GIS data accurately represent the boundaries of the option?
Rejection reason	If previously rejected in WRMP19, is the reason given still valid? If so, the option can be rejected.
Duplication	Check for duplicates and delete any identified.

3.2.2 Coarse screening criteria

The coarse screening criteria were developed expanding the criteria set out in the EBSD methodology[6]. Table 3 shows the main screening criteria, along with sub-categories, which each option was tested against.

Table 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 from regulators, planning authorities or 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 involve disproportionately high whole life cost (capex and opex), relative to alternatives that can provide the same outcome, and as such 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)?
	Technical	· 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?
	Sustainability	· 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?

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

3.2.3 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, with the initial environmental screening identifying that some pipelines were passing too close to environmental designated sites; these routes were refined to account for this, see Section 5.

3.3 Summary of screening results

Table 4 shows the list of all the unconstrained option types considered in each column and the row shows the number of options identified within that category.

Table 4 Unconstrained option types

	Aquifer recharge/Aquifer storage recovery	Catchment management	Desalination	Drought permits/orders	External potable bulk supply/transfer	External raw water bulk supply transfer	Groundwater enhancement	Internal potable transfer	Internal raw water transfer	International import	Licence trading	New groundwater	New reservoir	New surface water	New technology	Rainwater harvesting	Surface water enhancement	Water reuse	Water treatment works capacity increase	Water treatment works loss recovery	Total
Unconstrained	43	33	114	8	1	37	103	335	10	12	178	94	115	114	43	18	4	145	19	102	1528
Feasible	2	0	22	4	0	0	4	113	1	3	2	0	14	1	0	0	4	16	0	13	199
Constrained	2	0	18	3	0	0	4	93	1	3	1	0	12	1	0	0	3	16	0	13	170
Preferred[a]	0	0	4	1	0	0	4	20	0	0	1	0	2	1	0	0	3	1	0	13	50

a The preferred options are the subject of the WRMP24 Decision making technical supporting document.

Many options were screened out at a high level because they were generic option types or a specific option with a definable output couldn't be identified. Some options, particularly relating to catchment strategies, are captured elsewhere in our business plan and other longer-term strategies.

For example, sustainable drainage schemes (SuDS) have not been considered within WRMP because of the uncertainty around the resource they can provide from aquifer recharge. However, we do have a number of these schemes identified within our Drainage and Wastewater Management Plan (DWMP).

Table 5 gives a summary of the option types that returned no identified options and the reason none were progressed to the constrained list.

One of the most significant constraining factors limiting the number of options available to us is abstraction reform. Also very significant is the principle of no deterioration to waterbodies within the Water Framework Directive. This results in a conservative approach to considering licence trade opportunities. It is unlikely we would secure a licence where our intention would be to increase abstraction significantly above recent levels. We are also fortunate to live in a region with many designated sites, and these helped shape our option screening, as directed by the Habitats Directive.

The combination of these factors resulted in a significant drop in the number of options available after high-level screening in our constrained list.

Table 5 Summary of option types

Type	WRMP24 Comment	Wider Business	WRE
Abstraction licences trading	CAMS/ALS - none identified for WRMP24 due to lack of available resource.	Continuously under review.	New, previously unidentified, opportunities may arise through catchment workshops.
Aquifer Recharge (AR)	Uncertain DO and cost, so not considered for WRMP.	SuDS schemes identified in our DWMP.	New, previously unidentified, opportunities may arise through catchment workshops.
Asset transfers	CAMS/ALS - limited for WRMP24 due to lack of available resource. Options identified have been re-classified as Conjunctive use 3rd party.		New, previously unidentified, opportunities may arise through catchment workshops.
Bulk transfers of raw water	Terminology - replaced with potable transfers.		
Catchment Management schemes	Uncertain DO and complex to cost and model.	Get River Positive programme and similar initiatives will help resolve issues with costing and benefit realisation.	WRE flagship projects such as Norfolk Water Strategy Programme.
Catchment management schemes_WINEP	In Water Resources WINEP programme.	Water WINEP programme.	
Conjunctive use of operation of sources	Considered BAU optimisation dealt with in other areas of the business.		
Direct river abstraction	CAMS/ALS - no resource.		
Imports (icebergs)	Unproven technology. Not considered viable.		

Type	WRMP24 Comment	Wider Business	WRE
Infiltration galleries	Uncertain/unreliable DO. Potential to be used in conjunction with other options such as desalination or reuse but no specific option identified at this stage.		
Joint (shared asset) resources	Split into other categories - New reservoirs (multi sector use).	Potential for reuse where cDWF exceeds utilisation for public water supply.	New, previously unidentified, opportunities may arise through catchment workshops.
Options to trade other assets (infrastructure)	Limited opportunities re-classified as Conjunctive use 3rd party.		
Rain cloud seeding	This technology is heavily constrained by climatological conditions and can only be considered effective in certain locations in a limited number of weather conditions; mainly associated to mountainous area and thus not appropriate to the Anglian region.		
Rainwater harvesting	Whilst rainwater harvesting has potential for unlocking additional volumes of water to use by households, it is largely considered as a demand side option and therefore not deemed relevant for this assessment. SuDS options have been considered in our DWMP.		
Reclaimed water, water reuse, effluent reuse	Split into reuse and backwash recovery.	Further screening of water recycling centres that didn't meet WRMP HLS criteria is ongoing. It is expected this work will yield some small-scale schemes at a local catchment level - types of options being considered are agricultural irrigation, allotments and golf courses.	
Redevelopment of existing sources with increased yields	CAMS/ALS/no deterioration.		
Re-use of private supplies out of service	CAMS/ALS/no deterioration.		
Tankering	Weather and industry related reliability issues. Traffic impact.		
Tidal Barrage	Generic option type. None identified in our region. Uncertain DO/insufficient detail.		

3.4 Translation of option type definitions

There were a number of option categories in our unconstrained list which aren't listed in the defined list of options in WRP Table 4 'Option Appraisal Summary', so we carried out a translation exercise to confirm that all of our unconstrained options could be defined under the planning table defined list.

Table 6 shows we were able to satisfy ourselves that all unconstrained options could be categorised within the defined list by arriving at the same number of unconstrained options, ensuring we could demonstrate a consistent approach to option appraisal.

We retained our own option definitions in the description of our feasible and unconstrained lists internally, but used the same translation method described here for the population of the options appraisal summary.

Retaining our own definitions internally enabled us to have clear and consistent communications with different internal stakeholder groups.

Table 6 Option types

Option type (table 4 defined list)	Number identified
Aquifer recharge/Aquifer storage recovery	43
Catchment management	33
Desalination	114
Drought permits/orders	8
External raw water bulk supply/transfer	37
Groundwater enhancement	103
Internal potable transfer	340
Internal raw water transfer	8
International import	10
Licence trading	171
New groundwater	94
New reservoir	115
New surface water	120
New technology	43
Rainwater harvesting	18
Surface water enhancement	4
Water reuse	147
Water treatment works capacity increase	19
Water treatment works loss recovery	102
Total	1529

4 Feasible options

4.1 Stage 2b Feasibility studies

When we had completed our coarse screening, we used WRPG Section 8.2 to develop our list of feasible options. A feasible list is a set of options that are deemed suitable to assess for inclusion in a preferred programme of options. As such, it should not include options with unalterable constraints that make them unsuitable for promotion. For example, unacceptable environmental impacts that cannot be overcome or options which have a high risk of failure.

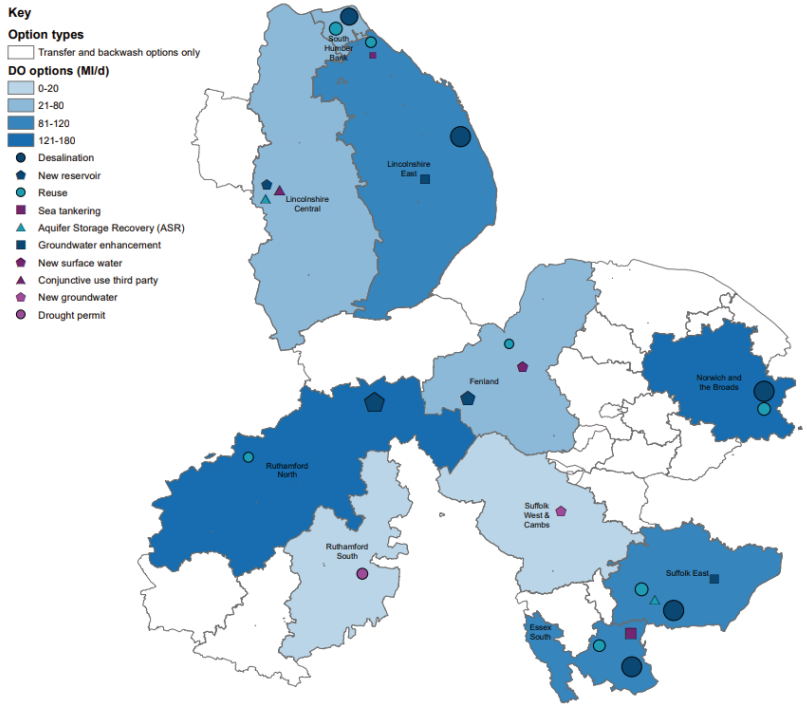
We discussed this list of feasible options with the Environment Agency, and other relevant consultees, to ensure that the option was appropriate and to determine any other considerations. We also conducted modelling to determine the benefit the scheme would have on the supply-demand balance, for example by providing deployable output or reducing outage.

The options were also subjected to studies to confirm their feasibility; 'feasibility studies'. As indicated in Figure 6 the option set is further refined at the fine screening stage. Further details about this assessment can be found in the accompanying Environmental Report[7]. 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.

4.2 Options and resource available

We now discuss the feasible options available to us. Figure 7 shows the maximum water we have available to use from new unique resource options. In this instance we have excluded our backwash recovery options.

Figure 7 Maximum water available for use from new resource options



For Figure 7, where multiple versions of an option are available, we have used the largest available. For example, if a desalination option has been modelled at 25, 50 and 100 Ml/d capacities, we have assumed the 100 Ml/d option is available. Figure 7 also depicts where the resource is initially deployed to. For instance, Bacton is located in our Happisburgh RZ but this is an isolated rural zone, so the DO of desalination from Bacton is realised in Norwich and the Broads RZ, where it can be distributed more efficiently to a wider area. Figure 10 shows the approximate location of desalination options with arrows to show where their initial transfer is to.

7 Mott Macdonald WRMP24 Environmental Report.

For illustrative purposes we have also assumed here that the maximum amount of resource available from desalination is 100 Ml/d in any one WRZ, however, this is not a constraint of our EBSD modelling. As these options are not mutually exclusive, it is feasible that a combination of options could be selected which could exceed 100 Ml/d. The South Humber Bank options are highlighted in red as the WAFU for these options is for non-potable use and therefore locked into that resource zone. We have not considered potential in-combination environmental impacts at this stage, which could reduce the WAFU availability.

Figure 7 shows that relatively few water resource zones have new resource options available in them, with many having no new resource options available at all, meaning they are solely reliant on transfers from those zones that do have resource available. This is why such a large number of our constrained option set is made up of transfers.

Figure 7 also shows that some of our smallest, and therefore most difficult to access water resource zones, have no new resource available. This is because they are discrete zones that are largely dependent on local groundwater and the need to reduce these abstractions limits options. This is particularly apparent in the east of our region.

In Ruthamford North and Fenland, the majority of new resource is available from reservoirs, whereas, in East Lincolnshire, Norfolk and the Broads, East Suffolk and South Essex the new resource is from desalination and water reuse.

4.3 Transfer options

4.3.1 Transfer option routes

The unconstrained list of transfer options was developed from the WRMP19 list. Some additional routes were identified through internal workshops with operational teams and by aligning with the WRE options set.

All of these options have been assessed using the Moata Route Optimiser (MRO) route optimisation tool developed by our consultants. This tool aims to minimise the CAPEX and TOTEX of a transfer route, in addition to avoiding key land use and environmental constraints. It evaluates topographical data along a route (OS tiles) and carries out hydraulic calculations, adjusting route outputs to minimise the pumping costs that would be needed by optimising the vertical profile of the transfer route. This is achieved by evaluating pumping costs against the costs of key pipeline features that can be avoided by route adjustments e.g. air valves, washout out valves, valve chambers.

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.

The environmental coarse screening 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 have been omitted from this report due to the requirements of the Security and Emergency Measures (SEMD)[8], however, below is a map showing connectivity of WRZs by feasible modelled options and summary details of each are listed in Figure 9.

8 Water Industry Act 1991, The Security and Emergency Measures (Water and Sewage Undertakers) Direction 1998

Figure 8 Feasible transfer routes

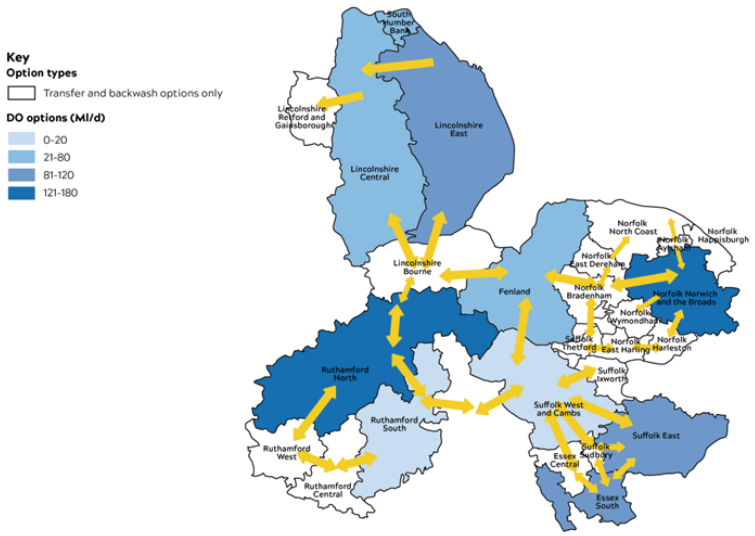


Figure 9 Transfer options showing next 4 AMPs

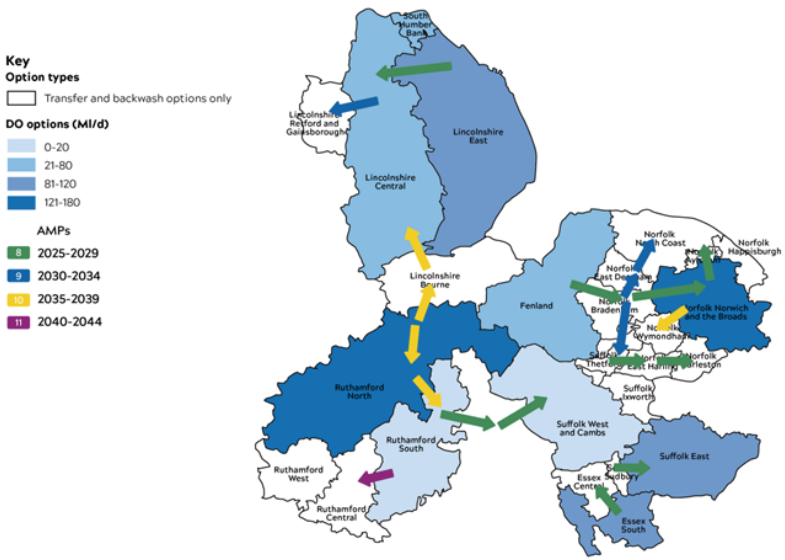


Figure 8 is shaded according to the amount of new resource available from new WRMP options. The darker the zone, the more resource we have available for development. Unshaded zones have no new resource, above 1 Ml/d, available. When we overlay the constrained transfers it shows how this resource can be distributed to where it is needed.

Figure 9 is the same map but only showing transfers selected in the BVP. Timings are also shown. It is important to note that this figure is only showing new resource and new transfers. Some transfers, particularly those early in the plan, are distributing existing resource.

4.3.2 Potable transfer option capacities

The potable water transfers are 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 move the resource from a new resource development in one WRZ to another WRZ in deficit.

We have provided our economic model with a number of alternative capacities for each transfer route. This allows 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.

4.3.3 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 are:

- Cost: any modifications to the pipeline route could have an impact on both capex and opex costs and the time to implement the solution.
- Programme: detailed consultation with Highways England, Environment Agency, Local Authorities and land owners could impact the costs and the time to implement the solution.

4.4 New Resources

The new resources options were grouped together into option type and the feasibility of each option assessed and reported.

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

4.4.1 Desalination options

Desalination has been assessed to be a viable option to provide additional water.

A high-level spatial screening of the east coast of England was carried out to identify possible viable locations for desalination, with 500 km of coastline (including estuaries) being evaluated. The identified locations were then cross-checked with the WRMP19 options and all of the 24 WRMP19 unconstrained options re-evaluated. This exercise resulted in a WRMP24 unconstrained list of 83 desalination options.

As part of this, three alternative types of desalination were identified:

- Coastal, with a high level process shown in Figure 11, are on shore desalination plants with an intake and outfall to sea.
- Estuarial (brackish) is when a desalination plant is located in an estuary with intake and outfall to the estuary system. This high level process is shown in Figure 12.
- Floating desalination is located on a barge, moored off shore then piped inland. The high level process is shown in Figure 13.

Figure 10 Desalination options

Some of these desalination options contained a conjunctive use element, for instance, we have been discussing possibilities to share outfall structures with energy producers to reduce construction cost and where possible. We are also looking into a number of co-location and resource sharing opportunities with green hydrogen production and renewable energy producers.

Figure 11 Outline seawater desalination process

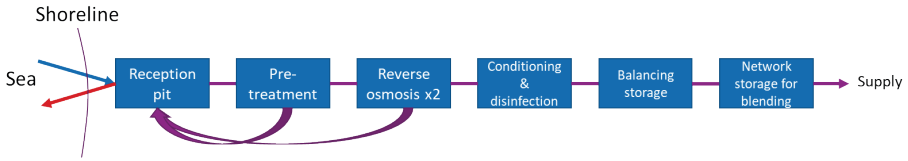
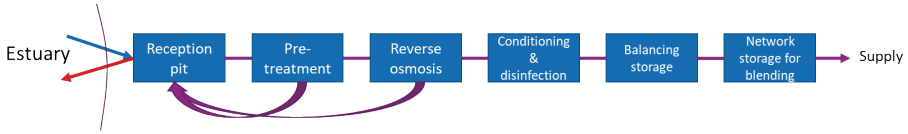
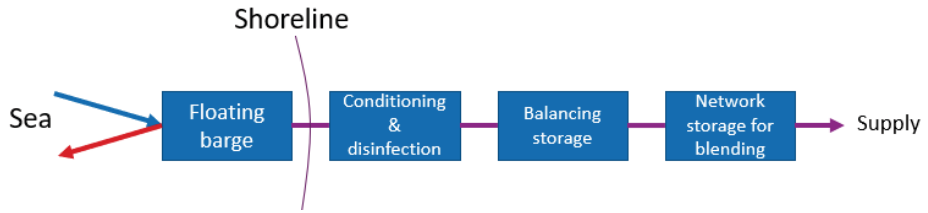


Figure 12 Outline brackish desalination process



Floating desalination consists of the same processes of pre-treatment and two-stage reverse osmosis but it would be entirely housed onboard a floating barge, moored offshore.

Figure 13 Outline offshore desalination process



The following pre-High Level Screening (HLS) screening criteria were applied to all desalination options:

- Land available for a site - can the site fit in the desired location?
- Land use in the vicinity - are there adjacent land uses that would make the option unfeasible?
- Environmental designations - does the location have an environmental designation e.g. SSSI, SPA, SAC, RAMSAR?
- Characteristics of adjacent marine or estuarial environment - does the marine or estuarial environment have aspects that would make the development of new intakes or pipelines unfeasible e.g. existing structures, submarine cables, sand?
- Superiority to other local options - is there another local option that would be better?

Additional High Level Screening (HLS) criteria were also applied to coastal (seawater) options. These included:

- Proximity to water depth >6m - is the marine environment adjacent to the coast too shallow for too far, meaning intakes or outfalls have to be unfeasibly long?
- Navigation and marine usage through navigation charts - does the marine environment adjacent to the coast experience such heavy traffic that the option would be unfeasible?

The following additional HLS criteria were applied to estuarial (brackish) options:

- Salinity in the estuary - if the water is fresh, desalination would not be used, so is there sufficient salinity in the raw water to make desalination a feasible treatment?
- Variability of salinity in the waterbody - is the variation of salinity with the tidal cycle sufficiently predictable that a consistent salinity of feedwater into the process could be obtained?
- Contaminant concentrations - are there contaminants in the estuary (e.g. from industrial discharges) that would make treatment by desalination unfeasible?

While estuarial desalination is technically feasible, it carries with it some additional risks over sea water desalination. Abstraction and discharges into estuary systems like the Humber and rivers that feed into The Wash, and Suffolk and Essex estuaries, could have impacts that we cannot mitigate against. There is some concern that discharge of brine into these systems would cause an increase in salinity that could create a chemical barrier between the freshwater and marine environments. There are no modelling techniques available or adequate empirical evidence that such concerns can be overcome and as a result we have rejected all estuarine and brackish desalination options.

No additional HLS criteria was applied to floating options, though it was noted that some onshore infrastructure would be required so land availability remained a HLS consideration.

Through pre-screening, HLS and feasibility studies, a feasible list of options was passed for further development and fine screening.

During fine screening we carried out a number of workshops with internal stakeholders and capital delivery partners to review deliverability of these options. From this, some additional risks associated with floating desalination options were raised. This prompted another workshop involving one potential supplier of floating desalination.

We concluded that there were residual risks associated with these floating desalination options that would be complex to resolve and, while this didn't make the options technically unfeasible, they demonstrated no benefit over the onshore equivalent options.

The risks identified were:

- No precedent in the UK and the technology has not been demonstrated in the North Sea.
- Examples elsewhere in the world tend to be used reactively and not permanently moored for continuous supply. This made it difficult to establish if additional maintenance to the vessel is required, leading to further outage.
- Operability - there are complexities around staffing. Staff with water treatment experience would also need to be trained to work offshore.
- Water quality issues around ensuring Materials In Contact compliance. These are not insurmountable but provide an additional layer of complexity.
- Outage and reliability and the need for storage - it's unclear what conditions may lead to outage (e.g. storms or pollution events) and what the duration of these events may be. This makes it difficult to quantify resilience storage required and therefore difficult to cost the option.
- Security - insufficient information available at time of appraisal to establish how SEMD compliance would be met at sea.

Floating desalination options were only identified at locations where onshore desalination is also feasible, so, as the floating options offer no benefit over onshore desalination and carry these additional risks, they have been rejected from the WRMP24 feasible option list.

It is acknowledged that if further resource from desalination is needed in the future, and designations or land availability reduces the capacity to develop desalination onshore, a floating option could be revisited.

Following this high level assessment and screening of our unconstrained desalination option set, we identified 12 locations where desalination was technically feasible. Five of these locations were in estuarial environments, these being the River Trent between Gainsborough and the Humber, the South Humber bank, Boston and Kings Lynn on The Wash and the Orwell estuary. In exploring these options further through stakeholder workshops and engagement with colleagues from around the world we concluded that the risks associated with abstracting from an estuary and discharging brine back into an estuary unmitigable. Consequently, we have rejected these options and are now only considering our remaining 7 coastal seawater desalination locations.

At those remaining coastal locations there are different capacity options, for example; Caister, Sizewell, Felixstowe, and Holland on Sea all have three capacity options 25, 50, and 100 Ml/d. Mablethorpe desalination has the same capacities with an additional option of 60 Ml/d for non-potable use for South Humber Bank. Bacton has four different capacity options of 10, 25, 50 and 100 Ml/d and Great Yarmouth has only two capacity options, 25 and 50, as it is constrained by land availability. This gives us a total of 22 constrained options.

More detail on the development of our sea water desalination options can be found in the desalination appendix.

4.4.2 Water reuse

We assessed the suitability of all of our Water Recycling Centres (WRCs) for the development of water reuse options. The criteria we used for suitability of a WRC's effluent for water reuse were:

- The WRC should be able to provide a sufficient output. Due to advanced water reuse treatment, the process losses would be around 30% of the inlet flow rate to the Water Reuse Plant (WRP). Consequently, all WRCs with a licenced Dry Weather Flow (DWF) of under 10 Ml/d were rejected.
- The flow from WRCs support river flow, and development of a scheme should not deprive sensitive rivers of flow. The CAMS report identifies particularly stressed water courses that would not be suitable for water reuse due to the diversion of effluent that would usually be put into the watercourse. The CAMS report uses a red, amber green (RAG) system

to show the amount of water available for abstraction with red being 'no water available', amber being 'restricted amount of water available' and green being 'water available'. Sites in CAMS assessment that were shown as red for all Q95-30 were removed.

When assessed against these criteria the number of viable WRCs reduced from over 1000 to 11. For each location a number of alternative option types were developed. Figure 14 shows the distribution of the viable WRCs in our region along with an indication of where the option's WAFU would be deployed[9].

We have explored a number of water reuse options with different process configurations. The first type of configuration is illustrated below in Figure 15; this shows indirect reuse via two environmental buffers. Water is taken from a WRC to a water reuse plant, a form of advanced treatment that prepares the water to be discharged into a river to be re-abstracted. These are stages 1 to 3 in Figure 15.

Figure 14 Water reuse options

This provides the benefit that there is an increase in flow to the river, which in turn can mean there is more water available to abstract. However, this may not always be the case. In some cases we have rivers with Minimum Residual Flow (MRF) or Hands off Flow (HOF) conditions. In these instances it is important to understand whether there is a benefit to the discharge of water from a reuse scheme. If the river is below MRF or HOF then it is unlikely that discharging water from a reuse scheme into it will raise the flow above this threshold and then give enough surplus that we can abstract.

9 The map shows the location of the WRCs; there may be several options at one WRC.

Options that discharge to a river can be less resilient to drought. The approach to modelling is described in the Supply Forecast report. Table 7 shows how this modelling ruled out some options because they have no WAFU or performed very inefficiently, for example, very low WAFU.

There can be additional risks associated with transferring through two environmental buffers. It is difficult to demonstrate that water is not being lost to the environment through a river bed. There may be some indirect benefit, through groundwater recharge, however it is complex to model and therefore we have not considered it at this stage. Two stage environmental buffering also increases the number of waterbodies that need to be considered for environmental assessment, monitoring and sampling. This increases cost and adds delivery timescales. It can also create an INNS risk if there isn't a pre-existing connection between the waterbodies; this can be mitigated through advanced treatment processes but limits opportunities for nature based solutions.

Figure 15 Indirect reuse via two environmental buffers

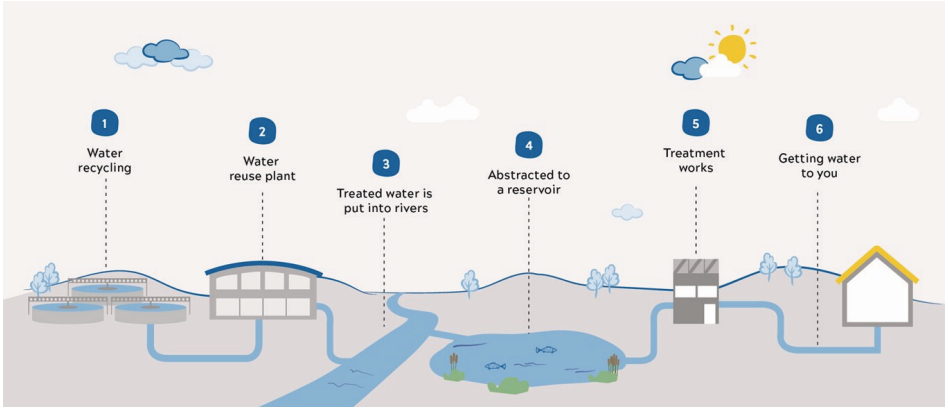
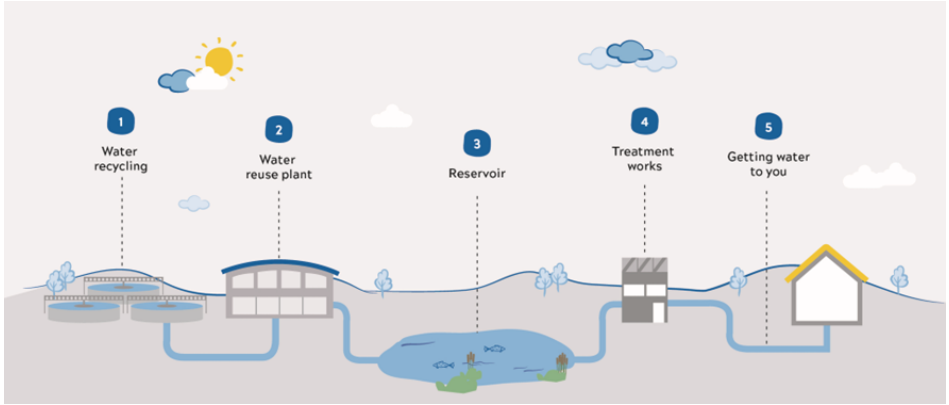


Figure 16 illustrates water reuse via a single environmental buffer. In general these environmental buffers are reservoirs but it could be river, like in the case of Caister and Lowestoft water reuse or Kings Lynn & West Walton water reuse, where we have not got a reservoir at the receiving site.

Figure 16 Water reuse via a single environmental buffer



In addition to the screening criteria, some of our options were further informed by internal and external stakeholder workshops. In discussion with the Drinking Water Inspectorate (DWI), it was noted that the route a water reuse scheme takes to the water treatment works should be the subject of a drinking water risk assessment, and be covered in the Drinking Water Safety Plan. There were no stipulations made on residence time in water bodies or necessity to pass through a natural water course such as a river.

We are also conscious that numerous factors can give rise to uncertainty in water reuse; these include climate change (increased frequency of drought and flooding events), population growth, efficacy of demand measures, and behavioural change. Some of these factors could result in a reduction in water available whilst others may result in an increase in resource.

Table 7 Options modelled

ID	Option name	River or reservoir	Potable treatment	Treatment capacity (Ml/d)	WAFU (Ml/d)
EXS4	Clacton-Holland Haven to Ardleigh Reservoir (no additional treatment at Ardleigh)	Reservoir	No	6.7	3
EXS3	Clacton-Holland Haven to Ardleigh Reservoir with additional treatment at Ardleigh)	Reservoir	Yes	6.7	6.7
EXS5	Colchester to Ardleigh Reservoir via the River Colne (with additional treatment)	River	Yes	15.2	0
EXS6	Colchester to Ardleigh Reservoir via the River Colne with no extra treatment	River	No	15.2	0
EXS19	Colchester direct to Ardleigh Reservoir (no additional treatment)	Reservoir	No	15.2	11.4
EXS1	Colchester direct to Ardleigh Reservoir (with additional treatment)	Reservoir	Yes	15.2	0
LNE2	Ingoldmells to Covenham via Rive Eau (no additional treatment at Covenham)	River	No	6.1	0
LNE1	Ingoldmells to Covenham via River Eau (with additional treatment at Covenham)	River	Yes	6.1	6.1
SUE1	Ipswich direct to Alton Reservoir (with additional abstraction and treatment at Alton)	Reservoir	Yes	11.5	14.5
SUE2	Ipswich direct to Alton Reservoir (with no additional abstraction or treatment at Alton)	Reservoir	No	11.5	0
SUE4	Ipswich to Alton via River Gipping (no additional abstraction or treatment at Alton)	River	No	11.5	0
SUE3	Ipswich to Alton via River Gipping (with additional treatment at Alton)	River	Yes	11.5	11.5
FND4	Kings Lynn and West Walton to Stoke Ferry WTW via the River Wissey - no additional treatment at Stoke Ferry	River	No	17.4	0
FND3	Kings Lynn and West Walton to Stoke Ferry WTW via the River Wissey - with additional treatment at Stoke Ferry	River	Yes	17.4	17.4
FND1	Kings Lynn to Stoke Ferry via river Wissey (extra treatment at Stoke Ferry WTW)	River	Yes	10.3	10.3
FND2	Kings Lynn to Stoke Ferry via river Wissey (no extra treatment at Stoke Ferry WTW)	River	No	10.3	0
NTB28	Lowestoft and Caister reuse combined (to Costessey) - treatment	River	Yes	27.5	27.5

ID	Option name	River or reservoir	Potable treatment	Treatment capacity (Ml/d)	WAFU (Ml/d)
NTB27	Lowestoft and Caister reuse combined (to Wensum) - treatment	River	Yes	27.5	27.5
RTN2	Peterborough Flag Fen to direct to Rutland Water / Wing WTW - No treatment at Wing WTW	Reservoir	No	7.7	0
RTN1	Peterborough Flag Fen to direct to Rutland Water / Wing WTW - with extra treatment at Wing WTW	Reservoir	Yes	7.7	7.4
NTB29	Whitlingham (additional treatment at Norwich WTW)	River	Yes	21.7	21.7
SHB1	Pyewipe WRC (non potable) (6 Ml/d)	Direct industrial	No	6	6
SHB2	Pyewipe WRC (non potable) (14 Ml/d)	Direct industrial	No	14	14
SHB3	Pyewipe WRC (non potable) (20 Ml/d)	Direct industrial	No	20	20[a]

a This table includes only options modelled in AQUATOR to confirm benefit, not all constrained options.

We are mindful of this and want to continue to expand our understanding of water reuse to ensure adaptability of our options to meet these challenge and the opportunities it can present in our region. This will be a focus of our adaptive planning.

We are also currently reviewing all of our WRCs with lower designated water flows (DWFs) to assess the viability of small-scale, local reuse schemes. We want to gather data and display it in an accessible way that is available to other water users. We hope to use this data to match available water resources to potential users.

The implementation of small-scale, local reuse schemes could help to minimise the impact of abstraction licence reform on existing small businesses, such as greenhouse growers or golf courses. It could also create a gateway platform to aid new industries looking to move to the region. For example, it could help hydrogen producers to select sites for grid connection or roadside production for vehicle refuelling. It could also help farmers who are losing abstraction licences and need a new source of water for irrigation. Additionally, it could help farming collectives that want to develop new reservoirs.

The promotion of such use of valuable resource could help to ensure that water resources are used efficiently and sustainably, and support economic growth. The project is already underway and we are looking at individual exemplar schemes to help us promote the concept, with the aim to scale up and develop a prototype map and platform to roll it out within AMP8.

4.4.3 Other feasible options

A number of other resource supply side option types were identified as feasible in our region. These are:

- Aquifer storage and recovery
- Conjunctive use
- Raw water storage reservoirs
- Sea tankering
- Supernatant return (backwash water recovery)

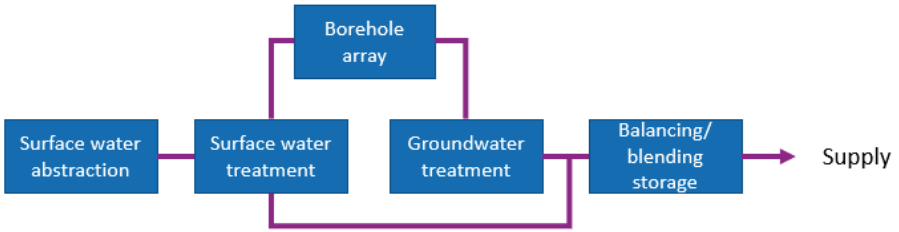
Figure 17 shows where these options are distributed around our region. Brief descriptions of the option types are now discussed.

Figure 17 Conventional new resource options

4.4.4 Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) is a technique used to replenish and store groundwater in aquifers for subsequent abstraction and supply. Figure 18 shows the outline process. Water is abstracted and treated when there is surplus water available then injected into the aquifer via an array of boreholes. The water is then left in the aquifer to be abstracted during drier months when less water is available from conventional sources. This water then undergoes conventional groundwater treatment before distribution.

Figure 18 ASR outline process



We do not currently operate any ASR schemes, and there are only limited operational examples in the United Kingdom. Four options were deemed feasible at WRMP19, so these were taken forward for feasibility studies in WRMP24.

The WRMP24 screening criteria was that ASR must have a sufficient benefit in an average year. A threshold of 2 Ml/d was set for this. To assess this, the amount of surplus water available from an existing abstraction in an average year was used. The average year benefit is calculated as the anticipated yield from re-abstraction.

The results of the assessment are shown below:

- Norfolk Wymondham WRZ ASR was rejected as there was no nearby surface abstraction to utilise.
- Essex South WRZ ASR fell below the yield threshold, so was rejected.
- Suffolk East WRZ and Lincolnshire Central WRZ ASR options were progressed as feasible for WRMP24.

Due to very limited knowledge and experience of ASR in the UK, the Sherwood Sandstone ASR (the Lincolnshire Central option above) was the subject of a WRMP19 adaptive planning detailed investigation. The aim of this was to develop our understanding of the option.

The investigation took the form of a review of previous reports and a gap analysis informed by stakeholder discussions with Environment Agency (EA) and water companies with previous ASR experience. Consideration was given to regulatory requirements, and baseline hydrogeological and water quality understanding.

The project also explored land availability and the borehole drilling requirements for a pilot project. It was at this stage that the project was put on hold, awaiting the results of WRMP24 modelling, as the cost of drilling, due to the diameter and depth of the borehole and observation well required, became prohibitive.

4.4.5 Conjunctive use

Conjunctive use in the context of this study is the sharing of resources with companies in other sectors. There are a number of instances where a power company possesses a consumptive abstraction licence that is not fully utilised. We could purchase the unused volume of these licences, abstract and treat it to support our own supply needs. There are risks with these options because the energy sector can be a volatile market place and this could impact the incumbent's utilisation practices, which may result in less water being available at the locations we identified.

It is also important that we consider the principle of no deterioration for the status of a water body. If a licensed abstraction has been out of use or under used for a period of time, it is very unlikely that we will be able to demonstrate that any utilisation, above recent actual levels, can be sustainably reintroduced.

Further to this where a desalination plant is located near to a power plant there is the option for power sharing, whereby we have the potential to buy power directly from the power plant. Additionally in some instances there is the potential for the brine waste from the desalination plant to be discharged into the existing power plant outfall, which would be a significant capital expenditure saving.

4.4.6 Reservoirs

Pre-screening was carried out on 104 options from the WRMP19 rejection register. Of those options, five passed the pre-screening as no reason for rejection could be found for these options. This excludes options currently being developed through the RAPID process. These are summarised in Section 6 of this report, with sources for further detail referenced there.

4.4.7 Sea Tankering

The process of sea tankering involves the importing of potable water from overseas, such as Norway, into UK ports. The aim is to guarantee water resilience at times of high demand in water networks or during drought events. The water is delivered from the tanker to a service reservoir via pipeline, and then from the service reservoir is delivered via pipeline to an existing WTW.

The sea tankering options have been developed based on a proposal received from a third party.

The only criterion for pre-screening of the sea tankering options was that they could provide sufficient benefit. These options came through our bid assessment process so the pre-screening is described in the Bid Assessment Framework section 4.4.9.

4.4.8 Resource sharing and third-party options

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.

Through our membership of WRE we have been able to work closely with other water company members to ensure that we've developed our options collaboratively. This in turn has aided the development of WRMP and WRE Best Value Plans.

We carried out a number of workshops with Yorkshire Water, and the consultants working on their option development, to explore water trading opportunities. Both companies have a resource deficit in adjoining resource zones and consequently the distances of transfers and water quality differences meant we did not identify any cost-effective water trading options.

As well as weekly WRE water company member alignment meetings, we have fortnightly supply-side options workshops with colleagues from Cambridge Water and Essex & Suffolk Water to discuss our developing plans and opportunities for resource sharing.

We have carefully considered the potential for put and take options across our borders with Essex and Suffolk Water. However, there are a number of challenges that would make it difficult to implement such an agreement.

One challenge is the configuration of our respective neighbouring networks. It would be difficult to balance an equitable trade between the two companies, as the demand for water varies throughout the day and the year, due to behaviour and weather. This could make it difficult for

the donor company to provide the necessary volumes whilst maintaining network pressures. It is extremely difficult to capture and represent this in modelling that uses annual averages.

The complexities created by these factors make it difficult to model accurately using supply and demand or economic modelling tools. As a result, these options are difficult to fairly test against other options. Additionally, our strategic pipeline is optimised to WRMP19 modelled capacities. Creating an option that can benefit both companies whilst maintaining these capacities is too complex, as shown in Figure 20.

Figure 20 helps illustrate the difficulty in implementing an 'put and take' arrangement. We explored possible 'take and put' options to support Essex and Suffolk Water's Hartismere WRZ via a connection to our strategic pipeline between Bury St Edmunds to Ipswich and an equal equivalent supporting connection back into the strategic pipeline near Colchester from their Essex WRZ. Once again, creating an equitable solution that could be modelled to demonstrate the benefit proved too complex, with each company agreeing there were more resilient options that could be modelled.

Another challenge is water quality. If water were to be imported into a less constrained zone, there would be a risk of water quality problems. Fluctuations in supply and demand, as well as potential pressure differentials, could make it difficult to manage water quality in the receiving zone.

Finally, both companies face uncertainty around future impacts of Habitats Regulations restrictions on abstractions within the Broads Special Area of Conservation (SAC). This uncertainty makes it difficult to commit to long-term water trade agreements beyond those that we already have in place.

As a result of these challenges, we have concluded that it is not feasible to implement any new inter-company transfers in AMP8 or include them in WRMP24. However, as new resource options become available, there may be opportunities in the future. We continue to work closely on this, both through the WRE partnership and at a company-to-company level.

Figure 19 In operation as designed

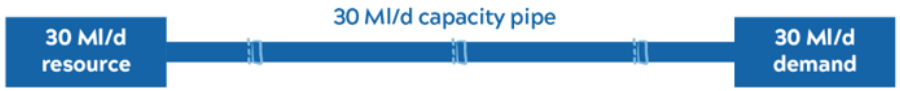


Figure 19 shows a balanced optimised strategic pipeline arrangement, with the supply capacity matched to demand.

Figure 20 Consequence of 'put and take'

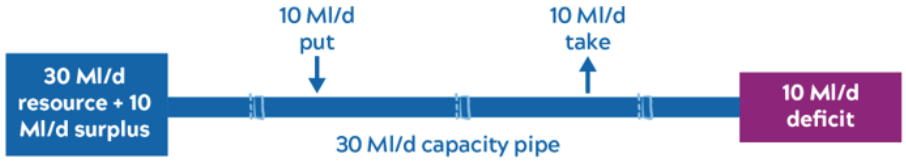


Figure 20 shows what could happen if a 'put and take' type arrangement is modelled retrospectively. As the pipe is at capacity, an input will result in DO being locked into the upstream zone and there will be an equal equivalent deficit in the downstream zone.

A key set of options developed in conjunction with Cambridge Water are detailed in Section 6 of this document.

4.4.9 Bid Assessment Framework

Through our Bid Assessment Framework we received an updated proposal from a third party for a sea tankering options, called Extreme Drought Resilience Service.

The options have been subject to a staged screening process, outlined below:

- (a) Pre-bid stage - opportunity for co-development of early concept options that are not significantly defined to complete a pre-qualification form.
- (b) Pre-qualification stage - where the option is tested for failure against a pre-determined list of basic requirements.

- (c) Fine screening stage - options which pass the pre-qualification stage will then be subject to further feasibility testing to ensure all screening criteria are passed.
- (d) Full evaluation stage - options which pass the fine Screening stage will be tested using Anglian Water economic modelling software and "Best Value" assessment process.

The first stage of this process is to assess the DO benefit using AQUATOR, our hydrology modelling software, in line with other options appraisals.

The assumptions made for this assessment were that water could be deployed at 20 Ml/d into Immingham, Great Yarmouth and/or Harwich.

- Great Yarmouth was excluded at this stage. There are no reservoirs or potential receiving water bodies close enough to Great Yarmouth to make the option viable.
- The DO yield assessment concluded that there is a small WAFU benefit of 0.4 Ml/d from transferring water from Immingham to Covenham reservoir. This benefit was dependent on the prior delivery of another option to enhance surface water treatment.
- The DO yield assessment concluded that there is a WAFU benefit of 4.2 Ml/d in a severe drought from transferring water from Harwich to Ardleigh reservoir. In an extreme drought this gave a benefit of 6.8 Ml/d.

We have received another proposal for the use of water from historic mining activities as a water resource. We have held a number of workshops with the option originator to explore and understand the proposal and its potential benefits, challenges and limitation. This proposal was received after the main cohort of options went through feasibility analysis so it is being explored separately, but within the guidelines of bid assessment. This is to ensure the option is appraised comparatively to other options.

The immaturity of the option means that it has not been costed using C55 or modelled to ascertain DO and as such has not been considered in our best value planning.

4.4.10 Backwash recovery

Backwash recovery is a means of maximising the resource we already have available by recycling water from existing treatment processes that would normally be discharged to the environment.

The bulk of this water that can be recovered is from filter backwashing processes. Groundwater sources with high levels of iron and manganese will typically have an oxidation process followed by rapid gravity sand filters for solid/liquid separation. Periodically the filters have to be backwashed, to remove the build-up of solids within the sand bed, in order to maintain the optimal performance. The backwash water from this process is captured in washwater recovery tanks. This is then normally settled over several hours, with the clean water from the surface being decanted to the environment, leaving the sludge behind.

Backwash water recovery is the process of returning the settled water to the front end of the treatment process, rather than discharging it to the environment. The sludge is still retained in the washwater recovery tanks from where it can be transferred to a sludge holding tank and subsequently tankered to water recycling centre. Here the sludge may be further dewatered, and the freshwater discharged to the environment via the water recycling centre outfall.

The component parts needed to convert from conventional environmental discharge to washwater recovery must all be compliant with DWI regulation 31 (the approval of materials and equipment in contact with drinking water) and the wash water recovery tanks must have secure, watertight covers. The turbidity of the water being returned has to be monitored to ensure there is no deterioration within the existing treatment process.

Where there are large volumes of backwash water to be recovered and existing backwash tanks don't have sufficient capacity, then clarification may be required. This is usually achieved through lamella clarifiers. In this process, a coagulant is applied to the backwash water, which is passed through a mixing stage then onto the lamellas. Here the heavier particles drop out of suspension and fall to the bottom of the hopper, with the clean water flowing over a weir from where it is pumped to the front end of the treatment process.

The majority of our backwash recovery options identified are of the simple settlement and decant type. In most cases these are very easy to retrofit to existing treatment processes, therefore represent a cost-effective means of maximising resource already available.

The same can be applied to surface water treatment works. In these options the backwash water is often made-up of coagulant, often in the form of iron salts, combined with solids and organic material that were not removed by upstream clarification processes. This process isn't always

appropriate because we have to consider the loading of the treatment process which is particularly relevant where there is a risk of cryptosporidium being present.

We consider these options to be of high value, even though they may be of relatively low yield. The DO of all backwash recovery is always 100% of their capacity but the yield in WAFU of the option may be less than its capacity where it is 'locked in' a resource zone. However, the capacity of the option above WAFU is water not abstracted and therefore left in the environment.

The options identified in this plan are all in the east of our region in some of the most groundwater stressed areas. Consequently, even when their isn't a clearly definable WAFU benefit, the benefit to the environment is absolutely quantifiable. Table 8 shows the modelled benefit and the potential benefit of backwash recovery options.

Table 8 Backwash recovery option benefits

Option ID	WTW DO	Option DO	Potential max DO
EXC7	8.4	0.3	0.4
EXS7	28	0.3	1.4
FND26	21	0.24	0.42
LNE3	50	1.3	6.5
NAY4	3	0.75	0.15
NAY5	2.7	0.1	0.14
NBR9	2.3	0.2	0.12
NED3	5.5	0.1	0.28
NHL7	11.7	0.2	1.17
NNC5	6.8	0.18	0.34
NNC6	6	0.2	0.3
SUE25	5	0.17	0.25
SUT6	3.4	0.05	0.17

Most of these options are WTWs with iron removal filters, as described above. The modelled DO of each option is a conservative estimate of water that can be recovered and has been arrived at from a simple calculation method, using input and output flows. However, we know that our WTW losses are in the order of 5% for this kind of treatment (see the WRMP24 Supply Forecast technical supporting document), so here we have given an upper limit that may be realised. As the work involved in retrospectively installing these options largely involves modification to existing assets and relatively low cost items, it is anticipated that opportunities to gain more DO from the option can be identified in detailed design and implemented without exceeding budget allowances.

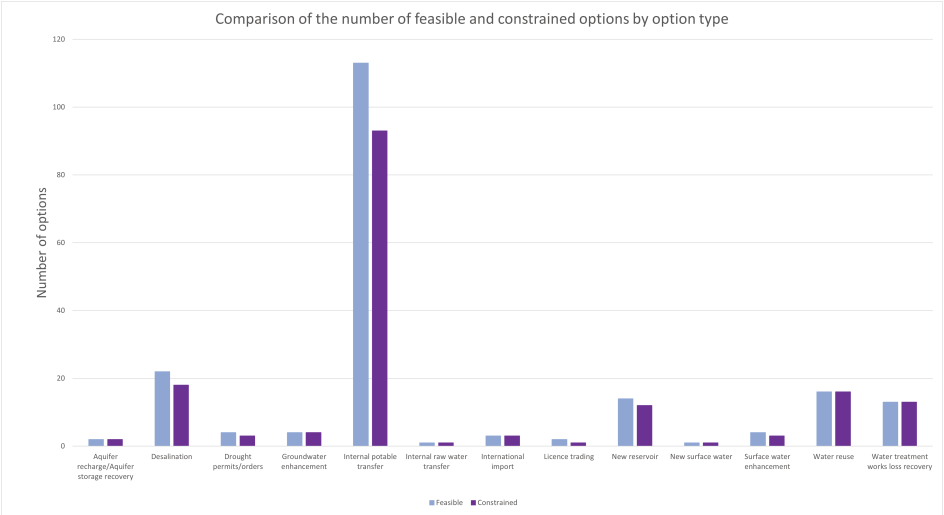
Figure 21 Location of the resource options

Figure 21 above shows the location of the resource options described above. We can see that our backwash recovery options are in those smaller isolated resource zones described in Section 6. This is another reason why we are keen to develop these options; this is explored in the WRMP24 Decision making technical supporting document.

4.4.11 Moving from a feasible option set to a constrained list

The majority of our feasible options made it to our constrained option set. These are shown in Figure 22 below. Figure 23 and Figure 24 show feasible and constrained options by option type for each resource zone. This illustrates that, while we went from 199 feasible options to 170 constrained options during fine screening, (see Table 4) we have retained a diversity of option types across our resource zones.

Figure 22 Comparison of the number of feasible and constrained options by option type



It should be noted the numbers of options considered here are simplified so that they only represent unique options. For example, a reservoir may yield a different volume depending on a particular abstraction regime. For modelling purposes these have to be represented as different options. However, for the purposes of this analysis we have only considered options that are unique, for example, a different size of reservoir represents a unique option. Different filling regimes of those reservoirs are not unique options.

Initially each reuse option was developed with enhanced treatment at the reuse centre and a larger capacity at the potable treatment works that takes water from the receiving waterbody. Then a secondary option was developed with no larger capacity needed at the potable treatment works at the receiving waterbody. These were then modelled in AQUATOR and compared to see if a gain in WAFU could be achieved without larger capacity, and therefore at lower cost. In most instances this demonstrated that there was no benefit to reuse without larger capacity at the potable treatment works, however, Colchester did show a benefit. This is why Colchester reuse represents good value. In most instances the larger capacity at the potable treatment works represents about 30% of the

total treatment cost of a reuse option. We have spare treatment capacity at the receiving waterbody for Colchester reuse, so we can yield the full benefit without that additional cost element.

In Ruthamford North all but one reuse option was screened out. This is because the resource available is very low relative to the cost of the option.

The number of desalination options reduced significantly over the screening processes because we found unmitigable risks associated with offshore and estuarial options. This is most notable in Lincolnshire Central and South Humber Bank resource zones. Lincolnshire Central had 8 feasible options, all of which have been rejected. South Humber Bank only has one remaining option, which is a feed to non-potable industrial cluster from desalination in Lincolnshire East (Mablethorpe).

We also screened out a number of potable transfer options. These were options that gave no benefit and didn't solve a deficit issue.

Figure 23 Feasible options by type and resource zone

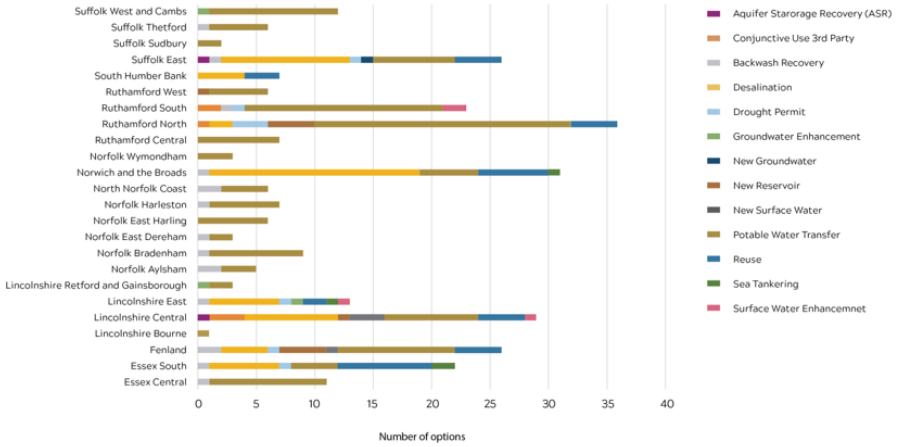
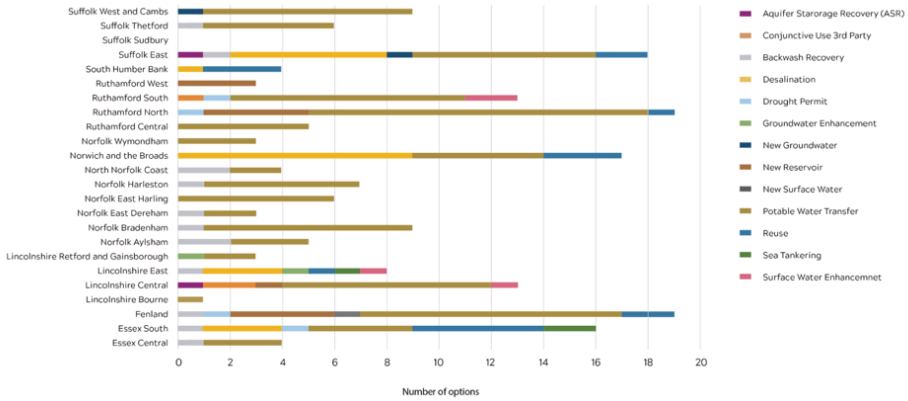


Figure 24 Constrained options by type and resource zone



4.4.12 Adaptive Planning

We believe that our diverse set of options gives us flexibility and adaptability in delivery. However, we are aware that an ambitious plan like ours comes with risks. To mitigate these risks, we have developed a number of options and alternatives that we can explore in more detail.

In addition to our preferred plan, we have also been working on adaptive pathways that we would take in the event of our preferred plan not being delivered or if it is delayed. More information about this can be found in the WRMP24 Decision making technical supporting document, Section 10.

We have also received Accelerated Infrastructure Delivery funding to progress our Colchester reuse scheme. More details about this can be found in Section 6 of this report.

Adaptive planning in AMP8

Whilst we continue to develop our Colchester reuse option, by conducting modelling and sampling for the pilot trial, we will gain learning that we can use to advance our understanding of other water reuse opportunities alongside the delivery of Colchester.

With this work already underway and continuing through AMP8 we believe we can have other reuse options at an advanced pre-delivery stage by the beginning of AMP9 if needed.

Some adaptive pathways may lead to us having to bring forward desalination in our plans. With this in mind we have been advancing our knowledge of the technologies available and learning from colleagues in the industry that have worked on the development and operation of successful desalination facilities. We'll be taking this learning and building on it, while looking at more specific locations. This will enable us to determine the kind of intake and outfall constraints and opportunities we will be presented with. We will continue to work with experts in the field to make sure we arrive at the best possible brine management strategies available.

We will work very closely with stakeholders, planning authorities and communities to minimise impact and inconvenience while maximising opportunities. We will also look to ensure anything we build is as sympathetic to the natural and historic environment as possible, with the technology available to us. We are keen that in doing this we don't close off opportunities to improve anything we build, so we want to future proof designs to allow for adaptation, expansion, contraction and decommissioning.

Effective engagement is going to be key to rapidly advancing our understanding and move towards a plan to deliver, within the next few years.

5 Constrained options

By following these processes outlined in Sections 2 to 4, we arrived at a constrained list. For this constrained list, we used WRPG Section 8.3, shown in Table 9 below to determine the information that was required to ensure our options were suitable for modelling. We indicate where this information cab be viewed in this table.

Table 9 WRPG Section 8.3: Information you should provide for each option

Information you should provide for each option	Location of information
(a) A profile of the deployable output, contribution to the supply-demand balance or demand saving (based on the capacity of the option) or water saved over 80 years. For a supply option, the deployable output should be based on the same assumptions as your baseline options. The yield of a demand side option should be based on a dry year (see Sub-Section 4.6).	Section 6 of this report
(b) An estimate of the lead-in time needed to investigate and implement the option, including the earliest date the option could put water into supply or reduce demand.	Section 5 of this report
(c) An assessment of the risks and uncertainty associated with the option, including the likelihood and impact on yield of climate change, environmental constraints or customer behaviour (for demand options). You should include an assessment of INNS (where relevant).	Section 5 WRMP24 Supply forecast technical supporting document WRMP24 Environmental Report
(d) A drinking water safety plan assessing the risks to drinking water quality. If there is a risk to wholesomeness, (such as discolouration, nitrates, pesticides) or a risk of deterioration in the quality of supply, the option will not be permitted until steps to mitigate those risks are in place.	Section 5
(e) An explanation of whether the option depends on an existing scheme or a proposed option, or is mutually exclusive with another option.	Section 6 of this report
(f) Any constraints specific to the option.	Section 6 of this report
(g) An assessment of your customers' support for the option.	Section 5 of this report WRMP24 Customer and stakeholder engagement report
(h) An assessment of the flexibility of the option to adapt to future uncertainty.	Section 5 and Section 6 of this report WRMP24 Supply forecast technical supporting document Decision making technical support document

Information you should provide for each option	Location of information
(i) A description of how the option will be utilised and the impact on operating costs and carbon costs. You should describe the expected utilisation in both an average year (assumed long term utilisation scenario) and a theoretical annual maximum utilisation scenario.	WRMP24 Decision Making technical supporting document
(j) An assessment of the environmental and social impacts of the option, including any SEA at an option level, an evaluation of the impacts on RBMP objectives, nature recovery objectives (England), Ecosystem resilience biodiversity duty (Wales) and well-being goals (Wales).	WRMP24 Environmental Report
(k) A HRA, if the option could affect any designated habitats site	WRMP24 Environmental Report
(l) (for supply and transfer options) a natural capital assessment including an assessment of the predicted impact of the option on natural assets and service flows.	WRMP24 Environmental Report
(m) (England only) an assessment of the contribution of the option to the conservation and enhancement of biodiversity and a high-level assessment of biodiversity net gain (if the option requires planning permission)	WRMP24 Environmental Report Anglian Water (2023) Revised draft Sustainable abstraction and environment technical supporting document
(n) Cost information	Section 5. WRP Tables 5a and 5b
(o) Greenhouse gas emissions	Appendix D in WRMP24 Decision making technical supporting document
(p) Other information relating to metrics developed to inform selection of your preferred programme	Section 6

5.1 Water quality

We have undertaken a high level Drinking Water Safety Plan (DWSP) risk assessment for the overarching WRMP options, completing an initial DWSP for desalination, water reuse and water transfer.

Following a hazard and control template based approach, risks have been identified and linked to a hazardous activity or event. An uncontrolled and controlled risk (RAG rating) was then applied, with a likelihood and consequence score given, where applicable at this stage.

Specific data source parameters have been taken from the World Health Organisation[10] and a DWSP developed at a compound level, looking at potential source contaminants likely to be present in sea water, such as which contaminants could be caused by a shipping accident.

The high level screening approach will be further developed when individual options have been refined , with risk data being sourced to enable further iteration of the DWSP. Future work will look at the identification of residual risks and data gaps, with relevant water quality data being used to design the options. Feasibility option reports have been developed for the design options for water treatment.

The main points from the high level Drinking Water Safety Plan screening exercise are now detailed.

5.1.1 Desalination:

The high level screening exercise highlighted that:

- Boron is likely to be present in brackish or seawater up to concentrations of 4 to 5 mg/l. This will require reverse osmosis to treat; once water

10 WHO/HSE/WSH/11.03- Safe Drinking-water from Desalination (2011)

quality data is further understood this will dictate the number of passes required.

- Bromide is likely to be present at values between 65 to 80 mg/l. The preferred choice of disinfection will be critical to minimise the risk of PCV failure and Disinfection By Product formation potential.
- Regulation 31 compliance will be required for all stages, including all raw water conveyance systems and treated water processes.
- Risk of adverse weather conditions, for example flooding risk, the impact of high tides, surges, storm impacts and their detrimental impact on water quality and asset capability and availability.
- Risk of shipping accidents and subsequent risk of contamination of the raw water which could pose a potential treatment risk.
- Risk of PFAS in the brackish or seawater and the potential for the requirement for additional treatment processes to ensure compliance on final treated water.
- Risk of customer lack of confidence in the water if it looks, tastes or feels different. Panel trials on remineralisation and optimal blend scenarios are required to inform this along with customer engagement and support.

5.1.2 Water reuse:

The high level screening exercise highlighted that:

- There is a risk of non-compliance with the upstream WRC and a need to understand how this could potentially have a detrimental impact on the raw water quality.
- There is a risk of PFAS in the WRC's final water effluent. so a potential for additional treatment processes to ensure compliance on final treated water.
- Non-permitted chemicals may be discharged into the water recycling works via tankers from a wide area, with tankers bringing effluent/waste from variety of locations. Management and controls would need to be identified.
- Permitted industrial discharges carry a risk; with additional monitoring likely to be required for parameters such as BOD, COD, ammonia, TSS etc.
- Regulation 31 compliance will be required with adherence to the regulation and evidence of that at all times this must include all raw water conveyance systems and treated water processes.
- There is a risk of customer lack of confidence in the water if it looks, tastes or feels different. Panel trials on optimal blend scenarios might be required to inform this along with customer engagement and support.
- Risk of customer perception that the water may be unsafe.

5.1.3 Potable Water Transfer

The high level screening exercise highlighted that:

- The mixing of waters from different sources, for example surface and ground water sources, means there is an inherent risk that customers could reject the water on appearance , taste and odour. Customer engagement is required.
- Mixing of waters with significantly different chlorine residuals which customers could identify and reject the water on taste or odour. Free chlorine and chloraminated systems will not be mixed in order to remove the risk of taste. Customer engagement and evidence of that engagement are required.
- General risk of a perceived change in the water quality due to changes in hardness, taste and odour or general appearance. Customer engagement will be required to build our knowledge of this.
- There is a risk of discolouration with transfer systems. Mains conditioning and effective control and management will be required to minimise the risk of discolouration.
- There is a risk of water age, in particular on Disinfection By Product formation potential.
- Risk of customer lack of confidence in the water if it looks, tastes or feels different. Customer engagement is required to explore this futher.
- Regulation 31 compliance will be required with adherence to the regulation and evidence of that at all times where fittings, materials or chemicals are used in the distribution system.

5.2 Environmental assessment of options

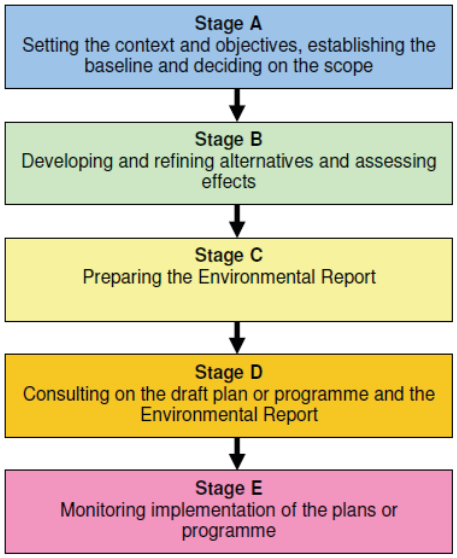
Option specific assessments were completed as part of the WRMP24 Environmental Assessments. These are reported in the WRMP24 Environmental Report and its related sub reports. Further information on environmental destination, strategy and ambitions can be found in our WRMP24 Sustainable Abstraction and Environment technical supporting document.

The scoping stage of the SEA process (Stage A in Figure 25) sets the context and scope for the SEA and Environmental Report. During scoping, key plans and programmes are reviewed, baseline conditions and key issues and opportunities are identified, and the SEA Framework is developed. The scoping stage for the WRMP was undertaken and a SEA Scoping Report produced in early 2021[11].

The approach proposed in the Scoping Report aimed to build on the environmental context defined in our WRMP19. Furthermore, as regional water resource plans are required to undertake the same suite of environmental assessments as water company WRMPs, the proposed approach aligned with the Integrated Environmental Assessment (IEA) approach of the Water Resources East (WRE) regional planning group.

The Scoping Report was issued for a formal five-week consultation between March-April 2021 to the three statutory bodies: Environment Agency, Natural England, and Historic England.

Figure 25 The stages involved in this approach



Key themes arising from the Scoping Report consultation included:

- Consistency between approaches, that is aligning with, and where necessary building on/ refining, previous work and regional-level plans (including Water Resources East's Integrated Environmental Assessment approach), as well as relevant guidance, planning and policy frameworks.
- Coverage of a full range of socio-environmental issues including interactions and synergistic impacts in both construction and operation, including but not limited to air quality, climate change, pollution, biodiversity, and aesthetic/character values.
- Mitigating potential impacts on the historic environment and heritage assets, including designated and non-designated heritage sites, and recognising that some heritage assets may currently be unknown.
- Representativeness across locations, customers, and stakeholders, and engagement of experts including local groups and advisors.
- Opportunities to have positive impacts, including in relation to biodiversity, responsible recreation and engagement with the natural and historic environments, climate resilience, and development of green infrastructure.

5.2.1 Strategic Environmental Assessment (SEA)

The purpose of the SEA is to provide high-level protection for the environment and to consider likely significant effects (LSE) across a series of environmental and social topics / objectives.

SEA is the only assessment that considers the impact of the plan as a whole and has the aim of influencing key decisions on option selection across a series of different proposed plans, whilst aiming to avoid or reduce the impact of negative effects and enhance positive effects.

Increasingly, the SEA has been used to aid the integration of the wider necessary environmental assessments, identifying how each assessment can provide adequate outputs to assess SEA objectives to ensure proportionality and coherence. The findings are presented in the WRMP24's SEA Environmental Report. Typical activities in SEA include:

- A review of relevant policies
- Scoping and consultation
- High-level screening of options
- Establishing environmental baselines

11 Anglian Water (2021). Water Resource Management Plan 2024 Strategic Environmental Assessment Scoping Consultation

- Assessment of options available to the plan-making (e.g.Policy Decisions, supply-side options)
- Assessment of the preferred plan (Plan B), it's reasonable alternatives (Plans A, C and D) and cumulative effects
- Environmental reporting and consultation (along with WRMP)

5.2.2 Water Framework Directive (WFD)

The Water Framework Directive (WFD) considers legally binding objectives from the River Basin Management Plans (RBMP), ensuring feasible options bear no risk of deterioration to waterbodies such as rivers, groundwater, lakes, wetlands and coastal waters. Furthermore, there is an emphasis on practical, catchment-based solutions and partnerships that help waterbodies achieve 'good ecological status' in characteristics such as flow, water quality, morphology and habitats. The findings are presented in the WFD Sub-report, as well as feeding into the over-arching Environmental Report findings.

Our WFD assessment has concluded that at the plan level, the options in our best value plan are considered to be compliant with WFD objectives. Please refer to the WFD Sub-report for further information.

5.2.3 Habitats Regulations Assessment (HRA)

Habitats Regulations Assessments (HRA) must be carried out to ensure any likely significant effects to protected European sites ('Natura 2000' network) are considered. Examples of protected sites are Special Areas of Conservation (and candidate SACs), Special Protection Areas (and potential SPAs) and Ramsar sites (and proposed Ramsar sites).The findings are presented in the HRA Sub-report, as well as feeding into the over-arching Environmental Report findings.Typical stages of HRA include:

- Initial screening to test for any likely significant effects (LSE) of an option or plan on protected sites (using the 'Precautionary Principle' as a guide).
- Formulating the scope and methods for Appropriate Assessment (AA). Detailed assessment of effects of an option or plan.
- Where there are adverse effects, an assessment of alternative solutions and mitigations should be undertaken for comparative purposes.
- In the unlikely event where no alternative solution to the assesses plan exists (less-damaging alternatives exist and adverse effects remain), a case for Imperative Reasons of Overriding Public Interest (IROPI) will need to be made.

The strategic plan-level approach to the HRA of our best value plan has concluded that it would not give rise to adverse effects on the integrity of any Habitats Sites. More can be read about this assessment within the HRA Sub-report.

5.2.4 Natural Capital Assessment

Natural Capital Assessment (NCA), including the assessment of changes to Ecosystem Services (ESS), has been undertaken of the options on Anglian Water's constrained list of supply-side options. The NCA process identified permanent changes in natural capital (habitat types) predicted to result from the options.

The assessment of ESS included: carbon sequestration (climate regulation), natural hazard regulation, water purification, water regulation, air pollutant removal, recreation and amenity value, food production. The findings are presented in the BNG and NCA Sub-report, as well as feeding into the over-arching Environmental Report's findings.

5.2.5 Biodiversity Net Gain Assessment

Biodiversity Net Gain (BNG) assessments have been undertaken on the options in our constrained list of supply-side options. This approach meets both the WRPG's requirements to consider biodiversity and habitats related ESS impacts and to assess net gain to biodiversity. The findings are presented in the BNG and NCA Sub-report, as well as feeding into the over-arching Environmental Report's findings.

5.2.6 Invasive Non-Native Species Risk Assessment

Invasive Non-Native Species (INNS) risk assessment has been undertaken to identify the potential risk of INNS transfer. The INNS assessment, in parallel with a Strategic Environmental Assessment (SEA) , ensures that an integrated approach to environmental assessment has been followed.

We have assessed the potential risk of transfer of INNS, both individually and in combination, for WRMP24. The findings are presented in the INNS Sub-report, as well as feeding into the Environmental Report's findings.

5.3 Customer support for options

We have engaged with our customers and stakeholders extensively on their supply-side option preferences. Whilst demand management options remain favoured, the following synthesised insight has been gained:

- Water reuse and reservoirs were highlighted as being preferred supply-side options. Reservoirs are seen as a familiar, tried and tested option which are environmentally friendly and an attractive community asset.
- Water reuse is seen as being economically and environmentally friendly. There is also a less of the 'yuck' factor seen in recent engagement, with perception that it is being undertaken already and is utilising an existing resource.
- Desalination is perceived to be quite an expensive process that needs new technology to be invested in and built, so there is concern that this could lead to bill increases. Some customers also mentioned that they feel it could cause the water to taste odd or salty at the end of the process. They also expressed concern about its environmental impact.

Table 10 on the next page shows customer prioritisation for options in descending order. These results are from engagement activities discussed on detail in the Customer and Stakeholder Engagement report[12] .

Table 10 Customer prioritisation for option types

Priority	Option Type
1	Leak reduction (company side)
2	Higher water efficiency
3	Water reuse
4	Using grey or rainwater
5	Reservoir
6	Leak reduction (customer side)
7	ASR
8	Smart metering
9	Universal metering
10	Desalination
11	Transferring water (between companies/regions)
12	Sea Tankering

For context the table shows all supply and demand side option types. The approach, principles of engagement and details of finding of our customer and stakeholder engagement can be found in our WRMP24 Customer and Stakeholder Engagement technical supporting document[13] .

12 Anglian Water WRMP24 Customer and Stakeholder Engagement.
13 Anglian Water (2022) draft WRMP24 Customer and Stakeholder Engagement.

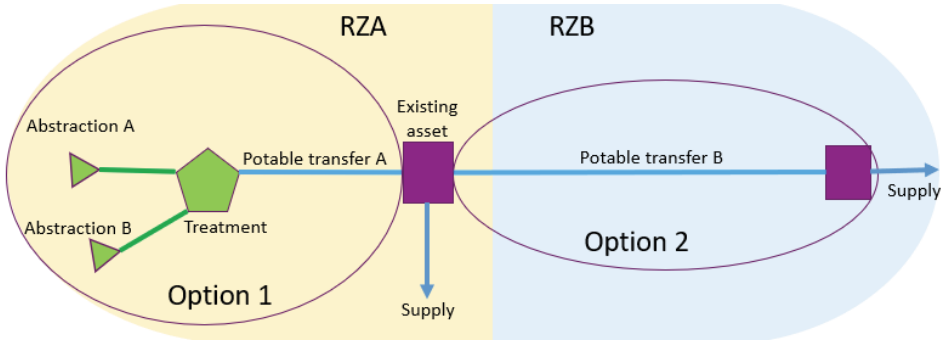
5.4 Costs estimates

This section describes how cost estimates have been created and how they are used. First we will briefly describe how our supply options costs are built up, so they can be costed accurately. We will also explain why this matters for EBSD modelling.

For each feasible option an outline scope is created. This includes a source of water, means of abstraction, outline treatment based on the water quality information available at the time and the necessary assets to transfer that water to existing distribution infrastructure.

Figure 26 shows how we build up a set of assets required for an option.

Figure 26 C55 investment build up

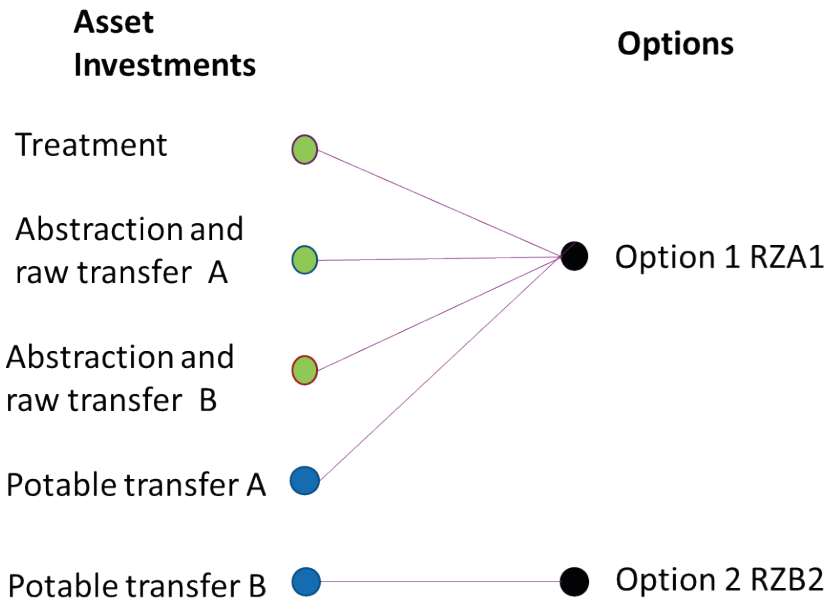


In this example we have two WRZs, resource zone A (RZA)and resource zone B (RZB). Within RZA we identify an option to abstract water from 2 sources, transfer the water to a central location for treatment and the forward the water to our distribution network. This is Option 1 in Figure 26.

Option 2 is an independent potable transfer. While it can be utilised to distribute resource from Option 1, it also has the potential to transfer further surplus from RZA to RZB, so it would be inappropriate to link it to the same option. By costing the option this way we can input the option into our EBSD modelling tool independently to allow system wide optimisation.

Figure 27 shows how the different asset investment, created in C55, combine to make a single option.

Figure 27 Investment to option build up



All our supply options have been entered into our C55 Asset Investment Planning and Management tool, a proprietary software tool we use for the estimation of all Business Plan investments. We post process the cost outputs of C55 to combine them; this ensures we do not double count or miss components. It also enable us to apply the appropriate level of Optimism Bias to each component of an option. For example, the Optimism Bias for transfers is not the same as it is for treatment, so it would be an over estimate to apply the same level to the whole of Option 1.

The cost estimation module within C55 contains a comprehensive asset cost model library covering assets from treatment steps (e.g. pumping station, filter). The cost models are common for all investments and the cost is driven by the asset attributes entered (e.g. pump kW or pipe length). Once the options are developed in C55, they follow a Quality Assurance

process, where the Anglian Water Cost Intelligence Team challenges the scope, in order to ensure alignment with current business practice. The cost models in C55 have been updated to 2022/2023 prices using AWS cost data from completed projects. We have deflated these costs to 2020/21 prices outside of C55.

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

5.4.1 Optimism Bias

An Optimism Bias (OB) methodology was developed by the RAPID All Company Working Group (ACWG) , comprising the nine water companies with SRO projects. The same methodology was used by WRE in regional planning, so has been applied in the same way to WRMP options for consistency.

Optimism Bias for each option can be found in WRMP Table 5a.

Table 11 shows the percentage of optimism bias applied by option type.

Table 11 Percentage of optimism bias applied by option type

Option type	% optimism bias applied
Desalination	55.3
Water reuse	32.1
Colchester water reuse	37.4
Reservoirs	37.38
Sea Tankering	35.6
Conventional treatment	20.3
Conjunctive use	20.3
Aquifer Storage and Recovery	32.2
Transfers	18.4
AMP8 preferred plan transfers	13.2

Transfers that were selected in our draft plan with 2030 availability have undergone some additional work to prepare them for potential AMP8 delivery. Additional route analysis has been carried out, as well as working towards establishing delivery mechanisms and detailed design. As a result, OB has reduced to reflect this greater confidence in deliverability.

We have also revised the OB for Colchester reuse scheme to more accurately reflect our current understanding.

Areas that where OB has been reduced since draft WRMP24:

- Engineering practices' - a significant amount of the process is common to known technologies that our delivery partners have experience of, for example BAF, filtration and UF membranes, so the optimism bias is reduced for these areas.
- Design complexity has been reduced. As with engineering practices above, some of this is known technology.
- For the unknown elements, AID funding will a enable pilot trial that will resolve some uncertainty.
- Stakeholder concern has slightly been reduced as our draft WRMP consultation closed with no significant negative response to the option was received, however, it's acknowledged that more outreach work could increase focus on the option.
- Project management has been reduced as we have established project delivery teams and governance.
- Well established capital delivery alliance frameworks and engagement with them for delivery of this project is underway.

Some aspects remain relatively low confidence:

- We are still at very early stages of environmental modelling and understanding water quality implications. OB elements relating to these elements remain at the highest category (lowest confidence).
- The complexity of integration of the new scheme into existing assets is the most unknown area of the project delivery.

5.4.2 Capital and Operational Carbon Assessment

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

Capital Carbon

In calculating the capital carbon of our assets we use a methodology verified against PAS2080 - Carbon Management in Infrastructure.

We have a host of carbon models pertaining to the materials, products and construction methods we use in the construction of our assets. As a design progresses we use a carbon modeller to bring together the carbon models and calculate the total capital carbon associated with each asset. Our capital carbon value is for the asset 'as built' - it includes the capital carbon associated with the production of materials and products, their transport and the methods used to construct the asset.

Operational Carbon

Our operational carbon footprint is built up from an understanding of the energy consumption required to operate our asset- for example, the energy required to pump water. Through our design approaches we understand the various elements of our design, the energy required to operate these elements and the operational profile. Together with an understanding of the carbon associated with the various energy sources used (primarily electricity), this allows us to calculate the operational carbon assessment.

5.4.3 C55 Lifecycle report

We use the C55 'Lifecycle report' to extract cost information for ESBD input data and the completion of WRMP Tables 5a and 5b.

This report provides a capex profile, annual opex (fixed and variable), capex repeats and carbon quantities (embodied and operational).

5.4.4 Capex repeats

The investment needed to renew an asset at the end of its useful life is referred to as capex repeats in C55. These have standard renewal periods (asset life) based on asset type. For the WRMP we use 'plant class' cost models which have the following asset lives:

- C01 - Studies / Models - Repeat zero
- C04 - Civils - Repeat 50 years
- C05 - Sewers and Mains - Repeat 200 years
- C06 - Mech & Elec - Repeat 15years
- C07 - Instrument and Control - Repeat 7 years

The capex repeats are different to the original CAPEX. The repeat only adds up the cost for that account (i.e. C07 instrumentation) then the on-cost equation is applied to the account. This ensures that the future costs are not overestimated by activities that may not be carried out as expected at that time, therefore the value should be lower than the original one.

The duration for the repeat is dependent on the length of time the original capex is profiled over. In general, the repeat is half of the time of the original spend profile, so for most of the WRMP investments they are profiled over 4 years and as such the capex repeat is profiled over 2 years. The split between years varies with asset type but in general is approximately 20:80 over 2 years for the WRMP options.

The scale of the capex repeats also varies over time to reflect the complexity of the investment needed over the asset life.

The C55 'life cycle report' profiles costs over 40 years, however for the WRMP we need to extend the profile to 80 years. For most asset types there is a capex repeat cycle within the 40 years, but for civils we need to manually add in a capex repeat into our extended 80 year profile. For civil repeats we have assumed the original capex will be repeated after 50 years, which will be profiled over 2 years based on 20:80 split.

5.4.5 Capex depreciation

To calculate financing costs as a stream of annual costs over the life of the option, we have followed an approach based on the Regulated Capital Value and Net Book Value (NBV) of capital assets. The guidance states the full NBV of an asset is included at the start of the first year and then reduced incrementally by a constant amount in each subsequent year to zero as its value depreciates, giving an annual "net capital value".

The C55 reports profiles the original capex over 3 or 4 years (depending on the scale and type of investment). The first 1 or 2 years cover planning, design and procurement, with the assets being installed within year 3 and operational 6 months into year 4. For this reason, the capex repeat periods are relative to year 3 rather than the start of the period e.g. For instrumentation and control (7 year asset life) with an option with a 4 year capex profile, the capex repeats will start in year 10 and continue into year 11, see Table 12.

Table 12 Extract from C55 Lifecycle report

Account Types 2	Account Types 3	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
CAPEX	C01 - Studies / Models	£18,089	£49,799	£80,405	£46,199							
CAPEX	C04 - Civils	£3,075,738	£8,438,299	£13,430,073	£7,539,406							
CAPEX	C05 - Sewers and Mains	£6,069,721	£16,397,278	£24,382,813	£12,100,122							
CAPEX	C06 - Mech & Elec	£1,925,178	£5,207,990	£7,793,073	£3,915,711							
CAPEX	C07 - Instrument and Control	£72,510	£19,9172	£318,614	£180,365							
CAPEX_REPEAT	C01 - Studies / Models - Repeat											
CAPEX_REPEAT	C04 - Civils - Repeat											
CAPEX_REPEAT	C05 - Sewers and Mains - Repeat											
CAPEX_REPEAT	C06 - Mech & Elec - Repeat											
CAPEX_REPEAT	C07 - Instrument and Control - Repeat										£131,909	£577,763

For the RVC calculation we have summed the capex for Years 1,2 and 3 for each asset type and then depreciated them using the relevant rate from Year 3. Capex for Year 4 is depreciated from this date. Studies/models expenditure has not been depreciated or included in the financing costs calculation.

For example, the Instrumentation and control capex will be simplified as shown in Table 13 below.

Table 13 Simplified capex profile to be used in financing cost calculation

	Units (£)	Year 1	Year 2	Year 3	Year 4	Year 5	
Original Capex Profile		72,510	199,172	318,615	180,365	0	
Capex to be depreciated from Year 3				590,297			
Capex to be depreciated from Year 4					180,365		

The capex in Year 3 will be depreciated over 7 years and in Year 10 £131,909 (see Table 14) will be reinvested and the depreciation cycle renews. For capex in Year 4 this will be depreciated until Year 11 when £577,763 (see Table 14) will be reinvested and the depreciation cycle renews.

Table 14 Example of financing costs for instrumentation and control

		Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 12
Capex to be depreciated from Year 3	RCV at start of year	590,297	505,969	421,641	337,313	252,985	168,656	84,328	131,909	113,065	94,221	75,377
	Depreciation	84,328	84,328	84,328	84,328	84,328	84,328	84,328	18,844	18,844	18,844	18,844
	RCV at end of year	505,969	421,641	337,313	252,985	168,656	84,328	-	113,065	94221	75377	56532
	Mid-year RCV	548,133	463,805	379,477	295,149	210,820	126,492	42,164	122,487	103,643	84,799	65,955
	Financing cost	**101,430**	**98,799**	**96,168**	**93,537**	**90,906**	**88,275**	**85,644**	**22,666**	**22,078**	**21,490**	**20,902**
Capex to be depreciated from Year 4	RCV at start of year		180,365	154,599	128,832	103,066	77,299	51,533	25,766	577,763	495,226	412,688
	Depreciation		25,766	25,766	25,766	25,766	25,766	25,766	25,766	82,538	82,538	82,538
	RCV at end of year		154,599	128,832	103,066	77,299	51,533	25,766	-	495,226	412,688	330,150
	Mid-year RCV		167,482	141,715	115,949	90,183	64,416	38,650	12,883	536,494	453,957	371,419
	Financing cost		**30,992**	**30,188**	**29,384**	**28,580**	**27,776**	**26,972**	**26,168**	**99,276**	**96,701**	**94,126**
	Total financing cost	**101,430**	**129,791**	**126,356**	**122,921**	**119,486**	**116,051**	**112,616**	**48,834**	**121,354**	**118,191**	**115,028**

5.4.6 Financing costs

To calculate the annual financing costs we have applied the WACC to the mid-year RCV and added on the depreciation.

We have used a WACC of 3.12% which is the CPIH deflated real allowed return for the wholesale business from the CMA redetermination[14].

Table 15, has an example of the financing calculation for Instrumentation and control starting in Year 3. The example only shows the calculation to Year 12, but for the WRMP24 the calculation in over 80 years.

For the total financing cost profile we added the financing costs from all the asset types, see Table 15.

For EBSD we need to convert the cost into an annual average cost for each option. To do this we have averaged the costs over 78 years[15].

Table 15 Example of total financing costs for all Account types

Financing Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
C07 - Instrument and Control	-	-	101,430	129,791	126,356	122,921	119,486	116,051	112,616	48,834	121,354	118,191
C06 - Mech & Elec Year			1,445,258	1,793,357	1,754,166	1,714,975	1,675,783	1,636,592	1,597,401	1,558,209	1,519,018	1,479,827
C05 - Sewers and Mains			1,692,309	2,122,081	2,112,885	2,103,689	2,094,492	2,085,296	2,076,100	2,066,904	2,057,708	2,048,511
C04 - Civils Year			1,269,356	1,637,456	1,617,186	1,596,917	1,576,647	1,556,377	1,536,108	1,515,838	1,495,568	1,475,298
TOTAL	**0**	**0**	**4,508,353**	**5,682,685**	**5,610,593**	**5,538,501**	**5,466,409**	**5,394,316**	**5,322,224**	**5,189,785**	**5,193,648**	**5,121,828**

14 Page 35, Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations Final report. 17 March 2021

15 As we deduct two years, attributing them as pure investment years.

5.5 Implementation periods

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 16.

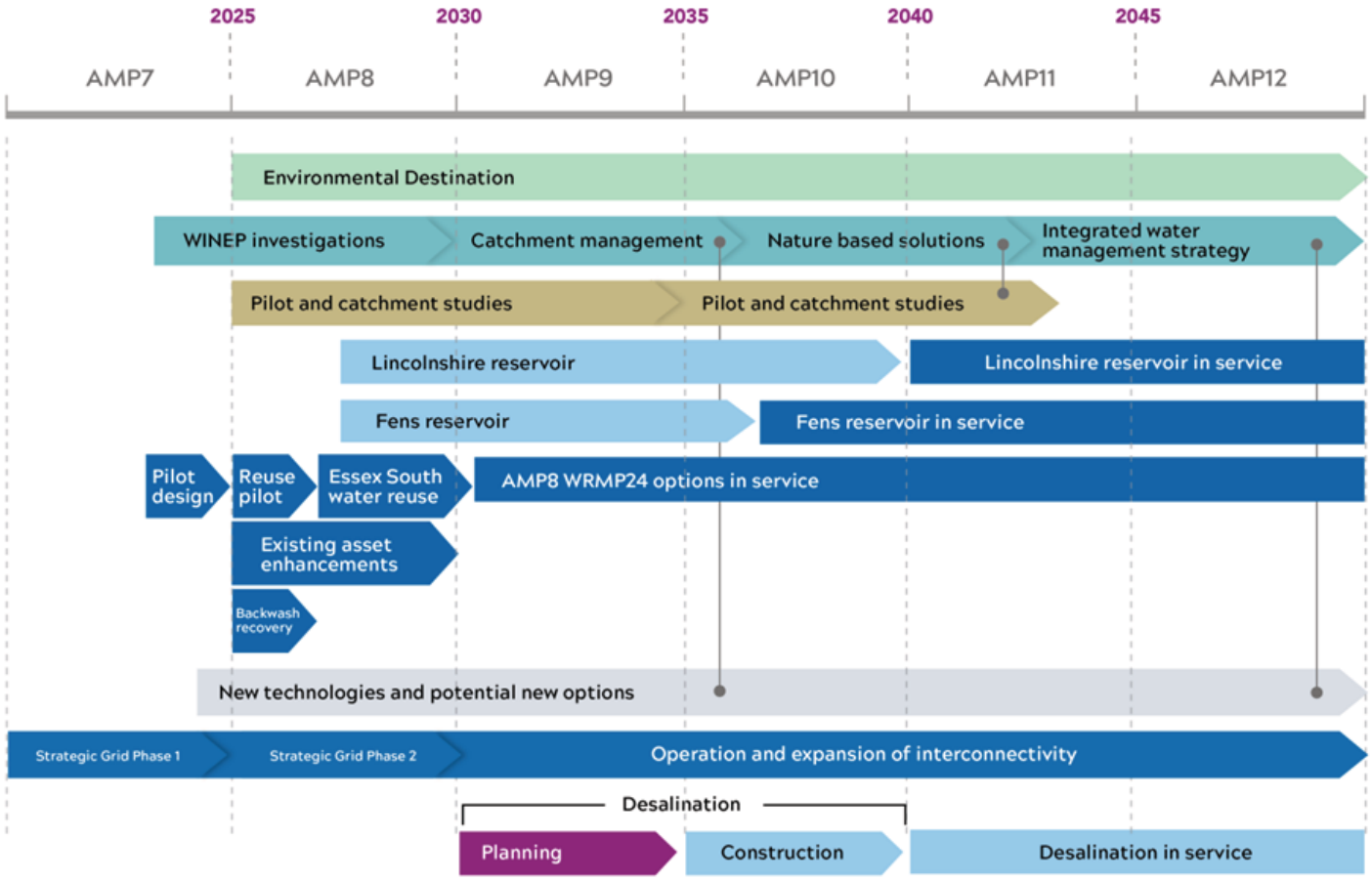
Table 16 Feasible option implementation periods

Option Type	Time to investigate, plan, design and implement option (years)	Earliest start date	Notes
Desalination	7-10	2032-2035	It has been assumed that design and construction of the treatment process could be completed within 4 years but several years of planning, testing and stakeholder engagement would be required.
Potable Water Transfer	3-5	2028-2030	Due to the planning, enabling works, environmental issues, large number of land owners and procurement these transfers have been assumed to be deliverable within 3-5 years depending on the complexity and length of the pipeline.
New Reservoir	13+	2036-2046	As most of the reservoirs options are >30Mm^3 they are considered as Nationally Significant Infrastructure Projects[a] (NSIPs) and would be subject to the Development Consent Order (DCO) process that accelerates the planning process.
Water Reuse for potable water use	7-10	2032-2035	It has been assumed that the design and construction of the treatment could be completed within 4 to 5 years but several years of planning, testing and stakeholder engagement would be required.
Water reuse for non-potable use	7-10	2032-2035	It has been assumed that the design and construction of the treatment could be completed within 4 to 5 years but several years of planning, testing and stakeholder engagement would be required.
Conjunctive use with treatment	5	2030	Planning and licence trade negotiations would take 2-3 years followed by 2 years construction and commissioning.
Aquifer Recharge	7	2032	Complex planning and permitting issues and includes time to recharge the Aquifer.
Backwash recovery	2-5	2027-2030	These schemes are within our existing sites, often needing only modification to existing assets. As a result there is minimal planning effort and short delivery timescales.
Enhancements to existing treatment	2-5	2027-2030	These schemes can range in scale but generally require only moderate planning effort (less than 12 months) and delivery timescales are relatively short.

a Planning Act 2008

Figure 28 shows a timeline of delivery of options.

Figure 28 Timeline of delivery options



It helps illustrate when resource is available and in service. It also shows how our strategy doesn't make all future resource options a certainty. The outcome of WINEP investigations, implementation of catchment management options through WRE and the future potential to develop nature based solutions means our option set is diverse, adaptable and sustainable.

5.6 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 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.

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 versus developing new resources.

5.7 Option resilience to climate change

Options in our preferred plan have been tested to ensure they are resilient to climate change and environmental destination scenarios. We will briefly discuss this approach for groundwater and surface water options. Further information is available on our approaches to sustainable abstraction in our WRMP24 Sustainable abstraction and environment technical supporting document, with further information on climate change modelling available in the WRMP24 Supply forecasting technical supporting documents.

5.7.1 Groundwater options

We have developed LNE11 - North Lincolnshire groundwater - by working closely with the Environment Agency. Through this engagement, we have been able to agree the following modelling outcomes which has formed the basis of the revised abstraction licences:

This means that, in all scenarios, we can maintain abstractions at the levels required for the North Lincolnshire Alternative solution.

For option SWC13, the results of groundwater modelling in 2022 show that transferring abstraction from Wixoe (current location) to the new source at Kedington and a relocated Wixoe Borehole causes the Bumpstead Brook waterbody to become compliant at recent actual abstraction levels. This improvement in low flows on Bumpstead Brook comes with no risk of deterioration to other surface water bodies or protected sites.

Having discussed the option with the Environment Agency we acknowledge that the policy regarding protection of headwaters may change and have an impact on the long term availability of this option, however, we have reached a mutual conclusion that the proposed new location 'Site 2' is the best of those modelled and the site that will be developed on selection of this option.

A trial conducted in 2022 demonstrated sustainable abstraction can be achieved from our Raydon source, however, it is anticipated that there will be long term monitoring required, river support will take priority over abstraction for public water supply and that there may be further conditions applied to the licence. This is option SUE23.

5.7.2 Surface water abstractions

In some cases, WRMP options have been modelled in AQUATOR, where the DO benefit is unclear from simpler methods of assessment.

An example of this is the Strategic Resource Options (SROs) known as the Lincolnshire Reservoir and Fens Reservoir. These options have been assessed with different sized capacities, different combinations of possible sources of supply and under different hydrological scenarios

- 1 in 500 year drought and median climate change
- 1 in 500 year drought and low climate change
- 1 in 500 year drought and high climate change

The results are shown below in Table 17.

Table 17 AQUATOR modelled reservoir yields in different hydrological scenarios

		AQUATOR Option Benefit (Ml/d)		AQUATOR Option Benefit (Ml/d)		AQUATOR Option Benefit (Ml/d)	
Option Ref	Option name	1in200yr High CC	1in500yr High CC	1in200yr Mid CC	1in500yr Mid CC	1in200yr Low CC	1in500yr Low CC
RTN17	Lincolnshire reservoir	195.0	144.0	207.0	169.0	206.0	184.0
FND19	Fens reservoir	81.0	55.0	100.0	64.0	112.0	72.0

These values are illustrative only, taken from a set of model output using the lowest yields from the fewest available abstraction sources. The values used for EBSD are shown in Section 6.

Other options modelled in AQUATOR are shown below in Table 18. We have included Colchester reuse here as a surface water abstraction as it effectively behaves as one in that its input into Ardleigh reservoir effects the reservoir yield. It is not a simple correlation to the option capacity.

Table 18 Aquator modelled option yields in different hydrological scenarios

		AQUATOR Option Benefit (Ml/d)		AQUATOR Option Benefit (Ml/d)		AQUATOR Option Benefit (Ml/d)	
Option Ref	Option name	1in200yr High CC	1in500yr High CC	1in200yr Mid CC	1in500yr Mid CC	1in200yr Low CC	1in500yr Low CC
EXS19	Colchester direct to Ardleigh Reservoir	13.8	10.6	11.4	13.9	16.2	7.7
FND22	Fenland surface water abstraction relocation	11.5	11.5	7.9	12.3	7.3	11.5
LNE12	Lincolnshire East Surface Water enhancement	12.7	2.3	13.0	7.3	13.1	12.4
RTS21	Ruthamford South surface water enhancement	9.6	4.4	9.5	6.0	0.0	10.9
LNC30	Lincolnshire central surface water enhancement	6.7	8.8	3.2	7.2	3.2	3.2

5.8 Strategic Resource Options (SRO)

As part of the RAPID process, a dedicated project team has refined the WRMP19 option, refining the sources of water, the treatment needed and the preferred location for the reservoirs. Water resources planning processes have determined that both reservoirs should be 55 million cubic metre raw water storage reservoirs, with 50 million cubic metres of usable water. The need for them, and consequently their size, has been determined through regional and company planning processes. A brief overview of this is provided below:

- A multi-objective robust decision making process was undertaken by WRE to ascertain the needs of its region. New supply-side options from all WRE water companies were tested against differing hydrological, demand and environmental scenarios, with stakeholder input shaping the best value metrics to be applied to the portfolios generated. Through this process, the Fens and Lincolnshire reservoirs were determined to be low regret regional options.
- An independent national model, the Water Resources of England and Wales water resources model, identified the need for and value of both the Lincolnshire and Fens reservoirs. This modelling also confirmed that both reservoirs are resilient against uncertainty in supply and demand over the long-term.
- Our WRMP24 modelling confirmed the need for the reservoirs with unconstrained model runs selecting both reservoirs. We also found that the reservoirs satisfied more objectives on our best value planning framework than feasible alternatives, such as desalination or water reuse.

6 Options by Water Resource Zone

In the following section we'll describe our options in more detail. Where applicable[16] it will take the following structure:

- Resource zone - ordered alphabetically.
- Table of constrained options
- New resource option details
- - Overview
  - Schematic
  - Technical summary
  - Option summary table
  - Cost summary
- Table of transfer options
- Table of option costs
- Feasible options not modelled

16 Not all sections are relevant to all resource zones.

6.1 Cambridge WRZ

6.1.1 Constrained options

Cambridge Water co. is geographically between two of our WRZs, Ruthamford South and Cambridge and West Suffolk. We have developed a set of transfer options that can be mutually beneficial to us and Cambridge Water, so we have included Cambridge Water WRZ in this section to describe the options.

6.1.2 Transfer options

Table 19 Cambridge WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
CAM1	Potable water transfer	10	0.75	West Suffolk & Cams to Cambridge Water Co potable transfer (10 Ml/d)	31	327
CAM2	Potable water transfer	10	1.19	Ruthamford South to Cambridge Water potable transfer (10 Ml/d)	39	368
CAM3	Potable water transfer	20	2.20	Ruthamford South to Cambridge Water potable transfer (20 Ml/d)	39	500
CAM4	Potable water transfer	50	4.31	Ruthamford South to Cambridge Water potable transfer (50 Ml/d)	21	900
CAM5	Potable water transfer	20	1.47	Suffolk West & Cambs to Cambridge Water Co potable transfer (20 Ml/d)	31	458
CAM6	Potable water transfer	50	3.44	Suffolk West & Cambs to Cambridge Water Co (50 Ml/d)	31	700

Figure 29 illustrates how the transfers can interact. The overall transfer is from Ruthamford South WRZ to West Suffolk and Cambridgeshire WRZ. However, through discussions with Cambridge Water Co. we have been able to develop the option in a way that is beneficial to both companies by creating a 'drop-off node' along the route. Additionally, by developing the option in this way it enables the company EBSD models or the WRE regional model to select any section of the transfer in reverse. Options of 10, 20 and 50 Ml/d have been developed in both directions. The combination of these available options gave flexibility for the modelling to provide the best value overall option.

Figure 29 Illustration of how the Anglian Cambridge transfer options interact

Option ID	Option name	Max capacity (Ml/d)
RTS10	Transfer from Cambridge Water to Ruthamford South	10
RTS14	Transfer from Cambridge Water to Ruthamford South	20
RTS15	Transfer from Cambridge Water to Ruthamford South	50

Option ID	Option name	Max capacity (Ml/d)
CAM1	Transfer from Cambs & West Suffolk to Cambridge Water	10
CAM5	Transfer from Cambs & West Suffolk to Cambridge Water	20
CAM6	Transfer from Cambs & West Suffolk to Cambridge Water	50

Option ID	Option name	Max capacity (Ml/d)
CAM2	Transfer from Ruthamford South Cambridge Water	10
CAM3	Transfer from Ruthamford South Cambridge Water	20
CAM4	Transfer from Ruthamford South Cambridge Water	50

Option ID	Option name	Max capacity (Ml/d)
SWC1	Transfer from Cambridge Water Co to Cambs & West Suffolk	10
SWC7	Transfer from Cambridge Water Co to Cambs & West Suffolk	20
SWC8	Transfer from Cambridge Water Co to Cambs & West Suffolk	50

6.1.3 Option costs

Table 20 Cambridge WRZ option costs

Option ID	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual OPEX (£k)	Capital Carbon (tCO2e)	Operational Carbon (tCO2e)
CAM1	10	West Suffolk & Cams to Cambridge Water Co potable transfer (10 Ml/d)	31,590.85	114.47	6,007	416
CAM2	10	Ruthamford South to Cambridge Water potable transfer (10 Ml/d)	64,968.25	135.36	9,325	473
CAM3	20	Ruthamford South to Cambridge Water potable transfer (20 Ml/d)	138,259.37	252.12	17,086	872
CAM4	50	Ruthamford South to Cambridge Water potable transfer (50 Ml/d)	77,381.38	459.38	16,957	585
CAM5	20	Suffolk West & Cambs to Cambridge Water Co potable transfer (20 Ml/d)	44,790.19	138.47	9,857	500
CAM6	50	Suffolk West & Cambs to Cambridge Water Co (50 Ml/d)	74,960.55	271.92	13,030	994

6.2 Essex Central

6.2.1 Transfer options

Table 21 Essex Central WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
EXC15	Potable water transfer	10	2.61	Suffolk West & Cambs to Essex Central potable transfer (10 Ml/d)	48	494
EXC3	Potable water transfer	10	0.29	Essex South to Essex Central potable transfer (10 Ml/d)	8	409
EXC5	Potable water transfer	10	0.37	Suffolk West & Cambs to Essex Central potable transfer (10 Ml/d)	10	409

6.2.2 Option costs

Table 22 Essex Central WRZ option costs

Option ID	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual OPEX (£k)	Carbon (tCO2e)	Carbon (tCO2e)
EXC15	10	Suffolk West & Cambs to Essex Central potable transfer (10 Ml/d)	89,331	97	11,389	105
EXC3	10	Essex South to Essex Central potable transfer (10 Ml/d)	9,597	43	2,382	53
EXC5	10	Suffolk West & Cambs to Essex Central potable transfer (10 Ml/d)	13,999	42	2,827	150

6.2.3 Feasible options not modelled

Table 23 Essex Central WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
EXC1	Potable water transfer	Cambs & West Suffolk to Essex Central potable transfer (5 Ml/d)	Yes	Not preferred route
EXC13	Potable water transfer	Essex Central to Essex Central potable transfer (10 Ml/d)	Yes	Intra WRZ
EXC14	Potable water transfer	Essex Central to Essex Central potable transfer (10 Ml/d)	Yes	Intra WRZ
EXC16	Potable water transfer	Essex Central to Essex Central potable transfer (10 Ml/d)	Yes	Intra WRZ
EXC2	Potable water transfer	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	Yes	Not preferred route
EXC4	Potable water transfer	Essex Central to Essex Central potable transfer (10 Ml/d)	Yes	Intra WRZ
EXC6	Potable water transfer	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	Yes	Not preferred route

6.3 Essex South

6.3.1 Constrained options

Table 24 Essex South WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
EXS7	Backwash water recovery	0.3	Essex South WTW Backwash water recovery	Yes	Yes
EXS8	Sea tankering	4.2	Sea Tankering BAU	Yes	Yes
EXS10	Desalination	26	Holland on Sea desalination (seawater) 25 Ml/d	Yes	Yes
EXS11	Desalination	50	Holland on Sea desalination (seawater) 50 Ml/d	Yes	Yes
EXS12	Desalination	100	Holland on Sea desalination (seawater) 100 Ml/d	Yes	Yes
EXS23	Sea tankering	11.4	Sea Tankering drought	Yes	Yes
EXS19	Reuse	11.4	Colchester direct to Ardleigh Reservoir (no additional treatment)	Yes	Yes
EXS3	Reuse	6.7	Clacton-Holland Haven to Ardleigh Reservoir with additional treatment at Ardleigh)	Yes	Yes
EXS4	Reuse	3	Clacton-Holland Haven to Ardleigh Reservoir (no additional treatment at Ardleigh)	Yes	Yes

6.3.2 EXS10, EXS11 and EXS12 Holland on Sea desalination

Seawater would be abstracted from the North Sea off the coast of the Tendring peninsula in Essex. From an intake chamber located onshore the seawater would pass through screens to exclude course material and be pumped to a desalination plant. Details of the process of desalination can be found in the desalination appendix of this report. Following desalination and condition the water would be pumped to an existing reservoir in Essex South WRZ for blending and distribution into our existing network.

Feasibility studies demonstrate that up to 100 Ml/d of water is available for desalination from this source.

Figure 30 Schematic of Holland on Sea desalination

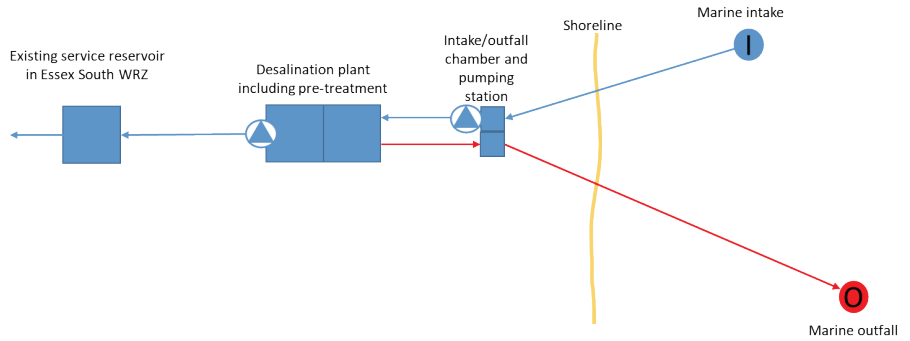


Table 25 Option summary for Holland on Sea desalination

Attribute	Description
Water source	North Sea.
Deployable Output	Assessed at 25, 50 and 100 Ml/d.
Water Quality	Expected feed water quality and treatment performance outlined in Table 26. Discharge - modelling will be required to assess the full impact of the discharge plume.
Benefit	Desalination options are not impacted by supply forecast scenarios, so WAFU is equal to deployable output.
Delivery timescale	Delivery could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032.

Table 26 Expected treatment performance for Holland on Sea desalination

Parameter	Feed (mg/l)	Screening and clarification (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Solids	150	32	2	0.08
Dissolved solids	35000	35000	35000	192

6.3.3 EXS2, EXS19 and EXS22 Colchester reuse

EXS2, EXS19 and EXS22[17] are water reuse options for potable supply. Final treated water effluent from Colchester currently discharges into the river Colne. This option would intercept the effluent before discharge and divert to an advanced treatment process. From here the water could be transferred to Ardleigh reservoir for abstraction and treatment at the existing Ardleigh WTW.

Option EXS2 assumes the full benefit of the reuse scheme to be available to Anglian Water in a drought-only scenario, whereas Option EXS19 assumes the full benefit of the reuse scheme will be available to Anglian Water and Affinity will receive up to a fixed export, based on 50% of the reservoir yield in 2025.

Figure 31 Option summary for Colchester water reuse

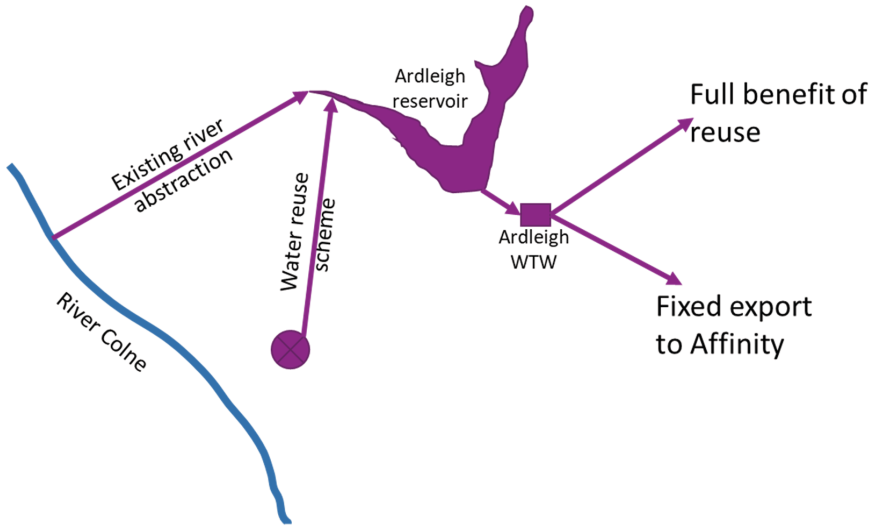


Table 27 Option summary for Colchester water reuse

Attribute	Description
Water source	Colchester via Ardleigh reservoir
Deployable Output	Colchester has a CDWF of 29,284 m3. Recent actual flows show reliable volumes in excess of 20 Ml/d are available. The treatment capacity of this option is 15.2 Ml/d. This can yield different WAFU benefits depending on the scenario in which it is considered.
Water quality	Feed water quality and expected treatment performance is shown in Table 29.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (River Colne) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	EXS19 - WAFU benefit in AWS Essex South WRZ is 11.4 Ml/d EXS2 - WAFU benefit in AWS Essex South WRZ is 4.2 Ml/d EXS22 - WAFU benefit in AWS Essex South WRZ is 5.7 Ml/d
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

17 Option EXS22 assumes a 50:50 share of the WAFU between Anglian Water and Affinity Water; this was discounted at a regional and company level.

Figure 32 EXS2 and EXS19 Colchester water reuse option schematic

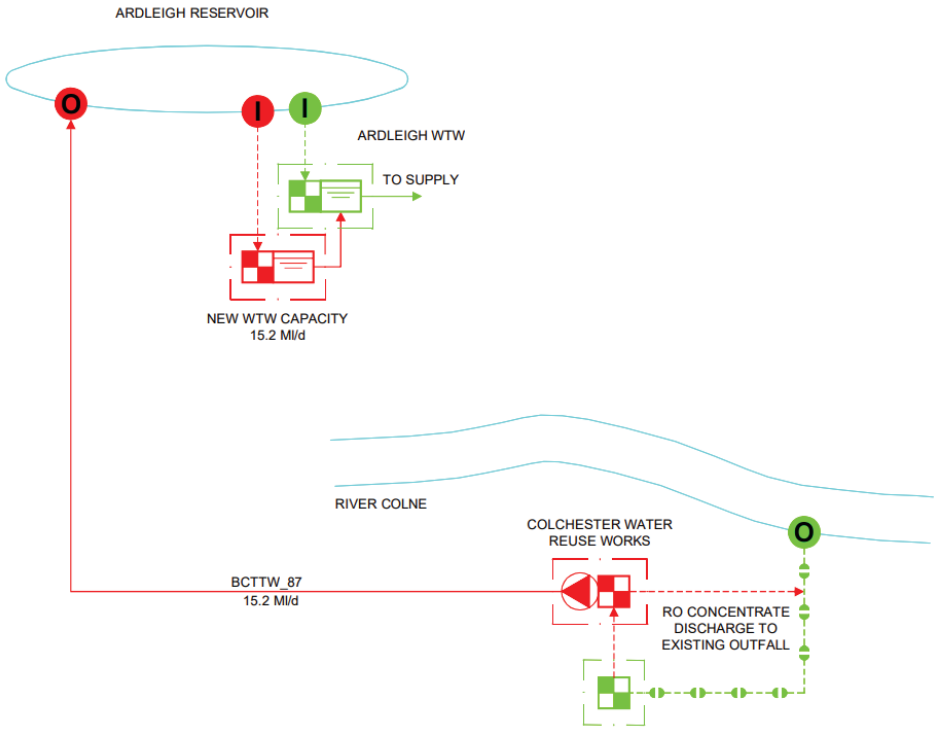


Figure 33 Recent actual flow at Colchester WRC

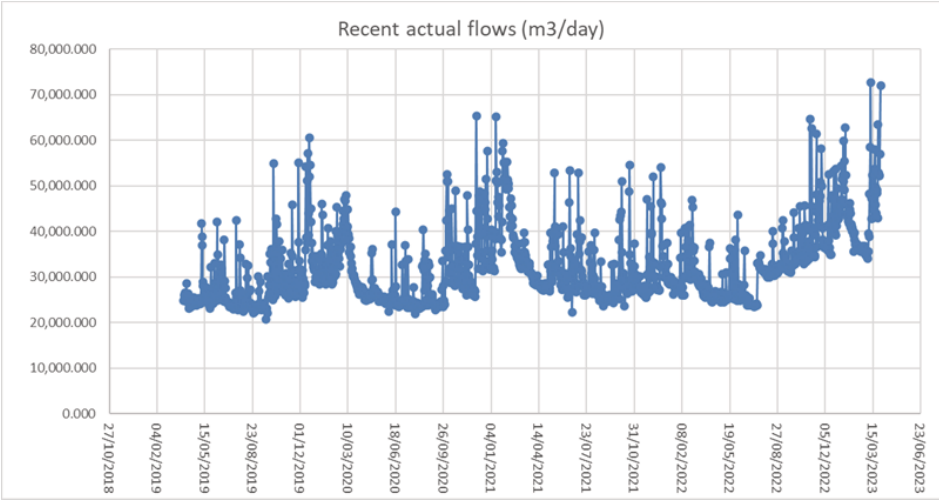


Table 28 Cost benefit summary of the Colchester water reuse options

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
EXS19	138,995	7,145	11.4	2032	Essex South
EXS2	56,962	7,128	4.2	2032	Essex South
EXS22	152,725	8,655	5.7	2032	Essex South

Table 29 Expected treatment performance for Colchester water reuse

Consideration	Feed (mg/l)	Nitrifying BAF (mg/l)	Denitrifying BAF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids (mg/l)	62	37	18	0.92	0.02
Ammonia	50	4.96	4.96	0.99	0.99
Nitrate	10	55	4.7	0.09	0.09
Phosphate	6.6	3.3	1.65	0.02	0.02
Sodium	100	100	100	100	2
Chloride	491	491	491	491	9.82

Colchester water reuse and the Advanced Infrastructure Delivery programme

We have had a bid for Advanced Infrastructure Delivery funding for two key elements of the Colchester reuse scheme approved. This will enable earlier delivery of the overall project and provide greater drought resilience. The two elements that are to be progressed though this mechanism are; a Demonstration Centre and the transfer pipeline to take water from the Water Recycling Centre to Ardleigh reservoir.

We have started work on the development of what we would like to call a Demonstration Centre (previously referred to as 'pilot'). We feel that demonstration centre better reflects what we hope to achieve.

A team has been set up to manage the delivery of the projects and in parallel we have a working group to ensure that throughout delivery we maintain focus on the deliverables and required outputs from the project.

There are various strands to the delivery but it has been split into two main focus areas so that the sub-section elements can be worked on in parallel:

- Transfer main:
  - Route planning
  - Planning applications
  - Stakeholder engagement (main laying)
- Demonstration Centre:
  - Treatability study
  - Plant design
  - Discharge management
  - Customer engagement

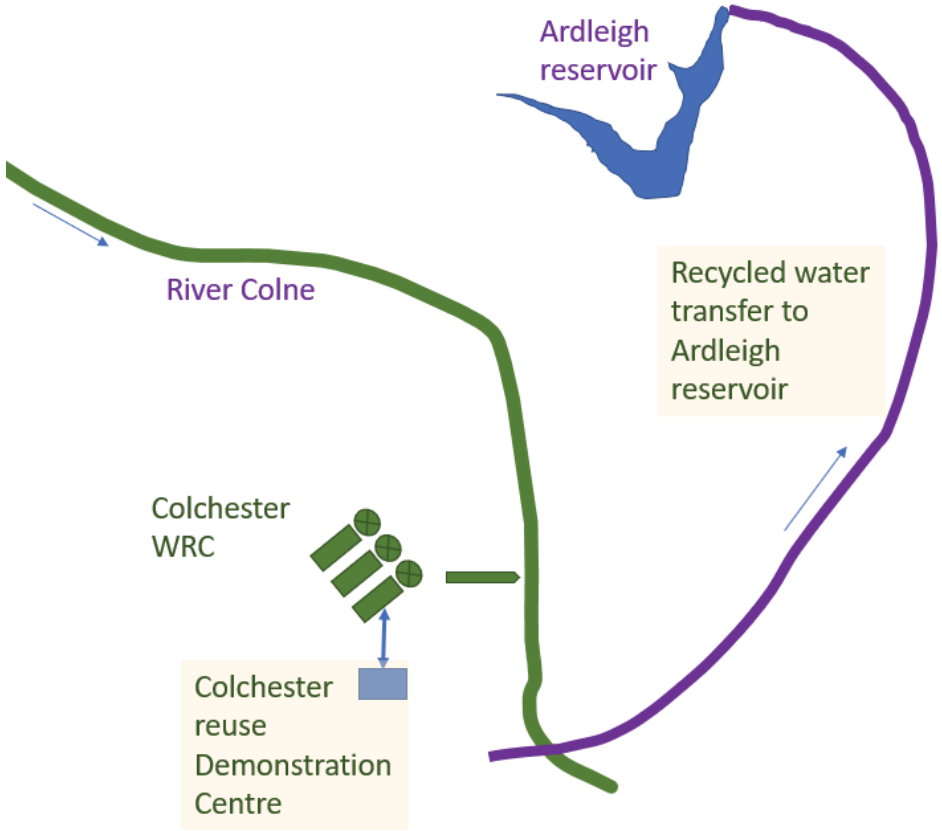
There are some common themes that will be worked on together, such as some of the environmental monitoring and modelling activities as these will impact both delivery elements. For example, reservoir and quality modelling will determine the the transfer route as well as the operation of the Demonstration Centre.

The main objectives of the Demonstration Centre will be; gathering performance data over a prolonged period (12 months or more) to demonstrate that the yield per unit of feed water is as expected. Gathering a bank of water quality data to to provide assurance to stakeholders and customers that Advanced Water Recycling represents a safe, wholesome, sustainable source of water.

Water from the Centre can also be utilised to provide a WAFU benefit during its demonstration phase. By using this for internal processes that currently use a potable supply we can offset at least 0.5 Ml/d in our Essex South WRZ.

The transfer pipeline will provide part of an emergency drought solution during the construction phase of the main Advanced Water Recycling plant. Once in place, we could install temporary treatment at Colchester WRC and use the transfer pipeline to move resource to the reservoir, if it were required. Figure 34 shows the elements in AID.

Figure 34 The elements of Colchester water reuse in AID



6.3.4 EXS3 and EXS4 Clacton on Sea reuse

EXS3 and EXS4 are water reuse options for potable supply. Final treated water effluent from Clacton WRC currently discharges into the North Sea. This option would intercept effluent before discharge and divert to an advanced treatment process. From here the water could be transferred to Ardleigh reservoir for abstraction and treatment at the existing Ardleigh WTW.

EXS3 would provide a benefit in WAFU of 6.7 Ml/d in the Essex South WRZ. The same assumptions about utilisation split between Anglian Water and Affinity Water would be made as in EXS19.

EXS4, like EXS2, is a drought only option and therefore has a WAFU benefit of 3 Ml/d.

Table 30 Option summary for Clacton on Sea water reuse

Attribute	Description
Water source	Clacton WRC via Ardleigh reservoir.
Deployable Output	Treatment capacity of the reuse option is 6.7 Ml/d. Minimal effluent required for discharge dilution as outfall is to sea.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (North Sea) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	EXS3 - WAFU benefit in Essex South WRZ would be 6.1 Ml/d. EXS4 - WAFU benefit in Essex South WRZ would be 3 Ml/d.
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

Figure 35 EXS3 and EXS4 Clacton on Sea water reuse option schematic

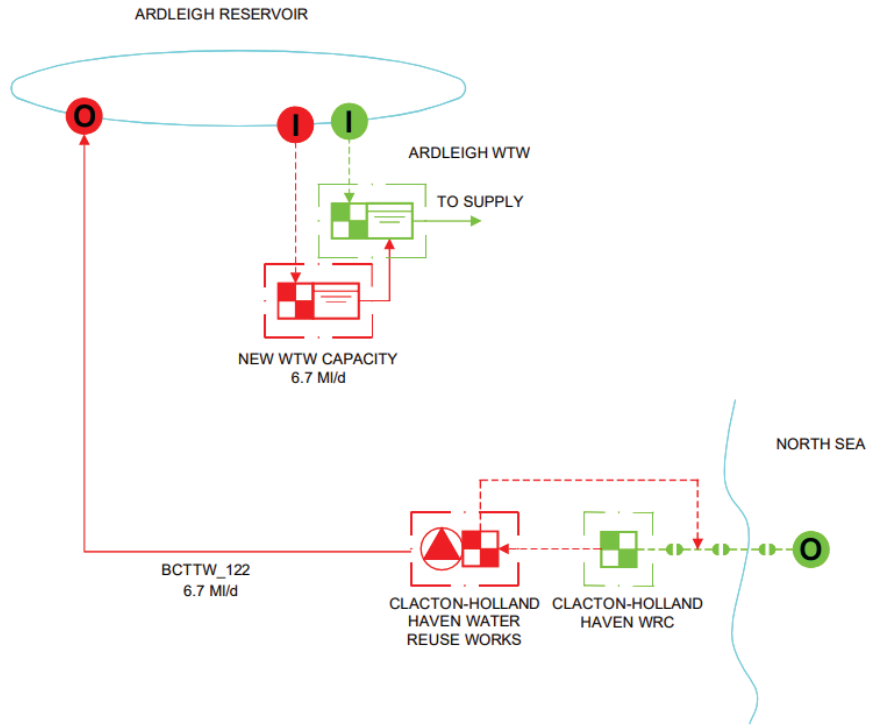


Table 31 Cost benefit summary for Clacton on Sea water reuse options

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
EXS3	£119,071	£4,145	6.7	2032	Essex South
EXS4	£86,534	£4,168	3	2032	Essex South

Figure 36 Recent actual flow for Clacton on Sea water recycling centre

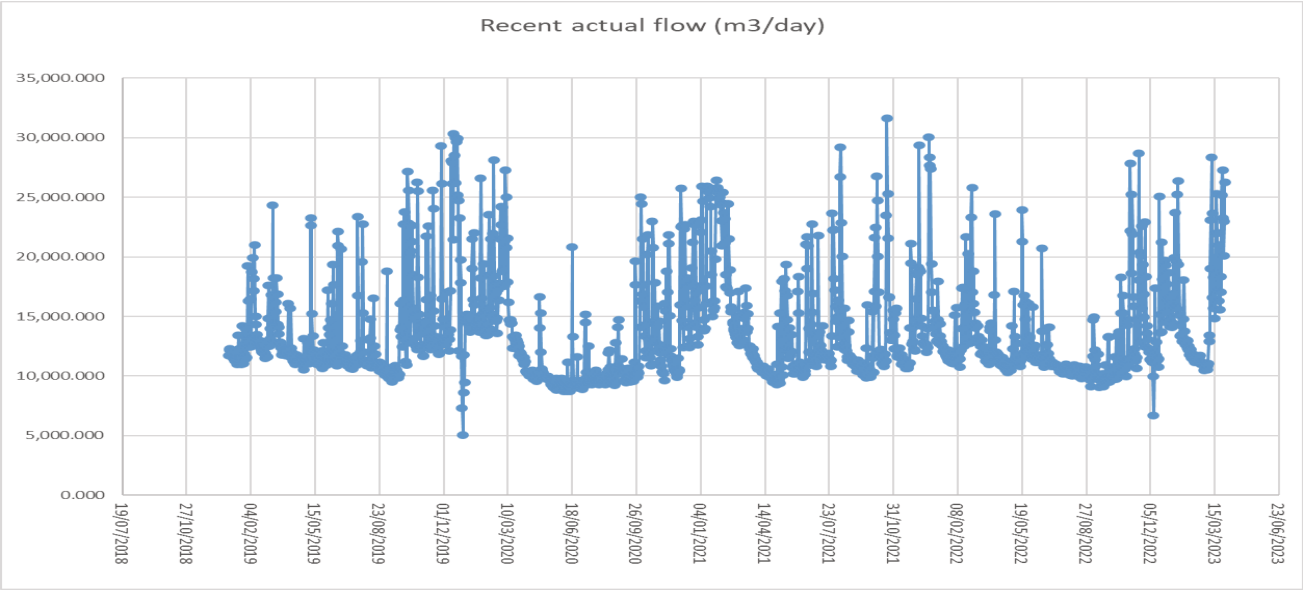


Table 32 Expected treatment performance for Clacton on Sea water reuse

Consideration	Feed (mg/l)	Nitrifying BAF (mg/l)	Denitrifying BAF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids (mg/l)	250	131	65	3.27	0.07
Ammonia	42	4.18	4.18	4.18	0.84
Nitrate	18	56	4.7	4.7	0.09
Phosphate	10	5.15	2.57	1.35	0.03
Sodium	100	100	100	100	2
Chloride	200	200	200	200	3.97

6.3.5 Transfer options

Table 33 Essex South WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
EXS16	Potable water transfer	10	0.80	East Suffolk to Essex Central potable transfer (10 Ml/d)	26	368
EXS17	Potable water transfer	20	1.48	East Suffolk to Essex Central potable transfer (20 Ml/d)	26	500
EXS18	Potable water transfer	10	2.33	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	16	352
EXS9	Potable water transfer	10	0.15	Essex South to Essex Central potable transfer (10 Ml/d)	8	290

6.3.6 Option costs

Table 34 Essex South WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats units (required restoration)	BNG cost (£k)
EXS7	Backwash water recovery	0.3	Essex South WTW Backwash water recovery	277.67	-	142	-	-	-
EXS10	Desalination	26	Holland on Sea desalination (seawater) 25 Ml/d	394,661.52	12,876.48	53,185	6,749	32	1,318
EXS11	Desalination	50	Holland on Sea desalination (seawater) 50 Ml/d	677,504.42	24,557.03	67,258	13,497	32	1,318
EXS12	Desalination	100	Holland on Sea desalination (seawater) 100 Ml/d	1,106,883.10	25,820.11	86,265	26,995	32	1,318

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats units (required restoration)	BNG cost (£k)
EXS16	Potable water transfer	10	East Suffolk to Essex Central potable transfer (10 Ml/d)	32,167.98	106.33	6,010	384	-	-
EXS17	Potable water transfer	20	East Suffolk to Essex Central potable transfer (20 Ml/d)	51,746.52	196.57	11,925	719	-	-
EXS18	Potable water transfer	10	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	41,154.95	81.10	5,243	96	-	-
EXS21	Drought permit	0	Ardleigh drought permit	500.00	20.00	-	-	-	-
EXS19	Reuse	11.4	Colchester WRC direct to Ardleigh Reservoir (no additional treatment)	138,995.01	7,145.42	14,713	271	29	921
EXS22	Reuse	5.7	Colchester WRC direct to Ardleigh Reservoir 50:50	56,962.00	7,128.45	-	-	29	921
EXS2	Reuse	4.2	Colchester WRC direct to Ardleigh Reservoir (no additional treatment)	152,724.93	8,654.76	14,997	271	29	921
EXS3	Reuse	6.7	Clacton-Holland Haven to Ardleigh Reservoir with additional treatment at Ardleigh)	119,070.58	4,145.06	21,804	278	16	620
EXS4	Reuse	3	Clacton-Holland Haven to Ardleigh Reservoir (no additional treatment at Ardleigh)	86,534.28	4,167.80	14,125	278	16	620
EXS23	Sea tankering	11.4	Sea Tankering BAU	83,283.16	99,135.68	26,434	1,042	-	-
EXS8	Sea tankering	4.2	Harwich Sea Tankering	81,617.37	35,493.07	26,434	1,042	-	-
EXS9	Potable water transfer	10	Essex South to Essex Central potable transfer (10 Ml/d)	9,517.82	88.82	1,779	334	-	-

6.3.7 Feasible options not modelled

Table 35 Essex South WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
EXS13	Desalination	Holland on Sea floating desalination (seawater) 25 Ml/d	Yes	Offshore desalination rejected
EXS14	Desalination	Holland on Sea floating desalination (seawater) 50 Ml/d	Yes	Offshore desalination rejected
EXS15	Desalination	Holland on Sea floating desalination (seawater) 100 Ml/d	Yes	Offshore desalination rejected
EXS1	Reuse	Colchster direct to Ardleigh Reservoir (with additional treatment)	Yes	No benefit to additional treatment
EXS5	Reuse	Colchester to Ardleigh Reservoir via the River Colne (with additional treatment)	Yes	No benefit to additional treatment
EXS6	Reuse	Colchester to Ardleigh Reservoir via the River Colne with no extra treatment	Yes	Additional risks with transfer via river.

6.4 Fenland

6.4.1 Constrained options

Table 36 Fenland WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
FND26	Backwash water recovery	0.24	Fenland WTW Backwash water recovery	Yes	Yes
FND21	New Reservoir	27	Fens reservoir 25 Mm3 Low yield	Yes	Yes
FND23	New Reservoir	38.6	Fens reservoir 50 Mm3 Low yield	Yes	Yes
FND24	New Reservoir	50.1	Fens reservoir 75 Mm3 Low yield	Yes	Yes
FND25	New Reservoir	72.8	Fens reservoir 100 Mm3 Low yield	Yes	Yes
FND28	New Reservoir	33.1	Fens reservoir 25 Mm3 High Yield	Yes	Yes
FND29	New Reservoir	44.4	Fens reservoir 50 Mm3 High Yield	Yes	Yes
FND30	New Reservoir	61.1	Fens reservoir 75 Mm3 High Yield	Yes	Yes
FND31	New Reservoir	80.5	Fens reservoir 100 Mm3 High Yield	Yes	Yes
FND22	New surface water	7.9	Marham abstraction relocation	Yes	Yes
FND1	Reuse	10.3	Kings Lynn to Stoke Ferry via river Wissey (extra treatment at Stoke Ferry WTW)	Yes	Yes
FND3	Reuse	17.4	Kings Lynn and West Walton to Stoke Ferry WTW via the River Wissey - with additional treatment at Stoke Ferry	Yes	Yes

6.4.2 FND21, FND23, FND24, FND25, FND28, FND29, FND30 and FND31- Fens Reservoir

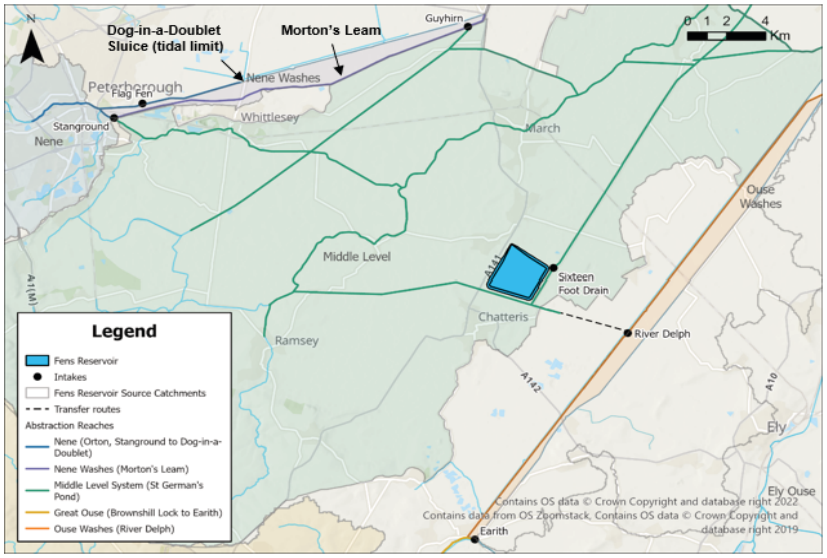
Anglian Water and Cambridge Water[18] are working together to progress the Fens Reservoir, a 55 million cubic metres (MCM) raw water reservoir. with a useable volume of 50 MCM. This is to be situated in the Fenland district of Cambridgeshire.

There are five possible sources of supply to fill Fens Reservoir; these are the:

- **Middle Level**which will provide the primary source of water via the Sixteen Foot Drain (or the Forty Foot Drain) adjacent to the reservoir site, when water is available. If required, due to level constraints, water will be transferred to the Middle Level from the other available sources to the reservoir, described below.
- **River Nene (Stanground)** which feeds the Middle Level at Stanground via the King's Dyke throughout the year. It may be proposed to improve the capacity of this transfer and channel, if required, to enable additional transfer from the River Nene, when water is available.
- **River Great Ouse (Earith)** is being assessed as a transfer option involving either a pipeline to the reservoir or a combination of pipeline and open water transfers to the Middle Level system.
- **Counter Drain (Nene)** is expected to provide a resilient yield to supply the reservoir. The Nene Counter Drain currently discharges to the tidal River Nene, downstream of the Dog-in-a-Doublet. Subject to ongoing assessment of water availability and quality, available water could be discharged into the fluvial Nene and transferred to the reservoir via the connection to the Middle Level.
- **Ouse Washes (River Delph)** is located in close proximity to the reservoir and is regularly flooded with water diverted from the River Great Ouse at Earith. This potential source option involves a proposed transfer from the River Delph at or nearby Welches Dam, and improvements to the Forty Foot Drain to transfer water into the Middle Level system.

The earliest the Fens Reservoir will be in supply is 2036. Once in use, it is expected that the associated water treatment works supply up to 44.4 Ml/d of potable water through new mains to over 125,000 Anglian Water customers in Cambridgeshire and Norfolk via a connection into our network at Bexwell. The remaining 44.4 Ml/d will aid Cambridge Water, reducing abstractions from the sensitive environments in their area.

Figure 37 Proposed locations and transfers



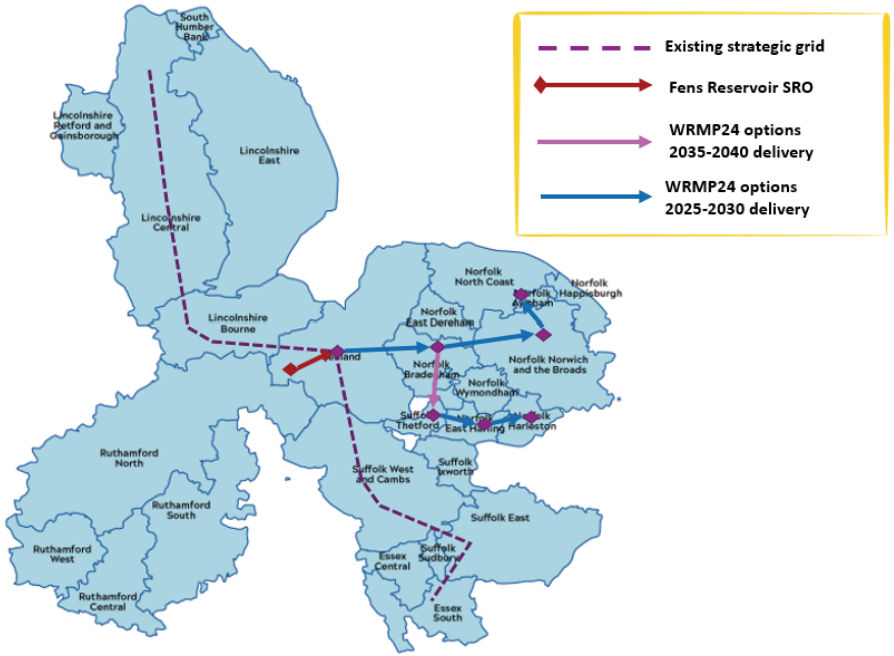
The yield of the reservoir, and therefore deployable output is dependent on its capacity and combination of water sources, as shown in Table 37 below. This table shows the low yield sources modelled (the Gate 2 sources of the Ouse Washes (River Delph) and River Great Ouse (Earith), plus the Middle Level) and the high yield sources (the Middle Level, the River Nene and Counter Drain (Nene)). We will continue to assess and optimise the potential abstractions from these sources throughout RAPID Gate 3 and beyond.

18 To reflect this 50:50 partnership, the costs and benefits for Fens reservoir has been modelled on a proportional basis. This has been based on a 50% share for reservoir options with a total yield of less than 100 Ml/d. For options providing more than 100 Ml/d, it has been agreed that Cambridge Water would require 50 Ml/d with Anglian Water utilising the rest of the yield.

Table 37 Fens Reservoir sizing and yields

Res size in Million metres cubed	Low yield sources		High yield sources	
	Total yield (Ml/d)	Benefit to AW	Total yield (Ml/d)	Benefit to AW
25	54	50%	66.1	50%
50	77.1	50%	88.8	50%
75	100.1	50%	111.1	55%
100	122.8	59%	130.5	62%

Figure 38 Fens Reservoir and network connections



Water will be abstracted from the reservoir and transferred to a new water treatment works. From here the potable water will be transferred to a connection into our distribution network in our Fenland WRZ.

Table 38 Option summary for Fens Reservoir

Attribute	Description
Water source	Water will be abstracted from: · Middle Level · River Nene (Stanground) · Counter Drain (Nene) · Ouse Washes (River Delph) · River Great Ouse (Earith)
Deployable Output	The yield of the reservoir, and therefore deployable output is dependent on its capacity and combination of water sources, as shown in Table 37.
Water Quality	Assessment of raw water quality from the potential abstraction locations is ongoing - this will inform the detailed design of the treatment solution of water from the reservoir.
Benefit	As deployable output, above. The potable water will be connected to our distribution network in the Fenland WRZ. The benefit from the yield of the reservoir is split 50:50 between Anglian Water and Cambridge Water, until all of Cambridge's need has been satisfied, then a greater proportion will go to Anglian Water.
Delivery timescale	This is a large scale project will complex planning consideration but it is anticipated that water will become available in 2036.

The difference in split of yield between the different size options is also reflected in the costs. Anglian Water will pay for the additional capacity in treatment and transfer, above the requirements of Cambridge Water, that the yield affords. The costs for the options are shown in Table 39 below.

Table 39 Cost benefit summary for Fens Reservoir

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
FND21	851,490.11	2,513.34	38.6	2036	Fenland WRZ
FND23	710,027.80	1,365.85	27	2036	Fenland WRZ
FND24	970,959.20	3,388.85	50.1	2038	Fenland WRZ
FND25	1,287,133.05	4,262.19	72.8	2040	Fenland WRZ
FND28	710,027.80	1,365.85	33.1	2036	Fenland WRZ
FND29	851,490.11	2,513.34	44.4	2036	Fenland WRZ
FND30	1,145,397.31	3,997.68	61.1	2038	Fenland WRZ
FND31	1,421,962.87	4,708.67	80.5	2040	Fenland WRZ

6.4.3 FND22- Marham Surface Water Abstraction

Our Marham WTW abstracts water from the river Nar several kilometres from its confluence with the River Great Ouse. As of 2025 the abstraction will be constrained by a Hands-Off Flow (HoF) condition. The HoF is increasing from 4.3Ml/d up to 81.3Ml/d which means abstraction would be available only around 50% of the year. Taking this into consideration and layering in that our existing treatment process would need a 7-14-day recommissioning period to reinstate DO each time we re-start abstraction, the existing source and treatment does not provide sufficient WAFU to remain viable.

By moving the abstraction point to either the furthest reach of the river Nar, before its confluence with the Great Ouse, or the Great Ouse Relief channel, we could take the abstraction point close to the limit of, or even out of the SSSI and minimize environmental impact on the upstream river. This could in-turn mean that abstraction can be maintained at similar to current levels.

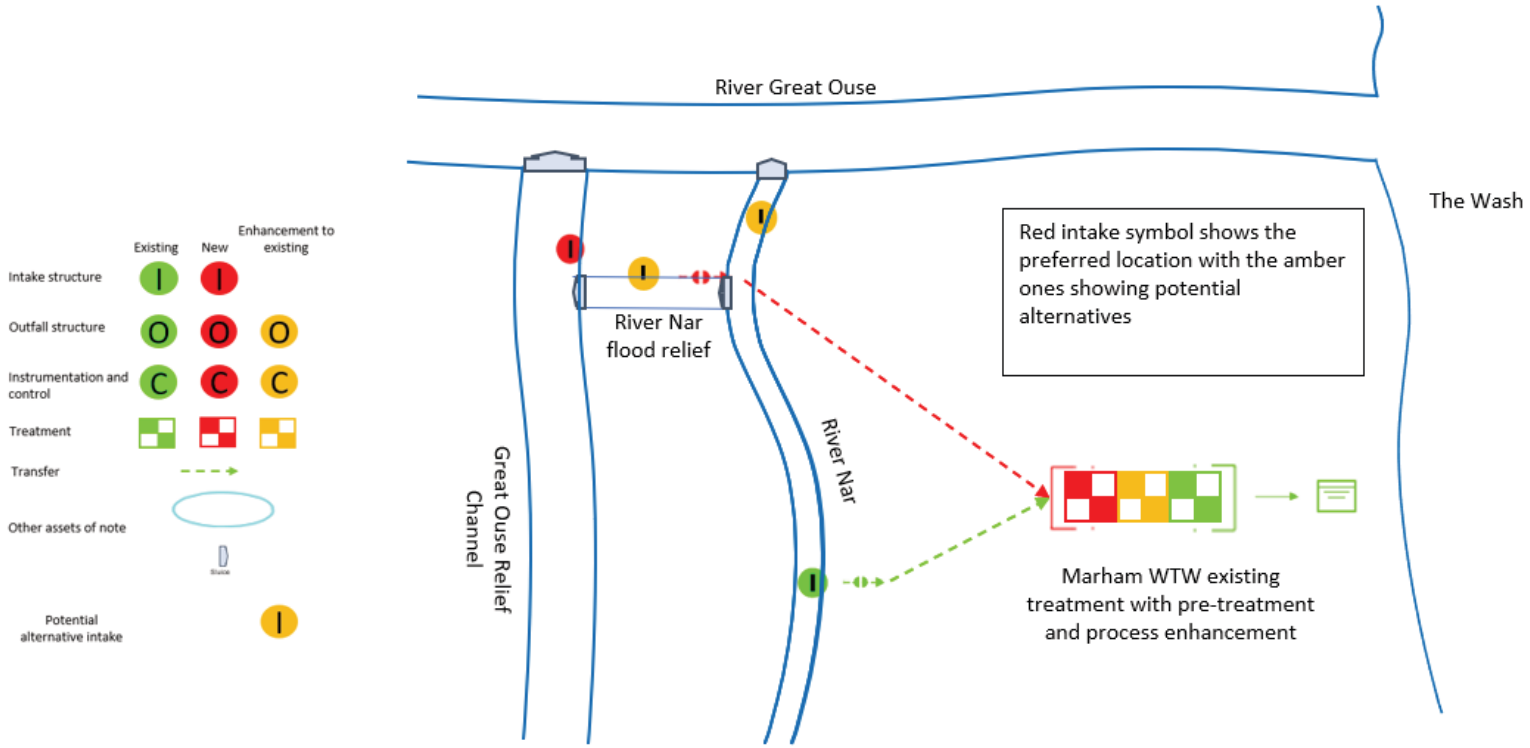
The option FND22 will install a new intake with necessary fish exclusion devices and a new raw water transfer to the existing Marham site. The water treatment works will be upgraded to treat the water from the new abstraction to include ozone, clarification and membrane ultrafiltration suitable for direct surface water abstraction. The new treatment facility will also give us the opportunity to build in washwater recover system meaning the new process will be much more efficient that the existing.

The option will result in an additional 7.9 Ml/d WAFU available in the Fenland (FND) WRZ.

Table 40 Option summary for Marham surface water abstraction

Attribute	Description
Source	Existing abstraction is the river Nar. The option proposes to move the abstraction point to either the furthest reach of the river Nar, before its confluence with the Great Ouse, or the Great Ouse Relief channel, we could take the abstraction point close to the limit of, or even out of the SSSI and minimize environmental impact on the upstream river.
Deployable Output/Capacity	The abstraction and treatment capacity of this option is 13.6 Ml/d.
Water Quality	To enable this option, we will have to carry out a treatability study once we have confirmed the abstraction point.
Benefit/WAFU	The benefit in WAFU is 7.9 Ml/d to the FND WRZ.
Delivery timescale	WAFU from this option would be available from 2030.

Figure 39 FND22 Marham surface water abstraction



The costs, year available, WAFU and receiving WRZ are shown in Table 41 below.

Table 41 Cost benefit summary for Marham surface water abstraction

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
FND22	£42,017	£334	7.9	2030	Fenland

6.4.4 FND1- Kings Lynn water reuse

FND1 is a water reuse option for potable supply. Final treated water effluent from Kings Lynn water recycling centre currently discharges into the river Great Ouse. This option would intercept the effluent before discharge and divert it to an advanced treatment process. Following treatment and conditioning the water would be transferred to the river Wissey and then could be abstracted and treated with an extension to the existing Stoke Ferry water treatment works.

Figure 40 FND1 Kings Lynn water reuse

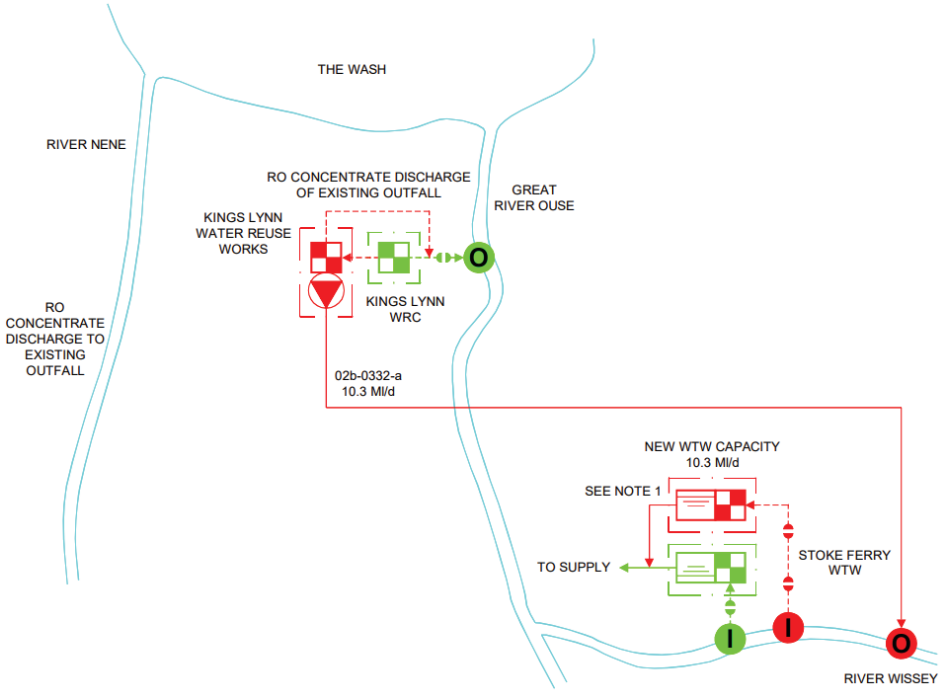


Table 42 Option summary for Kings Lynn water reuse

Attribute	Description
Water source	Kings Lynn WRC (discharge to river Great Ouse)
Deployable Output	Kings Lynn has a CDWF of 21,600m³. Recent actual flows suggest there is a reliable flow if at least 10.3 Ml/d available. Because the discharge point has a higher chloride concentration than the discharge very little dilution is required so all of the final effluent is potentially available for reuse.
Water Quality	Feed water quality and expected treatment performance is shown in Table 44.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (River Gt Ouse into The Wash) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	This option would provide an additional 10.3 Ml/d WAFU into the Fenland WRZ.
Delivery timescale	Delivery of this option could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032.

The costs, year available, WAFU and receiving WRZ for the option are shown in Table 43 below.

Table 43 Cost benefit summary for Kings Lynn water reuse

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
FND1	£226,915	£5,660	10.3	2032	Fenland

Figure 41 Recent actual flow at Kings Lynn WRC

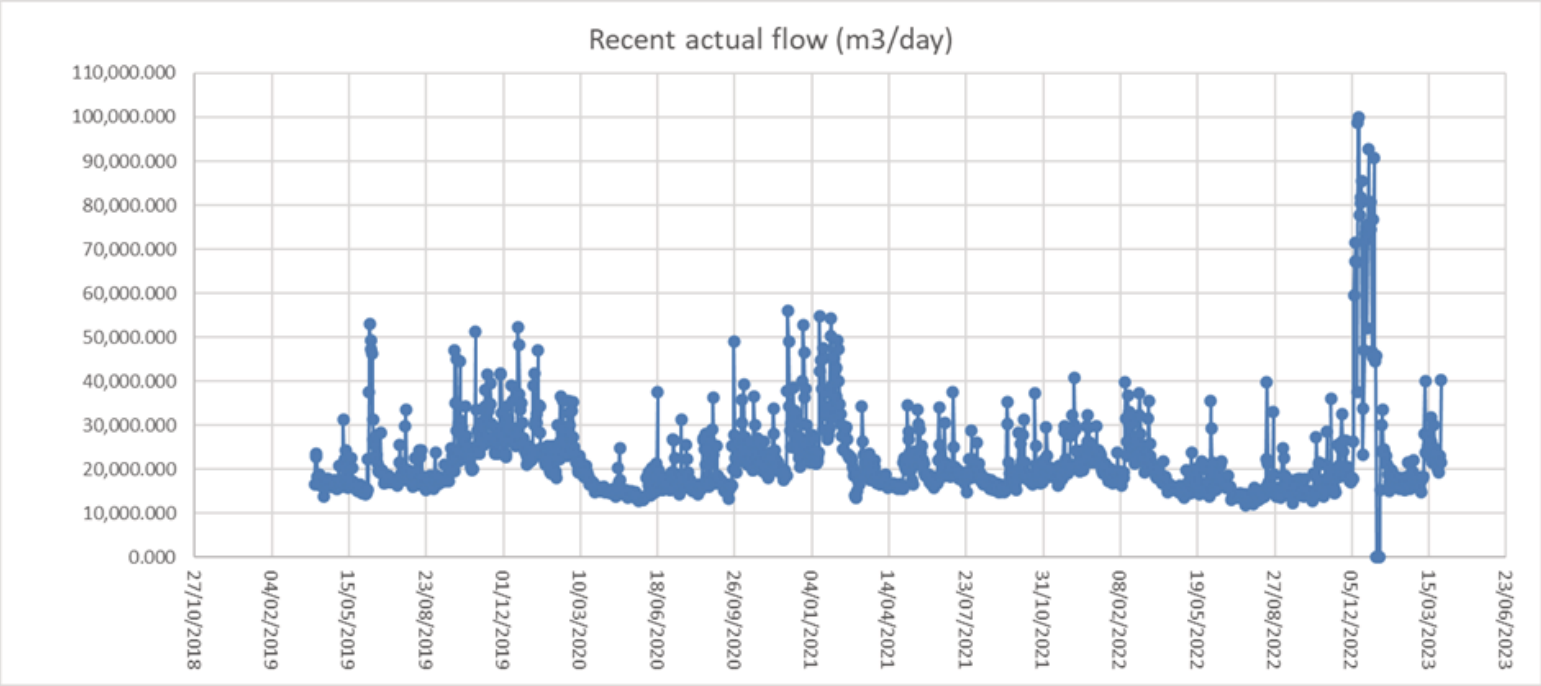


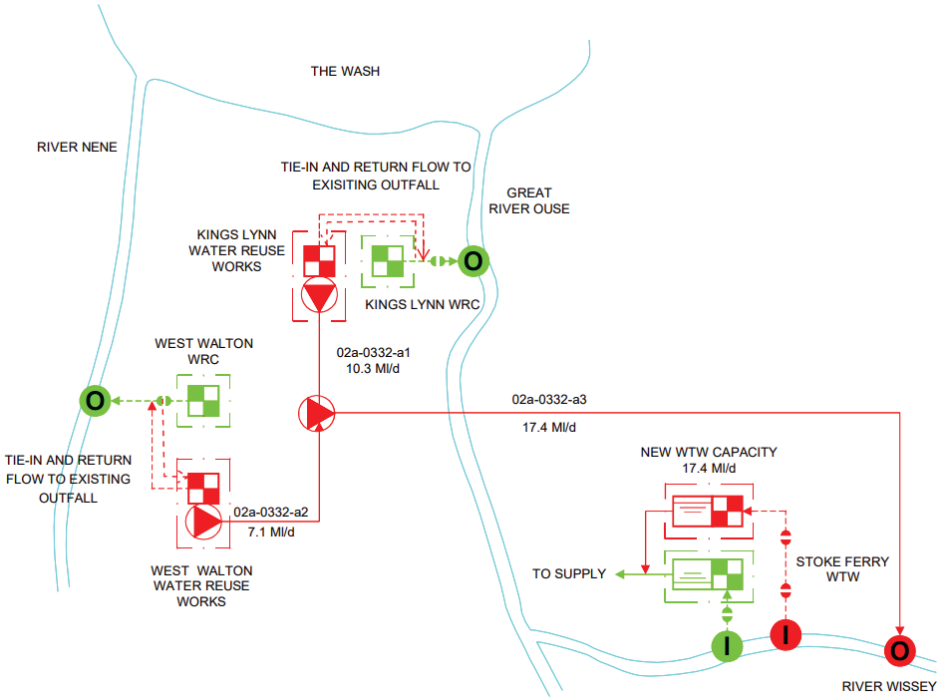
Table 44 Expected treatment performance for Kings Lynn water reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids (mg/l)	28	20	9.9	0.49	0.01
Ammonia	46	4.6	4.6	0.92	0.92
Nitrate	14	55	4.7	0.09	0.09
Phosphate	13	6.4	3.2	1.7	0.03
Sodium	100	100	100	100	2
Chloride	513	513	513	513	10

6.4.5 FND3- Kings Lynn and West Walton water reuse

FND3 is a water reuse option for potable supply. Final treated water effluent from Kings Lynn currently discharges into the river Great Ouse and West Walton discharges into the river Nene. This option would intercept the effluent before discharge and divert to an advanced treatment process. Following treatment and conditioning the water would be transferred to a pumping station near Downham Market where they would combine and transfer to the River Wissey and then could be abstracted and treated with an extension to the existing Stoke Ferry water treatment works.

Figure 42 FND3 Kings Lynn and West Walton water reuse option schematic



The option summary for Kings Lynn and West Walton water reuse is shown in Table 45 below.

Table 45 Option summary for Kings Lynn and West Walton water reuse

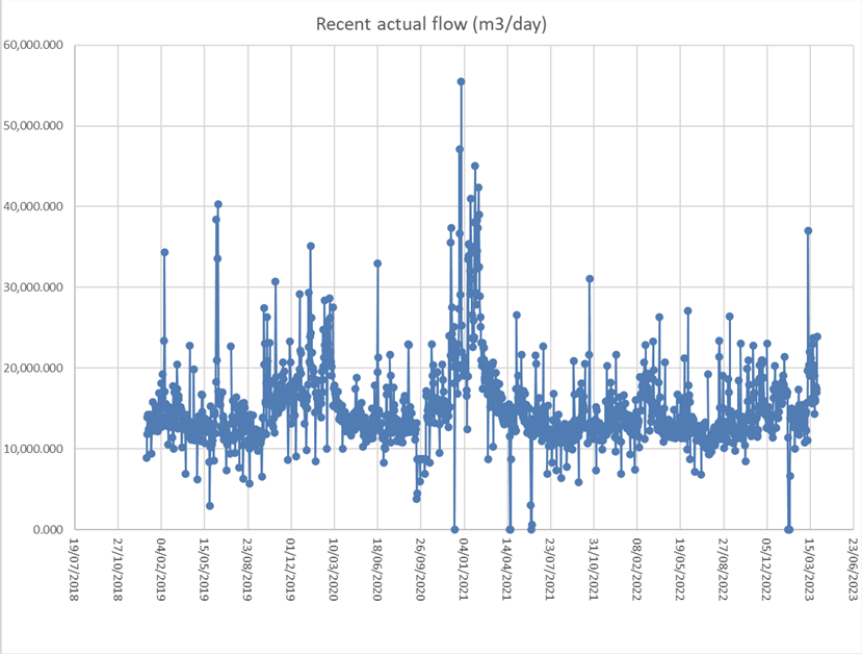
Attribute	Description
Water source	Kings Lynn (discharge to river Gt Ouse) and West Walton (discharge to river Nene) WRCs
Deployable Output	Kings Lynn has a CDWF of 21,600m³ West Walton has a CDWF of 14,421m³ Combined, after treatment, these give a DO of 17.4 Ml/d
Water Quality	Feed water quality and expected treatment performance is shown in Table 47.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (River Orwell) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	This option would provide an additional 17.4 Ml/d WAFU into the Fenland WRZ.
Delivery timescale	Delivery could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032.

The costs, year available, WAFU and receiving WRZ for the option are show in Table 46 below.

Table 46 Cost benefit summary for Kings Lynn and West Walton water reuse

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
FND3	£303,243	£8,843	17.4	2032	Fenland

Figure 43 Recent actual flow at West Walton WRC



For the recent actual flow at Kings Lynn, please refer to Figure 41.

Table 47 Expected treatment performance for Kings Lynn and West Walton water reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids (mg/l)	41	26	13	0.65	0.01
Ammonia	48	0.48	0.48	0.1	0.1
Nitrate	55	59	5.04	0.1	0.1
Phosphate	11	5.5	2.75	1.44	0.03
Sodium	100	100	100	100	2
Chloride	346	346	346	346	6.93

6.4.6 Transfer options

Table 48 Fenland WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
FND10	Potable water transfer	5	0.81	Norfolk Bradenham to Fenland potable transfer (5 Ml/d)	34	327
FND11	Potable water transfer	10	1.26	Norfolk Bradenham to Fenland potable transfer (10 Ml/d)	34	409
FND12	Potable water transfer	20	2.71	Norfolk Bradenham to Fenland potable transfer (20 Ml/d)	34	600
FND14	Potable water transfer	10	2.63	West Suffolk & Cambs to Fenland potable transfer (10 Ml/d)	56	458
FND15	Potable water transfer	20	4.52	West Suffolk & Cambs to Fenland potable transfer (20 Ml/d)	56	600
FND16	Potable water transfer	20	4.14	Ruthamford South to Fenland potable transfer (20 Ml/d)	51	600
FND17	Potable water transfer	50	10.17	West Suffolk & Cambs to Fenland potable transfer (50 Ml/d)	56	900
FND18	Potable water transfer	50	4.82	Norfolk Bradenham to Fenland potable transfer (50 Ml/d)	34	800
FND20	Potable water transfer	100	7.54	Norfolk Bradenham to Fenland potable transfer (100 Ml/d)	34	1000
FND9	Potable water transfer	10	1.93	Ruthamford South to Fenland potable transfer (10 Ml/d)	51	409
FND10	Potable water transfer	5	0.81	Norfolk Bradenham to Fenland potable transfer (5 Ml/d)	34	327

6.4.7 Option costs

Table 49 Fenland WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats units (required restoration)	BNG cost (£k)
FND19	New Reservoir	77.1	Fens Reservoir SRO	1,702,980.23	5,026.67	323,593	8,401	52	15,155
FND21	New Reservoir	38.6	Fens Reservoir 50 MCMD low yield	851,490.11	2,513.34	161,796	4,200	26	7,577
FND23	New Reservoir	27	Fens Reservoir 25 MCMD low yield	710,027.80	1,365.85	48,087	4,152	26	7,577
FND24	New Reservoir	50.1	Fens Reservoir 75 MCMD low yield	970,959.20	3,388.85	83,947	5,380	26	7,577
FND25	New Reservoir	72.8	Fens Reservoir 100 MCMD low yield	1,287,133.05	4,262.19	102,680	6,700	31	8,984
FND28	New Reservoir	33.1	Fens Reservoir 25 MCMD high yield	710,027.80	1,365.85	48,087	4,152	26	7,577
FND29	New Reservoir	44.4	Fens Reservoir 50 MCMD high yield	851,490.11	2,513.34	161,796	4,200	26	7,577
FND30	New Reservoir	61.1	Fens Reservoir 75 MCMD high yield	1,145,397.31	3,997.68	99,029	6,346	30	8,939
FND31	New Reservoir	80.5	Fens Reservoir 100 MCMD high yield	1,421,962.87	4,708.67	113435	7,402	34	9,925
FND22	New surface water	7.9	Marham abstraction relocation	42,017.05	334.49	6,589	430	4	207
FND1	Reuse	10.3	Kings Lynn to Stoke Ferry via river Wissey (extra treatment at Stoke Ferry WTW)	226,914.63	5,659.58	28,020	490	9	379
FND3	Reuse	17.4	Kings Lynn and West Walton to Stoke Ferry WTW via the River Wissey - with additional treatment at Stoke Ferry	303,242.73	8,842.65	40,073	1,431	22	728

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats units (required restoration)	BNG cost (£k)
FND10	Potable water transfer	5	Norfolk Bradenham to Fenland potable transfer (5 Ml/d)	29644.02769	5.53322146	5882.13	0	-	-
FND11	Potable water transfer	10	Norfolk Bradenham to Fenland potable transfer (10 Ml/d)	33763.43557	6.30213123	8292.11	0	-	-
FND12	Potable water transfer	20	Norfolk Bradenham to Fenland potable transfer (20 Ml/d)	55477.09094	10.3551016	18047.24	0	-	-
FND14	Potable water transfer	10	West Suffolk and Cambs to Fenland potable transfer (10 Ml/d)	67185.09803	12.5404592	16118.31	0	-	-
FND15	Potable water transfer	20	West Suffolk and Cambs to Fenland potable transfer (20 Ml/d)	102093.103	19.0562296	28987.74	0	-	-
FND16	Potable water transfer	20	Ruthamford South to Fenland potable transfer (20 Ml/d)	122045.1351	205.573123	28006.95	703.5901	-	-
FND17	Potable water transfer	50	West Suffolk and Cambs to Fenland potable transfer (50 Ml/d)	146150.0974	27.2797101	33806.9	0	-	-
FND18	Potable water transfer	50	Norfolk Bradenham to Fenland potable transfer (50 Ml/d)	72376.15026	13.5093986	16934.89	0	-	-
FND20	Potable water transfer	100	Norfolk Bradenham to Fenland potable transfer (100 Ml/d)	88640.52118	16.5452352	25313.47	0	-	-
FND9	Potable water transfer	10	Ruthamford South to Fenland potable transfer (10 Ml/d)	42762.30358	134.880593	13135.33	486.6657	-	-

6.4.8 Feasible options not modelled

Table 50 Fenland WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
FND13	Backwash water recovery	Fenland WTW backwash water recovery	Yes	Water quality risk
FND5	Desalination	Kings Lynn (brackish) 10 Ml/d	Yes	Brackish desalination rejected
FND6	Desalination	Kings Lynn (brackish) 25 Ml/d	Yes	Brackish desalination rejected
FND7	Desalination	Kings Lynn (brackish) - power supply from power station (10 Ml/d)	Yes	Brackish desalination rejected
FND8	Desalination	Kings Lynn (brackish) - power supply from power station (25 Ml/d)	Yes	Brackish desalination rejected
FND2	Reuse	Kings Lynn to Stoke Ferry via river Wissey (no extra treatment at Fenland WTW)	Yes	No benefit without potable treatment expansion
FND4	Reuse	Kings Lynn and West Walton to Stoke Ferry WTW via the River Wissey - no additional treatment at Fenland WTW	Yes	No benefit without potable treatment expansion

6.5 Lincolnshire Bourne

6.5.1 Transfer options

Table 51 Lincolnshire Bourne WRZ transfer options

Option ID	Max Capacity (Ml/d)	Min Capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
LNB1	20	0.32	Ruthamford North to Bourne (20 Ml/d)	14	458

6.5.2 Option costs

Table 52 Lincolnshire Bourne option costs

Option ID	Option type	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
LNB1	Potable water transfer	Ruthamford North to Bourne potable transfer (20 Ml/d)	17,542.01	189.27	716	261,286

6.6 Lincolnshire Central

6.6.1 Constrained options

Table 53 Lincolnshire Central WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
LNC10	New Reservoir	7	Extension /new reservoir at Hall - with new treatment	Yes	Yes
LNC11	Conjunctive 3rd party	7	Trent trade with extension to existing treatment	Yes	Yes
LNC14	Aquifer storage and recharge	7	Sherwood Sandstone ASR	Yes	Yes
LNC28	Conjunctive 3rd party	7	Trent trade	Yes	Yes
LNC30	Surface water enhancement	3.2	Hall WTW surface water enhancement	Yes	Yes

6.6.2 LNC14 Sherwood Sandstone aquifer storage recharge

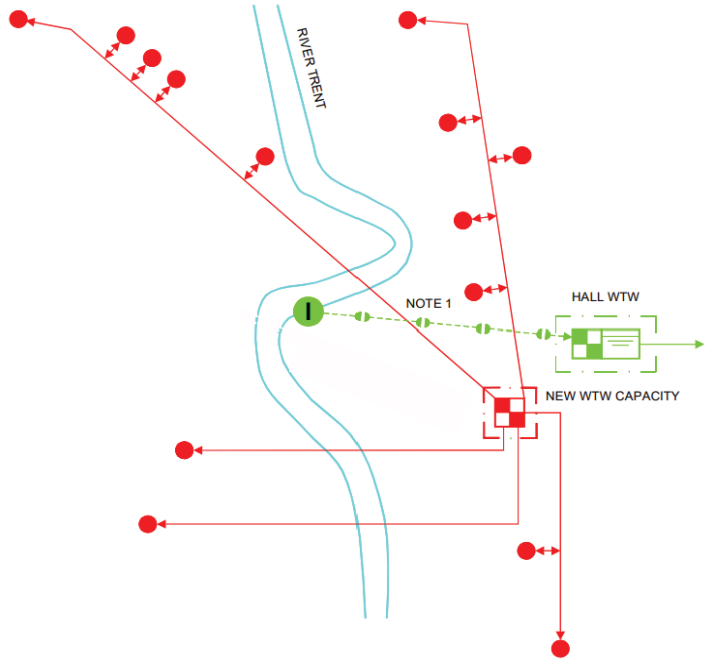
This option would take surplus water from Hall WTW in wetter months when demand is low and transfer it to a borehole array for groundwater injection and storage. The water could then be abstracted from these boreholes and treated to drinking water standard and transferred to an existing service reservoir for distribution.

There may be periods when the hands-off-flow condition on the abstraction licence from the River Trent will limit recharge. As such there may be certain years when it is not possible to realise the full recharge volumes. It is expected that on average there will be sufficient recharge volume to support abstraction but this is subject to agreement with the Environment Agency and will required continuous monitoring.

Table 54 Option summary for Sherwood Sandstone aquifer storage recharge

Attribute	Description
Water source	Abstracted from the River Trent, injected into the aquifer and then re-abstracted when needed.
Deployable output/capacity	Maximum abstraction of 26.3 Ml/d for 151 days of the year, giving an annual equivalent benefit of 10.9 Ml/d.
Water quality	Water from an existing surface water treatment works at Hall would be the source, as such the water is drinking water standard.
Benefit/WAFU	Aquator modelling demonstrates that an additional 7 Ml/d WAFU would be available into the Lincolnshire Central WRZ.
Delivery timescale	WAFU benefit would be available in 2035

Figure 44 Sherwood Sandstone aquifer storage recharge



The costs for the option is shown below in Table 55.

Table 55 Cost benefit summary for Sherwood Sandston aquifer storage recharge

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
LNC14	202,260.35	2,761.61	7	2032	Lincolnshire East

6.6.3 LNC28 Trent trade- conjunctive use

Another abstractor on the river Trent at Staythorpe has a consumptive element to their abstraction licence. This means that they can take water from the river Trent that is not returned to the environment locally. This is similar to the kind of licences issued for public water supply.

As the other abstractor doesn't always use the full amount of their licence, we could trade a part of that licence for public water supply.

Table 56 Option summary for Trent trade- conjunctive use

Attribute	Description
Water source	River Trent (Newark)
Deployable output/capacity	20 Ml/d
Water Quality	Abstraction is close enough to our existing abstraction to Hall WTW that water quality will be similar and therefore treatable with the enhancements outlined in option LNC30.
Benefit/WAFU	The licence trade arrangement and new abstraction will result in a WAFU benefit of 7 Ml/d.
Delivery timescale	It is anticipated delivery could be achieved within 5 years. Due to an existing trade agreement, there is no benefit to this option being available before 2035.

Figure 45 Trent trade- conjunctive use option schematic

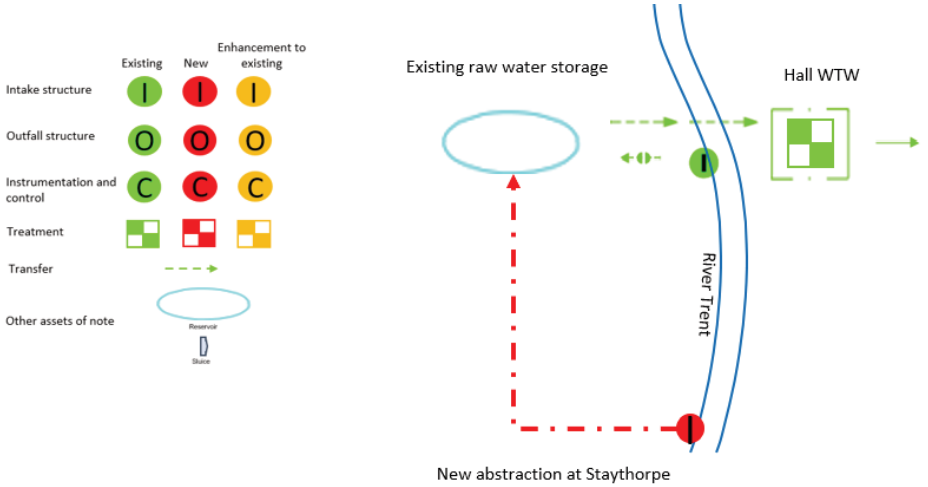


Table 57 Cost benefit summary for the Trent trade

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
LNC28	34674	384	7	2030	LNC

6.6.4 LNC30 Hall WTW surface water enhancement

Water is abstracted from the river Trent and stored in a raw water reservoir. The reservoir capacity is approximately 316,353m³which equates to around 10 days storage. Treated water is distributed into Lincolnshire Central WRZ.

The water in the river is of variable quality with no significant storage or opportunities for raw water blending. As a result, the existing treatment processes cannot reliably treat the full licensed volume of 20 Ml/d. The current maximum reliable treated water output is 13 Ml/d.

The option LNC30 will enhance the existing treatment process by adding additional filtration capacity and an ion exchange process to aid Total Organic Carbon (TOC) removal. This will enable the treatment works to achieve its full output of 20 Ml/d, which will result in an additional 3.2 Ml/d of WAFU available in Lincolnshire Central (LNC) WRZ.

Figure 46 Hall WTW surface water enhancement

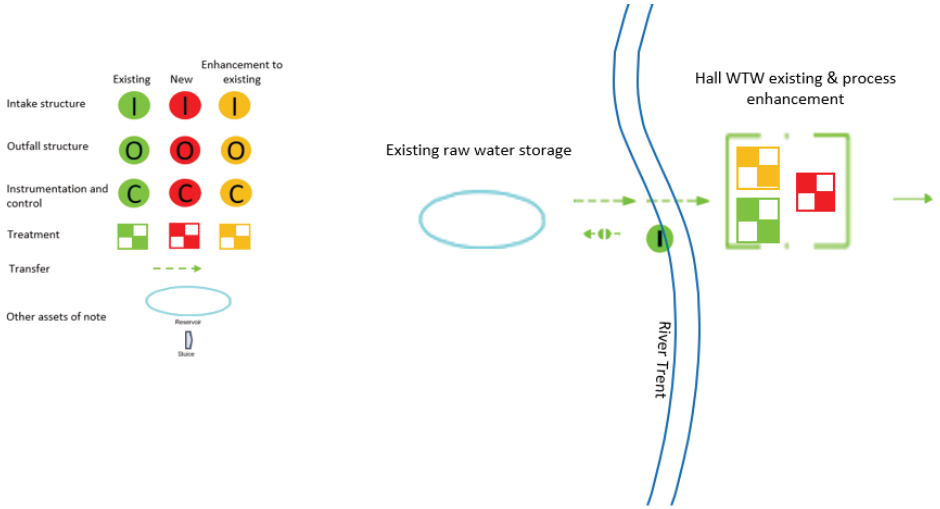


Table 58 Hall WTW surface water enhancement costs

Attribute	Description
Water source	River Trent
Deployable output/capacity	The treatment capacity of Hall WTW is 13 Ml/d. This option will increase that to 20 Ml/d.
Water quality	Water quality in the river Trent is seasonably variable with TOC and nitrate challenges. This option addresses those issues to maximise output.
Benefit/WAFU	This option will provide an additional 3.2 Ml/d DO in the LNC WRZ.
Delivery timescale	WAFU from this option would be available from 2030.

Table 59 Cost benefit summary for Hall WTW surface water enhancement

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
LNC30	29,229	542	3.2	2030	Lincolnshire Central

6.6.5 Transfer options

Table 60 Lincolnshire Central WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
LNC15	Potable water transfer	10	3.22	Ruthamford North to Lincolnshire Central potable transfer (10 Ml/d)	68	458
LNC16	Potable water transfer	20	5.53	Ruthamford North to Lincolnshire Central potable transfer (20 Ml/d)	68	600
LNC17	Potable water transfer	100	26.45	Lincolnshire Central to Lincolnshire Central potable transfer (100 Ml/d)	52	1500
LNC18	Potable water transfer	20	7.52	Lincolnshire Central to Lincolnshire Central potable transfer (20 Ml/d)	52	800
LNC19	Potable water transfer	100	18.58	Ruthamford North to Lincolnshire Central potable transfer (100 Ml/d)	68	1100
LNC25	Potable water transfer	29	3.50	Lincolnshire East to Lincolnshire Central potable transfer (29 Ml/d)	19	800
LNC29	Potable water transfer	50	5.53	Lincolnshire East to Lincolnshire Central potable transfer (50 Ml/d)	39	800
LNC9	Potable water transfer	10	4.23	Lincolnshire Central to Lincolnshire Central potable transfer (10 Ml/d)	52	600

6.6.6 Option costs

Table 61 Lincolnshire Central WRZ option costs

Option ID	Option type	Option name	CAPEX (£k)	Annual opex (£k)	Year available	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
LNC14	Aquifer Storage Recovery (ASR)	Sherwood Sandstone ASR	202,260.35	2,761.61	2035	36,467	369	46	1,840
LNC11	Conjunctive use 3rd party	Staythorpe DTT with Hall WTW extension	73,787.61	7,532.57	2035	13,681	-	0	49
LNC28	Conjunctive use 3rd party	Trent trade (Staythorpe)	34,258.50	640.16	2035	8,285	825	3	89
LNC10	New Reservoir	Extension /new reservoir at Hall - conjunctive with new treatment	67,972.63	879.50	2035	13,845	1,120	-	1,121
LNC15	Potable water transfer	Ruthamford North to Lincolnshire Central potable transfer (10 Ml/d)	96,354.02	157.71	2035	20,511	536	-	-
LNC16	Potable water transfer	Ruthamford North to Lincolnshire Central potable transfer (20 Ml/d)	147,138.80	305.55	2035	37,677	1,072	-	-
LNC17	Potable water transfer	Lincolnshire Central to Lincolnshire Central potable transfer (100 Ml/d)	226,380.36	42.26	2035	87,605	-	-	-
LNC18	Potable water transfer	Lincolnshire Central to Lincolnshire Central potable transfer (20 Ml/d)	117,621.11	21.95	2035	25,331	-	-	-
LNC19	Potable water transfer	Ruthamford North to Lincolnshire Central potable transfer (100 Ml/d)	267,833.80	949.33	2035	65,610	6,254	-	-
LNC25	Potable water transfer	Lincolnshire East to Lincolnshire Central potable transfer (29 Ml/d)	68,924.16	598.35	2030	12,667	767	-	-
LNC29	Potable water transfer	Lincolnshire East to Lincolnshire Central potable transfer (50 Ml/d)	116,574.54	705.77	2030	22,160	2,641	-	-
LNC9	Potable water transfer	Lincolnshire Central to Lincolnshire Central potable transfer (10 Ml/d)	94,422.57	17.62	2035	28,296	-	-	-

Option ID	Option type	Option name	CAPEX (£k)	Annual opex (£k)	Year available	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
LNC30	Surface water enhancement	Hall WTW surface water enhancement	29,228.75	541.62	2030	4,943	244	-	-

6.6.7 Feasible options not modelled

Table 62 Lincolnshire Central WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
LNC1	Reuse	Canwick WRC to the Hall via River Trent (additional treatment at Hall WTW)	Yes	Canwick effluent supports flows and abstraction downstream
LNC20	Desalination	South Humber bank desalination (seawater) collocated with SHB Power Station (10 Ml/d)	Yes	Estuarial desalination options rejected
LNC21	Desalination	South Humber bank desalination (seawater) 10 Ml/d	Yes	Estuarial desalination options rejected
LNC22	New surface water	Lincolnshire Central non-potable to potable treatment (10 Ml/d)	Yes	WFD no water available from Ancholme
LNC23	New surface water	Lincolnshire Central non-potable to potable treatment (31 Ml/d)	Yes	WFD no water available from Ancholme
LNC24	New surface water	Lincolnshire Central non-potable to potable treatment (50 Ml/d)	Yes	WFD no water available from Ancholme
LNC2	Reuse	Canwick WRC to the Hall via River Trent (no additional treatment at Hall WTW)	Yes	Canwick effluent supports flows and abstraction downstream
LNC3	Desalination	South Humber bank desalination (seawater) collocated with SHB Power Station (25 Ml/d)	Yes	Estuarial desalination options rejected
LNC4	Desalination	South Humber bank desalination (seawater) collocated with SHB Power Station (50 Ml/d)	Yes	Estuarial desalination options rejected
LNC5	Desalination	South Humber bank desalination (seawater) 27 Ml/d	Yes	Estuarial desalination options rejected
LNC6	Desalination	South Humber bank desalination (seawater) 50 Ml/d	Yes	Estuarial desalination options rejected
LNC7	Desalination	Desalination (brackish) on Trent between Gainsborough and the Humber (10 Ml/d)	Yes	Estuarial desalination options rejected
LNC8	Desalination	Desalination (brackish) on Trent between Gainsborough and the Humber (25 Ml/d)	Yes	Estuarial desalination options rejected

6.7 Lincolnshire East

Table 63 Lincolnshire East WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
LNE1	Reuse	6.1	Ingoldmells to Covenham via River Eau (with additional treatment at Covenham)	Yes	Yes
LNE3	Backwash water recovery	1.3	Lincolnshire East WTW backwash water recovery	Yes	Yes
LNE5	Desalination	25	Mablethorpe desalination Seawater (25 Ml/d)	Yes	Yes
LNE6	Desalination	50	Mablethorpe desalination Seawater (50 Ml/d)	Yes	Yes
LNE7	Desalination	100	Mablethorpe desalination Seawater (100 Ml/d)	Yes	Yes
LNE11	Groundwater enhancement	7.5	Lincolnshire East Groundwater enhancement	Yes	Yes
LNE12	Surface water enhancement	7.3	Lincolnshire East Surface Water enhancement	Yes	Yes

6.7.1 LNE1 Ingoldmells water reuse

LNE1 is a water reuse options for potable supply. Final treated water effluent from Ingoldmells WRC currently discharges into the North Sea. This option would intercept effluent before discharge and divert to an advanced treatment process. Following treatment and conditioning, the water would be transferred to the River Great Eau where it would be transferred via a new abstraction and pipeline to Covenham reservoir. From here it would be treated at an expansion to an existing potable water treatment works, Figure 47.

Figure 47 LNE1 Ingoldmells water reuse

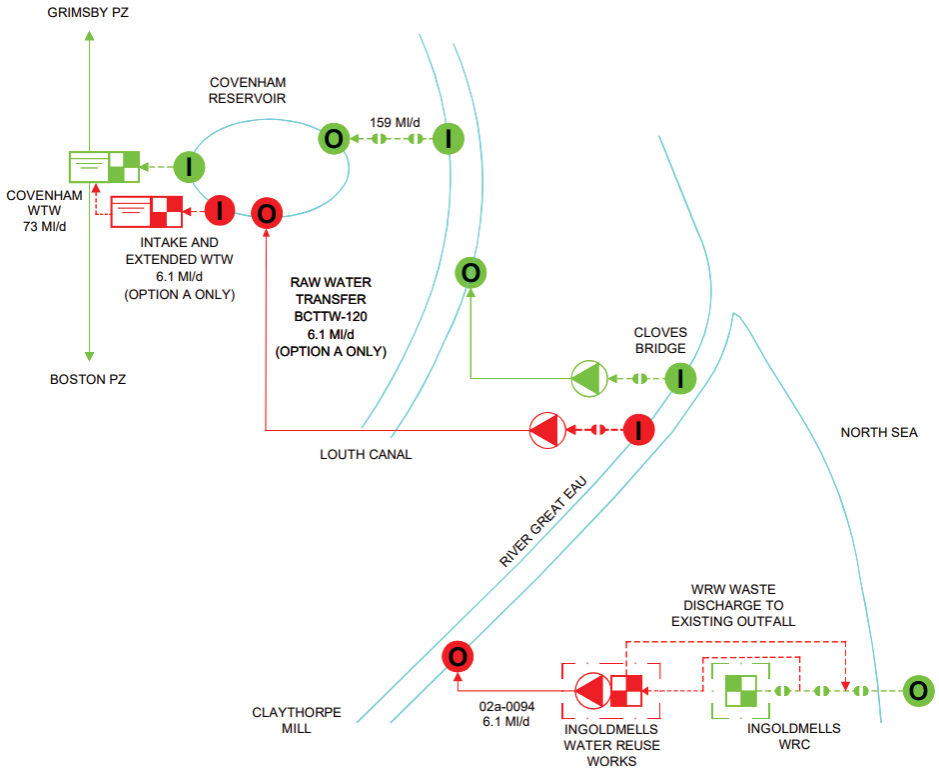


Table 64 Option summary for Ingoldmells water reuse

Attribute	Description
Water source	Ingoldmells WRC via river Great Eau and Covenham reservoir.
Deployable Output	6.1 Ml/d. Minimal effluent required for discharge dilution as outfall is to sea.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (North Sea) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	6.1 Ml/d benefit in Lincolnshire East WRZ.
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

Table 65 Cost benefit summary for Ingoldmells water reuse

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
LNE1	178,697	4,221.24	6.1	2032	Lincolnshire Eat

Figure 48 Recent actual flow at Ingoldmells WRC

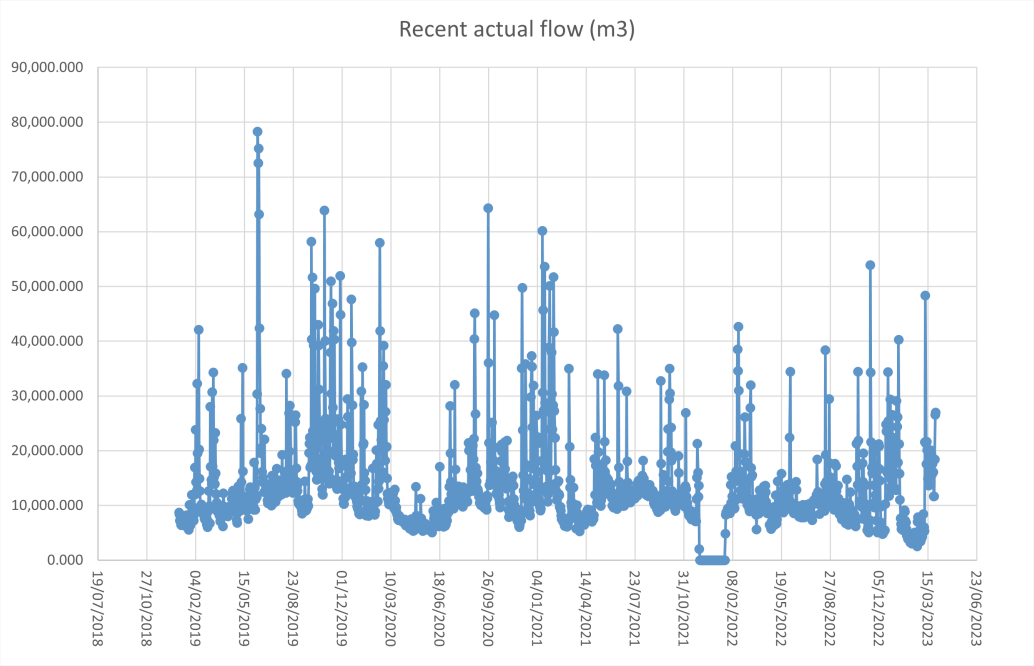


Table 66 Expected treatment performance for Ingoldmells water reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids	118	65	32	1.62	0.03
Ammonia	46	4.61	4.6	0.92	0.92
Nitrate	13.9	55	4.7	0.09	0.09
Phosphate	8.2	4.1	2.05	1.08	0.02
Sodium	100	100	100	100	2
Chloride	1678	1678	1678	1678	34

6.7.2 LNE11 Lincolnshire East groundwater enhancement

Healing: enhancement to existing BH assets to maximise abstraction.

Little London: Ion exchange nitrate removal to enable maximum abstraction from the combined chalk sources.

6.7.3 LNE12 Lincolnshire East surface water enhancement

There will be modifications to the control system at the **River Great Eau Abstraction;** these will optimise the abstraction by:

- Providing a flow monitoring station at the weir bypass to ensure minimum river flow is maintained while maximising abstraction.
- Enhancing the weir and it's control system.
- Enhancing the pumping station and its control system to optimise abstraction.

Tetney Lock and the river Tud at Louth will include the provision of a flow monitoring station at Tetney Lock and the river Tud at Louth to monitor the flow and ensure we maximise the abstraction from the Louth Canal.

Covenham WTW: this, combined with ongoing work that started in AMP7 to enhance treatment at Covenham WTW, will enable us to maximise abstraction and treatment to 60 Ml/d which will yield an additional 7.3 Ml/d in WAFU in Lincolnshire East WRZ.

Table 67 Option summary for Lincolnshire East surface water enhancement

Attribute	Description
Water source	Abstraction from the Louth Canal supported by abstraction from the river Great Eau.
Deployable output/capacity	Output of Covenham WTW will be a reliable 60 Ml/d.
Water quality	The abstraction point from the Louth Canal and transfer from the River Great Eau remain the same so no additional water quality considerations.
Benefit/WAFU	The sum of these enhancements and ongoing WTW enhancements included our North Lincolnshire Alternative Solution will increase WAFU in LNC by 7.3 Ml/d
Delivery timescale	WAFU benefit would be available in 2030.

Figure 49 LNE12 Lincolnshire East surface water enhancement

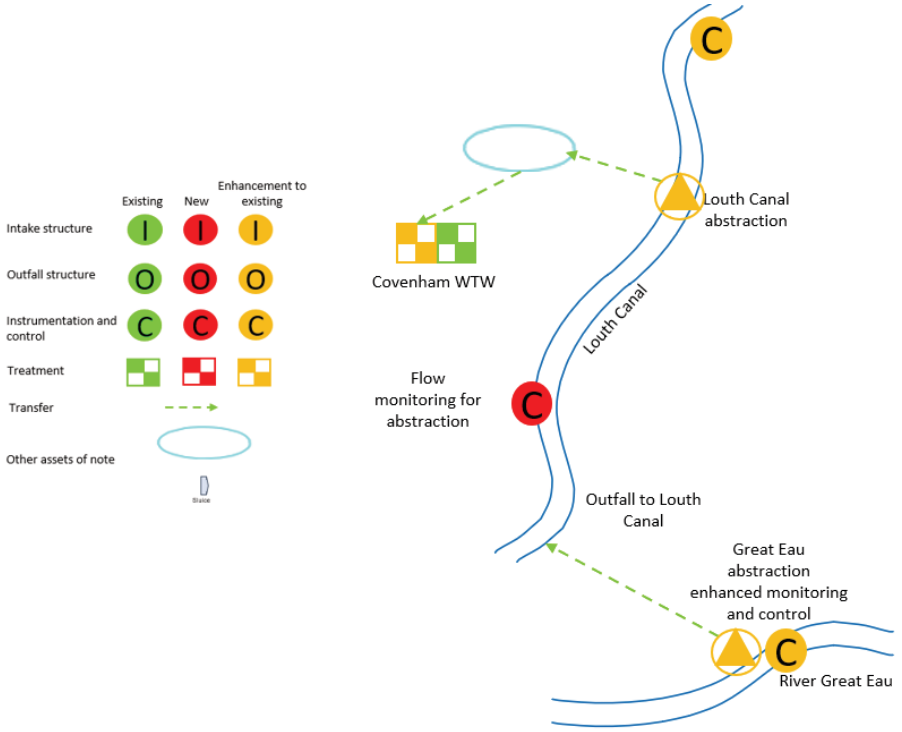


Table 68 Cost benefit summary for Lincolnshire East surface water enhancement

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
LNE12	£59,471	£364	7.3	2030	Lincolnshire Central

6.7.4 Option costs

Table 69 Lincolnshire East option costs

Option ID	Option type	Gain in WAFU	Option name	CAPEX (£k)	Annual opex (£k)	Carbon (tCO2e)	Operational Carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
LNE1	Reuse	6.1	Ingoldmells to Covenham via River Eau (with additional treatment at Covenham)	178697.3308	4221.23654	22010.05	546	31.85	1082.244
LNE11	Groundwater enhancement	7.5	Lincolnshire East Groundwater enhancement	18,485.99	334.15	2,745	343	1	23
LNE12	Surface water enhancement	7.3	Lincolnshire East Surface Water enhancement	59,470.70	363.69	15,055	283	-	-
LNE3	Backwash water recovery	1.3	Lincolnshire East WTW backwash water recovery	5,359.79	9.05	686	9	-	-
LNE4	Sea tankering	0.4	Immingham Sea Tankering	87,852.44	37,714.09	23,288	1,339	-	-
LNE5	Desalination	25	Mablethorpe desalination Seawater (25 Ml/d)	418,102.44	13,178.36	110,626	6,749	27	798
LNE6	Desalination	50	Mablethorpe desalination Seawater (50 Ml/d)	515,227.29	12,967.70	44,938	13,497	27	798
LNE7	Desalination	100	Mablethorpe desalination Seawater (100 Ml/d)	904,601.96	13,182.14	92,837	26,995	27	798

6.7.5 Feasible options not modelled

Table 70 Lincolnshire East feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
LNE10	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Mablethorpe (100 Ml/d)	Yes	Offshore desalination rejected
LNE1	Reuse	Ingoldmells to Covenham via Rive Eau (no additional treatment at Covenham)	Yes	No benefit without potable treatment expansion
LNE8	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Mablethorpe (25 Ml/d)	Yes	Offshore desalination rejected
LNE9	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Mablethorpe (50 Ml/d)	Yes	Offshore desalination rejected

6.8 Lincolnshire Retford and Gainsborough

6.8.1 Constrained options

Table 71 Lincolnshire, Retford and Gainsborough WRZ constrained options

Option ID	Option type	WAFU (Ml/d)	Option name	Feasible	Constrained
LNN3	Groundwater enhancement	0.72	Lincolnshire Retford and Gainsborough resource optimisation	Yes	Yes

6.8.2 LNN3 Groundwater enhancement

Part 1 - Gainsborough has a borehole with a water quality challenge (hydrocarbon) that means it cannot be fully utilised. By installing Granular Activated Carbon (GAC) adsorption filters we can fully utilise this source.

Part 2 - Enhancement of a booster pump set will give us the pumping capacity to distribute the water made available by part 1 of this option.

The combined benefit of these enhancements will increase WAFU in our Lincolnshire Retford and Gainsborough of 0.72 Ml/d.

6.8.3 Transfer options

Table 72 Lincolnshire Retford and Gainsborough WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
LNN1	Potable water transfer	3.5	0.24	Lincolnshire Central to Lincolnshire Retford and Gainsborough potable transfer (3.5 Ml/d)	20	229
LNN2	Potable water transfer	10	0.49	Lincolnshire Central to Lincolnshire Retford and Gainsborough potable transfer (10 Ml/d)	20	327

6.8.4 Option costs

Table 73 Lincolnshire Retford and Gainsborough WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Carbon (tCO2e)	Operational Carbon (tCO2e)
LNN1	Potable water transfer	3.5	Lincolnshire Central to Lincolnshire Retford and Gainsborough potable transfer (3.5 Ml/d)	15,696.02	46.45	2,695	165
LNN2	Potable water transfer	10	Lincolnshire Central to Lincolnshire Retford and Gainsborough potable transfer (10 Ml/d)	24,419.78	149.32	4,500	557
LNN3	Groundwater enhancement	0.72	Lincolnshire Retford and Gainsborough resource optimisation	5,690.60	108.80	1,349	139

6.9 Norfolk Aylsham

6.9.1 Constrained options

Table 74 Norfolk Aylsham WRZ constrained options

Option ID	Option type	WAFU (Ml/d)	Option name	Feasible	Constrained
NAY4	Backwash water recovery	0.75	Norfolk Aylsham WTW backwash water recovery	Yes	Yes
NAY5	Backwash water recovery	0.1	Norfolk Aylsham WTW backwash water recovery	Yes	Yes

6.9.2 Transfer options

Table 75 Norfolk Aylsham WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NAY1	Potable water transfer	3	0.18	Norwich and the Broads to Aylsham potable transfer (3 Ml/d)	14	246
NAY2	Potable water transfer	10	0.40	Happisburgh to Aylsham potable transfer (10 Ml/d)	17	327
NAY3	Potable water transfer	10	0.65	Norwich and the Broads to Aylsham potable transfer (10 Ml/d)	22	368

6.9.3 Option costs

Table 76 Norfolk Aylsham WRZ option costs

Option ID	Option type	Gain in WAFU	Option name	CAPEX (£k)	Annual opex (£k)	Carbon (tCO2e)	Operational Carbon (tCO2e)
NAY1	Potable water transfer	3	Norwich and the Broads to Aylsham potable transfer (3 Ml/d)	14,614.61	109.16	2,379	139
NAY2	Potable water transfer	10	Happisburgh to Aylsham potable transfer (10 Ml/d)	22,508.73	141.18	4,061	525
NAY3	Potable water transfer	10	Norwich and the Broads to Aylsham potable transfer (10 Ml/d)	38,321.87	74.03	5,903	255
NAY4	Backwash water recovery	0.75	Norfolk Aylsham WTW backwash water recovery	367.75	0.47	67	-
NAY5	Backwash water recovery	0.1	Norfolk Aylsham WTW backwash water recovery	170.54	0.24	53	-

6.10 Norfolk Bradenham

6.10.1 Constrained options

Table 77 Norfolk Bradenham WRZ constrained options

Option ID	Option type	WAFU (Ml/d)	Option name	Feasible	Constrained
NBR9	Backwash water recovery	0.2	Norfolk Bradenham WTW backwash water recovery	Yes	Yes

6.10.2 Transfer options

Table 78 Norfolk Bradenham WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NBR1	Potable water transfer	5	0.63	Fenland to Norfolk Bradenham potable transfer (5 Ml/d)	34	290
NBR2	Potable water transfer	10	1.26	Fenland to Norfolk Bradenham potable transfer (10 Ml/d)	34	409
NBR3	Potable water transfer	20	2.71	Fenland to Norfolk Bradenham potable transfer (20 Ml/d)	34	600
NBR4	Potable water transfer	10	1.40	Norwich and the Broads to Norfolk Bradenham potable transfer (10 Ml/d)	37	409
NBR5	Potable water transfer	20	3.01	Norwich and the Broads to Norfolk Bradenham potable transfer (20 Ml/d)	37	600
NBR6	Potable water transfer	45	1.40	Fenland to Norfolk Bradenham potable transfer (45 Ml/d)	36	900
NBR7	Potable water transfer	50	5.35	Norwich and the Broads to Norfolk Bradenham potable transfer (50 Ml/d)	37	800
NBR8	Potable water transfer	100	9.21	Norwich and the Broads to Norfolk Bradenham potable transfer (100 Ml/d)	37	1050

6.10.3 Option costs

Table 79 Norfolk Bradenham WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
NBR1	Potable water transfer	5	Fenland to Norfolk Bradenham potable transfer (5 Ml/d)	32,456.15	75.69	5,816	266
NBR2	Potable water transfer	10	Fenland to Norfolk Bradenham potable transfer (10 Ml/d)	46,101.33	119.47	9,278	424
NBR3	Potable water transfer	20	Fenland to Norfolk Bradenham potable transfer (20 Ml/d)	72,590.42	188.55	19,263	674
NBR4	Potable water transfer	10	Norwich and the Broads to Norfolk Bradenham potable transfer (10 Ml/d)	74,463.46	118.35	11,527	400
NBR5	Potable water transfer	20	Norwich and the Broads to Norfolk Bradenham potable transfer (20 Ml/d)	145,956.39	185.30	23,204	608
NBR6	Potable water transfer	45	Fenland to Norfolk Bradenham potable transfer (45 Ml/d)	102,885.53	1,183.28	26,215	1,532
NBR7	Potable water transfer	50	Norwich and the Broads to Norfolk Bradenham potable transfer (50 Ml/d)	198,926.85	532.38	24,071	1,912
NBR8	Potable water transfer	100	Norwich and the Broads to Norfolk Bradenham potable transfer (100 Ml/d)	257,018.81	952.35	37,281	3,494
NBR9	Backwash water recovery	0.2	Norfolk Bradenham WTW backwash water recovery	321.11	0.24	72	-

6.11 Norfolk East Dereham

6.11.1 Constrained options

Table 80 Norfolk East Dereham WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
NED3	Backwash water recovery	0.1	Norfolk East Dereham WTW backwash water recovery	Yes	Yes

6.11.2 Transfer options

Table 81 Norfolk East Dereham WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NED1	Potable water transfer	5	0.11	Norfolk Bradenham to Norfolk East Dereham potable transfer (5 Ml/d)	9	229
NED2	Potable water transfer	10	0.18	Norfolk Bradenham to Norfolk East Dereham potable transfer (10 Ml/d)	9	290

6.11.3 Option costs

Table 82 Norfolk East Dereham WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual OPEX (£k)	Carbon (tCO2e)	Operational Carbon (tCO2e)
NED1	Potable water transfer	5	Norfolk Bradenham to Norfolk East Dereham potable transfer (5 Ml/d)	7,552.12	44.01	1,395	162
NED2	Potable water transfer	10	Norfolk Bradenham to Norfolk East Dereham potable transfer (10 Ml/d)	10,664.34	99.11	2,005	371
NED3	Backwash water recovery	0.1	Norfolk East Dereham WTW backwash water recovery	259.38	0.24	113	-

6.12 Norfolk East Harling

6.12.1 Transfer options

Table 83 Norfolk East Harling WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NEH1	Potable water transfer	5	0.44	Norfolk Harleston to Norfolk East Harling potable transfer (5 Ml/d)	23	290
NEH2	Potable water transfer	10	0.71	Norfolk Harleston to Norfolk East Harling potable transfer (10 Ml/d)	23	368
NEH3	Potable water transfer	5	0.27	Suffolk Thetford to Norfolk East Harling potable transfer (5 Ml/d)	19	256
NEH4	Potable water transfer	15	0.70	Suffolk Thetford to Norfolk East Harling potable transfer (10 Ml/d)	19	409
NEH5	Potable water transfer	10	0.43	Suffolk Thetford to Norfolk East Harling potable transfer (10 Ml/d)	20	311
NEH6	Potable water transfer	15	0.87	Norfolk Harleston to Norfolk East Harling potable transfer (15 Ml/d)	23	409

6.12.2 Option costs

Table 84 Norfolk East Harling WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Carbon (tCO2e)	Operational Carbon (tCO2e)
NEH1	Potable water transfer	5	Norfolk Harleston to Norfolk East Harling potable transfer (5 Ml/d)	22,431.40	46.33	4,120	160
NEH2	Potable water transfer	10	Norfolk Harleston to Norfolk East Harling potable transfer (10 Ml/d)	29,367.35	97.56	5,751	352
NEH3	Potable water transfer	5	Suffolk Thetford to Norfolk East Harling potable transfer (5 Ml/d)	20,047.85	102.89	3,430	129
NEH4	Potable water transfer	15	Suffolk Thetford to Norfolk East Harling potable transfer (10 Ml/d)	28,396.77	160.60	5,716	597
NEH5	Potable water transfer	10	Suffolk Thetford to Norfolk East Harling potable transfer (10 Ml/d)	42,385.33	174.05	5,494	218
NEH6	Potable water transfer	15	Norfolk Harleston to Norfolk East Harling potable transfer (15 Ml/d)	34,102.19	174.04	6,924	644

6.13 Norfolk Harleston

6.13.1 Constrained options

Table 85 Norfolk Harleston WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
NHL7	Backwash water recovery	0.2	Norfolk Harleston WTW backwash water recovery	Yes	Yes

6.13.2 Transfer options

Table 86 Norfolk Harleston transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NHL1	Potable water transfer	5	0.57	Norwich and the Broads to Norfolk Harleston potable transfer (5 Ml/d)	30	290
NHL2	Potable water transfer	10	0.92	Norwich and the Broads to Norfolk Harleston potable transfer (10 Ml/d)	30	368
NHL3	Potable water transfer	10	0.56	Norfolk East Harling to Norfolk Harleston potable transfer (10 Ml/d)	23	327
NHL4	Potable water transfer	5	0.56	Norfolk East Harling to Norfolk Harleston potable transfer (5 Ml/d)	26	311
NHL5	Potable water transfer	15	0.00	Norfolk East Harling to Harleston potable transfer (15 Ml/d)	23	458
NHL6	Potable water transfer	15	1.43	Norwich and the Broads to Norfolk Harleston potable transfer (15 Ml/d)	30	458

6.13.3 Option costs

Table 87 Norfolk Harleston WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
NHL1	Potable water transfer	5	Norwich and the Broads to Norfolk Harleston potable transfer (5 Ml/d)	38,340.67	50.21	5,982	164
NHL2	Potable water transfer	10	Norwich and the Broads to Norfolk Harleston potable transfer (10 Ml/d)	48,930.49	106.71	8,157	374
NHL3	Potable water transfer	10	Norfolk East Harling to Norfolk Harleston potable transfer (10 Ml/d)	26,703.37	118.69	4,771	427
NHL4	Potable water transfer	5	Norfolk East Harling to Norfolk Harleston potable transfer (5 Ml/d)	24,928.89	106.35	3,814	132
NHL5	Potable water transfer	15	Norfolk East Harling to Harleston potable transfer (15 Ml/d)	38,888.61	158.44	8,019	616
NHL6	Potable water transfer	15	Norwich and the Broads to Norfolk Harleston potable transfer (15 Ml/d)	60,001.33	120.23	10,924	419
NHL7	Backwash water recovery	0.2	Norfolk Harleston WTW backwash water recovery	1,521.88	15.12	226	6

6.14 North Norfolk Coast

6.14.1 Constrained options

Table 88 North Norfolk Coast constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
NNC5	Backwash water recovery	0.18	North Norfolk Coast1 WTW backwash water recovery	Yes	Yes
NNC6	Backwash water recovery	0.2	North Norfolk Coast2 WTW backwash water recovery	Yes	Yes

6.14.2 Transfer options

Table 89 North Norfolk Coast WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NNC3	Potable water transfer	10	0.36	Norfolk Aylsham to North Norfolk Coast potable transfer (10 Ml/d)	15	327
NNC4	Potable water transfer	10	0.65	Norfolk East Dereham to North Norfolk Coast potable transfer (10 Ml/d)	21	368

6.14.3 Option costs

Table 90 North Norfolk Coast WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
NNC3	Potable water transfer	10	Norfolk Aylsham to North Norfolk Coast potable transfer (10 Ml/d)	17,734.92	125.17	3,391	468

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
NNC4	Potable water transfer	10	Norfolk East Dereham to North Norfolk Coast potable transfer (10 Ml/d)	25,223.50	75.25	4,934	270
NNC5	Backwash water recovery	0.18	North Norfolk Coast1 WTW backwash water recovery	209.20	0.24	86	0
NNC6	Backwash water recovery	0.2	North Norfolk Coast2 WTW backwash water recovery	167.51	0.24	27	0

6.15 Norfolk and The Broads

6.15.1 Constrained options

Table 91 Norfolk and the Broads WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
NTB17	Desalination	25	Bacton desalination (seawater) 25 Ml/d	Yes	Yes
NTB18	Desalination	50	Bacton desalination (seawater) 50 Ml/d	Yes	Yes
NTB19	Desalination	100	Bacton desalination (seawater) 100 Ml/d	Yes	Yes
NTB1	Reuse	11.1	Water Reuse at Lowestoft WRC with outfall received on the River Wensum. With water treatment extension at Heigham WTW.	Yes	Yes
NTB20	Desalination	25	Desalination (seawater) plant in the Caister area (25 Ml/d)	Yes	Yes
NTB21	Desalination	50	Desalination (seawater) plant in the Caister area (50 Ml/d)	Yes	Yes
NTB22	Desalination	100	Desalination (seawater) plant in the Caister area (100 Ml/d)	Yes	Yes
NTB27	Reuse	27.5	Lowestoft and Casiter reuse combined (to Wensum) - treatment	Yes	Yes
NTB28	Reuse	27.5	Lowestoft and Casiter reuse combined (to Costessey) - treatment	Yes	Yes
NTB29	Reuse	21.7	Water reuse Whitlingham	Yes	Yes
NTB30	Desalination	10	Bacton sea water desalination	Yes	Yes
NTB3	Desalination	25	Great Yarmouth desalination (seawater) 25 Ml/d	Yes	Yes
NTB4	Desalination	50	Great Yarmouth desalination (seawater) 50 Ml/d	Yes	Yes

6.15.2 NTB27 and NTB28 Lowestoft and Caister on Sea water reuse

NTB27 and NTB28 are water reuse options for potable supply. Final treated water effluent from Caister and Lowestoft WRCs currently discharges into the North Sea. This option would intercept effluent before discharge and divert to an advanced treatment process. Following treatment and conditioning the water from each recycling centre would be transferred to a pumping station to the east of Norwich. Here the transfers would combine and be forwarded to the River Wensum and then could be abstracted and treated with an extension to the existing Heigham water treatment works. NTB27 would transfer the effluent directly to the River Wensum, upstream of the Heigham abstraction. NTB28 would transfer to Costessey pits.

Figure 50 NTB27 and NTB28 Lowestoft and Caister on Sea water reuse

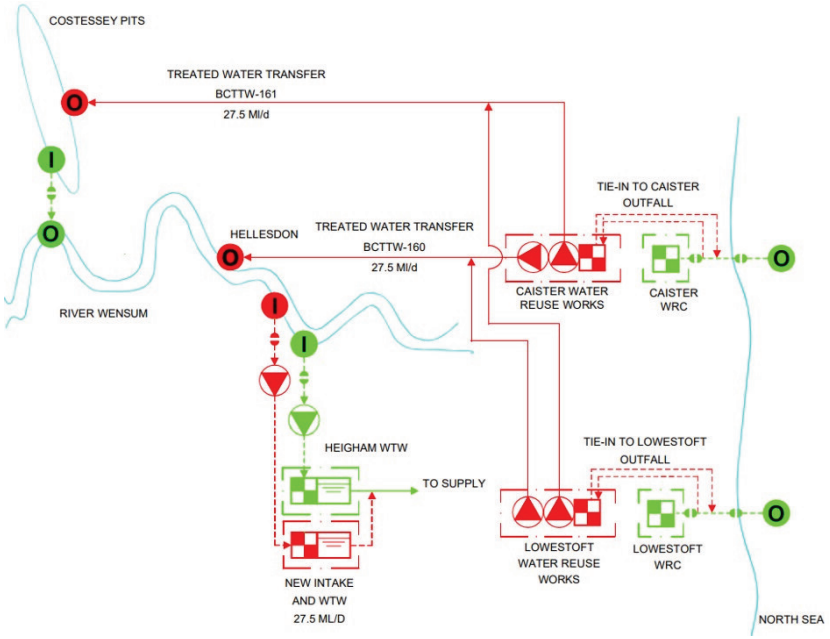


Table 92 Option summary for Lowestoft and Caister water reuse

Attribute	Description
Water source	Caister and Lowestoft WRCs via the River Wensum or Costessey pits.
Deployable Output	The deployable output of this option is 27.5 Ml/d. This is constrained by space available in Norwich to expand the potable water treatment works.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (River Yare) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations
Benefit	NTB27 and NTB28 - WAFU benefit of 27.5 Ml/d in the Norwich and the Broads WRZ.
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

Table 93 Cost benefit summary for Lowestoft and Caister water reuse options

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
NTB27	£455,693	£12,013	27.5	2032	Norwich and the Broads
NTB28	£422,995	£11,998	27.5	2032	Norwich and the Broads

Figure 51 Recent actual flow for Lowestoft WRC

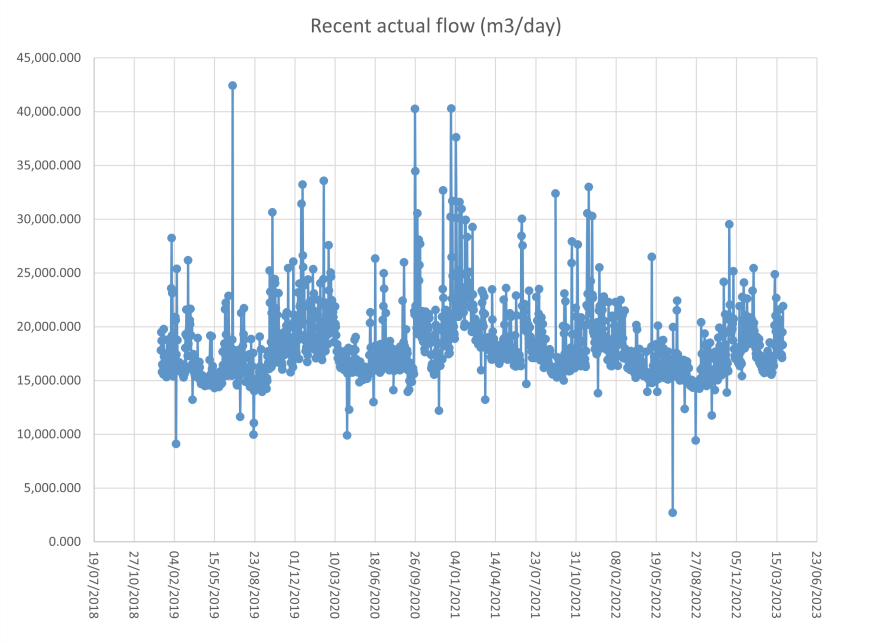


Table 94 Expected treatment performance for Lowestoft water reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/)
Total solids (mg/l)	279	145	73	0.07	0.07
Ammonia	47	4.69	4.69	0.94	0.94
Nitrate	13	55	4.69	0.09	0.09
Phosphate	9.8	4.9	2.45	1.29	0.03
Sodium	100	100	100	100	2
Chloride	1,687	1,687	1,687	34	34

Figure 52 Recent actual flow for Caister Pump Lane WRC

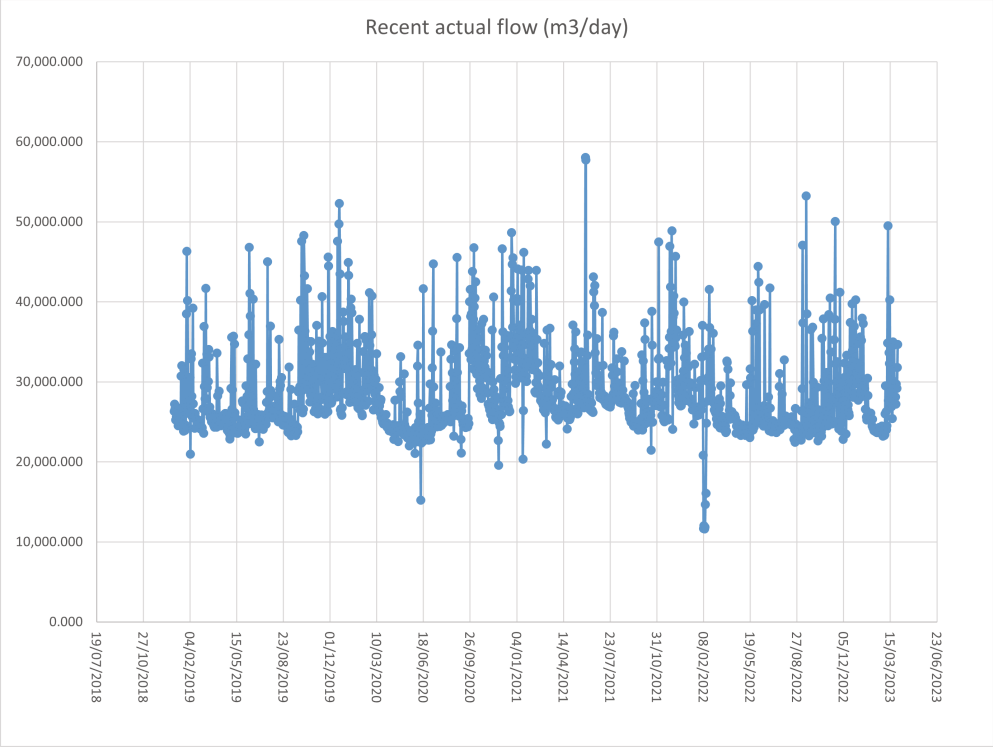


Table 95 Expected treatment performance for Caister-on-Sea water reuse

Consideration	Feed	Nitrifying BAFF	Denitrifying BAFF	UF membranes	Reverse osmosis
Total solids (mg/l)	135	73	36	1.82	0.04
Ammonia	55	5.51	5.51	1.1	1.1
Nitrate	4.9	54.6	4.62	0.09	0.09
Phosphate	9.1	4.55	2.27	1.19	0.02
Sodium	100	100	100	100	2
Chloride	1,382	1,382	1,382	1,382	28

6.15.3 NTB29 Whitlingham water reuse

NTB29 is a water reuse option for potable supply. Final treated water effluent from Whitlingham currently discharges into the river Yare. This option would intercept the effluent before discharge and divert to an advanced treatment process. Following treatment and conditioning the water would be transferred to the river Wensum and then could be abstracted and treated with an extension to the existing Heigham water treatment works.

Figure 53 Whitlingham water reuse option schematic

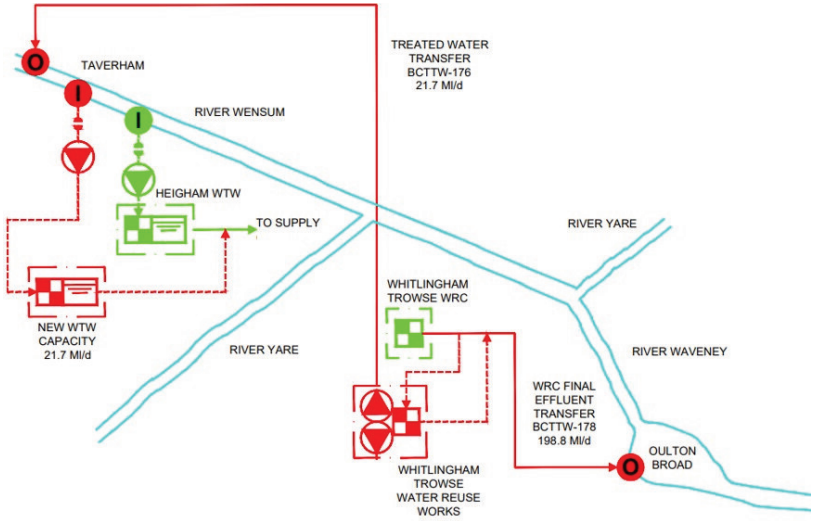


Table 96 Option summary for Whitlingham water reuse

Attribute	Description
Water source	Whitlingham WRC (discharge into the river Yare)
Deployable Output	Whitlingham WRC has a CDWF of 66,260m^3 Because treatment capacity in constrained by space at the receiving Water Treatment works in Norwich, the DO of this option is 21.7 Ml/d.
Water Quality	Feed water quality and expected treatment performance is shown in Table 98.
Benefit	This option would provide an additional 21.7 Ml/d WAFU into the Norwich & the Broads WRZ.
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

Table 97 Cost benefit summary for Whitlingham water reuse option

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
NTB29	£371,322	£9,951	21.7	2032	Norwich and the Broads

Further work needs to be done to understand the nutrient in chloride levels in the final effluent if these can be managed an alternative treatment solution could be utilised. There are potential nature based solutions available for this option, however, they could not be conclusively demonstrated as feasible and accurately costed for inclusion in EBSD. This will be resolved in out AMP8 adaptive planning programme.

Figure 54 Recent actual flow for Whitlingham water reuse

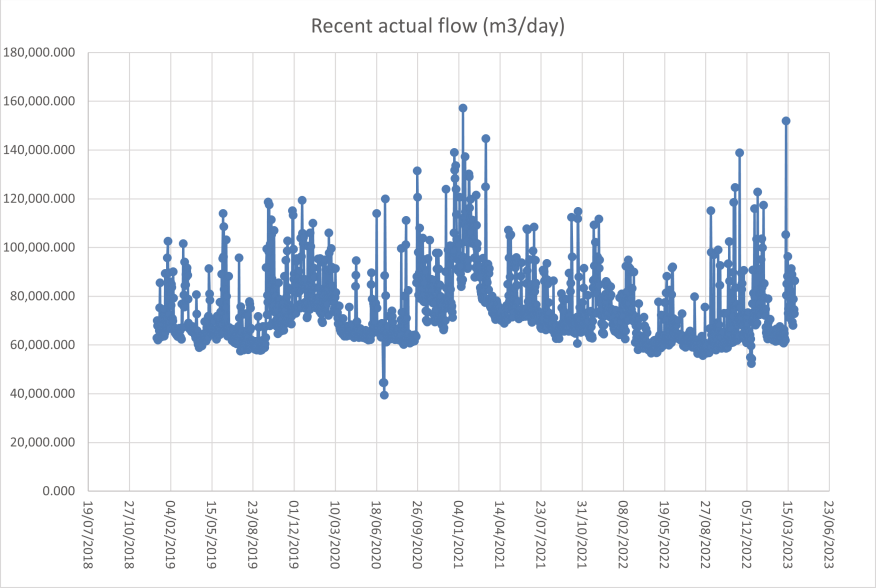


Table 98 Expected treatment performance for Whitlingham water reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids (mg/l)	26	13	6.6	0.33	0.07
Ammonia	0.62	0.06	0.06	0.06	0.01
Nitrate	59	59	5.08	0.1	0.1
Phosphate	14	7	3.5	1.84	0.04
Sodium	100	100	100	100	2
Chloride	290	290	290	290	5.8

6.15.4 NTB3, NTB4, NTB17, NTB18, NTB19, NTB20, NTB21, NTB22, NTB30 - Norfolk desalination options.

Seawater would be abstracted from the North Sea off the east coast of Norfolk.

From an intake chamber located onshore the seawater would pass through screens to exclude course material and be pumped to a desalination plant. Details of the process of desalination can be found in the desalination appendix of this report.

Following desalination and condition the water would be pumped to a blending tanks in our Norwich and the Broads WRZ from where it would be distribution into our existing network.

Feasibility studies demonstrate that up to 100 Ml/d of water is available from desalination from Bacton and Caister and up to 50 Ml/d from Great Yarmouth.

Norfolk desalination

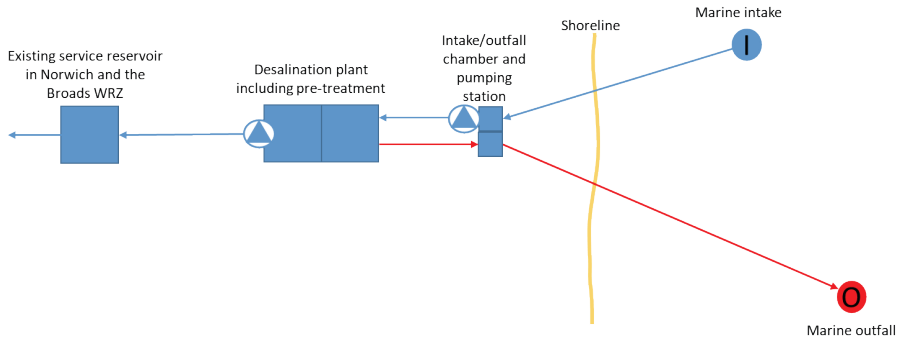


Table 99 Option summary for Norfolk desalination

Attribute	Description
Water source	North Sea.
Deployable output	Assessed at 25, 50 and 100 Ml/d.
Water quality	Expected feed water quality and treatment performance outlined in table Table 100. Discharge - modelling will be required to assess the full impact of the discharge plume.
Benefit	Desalination options are not impacted by supply forecast scenarios, so WAFU is equal to deployable output.
Delivery timescale	Delivery could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032.

Table 100 Expected treatment performance for Norfolk desalination

Parameter	Feed (mg/l)	Screening and clarification (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Solids (mg/l)	150	32	2	0.08
Dissolved solids (mg/l)	35000	35000	35000	192

6.15.5 Transfer options

Table 101 Norfolk and the Broads WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NTB10[a]	Potable water transfer	20	3.01	Norfolk Bradenham to Norwich and the Broads potable transfer (20 Ml/d)	37	600
		3	0.18		19	277
NTB24	Potable water transfer	5	0.57	Norfolk Harleston to Norwich and the Broads potable transfer (5 Ml/d)	30	290
NTB25	Potable water transfer	10	0.92	Norfolk Harleston to Norwich and the Broads potable transfer (10 Ml/d)	30	368
NTB26	Potable water transfer	50	6.77	Norfolk Bradenham to Norwich and the Broads potable transfer (50 Ml/d)	37	900
NTB9	Potable water transfer	10	1.75	Norfolk Bradenham to Norwich and the Broads potable transfer (10 Ml/d)	37	458

a NTB10 Norfolk Bradenham to Norwich and the Broads potable transfer reduces in capacity from 20 Ml/d to 3 Ml/d at Norwich, then continues to Kirby Cane. This is because we will lose our abstraction licence at Kirby Cane in 2030 for Habitats Directive compliance.

6.15.6 Option costs

Table 102 Norfolk and the Broads WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
NTB17	Desalination	25	Bacton desalination (seawater) 25 Ml/d	385,492.56	12,873.23	50,828	6,749	34	1,298
NTB18	Desalination	50	Bacton desalination (seawater) 50 Ml/d	663,306.68	24,242.54	66,848	13,479	34	1,298
NTB19	Desalination	100	Bacton desalination (seawater) 100 Ml/d	1,130,150.17	25,237.45	86,639	26,995	34	1,298
NTB20	Desalination	25	Desalination (seawater) plant in the Caister area (25 Ml/d)	362,855.51	12,882.86	48,513	6,749	41	1,470
NTB21	Desalination	50	Desalination (seawater) plant in the Caister area (50 Ml/d)	601,467.86	24,044.05	65,858	13,497	41	1,470
NTB22	Desalination	100	Desalination (seawater) plant in the Caister area (100 Ml/d)	1,036,059.00	25,214.52	81,486	26,995	41	1,470
NTB30	Desalination	10	Bacton sea water desalination	286,311.79	11,641.66	34,446	2,699	34	1,298
NTB3	Desalination	25	Great Yarmouth desalination (seawater) 25 Ml/d	416,082.97	12,742.16	52,744	6,749	27	1,025
NTB4	Desalination	50	Great Yarmouth desalination (seawater) 50 Ml/d	625,031.66	23,506.09	76,742	13,497	27	1,025
NTB10	Potable water transfer	20	Norfolk Bradneham to Norwich and the Broads potable transfer (20 Ml/d)	81,755.71	130.88	24,292	152	-	-
NTB24	Potable water transfer	5	Norfolk Harleston to Norwich and the Broads potable transfer (5 Ml/d)	36,700.06	47.16	5,667	153	-	-
NTB25	Potable water transfer	10	Norfolk Halreston to Norwich and the Broads potable transfer (10 Ml/d)	72,257.35	105.57	9,123	353	-	-

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
NTB26	Potable water transfer	50	Norfolk Bradenham to Norwich and the Broads potable transfer (50 Ml/d)	157,645.19	29.43	24,341	0	-	-
NTB9	Potable water transfer	10	Norfolk Bradenham to Norwich and the Broads potable transfer (10 Ml/d)	65,552.48	12.24	12,396	0	-	-
NTB1	Reuse	11.1	Water Reuse at Lowestoft WRC with outfall received on the River Wensum. With water treatment extension at Heigham WTW	240,095.79	5,786.57	31,476	605	129	4,192
NTB27	Reuse	27.5	Lowestoft and Casiter reuse combined (to Wensum) - treatment	455,692.51	12,012.59	62,544	1,396	101	3,601
NTB28	Reuse	27.5	Lowestoft and Casiter reuse combined (to Costessey) - treatment	422,995.39	11,998.48	59,975	1,349	101	3,601
NTB29	Reuse	21.7	Water reuse Whitlingham	371,321.82	9,951.21	41,266	753	21	1,041

6.15.7 Feasible options not modelled

Table 103 Norfolk and the Broads WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
NTB11	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Bacton (25 Ml/d)	Yes	Offshore desalination rejected
NTB12	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Bacton (50 Ml/d)	Yes	Offshore desalination rejected
NTB13	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Bacton (100 Ml/d)	Yes	Offshore desalination rejected
NTB14	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Caister (25 Ml/d)	Yes	Offshore desalination rejected
NTB15	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Caister (50 Ml/d)	Yes	Offshore desalination rejected
NTB16	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Caister (100 Ml/d)	Yes	Offshore desalination rejected
NTB1	Reuse	Lowestoft to Wensum / Heigham WTW (with additional treatment at Heigham WTW)	Yes	Exclusive to E&SW option - within their region
NTB2	Reuse	Water Reuse at Caister Pump Lane WRC with outfall received on the River Wensum. With water treatment extension at Heigham WTW	Yes	Exclusive to E&SW option - within their region
NTB2	Reuse	Caister Pump Lane to Heigham via River Wensum (no additional treatment)	Yes	Exclusive to E&SW option - within their region
NTB5	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Great Yarmouth (25 Ml/d)	Yes	Offshore desalination rejected
NTB6	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Great Yarmouth (50 Ml/d)	Yes	Offshore desalination rejected
NTB7	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Great Yarmouth (100 Ml/d)	Yes	Offshore desalination rejected

6.16 Norfolk Wymondham

6.16.1 Transfer options

Table 104 Norfolk Wymondham WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
NWY1	Potable water transfer	5	0.14	Norwich and the Broads to Norfolk Wymondham potable transfer (5 Ml/d)	12	229
NWY2	Potable water transfer	15	0.37	Norwich and the Broads to Norfolk Wymondham potable transfer (15 Ml/d)	12	368
NWY3	Potable water transfer	10	0.34	Norwich and the Broads to Norfolk Wymondham potable transfer (10 Ml/d)	12	353

6.16.2 Option costs

Table 105 Norfolk Wymondham WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
NWY1	Potable water transfer	5	Norwich and the Broads to Norfolk Wymondham potable transfer (5 Ml/d)	10,197.43	71.53	1,796	266
NWY2	Potable water transfer	15	Norwich and the Broads to Norfolk Wymondham potable transfer (15 Ml/d)	18,514.03	173.88	3,450	655
NWY3	Potable water transfer	10	Norwich and the Broads to Norfolk Wymondham potable transfer (10 Ml/d)	18,920.66	54.38	3,887	194

6.17 Ruthamford Central

6.17.1 Transfer options

Table 106 Ruthamford Central WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
RTC1	Potable water transfer	70	3.73	Ruthamford West to Ruthamford Central potable transfer (70 Ml/d)	26	800
RTC2	Potable water transfer	12	0.85	Ruthamford South to Ruthamford Central potable transfer (12 Ml/d)	23	409
RTC3	Potable water transfer	20	1.27	Ruthamford South to Ruthamford Central potable transfer (20 Ml/d)	23	500
RTC4	Potable water transfer	10	0.97	Ruthamford West to Ruthamford Central potable transfer (10 Ml/d)	26	409
RTC5	Potable water transfer	20	1.46	Ruthamford West to Ruthamford Central potable transfer (20 Ml/d)	26	500

6.17.2 Option costs

Table 107 Ruthamford Central WRZ option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
RTC1	Potable water transfer	70	Ruthamford West to Ruthamford Central potable transfer (70 Ml/d)	94,452.59	796.01	15,775	3,005
RTC2	Potable water transfer	12	Ruthamford South to Ruthamford Central potable transfer (12 Ml/d)	29,009.36	96.58	6,101	349

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
RTC3	Potable water transfer	20	Ruthamford South to Ruthamford Central potable transfer (20 Ml/d)	44,104.39	164.91	10,083	603
RTC4	Potable water transfer	10	Ruthamford West to Ruthamford Central potable transfer (10 Ml/d)	35,746.32	99.21	6,867	354
RTC5	Potable water transfer	20	Ruthamford West to Ruthamford Central potable transfer (20 Ml/d)	59,981.18	239.35	11,929	879

6.18 Ruthamford North

6.18.1 Constrained options

Table 108 Ruthamford North constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
RTN26	New Reservoir	105	Lincolnshire reservoir 25 Mm3	Yes	Yes
RTN17	New Reservoir	169	Lincolnshire reservoir 50 Mm3	Yes	Yes
RTN27	New Reservoir	195	Lincolnshire reservoir 75 Mm3	Yes	Yes
RTN28	New Reservoir	214	Lincolnshire reservoir 100 Mm3	Yes	Yes
RTN1	Reuse	7.4	Peterborough Flag Fen to direct to Rutland Water / Wing WTW - with extra treatment at Wing WTW	Yes	Yes

6.18.2 RTN17, RTN27, RTN26 and RTN28- Lincolnshire Reservoir

The Lincolnshire Reservoir was introduced into the RAPID gated process by both Anglian Water and Affinity Water, with the original solution including a transfer of up to 100 Ml/d of water from the reservoir to the Affinity Water (central) supply area. Through regional modelling and best value assessment at both WRE and WRSE level, it has been concluded that this transfer did not represent best value for customers. Consequently, Affinity Water has pursued other SROs, ceasing to be a project partner on the Lincolnshire Reservoir at Gate 2 of the RAPID process.

The Lincolnshire Reservoir is a 55 MCM raw water storage reservoir, with a usable volume of 50 MCM. There are three possible sources being assessed for the reservoir; these are the:

- River Trent which has significant water availability and provides a highly climate resilient source for the Lincolnshire Reservoir, in support of the Witham source. It is proposed to transfer, either by pipeline or open channel transfer from the Trent to the Witham at times when it is not possible to abstract from the Witham itself.
- River Witham catchment serves as an important source in its own right, in addition to its function as a transfer route to bring water from the Trent to the reservoir. A pipeline transfer from the Witham to the reservoir is being assessed, alongside an open channel transfer via the South Forty Foot Drain.
- South Forty Foot Drain is being considered as a potential additional source to supply the reservoir given its proximity, and potential function as a transfer route for water from the Witham.

These sources have been modelled to determine yield according to reservoir size. The yields are shown below inTable 109.

The earliest the Lincolnshire Reservoir will be available to use is 2039. Once in supply, it is expected that the associated water treatment works will supply 169 Ml/d of water to 500,000 customers in Lincolnshire, as well as connecting into our existing network in the south-west of region, through a new transfer from Peterborough to Grafham.

Table 109 An overview of the Lincolnshire Reservoir options that progressed to modelling

Reservoir size (MCM)	Total yield (Ml/d)	Construction of reservoir embankment (years)	Anticipated programme duration (years)	Estimated earliest year in service	Proportion to Anglian Water
25	105	5.4	9.5	2038	100%
50	169	6.7	10.5	2039	100%
75	195	9.2	3	2041	100%
100	214	14.4	18.5	2046	100%

Proposed abstraction locations and transfers

Table 110 Option summary for Lincolnshire Reservoir

RTN17, RTN26, RTN27 and RTN28	
Attribute	**Description**
Water source	Water will be abstracted from the River Witham and the South Forty Foot Drain. This will be supported by a transfer from the river Trent to the river Witham when surplus is available.
Deployable Output	The yield of the reservoir, and therefore deployable output is dependent on its capacity.
Water Quality	Assessment of raw water quality from the potential abstraction locations is ongoing - this will inform the detailed design of the treatment solution of water from the reservoir.
Benefit	As deployable output, above.
Delivery timescale	This is a large scale project will complex planning consideration but it is anticipated that water will become available between 2039 and 2041.

Table 111 Cost benefit summary for Lincolnshire Reservoir

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
RTN26	£2,050,500	£7,034	105	2038	Ruthamford North
RTN17	£2,290,443	£9,972	169	2039	Ruthamford North
RTN27	£2,588,800	£11,459	195	2041	Ruthamford North
RTN28	£2,963,041	£13,511	214	2047	Ruthamford North

Figure 55 Lincolnshire Reservoir and transfers

Option ID	Option name	Max capacity (Ml/d)
RTN26, RTN17, RTN27, RTN28	Lincolnshire reservoir	105 169 195 214

Option ID	Option name	Max capacity (Ml/d)
RTN10	Ruthamford North to Ruthamford North potable transfer (10 Ml/d)	10
RTN12	Ruthamford North to Ruthamford North potable transfer (50 Ml/d)	50
RTN13	Ruthamford North to Ruthamford North potable transfer (100 Ml/d)	100
RTN14	Ruthamford North to Ruthamford North potable transfer (150 Ml/d)	150

Option ID	Option name	Max capacity (Ml/d)
RTS1	Ruthamford North to Ruthamford South potable transfer (10 Ml/d)	10
RTS11	Ruthamford North to Ruthamford South potable transfer (50 Ml/d)	50
RTS12	Ruthamford North to Ruthamford South potable transfer (100 Ml/d)	100
RTS13	Ruthamford North to Ruthamford South potable transfer (150 Ml/d)	150

6.18.3 Transfer options

Table 112 Ruthamford North WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
RTN10	Potable water transfer	10	0.31	Lincolnshire Central to Ruthamford North potable transfer (10 Ml/d)	13	327
RTN11	Potable water transfer	20	5.53	Lincolnshire Central to Ruthamford North potable transfer (20 Ml/d)	68	600
RTN12	Potable water transfer	50	1.41	Lincolnshire Central to Ruthamford North potable transfer (50 Ml/d)	13	700
RTN13	Potable water transfer	100	2.87	Lincolnshire Central to Ruthamford North potable transfer (100 Ml/d)	13	1000
RTN14	Potable water transfer	150	4.14	Lincolnshire Central to Ruthamford North potable transfer (150 Ml/d)	13	1200
RTN15	Potable water transfer	20	5.64	Fenland to Ruthamford North potable transfer (20 Ml/d)	51	700
RTN16	Potable water transfer	100	18.58	Lincolnshire Central to Ruthamford North potable transfer (100 Ml/d)	68	1100
RTN21	Potable water transfer	16.9	8.09	River Trent to Ruthamford North transfer (19.9 Ml/d)	56	800
RTN22	Potable water transfer	100	19.46	Fenland to Ruthamford North potable transfer (100 Ml/d)	51	1300
RTN29	Potable water transfer	60	1.41	Lincolnshire Central to Ruthamford North potable transfer (60 Ml/d)	13	706
RTN30	Potable water transfer	75	2.33	Lincolnshire Central to Ruthamford North potable transfer (75 Ml/d)	13	900
RTN8	Potable water transfer	10	2.57	Lincolnshire Central to Ruthamford North potable transfer (10 Ml/d)	68	409

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
RTN9	Potable water transfer	10	1.93	Fenland to Ruthamford North potable transfer (10 Ml/d)	51	409

Options RTN10, RTN12, RTN13 and RTN14 are intra-resource zone transfers. These interactions shown on the map in Figure 55. This illustrated that, while RTN17 (Lincolnshire Reservoir) is not geographically in Ruthamford South, the benefit is to this WRZ and therefore we have modelled this way, along with the dependent downstream transfers. The map also shows how this set of options provide future support to the options described in the section above.

6.18.4 Option costs

Table 113 Cost benefit summary for Ruthamford North transfer options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
RTN10	Potable water transfer	10	Lincolnshire Central to Ruthamford North potable transfer (10 Ml/d)	17,845.86	116.94	2,883	435	-	-
RTN11	Potable water transfer	20	Lincolnshire Central to Ruthamford North potable trasnfer (20 Ml/d)	145,779.65	204.05	37,359	680	-	-
RTN12	Potable water transfer	50	Lincolnshire Central to Ruthamford North potable transfer (50 Ml/d)	52,949.66	442.37	6,943	1,669	-	-
RTN13	Potable water transfer	100	Lincolnshire Central to Ruthamford North potable transfer (100 Ml/d)	75,676.52	743.49	12,533	2,816	-	-
RTN14	Potable water transfer	150	Lincolnshire Central to Ruthamford North potable transfer (150 Ml/d)	93,405.80	1,039.55	17,305	2,816	-	-
RTN15	Potable water transfer	20	Fenland to Ruthamford North potable transfer (20 Ml/d)	114,246.85	21.32	19,662	-	-	-
RTN16	Potable water transfer	100	Lincolnshire Central to Ruthamford North potable transfer (100 Ml/d)	267,400.33	949.25	64,862	3,474	-	-
RTN31	Drought permit	0	Rutland drought permit	500.00	-			-	-
RTN17	New Reservoir	169	Lincolnshire reservoir 50 MCMD	2,290,443.03	9,972.20	449,738	13,954	618	18,552
RTN21	Potable water transfer	16.9	River Trent to Ruthamford North transfer (19.9 Ml/d)	408,508.14	10,911.42	173,451	14,195	-	-
RTN22	Potable water transfer	100	Fenland to Ruthamford North potable transfer (100 Ml/d)	177,776.53	33.18	54,974	-	-	-
RTN26	New Reservoir	105	Lincolnshire reservoir 25 MCMD	2,050,500.33	7,034.25	248,385	11,972	618	18,552
RTN27	New Reservoir	195	Lincolnshire reservoir 75 MCMD	2,588,800.23	11,458.79	325,915	14,954	618	18,552
RTN28	New Reservoir	214	Lincolnshire reservoir 100 MCMD	2,963,041.12	13,510.71	364,799	16,921	618	18,552

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
RTN29	Potable water transfer	60	Lincolnshire Central to Ruthamford North potable transfer (60 Ml/d)	55,973.53	577.17	7,259	2,188	-	-
RTN30	Potable water transfer	75	Lincolnshire Central to Ruthamford North potable transfer (75 Ml/d)	70,580.57	547.82	11,953	2,064	-	-
RTN1	Reuse	7.4	Peterborough Flag Fen to direct to Rutland Water / Wing WTW - with extra treatment at Wing WTW	263,374.59	4,905.82	38,857	861	33	1,702
RTN8	Potable water transfer	10	Lincolnshire Central to Ruthamford North potable transfer (10 Ml/d)	85,839.72	129.63	17,291	436	-	-
RTN9	Potable water transfer	10	Fenland to Ruthamford North potable transfer (10 Ml/d)	47,049.04	2,432.17	39,777	3,172	-	-

6.18.5 Feasible options not modelled

Table 114 Ruthamford North WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
RTN2	Reuse	Peterborough Flag Fen to direct to Rutland Water / Wing WTW - No treatment at Wing WTW	Yes	No benefit without potable treatment expansion
RTN3	Reuse	Peterborough Flag Fen to Rutland / Wing via River Nene (with additional treatment at Wing WTW)	Yes	Very little DO for cost of option
RTN4	Reuse	Peterborough Flag Fen to Rutland / Wing via River Nene (without additional treatment)	Yes	No benefit without potable treatment expansion
RTN5	Desalination	Boston Area (brackish) desalination (10 Ml/d)	Yes	Brackish desalination rejected
RTN6	Desalination	Boston Area (brackish) desalination (25 Ml/d)	Yes	Brackish desalination rejected
RTN7	Conjunctive use 3rd party	Little Barford Declined T&T[a] transfer to Rutland	Yes	20 Ml/d options would impact d/s abstractions

a Declined T&T means declined take and take. When the incumbent holder isn't taking the the full volume of the licence, thus declining it, the remainder it is available for us to take.

6.19 Ruthamford South

6.19.1 Constrained options

Table 115 Ruthamford South WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
RTS16	Drought permit	2.07	Ruthamford South Drought permit	Yes	Yes
RTS21	Surface water enhancement	6	Ruthamford South surface water enhancement	Yes	Yes
RTS22	Surface water enhancement	6.7	Ruthamford South Surface water expansion	Yes	Yes

6.19.2 RTS21 Clapham WTW surface water enhancement

Our Clapham water treatment works abstracts water directly from the River Great Ouse. Treated water is distributed into Ruthamford South WRZ.

The water in the river is of variable quality with no significant storage or opportunities for raw water blending. As a result, the existing treatment processes cannot reliably treat the full licensed volume of 27 Ml/d.

Option RTS21 will enhance the existing treatment process by adding pre-treatment and nitrate removal. This will enable the treatment works to achieve its full output of 25.7 Ml/d, after process losses, which will result in an additional 6.6 Ml/d of WAFU in Ruthamford South (RTS) WRZ.

Option RTS22 is an alternative to this option which would require the transfer of unused Foxcote licence to Clapham, then expand the existing treatment to accommodate the additional water available. Supply forecast modelling suggests that the additional licence could not be fully utilised in the planning scenario and therefore the additional WAFU from this option would be 6.7 Ml/d.

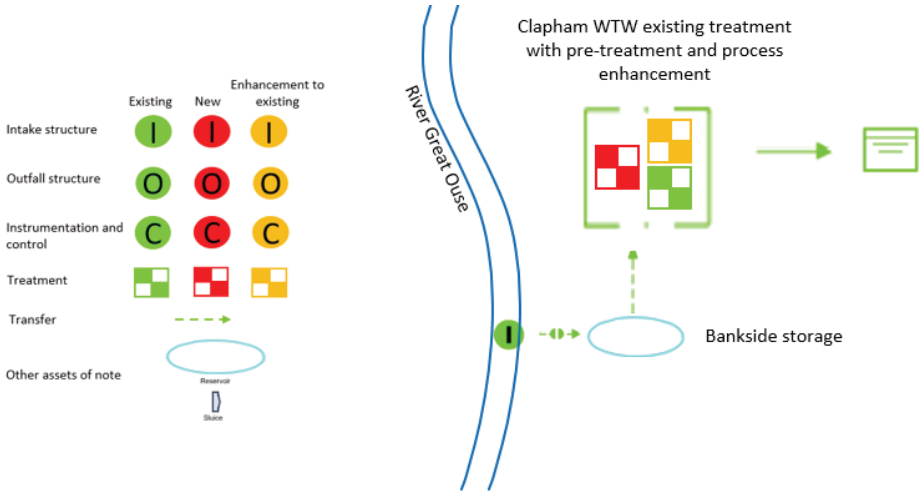


Table 116 Option summary for Clapham WTW surface water enhancement

Attribute	Description
Water source	River Great Ouse. Existing abstraction. **RTS21** is within existing licence. **RTS22** involves the transfer of unused Foxcote licence, increasing Clapham licence to 36 Ml/d.
Deployable output/capacity	RTS21 will increase the reliable treatment capacity to 25.7 Ml/d. This gives an additional 6 Ml/d WAFU. RTS22 would increase abstraction and reliable treatment capacity to 34 Ml/d. This gives an additional 6.7 Ml/d WAFU.
Water quality	Water quality in the River Great Ouse at Bedford is variable. **RTS22-** The new treatment processes will enable full utilisation of current abstraction licence. The existing membrane modules have sufficient capacity to treat the full licence. **RTS22-** The alternative option to transfer our Foxcote abstraction licence to Clapham would require a further expansion to the existing treatment processes, including additional membrane modules.
Benefit/WAFU	**RTS21** will increase WAFU in Ruthamford South WRZ by 6 Ml/d. **RTS22** will increase WAFU in Ruthamford South WRZ by 6.7 Ml/d.
Delivery timescale	WAFU benefit would be available by 2030

Table 117 Cost benefit summary for Clapham WTW surface water enhancement

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
RTS21	£34,674	£384	6	2030	Ruthamford South

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
RTS22	£50,253	£360	6.7	2030	Ruthamford South

6.19.3 Transfer options

Table 118 Ruthamford South WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
RTS1	Potable water transfer	10	0.96	Ruthamford North to Ruthamford South potable transfer (10 Ml/d)	32	368
RTS10	Potable water transfer	10	1.19	Cambridge Water to Ruthamford South potable transfer (10 Ml/d)	39	368
RTS11	Potable water transfer	50	3.48	Ruthamford North to Ruthamford South potable transfer (50 Ml/d)	32	700
RTS12	Potable water transfer	100	7.10	Ruthamford North to Ruthamford South potable transfer (100 Ml/d)	32	1000
RTS13	Potable water transfer	150	10.22	Ruthamford North to Ruthamford South potable transfer (150 Ml/d)	32	1200
RTS14	Potable water transfer	20	2.20	Cambridge Water to Ruthamford South potable transfer (20 Ml/d)	39	500
RTS15	Potable water transfer	50	5.63	Cambridge Water to Ruthamford South potable transfer (50 Ml/d)	39	800
RTS23	Potable water transfer	60	4.54	Ruthamford North to Ruthamford South potable transfer (60 Ml/d)	32	800
RTS24	Potable water transfer	75	5.75	Ruthamford North to Ruthamford South potable transfer (75 Ml/d)	32	900

6.19.4 Option costs

Table 119 Cost benefit summary for Ruthamford South options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
RTS1	Potable water transfer	10	Ruthamford North to Ruthamford South potable transfer (10 Ml/d)	36,180.58	112.12	7,123	404
RTS10	Potable water transfer	10	Cambridge Water to Ruthamford South potable transfer (10 Ml/d)	64,911.56	133.06	9,316	464
RTS11	Potable water transfer	50	Ruthamford North to Ruthamford South potable transfer (50 Ml/d)	84,709.01	558.71	14,522	2,096
RTS12	Potable water transfer	100	Ruthamford North to Ruthamford South potable transfer (100 Ml/d)	118,346.69	773.44	26,829	2,902
RTS13	Potable water transfer	150	Ruthamford North to Ruthamford South potable transfer (150 Ml/d)	140,908.26	976.95	36,898	3,673
RTS14	Potable water transfer	20	Cambridge Water to Ruthamford South potable transfer (20 Ml/d)	101,178.39	240.16	17,717	853
RTS15	Potable water transfer	50	Cambridge Water to Ruthamford South potable transfer (50 Ml/d)	177,034.42	343.66	17,225	1,197
RTS16	Drought permit	2.07	Ruthamford South Drought permit	500.00	20.00	-	
RTS21	Surface water enhancement	6	Ruthamford South surface water enhancement	34,673.77	384.24	3,909	488
RTS22	Surface water enhancement	6.7	Ruthamford South Surface water expansion	50,252.68	359.56	9,964	-
RTS23	Potable water transfer	60	Ruthamford North to Ruthamford South potable transfer (60 Ml/d)	78,558.25	1,433.59	17,806	1,853
RTS24	Potable water transfer	75	Ruthamford North to Ruthamford South potable transfer (75 Ml/d)	79,615.29	1,586.75	17,975	2,054

6.19.5 Feasible options not modelled

Table 120 Ruthamford South WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
RTS8	Backwash water recovery	Ruthamford South WTW backwash water recovery	Yes	Water quality risk
RTS9	Conjunctive use 3rd party	Little Barford (declined take and take)	Yes	Unreliable resource - impact on downstream abstraction

6.20 Ruthamford West

6.20.1 Transfer options

Table 121 Ruthamford West WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
RTW1	Potable water transfer	10	1.32	Ruthamford North to Ruthamford Central potable transfer (10 Ml/d)	35	409
RTW2	Potable water transfer	70	6.40	Ruthamford North to Ruthamford West potable transfer (70 Ml/d)	35	900
RTW4	Potable water transfer	20	1.97	Ruthamford North to Ruthamford West potable transfer (20 Ml/d)	35	500

6.20.2 Option costs

Table 122 Cost benefit summary for Ruthamford West options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
RTW1	Potable water transfer	10	Ruthamford North to Ruthamford Central potable transfer (10 Ml/d)	43,788.39	55.81	8,955	181
RTW2	Potable water transfer	70	Ruthamford North to Ruthamford West potable transfer (70 Ml/d)	108,650.00	265.84	23,023	947
RTW4	Potable water transfer	20	Ruthamford North to Ruthamford West potable transfer (20 Ml/d)	66,061.78	171.76	15,515	614

6.20.3 Feasible options not modelled

Table 123 Ruthamford West feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
RTW3	New Reservoir	Foxcote/Fosscott Reservoir	Yes	Stakeholder workshop concluded that there could be a possible impact on downstream abstraction. Difficult to mitigate impacts on SSSI. Water quality poses complex treatment challenges and phosphate impacts on waterbodies from recommissioning.

6.21 South Humber Bank

6.21.1 Constrained options

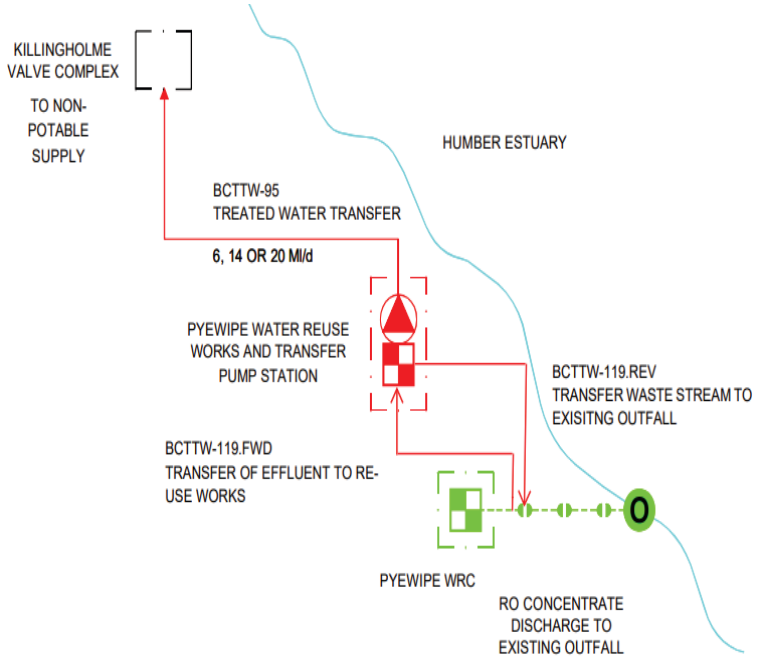
Table 124 South Humber Bank WRZ constrained options

Option ref	Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
SHB1	SHB1	Reuse	6	Pyewipe WRC (non potable - 6 Ml/d)	Yes	Yes
SHB2	SHB2	Reuse	14	Pyewipe WRC (non potable - 14 Ml/d)	Yes	Yes
SHB3	SHB3	Reuse	20	Pyewipe WRC (non potable - 20 Ml/d)	Yes	Yes
SHB9	SHB9	Desalination	60	South Humber Bank non-potable desal (Mablethorpe seawater)	Yes	Yes

6.21.2 SHB1, SHB2 and SHB3- Pyewipe non-potable reuse

SHB1, SHB2 and SHB3 are water recycling for non-potable use options. Treated water from Pyewipe WRC is currently discharged into the Humber Estuary. The purpose of these options is to intercept this water before it is discharged and transfer it to an advanced treatment process. This process will treat and condition the water to a standard that is suitable for non-potable use by South Humber Bank industry.

Pyewipe non-potable reuse



The option has been developed at 3 different capacities to enable flexibility in scheme delivery.

It is anticipated that industrial demand will grow on the South Humber Bank over the coming decades and this approach gives us the opportunity to expand capacity to meet demand with a modular solution, up to a maximum capacity of 20 Ml/d.

Table 125 Option summary for Pyewipe non-potable reuse

Attribute	Description
Deployable output	Pyewipe has a CDWF of 46,270 m³/day. Actual flows show that approx. 30 Ml/d is a reliable figure to use. This means 6, 14 and 20 Ml/d versions of this option are feasible.
Water quality at brine outfall discharge location	The discharge location for the brine outfall (Humber estuary) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	Increased deployable output at Immingham Port and South Humber Bank non-potable demand hub. Potential opportunity to provide softer water (including boiler feed) to local industry which could improve efficiency of processes resulting in less demand.
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

Table 126 Cost benefit summary for Pyewipe non-potable reuse

Option ID	CAPEX (£k)	£/m³	WAFU (Ml/d)	Year available	Receiving WRZ
SHB1	86,416	3,909	6	2032	SHB
SHB2	136,400	7,001	14	2032	SHB
SHB3	159,186	9,435	20	2032	SHB

Figure 56 Recent actual flow at Pyewipe WRC

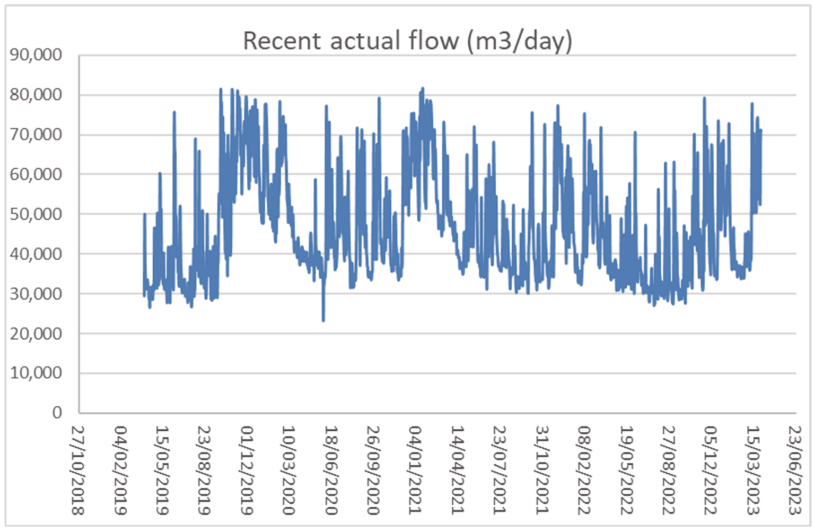


Table 127 Expected treatment performance for Pyewipe non-potable reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids	56	14	14	0.7	0.1
Ammonia	45	4.5	4.5	4.5	0.9
Nitrate	15	56	4.7	4.7	0.9
Phosphate	7	3.5	1.75	0.92	0.02
Sodium	100	100	100	100	2
Chloride	125	125	125	125	2.5

6.21.3 SHB9 non-potable desalination

Seawater would be abstracted from the North Sea off the east coast of Lincolnshire near Mablethorpe. From an intake chamber located onshore, the seawater would pass through screens to exclude course material and be pumped to a desalination plant. Details of the process of desalination can be found in the desalination appendix of this report. Following desalination and condition, the water would be pumped to a blending tanks in our non-potable network which supplies water to the South Humber Bank industrial cluster.

Feasibility studies demonstrate that up to 100 Ml/d of water is available from desalination from Mablethorpe.

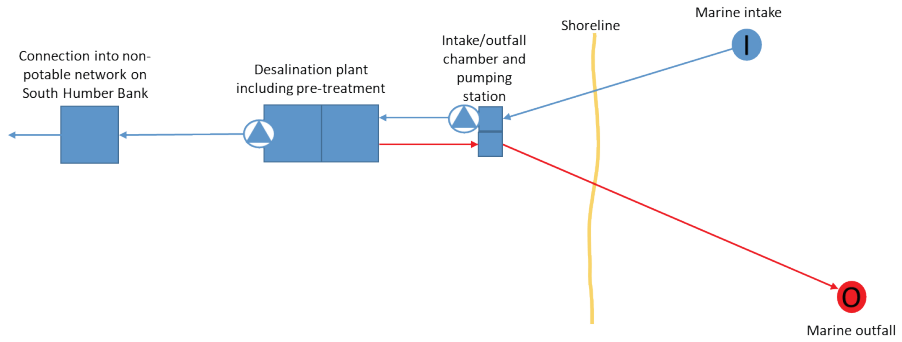


Table 128 Option summary for South Humber non-potable desalination

Attribute	Description
Water source	North Sea.
Deployable output	Assessed at 25, 50 and 100 Ml/d.
Water quality	Expected feed water quality and treatment performance outlined in Table 129. Discharge - modelling will be required to assess the full impact of the discharge plume.
Benefit	Desalination options are not impacted by supply forecast scenarios, so WAFU is equal to deployable output.
Delivery timescale	Delivery could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032.

Table 129 Expected treatment performance for South Humber Bank non-potable desalination

Parameter	Feed (mg/l)	Screening and clarification (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Solids (mg/l)	150	32	2	0.08
Dissolved solids (mg/l)	35000	35000	35000	192

6.21.4 Options cost

Table 130 South Humber Bank WRZ option costs

Option ID	Option type	Gain in WAFU	Option name	CAPEX £k	Annual opex £k	Carbon TCO2E	Operational Carbon TCO2E2	Habitats Units (required restoration)	BNG cost £k
SHB9	Desalination	60	South Humber Bank desalination NP	515,227.3	12,967.7	61,555.3	398	5	299
SHB1	Reuse	6	Pyewipe (non-potable 6 Ml/d)	86,416.04	3,909.27	10,361	786	4	197
SHB2	Reuse	14	Pyewipe (non-potable 14 Ml/d)	136,399.69	7,000.53	14,788	1,234	4	197
SHB3	Reuse	20	Pyewipe (non-potable 20 Ml/d)	159,186.14	9,434.88	17,857	1,199	4	197

6.21.5 Feasible options not modelled

Table 131 South Humber Bank WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
SHB6	Desalination	Desalination (seawater) on the South Humber Bank feeding the non-potable network (10 Ml/d)	Yes	Estuarial desalination rejected
SHB7	Desalination	Desalination (seawater) on the South Humber Bank feeding the non-potable network (25 Ml/d)	Yes	Estuarial desalination rejected
SHB8	Desalination	South Humber Bank desalination NP	Yes	Estuarial desalination rejected

6.22 Suffolk East

6.22.1 Constrained options

Table 132 Suffolk East WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
SUE14	Desalination	25	Sizewell desalination (seawater) 25 Ml/d	Yes	Yes
SUE15	Desalination	50	Sizewell desalination (seawater) 50 Ml/d	Yes	Yes
SUE16	Desalination	100	Sizewell desalination (seawater) 100 Ml/d	Yes	Yes
SUE17	Aquifer Storage Recovery (ASR)	2.3	Bucklesham ASR	Yes	Yes
SUE1	Reuse	14.5	Ipswich Cliff Quay direct to Alton Reservoir (with additional abstraction and treatment at Alton)	Yes	Yes
SUE23	Groundwater enhancement	1.7	Suffolk East groundwater enhancement	Yes	Yes
SUE25	Backwash water recovery	0.17	Suffolk East WTW backwash water recovery	Yes	Yes
SUE3	Reuse	11.5	Ipswich Cliff Quay to Alton via River Gipping (with additional treatment at Alton)	Yes	Yes
SUE5	Desalination	25	Felixstowe desalination (seawater) 25 Ml/d	Yes	Yes
SUE6	Desalination	50	Felixstowe desalination (seawater) 50 Ml/d	Yes	Yes
SUE7	Desalination	100	Felixstowe desalination (seawater) 100 Ml/d	Yes	Yes

6.22.2 SUE1 and SUE3 Ipswich reuse

SUE1 and SUE3 are water reuse options for potable supply. Final treated water effluent from Ipswich WRC currently discharges into the river Orwell. This option would intercept the effluent before discharge and divert to an advanced treatment process.

SUE1 is the transfer water from the advanced treatment to Alton Water for abstraction and treatment at an expansion to the existing water treatment works. Schematic shown in Figure 57. SUE3 is the transfer to the river Gipping, then abstract from the river Gipping and transfer to Alton Water for abstraction and treatment at an expansion to the existing water treatment works .

Figure 57 SUE1- Ipswich reuse direct to reservoir

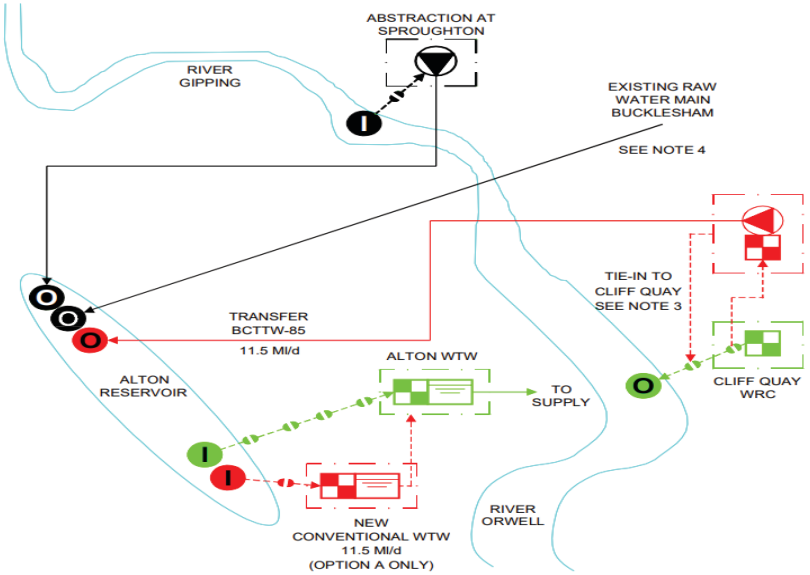


Table 133 Option summary for Ipswich reuse

Attribute	Description
Water source	Ipswich WRC (SUE1 - via Alton Water / SUE3 - via river Gipping and Alton Water)
Deployable Output	Ipswich WRC has a CDWF of 34,200 m³. Following advanced treatment and brine dilution the DO is 11.5 Ml/d
Water quality	Feed water quality and expected treatment performance is shown in Table 135.
Water Quality at brine outfall discharge location	The discharge location for the brine outfall (River Orwell) has high levels of chloride. This means that the chloride levels in the brine will be lower than the background chloride levels at the discharge location. The reverse osmosis brine will increase the concentrations of phosphate, sodium and chloride in the plant waste effluent compared to current concentrations.
Benefit	SUE1 - WAFU available in Suffolk East WRZ is 14.5 Ml/d SUE3 - WAFU available in Suffolk East WRZ is 11.5 Ml/d
Delivery timescale	Delivery timescale is 7 to 10 years. This means the earliest date water could be available for use is 2032.

SUE3- Ipswich reuse to river

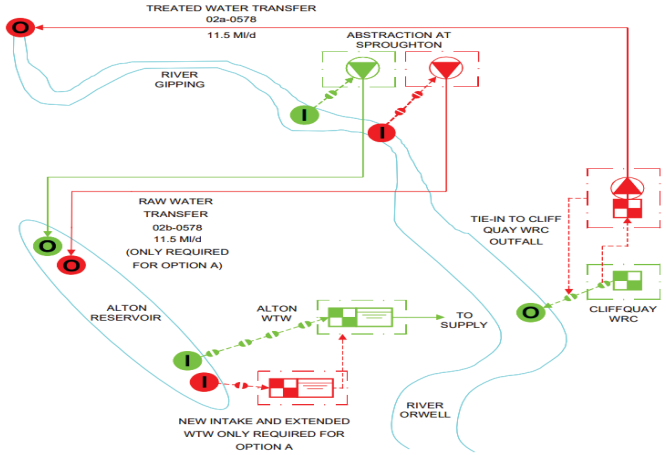


Table 134 Cost benefit summary for Ipswich reuse options

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
SUE1	£196,441	£5,926	14.5	2032	Suffolk East
SUE3	£225,343	£6,558	11.5	2032	Suffolk East

Figure 58 Recent actual flow for Ipswich WRC

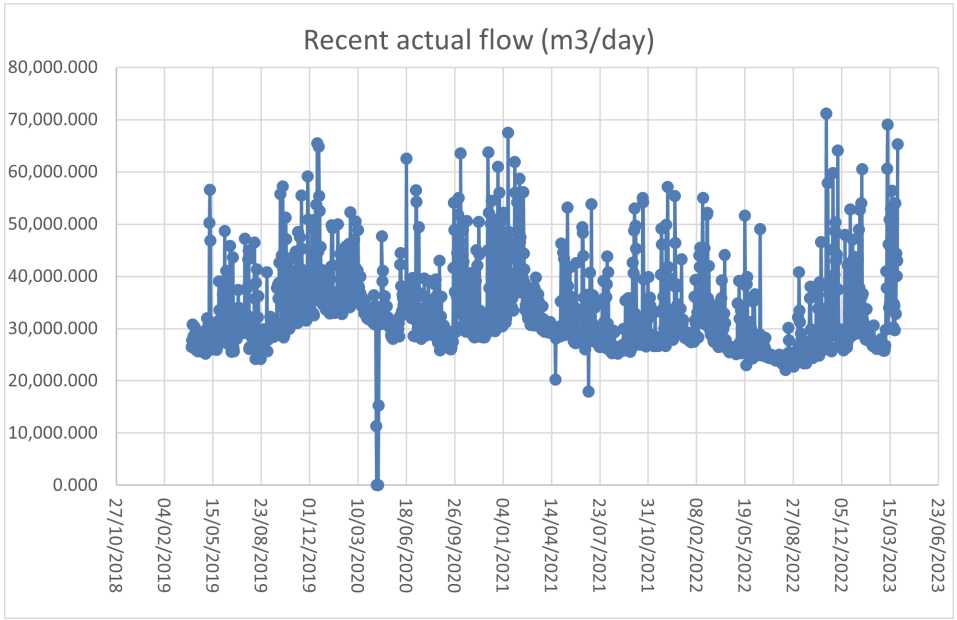


Table 135 Expected treatment performance for Ipswich reuse

Consideration	Feed (mg/l)	Nitrifying BAFF (mg/l)	Denitrifying BAFF (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Total solids (mg/l)	62	37	18	0.92	0.02
Ammonia	50	4.96	4.96	0.99	0.99
Nitrate	10	55	4.7	0.09	0.09
Phosphate	6.6	3.3	1.65	0.02	0.02
Sodium	100	100	100	100	2
Chloride	491	491	491	491	9.82

6.22.3 SUE17 Bucklesham ASR

Bucklesham ASR scheme would abstract water from the river Gipping and treat it to an acceptable standard for groundwater injection at a new surface water treatment works. The water would then be transferred to an array of boreholes for groundwater injection. The water could then be abstracted from these boreholes and treated to drinking water standard and transferred to an existing service reservoir for distribution.

There may be periods when the hands-off-flow condition on the abstraction licence from the River Gipping will limit recharge. As such there may be certain years when it is not possible to realise the full recharge volumes. It is expected that on average there will be sufficient recharge volume to support abstraction but this is subject to agreement with the Environment Agency and will require continuous monitoring.

Table 136 Option summary for Bucklesham ASR

Attribute	Description
Water source	Abstraction from the river Gipping. Then injection into the aquifer and reabstracted.
Deployable output/capacity	Maximum abstraction of 15.7 Ml/d for 63 days of the year, giving an annual equivalent benefit of 2.3 Ml/d
Water Quality	The surface water treatment works would be a direct abstraction. There would have to be significant water quality monitoring to ensure that we could treat the water at times when it is available.
Benefit/WAFU	The benefit would be an annual average of 2.3 Ml/d additional WAFU into the Suffolk East WRZ.
Delivery timescale	WAFU benefit would be available in 2032

Figure 59 Bucklesham ASR option schematic

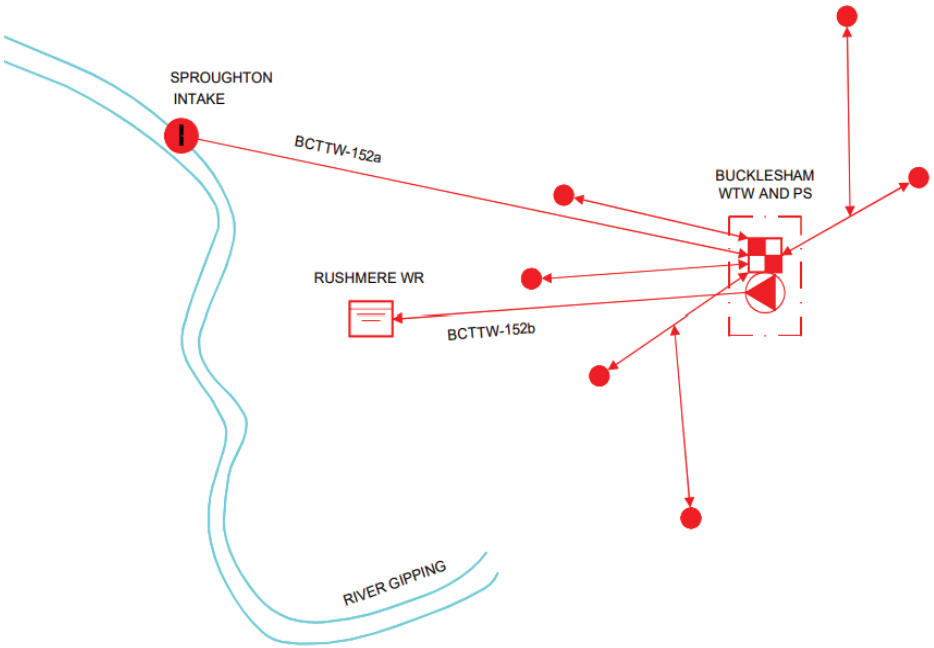


Table 137 Cost benefit summary for Bucklesham ASR option

Option ID	CAPEX (£k)	Annual OPEX (£k)	WAFU (Ml/d)	Year available	Receiving WRZ
SUE17	108,665.11	2,953.05	2.3	2032	Suffolk East

6.22.4 SUE5, SUE6, SUE7, SUE14, SUE15 and SUE16- East Suffolk desalination

Seawater would be abstracted from the North Sea off the east coast of Suffolk.

The seawater passes through an intake chamber, being screened to exclude coarse material, before being pumped to a desalination plant. Details of the process of desalination can be found in the desalination appendix of this report.

Following desalination and condition the water would be pumped to a blending tanks in our Suffolk East WRZ from where it would be distribution into our existing network.

Feasibility studies demonstrate that up to 100 Ml/d of water is available from desalination from Sizewell or Felixstowe.

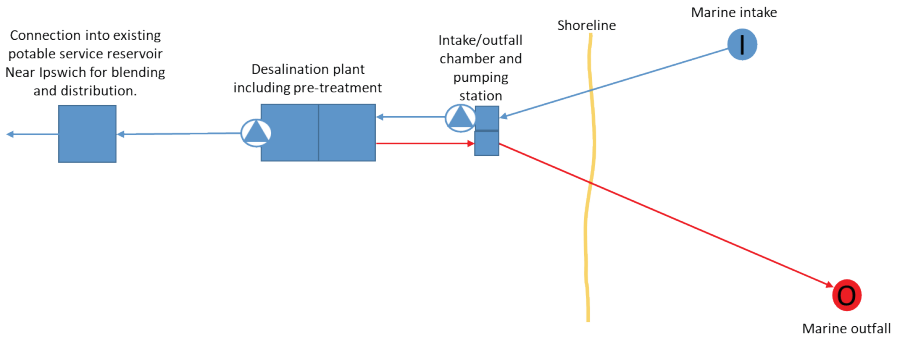


Table 138 Option summary for East-Suffolk desalination

Attribute	Description
Water source	North Sea.
Deployable Output	Assessed at 25, 50 and 100 Ml/d.
Water Quality	Expected feed water quality and treatment performance outlined in Table 139. Discharge - modelling will be required to assess the full impact of the discharge plume.
Benefit	Desalination options are not impacted by supply forecast scenarios, so WAFU is equal to deployable output.
Delivery timescale	Delivery could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032.

Table 139 Expected treatment performance for East-Suffolk desalination

Parameter	Feed (mg/l)	Screening and clarification (mg/l)	UF membranes (mg/l)	Reverse osmosis (mg/l)
Solids (mg/l)	150	32	2	0.08
Dissolved solids (mg/l)	35000	35000	35000	192

6.22.5 Transfer options

Table 140 Suffolk East WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
SUE13	Potable water transfer	10	1.59	West Suffolk & Cambs to East Suffolk potable transfer (10 Ml/d)	52	368
SUE18	Potable water transfer	10	0.63	South Essex to East Suffolk potable transfer (10 Ml/d)	26	327
SUE19	Potable water transfer	10	0.16	Essex and Suffolk Water to East Suffolk potable transfer (10 Ml/d)	8	290
SUE20	Potable water transfer	50	5.76	West Suffolk & Cambs to East Suffolk potable transfer (50 Ml/d)	52	700
SUE21	Potable water transfer	50	2.90	South Essex to East Suffolk potable transfer (50 Ml/d)	26	700
SUE22	Potable water transfer	20	1.48	South Essex to East Suffolk potable transfer (20 Ml/d)	26	500
SUE24	Potable water transfer	5	0.87	Suffolk Sudbury to East Suffolk potable transfer (5 Ml/d)	6	352

WRMP19 was planned on the basis of groundwater licences being capped to recent actual peak in 2024/25. Since WRMP19, following a change in policy from the Environment Agency, we must plan to cap our abstraction licences to recent actual average either on renewal (for time limited licences) or by 2030 for permanent licences; this has been reflected in WRMP24. This creates a further 4.25Ml/d (6.3%) reduction in the Deployable Output of Suffolk East (based on WRMP24 modelling), which is concentrated in the groundwater supplied portion of the WRZ. Our WRMP24 WRZ integrity assessment and problem characterisation were completed in September 2020, before this change occurred, so did not take this factor into account. If this information had been available, it would be likely that the Suffolk East WRZ would have been split into two separate WRZs, making this scheme an inter-zonal interconnector.

In these changed circumstances, we have found that the existing intra-WRZ network within Suffolk East can no longer provide sufficient supporting supply to the northern area. This creates a requirement for additional connectivity from the strategic grid to the north of the WRZ via the proposed connection to Bramford Tye WR, resulting in a WRZ sub-zonal scheme.

This need is also emphasised by the reduce yield of Belstead WTW in the Suffolk East WRZ, due to saline intrusion issues. These have been caused by its proximity to the coast, and the only possible mitigation is to reduce abstraction.

Though this issue hasn't reduced average deployable output for the Suffolk East zone, it creates additional pressure within the groundwater system during peak summer operation, and in the management of outage events, the Bramford Tye connection would provide additional resilience to alleviate these issues.

6.22.6 Options cost

Table 141 Suffolk East option costs

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
SUE17	Aquifer Storage Recovery (ASR)	2.3	Bucklesham ASR	108,665.11	2,953.05	29036	1,512	61	2,105
SUE25	Backwash water recovery	0.17	Suffolk East WTW backwash water recovery	315.99	0.24	68	-	-	-
SUE14	Desalination	25	Sizewell desalination (seawater) 25 Ml/d	479,419.18	14,258.99	61,712	6,749	41	1,769
SUE15	Desalination	50	Sizewell desalination (seawater) 50 Ml/d	803,988.69	24,446.71	80,372	13,497	41	1,769
SUE16	Desalination	100	Sizewell desalination (seawater) 100 Ml/d	1,283,654.84	26,408.61	102,453	26,995	41	1,769
SUE5	Desalination	25	Felixstowe desalination (seawater) 25 Ml/d	480,427.14	13,122.90	64,591	6,479	52	1,741
SUE6	Desalination	50	Felixstowe desalination (seawater) 50 Ml/d	815,858.59	24,860.61	91,824	13,497	52	1,741
SUE7	Desalination	100	Felixstowe desalination (seawater) 100 Ml/d	1,294,149.32	44,890.79	119,520	26,995	52	1,741
SUE23	Groundwater enhancement	1.7	Suffolk East groundwater enhancement	5,137.30	166.37	1,023	177	6	163
SUE13	Potable water transfer	10	Cambs and West Suffolk to Suffolk East potable transfer (10 Ml/d)	48,264.25	95.59	11,252	332	-	-
SUE18	Potable water transfer	10	Essex South to Suffolk East potable transfer (10 Ml/d)	28,959.92	135.51	5,242	499	-	-
SUE20	Potable water transfer	50	Cambs and West Suffolk to Suffolk East potable transfer (50 Ml/d)	129,425.11	461.22	22,241	1,686	-	-

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)	Habitats Units (required restoration)	BNG cost (£k)
SUE21	Potable water transfer	50	Essex South to Suffolk East potable transfer (50 Ml/d)	71,034.25	354.57	11,823	1,316	-	-
SUE22	Potable water transfer	20	Essex South to Suffolk East potable transfer (20 Ml/d)	34,318.53	200.65	11,623	748	-	-
SUE24	Potable water transfer	19	Suffolk Sudbury to Suffolk East potable transfer (5 Ml/d)	7,464.76	111.95	1,721	143	-	-
SUE1	Reuse	14.5	Ipswich Cliff Quay direct to Alton Reservoir (with additional abstraction and treatment at Alton)	196,441.25	5,925.56	22,435	331	7	290
SUE3	Reuse	11.5	Ipswich Cliff Quay to Alton via River Gipping (with additional treatment at Alton)	225,342.85	6,558.31	27,499	1,162	18	765

6.22.7 Feasible options not taken forward to modelling

Table 142 Suffolk East WRZ feasible options not modelled

Option ID	Option type	Option name	Feasible	Reason for not modelling
SUE10	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Felixstowe (100 Ml/d)	Yes	Offshore desalination rejected
SUE11	Desalination	Orwell Estuary desalination (25 Ml/d)	Yes	Estuarial desalination rejected
SUE12	Desalination	Orwell Estuary desalination (50 Ml/d)	Yes	Estuarial desalination rejected
SUE2	Reuse	Ipswich Cliff Quay direct to Alton Reservoir (with no additional and abstraction treatment at Alton)	Yes	No benefit without potable treatment expansion
SUE4	Reuse	Ipswich Cliff Quay to Alton via River Gipping (no additional abstraction or treatment at Alton)	Yes	No benefit without potable treatment expansion
SUE8	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Felixstowe (25 Ml/d)	Yes	Offshore desalination rejected
SUE9	Desalination	Desalination barge moored offshore with a pipeline coming onshore at Felixstowe (50 Ml/d)	Yes	Offshore desalination rejected

6.23 Suffolk Sudbury

6.23.1 Constrained options

Both of the feasible options identified in Suffolk Sudbury WRZ are potable water transfers. However, there is no deficit in Sudbury WRZ so neither option was added to the constrained list or was modelled.

6.23.2 Transfer options

Table 143 Suffolk Sudbury WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
SUS1	Potable water transfer	7	0.14	Cambs and West Suffolk to Suffolk Sudbury (7 Ml/d)	12	327
SUS2	Potable water transfer	10	1.1	Cambs and West Suffolk to Suffolk Sudbury (10 Ml/d)	20	409

6.24 Suffolk Thetford

6.24.1 Transfer options

Table 144 Suffolk Thetford WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
SUT1	Potable water transfer	5	0.45	Norfolk East Harling to Suffolk Thetford potable transfer (5 Ml/d)	19	327
SUT2	Potable water transfer	15	1.04	Norfolk East Harling to Suffolk Thetford potable transfer (15 Ml/d)	19	500
SUT3	Potable water transfer	10	0.87	Norfolk East Harling to Suffolk Thetford potable transfer (10 Ml/d)	19	458
SUT4	Potable water transfer	5	1.02	Norfolk Bradenham to Suffolk Thetford (5 Ml/d)	33	368
SUT5	Potable water transfer	15	2.71	Norfolk Bradenham to Suffolk Thetford (15 Ml/d)	33	600

6.24.2 Option costs

Table 145 Cost benefit summary for Suffolk Thetford options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Year available	Capital carbon (tCO2e)	Operational carbon (tCO2e)
SUT1	Potable water transfer	5	Norfolk East Harling to Suffolk Thetford potable transfer (5 Ml/d)	13,612.93	2.54	2030	3,136	0
SUT2	Potable water transfer	15	Norfolk East Harling to Suffolk Thetford potable transfer (15 Ml/d)	28,073.41	5.24	2030	7,695	0
SUT3	Potable water transfer	10	Norfolk East Harling to Suffolk Thetford potable transfer (10 Ml/d)	20,215.20	3.77	2030	5,356	0
SUT4	Potable water transfer	5	Norfolk Bradenham to Suffolk Thetford (5 Ml/d)	30,158.55	5.63	2030	6,927	0
SUT5	Potable water transfer	15	Norfolk Bradenham to Suffolk Thetford (15 Ml/d)	55,268.32	10.32	2030	17,903	0
SUT6	Backwash water recovery	0.05	Suffolk Thetford WTW backwash water recovery	178.64	0.24	2028	60	0

6.25 Suffolk West and Cambridgeshire

6.25.1 Constrained options

Table 146 Suffolk West and Cambs WRZ constrained options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	Feasible	Constrained
SWC13	New groundwater	2.6	Suffolk West & Cambs groundwater relocation	Yes	Yes

6.25.2 SWC 13- Suffolk West and Cambs groundwater relocation

SWC13 is a new groundwater option that seeks to relocate some licence that will be lost from our existing source at Wixoe. Our current abstraction location and volume is unsustainable but by relocating the abstraction point we can lessen the impact on the waterbody and hope to retain 2.6 Ml/d of the licence. This is currently under discussion with the Environment Agency.

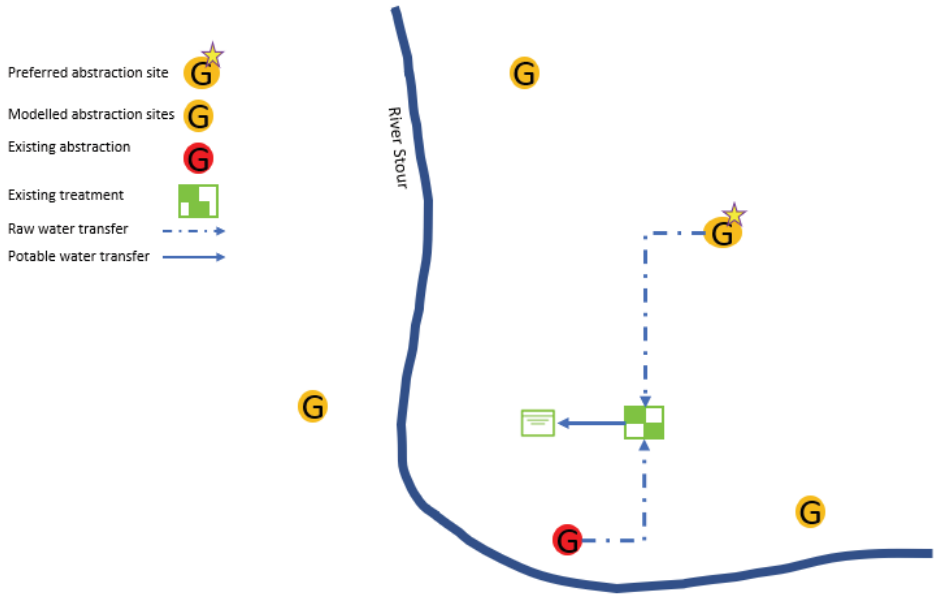
The option does carry the risk that, even if abstraction at the new location is deemed sustainable now, it that cannot be guaranteed long term.

The options would consist of the drilling of a new borehole with a transfer to existing treatment. A number of sites have been considered and modelled to examine their impact on WFD compliance. The site selected as preferred would have a positive impact of WFD compliance and is likely to be the most sustainable from the perspective of lesser impact on headwaters.

Table 147 Option summary for Suffolk West and Cambs groundwater relocation

Attribute	Description
Water source	A new groundwater abstraction.
Deployable output/capacity	2.3 Ml/d
Water quality	Groundwater quality will be assessed during test pumping of the newly developed source.
Benefit/WAFU	The benefit would be an annual average of 2.3 Ml/d additional WAFU into the Suffolk East WRZ.
Delivery timescale	WAFU benefit would be available in 2030

Figure 60 Option summary for Suffolk West and Cambs groundwater relocation



6.25.3 Transfer options

Table 148 Suffolk West and Cambs WRZ transfer options

Option ID	Option type	Max capacity (Ml/d)	Min capacity (Ml/d)	Option name	Length (km)	Diameter (mm)
SWC1	Potable water transfer	10	1.47	Cambridge Water to West Suffolk & Cambs(10 Ml/d)	31	458
SWC2	Potable water transfer	10	4.52	Fenland to West Suffolk & Cambs potable transfer (10 Ml/d)	56	600
SWC3	Potable water transfer	10	1.59	East Suffolk to West Suffolk & Cambs potable transfer (10 Ml/d)	52	368
SWC4	Potable water transfer	20	6.15	Fenland to West Suffolk & Cambs potable transfer (20 Ml/d)	56	700
SWC5	Potable water transfer	50	12.55	Fenland to West Suffolk & Cambs potable transfer (50 Ml/d)	56	1000
SWC6	Potable water transfer	50	5.76	East Suffolk to West Suffolk & Cambs potable transfer (50 Ml/d)	52	700
SWC7	Potable water transfer	20	2.53	Cambridge Water to West Suffolk & Cambs(20 Ml/d)	31	600
SWC8	Potable water transfer	50	4.49	Cambridge Water to West Suffolk & Cambs(50 Ml/d)	31	800

6.25.4 Option costs

Table 149 Cost benefit summary for Suffolk West and Cambs WRZ options

Option ID	Option type	Gain in WAFU (Ml/d)	Option name	CAPEX (£k)	Annual opex (£k)	Capital carbon (tCO2e)	Operational carbon (tCO2e)
SWC1	Potable water transfer	10	Cambridge Water to Cambs and West Suffolk (10 Ml/d)	44,509.17	112.76	9,732	400
SWC13	New groundwater	2.6	Suffolk West & Cambs groundwater relocation	7,719.66	39.38	1,214	48
SWC2	Potable water transfer	10	Fendland to Cambs and West Suffolk potable transfer (10 Ml/d)	126,491.29	119.81	30,105	368
SWC3	Potable water transfer	10	East Suffolk to Cambs and West Suffolk potable transfer (10 Ml/d)	65,574.39	245.42	13,061	894
SWC4	Potable water transfer	20	Fenland to Cambs and West Suffolk potable transfer (20 Ml/d)	145,720.75	243.44	22,812	832
SWC5	Potable water transfer	50	Fenland to Cambs and West Suffolk potable transfer (50 Ml/d)	207,462.08	578.41	44,428	2,083
SWC6	Potable water transfer	50	East Suffolk to Cambs and West Suffolk potable transfer (50 Ml/d)	154,207.17	990.42	28,572	3,712
SWC7	Potable water transfer	20	Cambridge Water to Cambs and West Suffolk (20 Ml/d)	63,923.92	137.00	17,079	464
SWC8	Potable water transfer	50	Cambridge Water to Cambs and West Suffolk (50 Ml/d)	192,854.94	1,743.08	46,708	2,233

6.25.5 Feasible options not modelled

Table 150 Suffolk West and Cambs WRZ feasible options not modelled

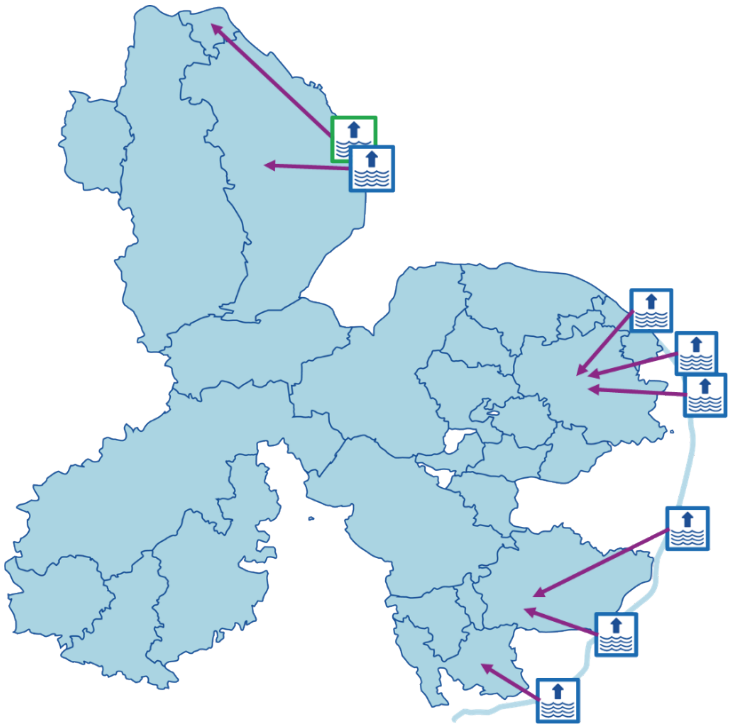
Option ID	Option type	Option name	Unconstrained	Feasible	Constrained
SWC10	Potable water transfer	Cambs and West Suffolk to Cambs and West Suffolk potable transfer (10 Ml/d)	Yes	Yes	Intra RZ transfer. Doesn't solve planning problem.
SWC11	Potable water transfer	Cambs and West Suffolk to Cambs and West Suffolk potable transfer (10 Ml/d)	Yes	Yes	Intra RZ transfer. Doesn't solve planning problem.
SWC12	Potable water transfer	Essex Central to Cambs and West Suffolk potable transfer (10 Ml/d)	Yes	Yes	Intra RZ transfer. Doesn't solve planning problem.

7 Appendix

7.1 Appendix A: Part 1 Desalination

Figure 61 shows the potential locations available for the development of desalination with arrows depicting the primary transfer of water. Note that we have developed two separate options for Mablethorpe; one is for public water supply with the second an alternative to supply non potable water to the South Humber bank industrial cluster. This was developed to replace the South Humber bank desalination option that has been rejected.

Figure 61 Desalination locations



We've carried out a review shoreline management plans in order to verify the feasibility of developing desalination at these locations. this review has concluded that all 7 locations are viable. We have rejected all of the desalination options we had in our draft plan feasible, constrained option set. After consulting with stakeholders and colleagues around the world who are successfully operating desalination facilities we concluded that we cannot mitigate against the risks that brine discharges into and estuary system present. It is possible that freshwater flows from inland and tidal movement would not be sufficient to flush the estuary of brine sufficiently to prevent a build up of salinity in the system. This could have severe detrimental impacts on sensitive estuarine ecologies and create a saline barrier within the water body that could inhibit fish migration and other unforeseeable impacts.

However, some sites carry greater risk than others and this risk is increased when we consider it in conjunction with land availability.

Summary of risks for locations

Table 151 Desalination site risk scoring summary

	SMP risk	Land availability risk	Overall risk
Mablethorpe	Low	Low	Low
Bacton	Low	Low	Low
Caister	Medium	Low	Medium
Gt Yarmouth	Low	High	High
Sizewell	High	Medium	High
Sizewell PS	Low	Medium	Medium
Felixstowe	Low	Low	Low
Holland on Sea	Low	Low	Low

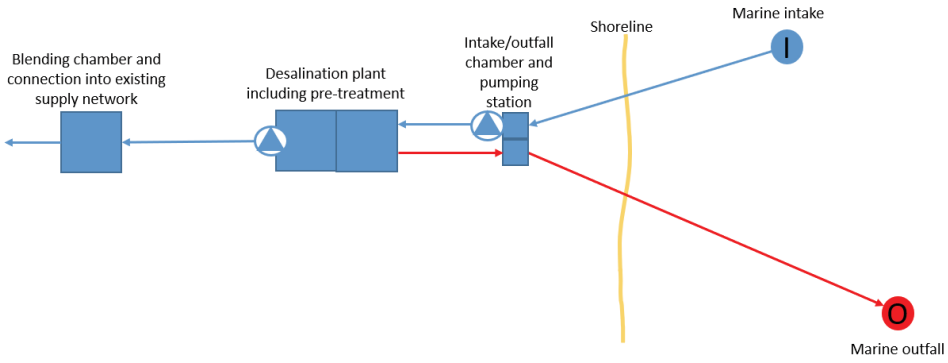
Table 151 shows a simple scoring mechanism used to evaluate the relative risks of each of our feasible locations. This used a precautionary approach that the overall score for each location is the highest risk identified in either a shoreline management plan or land availability assessment.

All locations remain technically feasible; however Great Yarmouth and Sizewell carry the greatest risks. This is because only a single site has been identified at each of these locations as land availability in Great Yarmouth is particularly constraining and could actually limit the capacity of desalination that could be developed at this site.

There are two potential sites identified at Sizewell, one in the Minsmere valley and the other on the site of the power station. The shoreline management plan to the north the power stationstates that the site is designated for managed realignment.This will result in larger areas of the Minsmere valley being at risk of flooding, limiting the number of suitable sites. The policy for the power station site is to hold the line which means defences will be maintained or improved to protect the site for the foreseeable future.

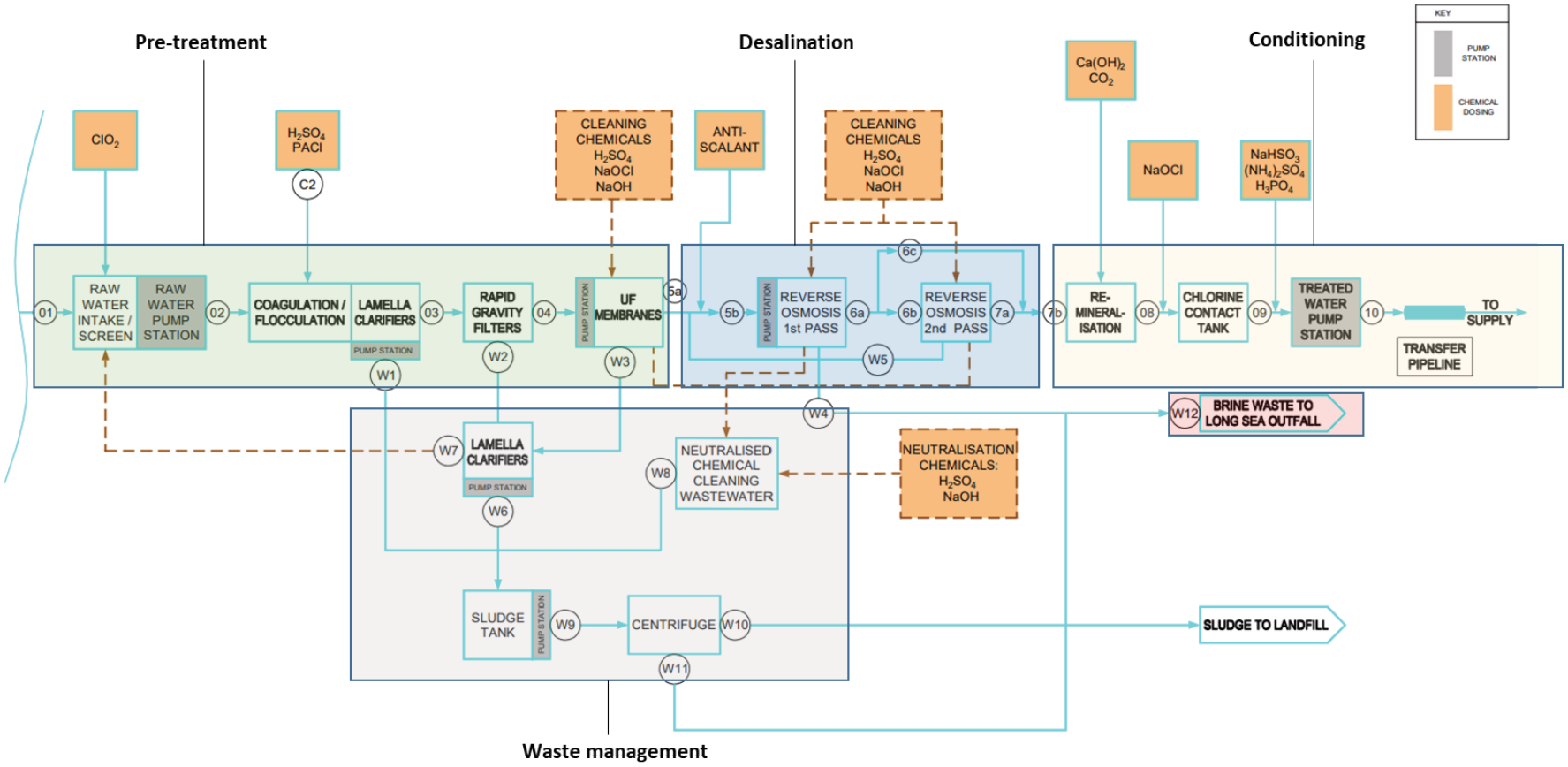
More detail of the shoreline management plans and land availability risk can be found at the end of this appendix.

Figure 62 Outline process



Treatment process

Figure 63 Desalination treatment process



Desalination is the process of removing salt from seawater to make it usable as fresh water. However, when we talk about desalination, we are usually referring to the whole process, from the point where we abstract water from the sea to it being fit to supply to our customers.

We can break this process down into different stages; pre-treatment, desalination and water conditioning. The first stage is critical in preparing the water before it goes on to the desalination stage. The more care and emphasis we put on this part of the process the less energy intensive and therefore the less costly the desalination process will be.

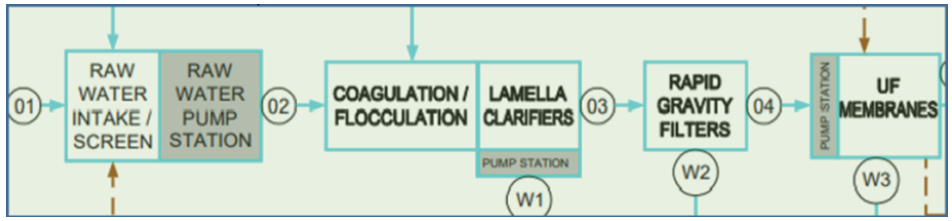
The reason desalination is an energy intensive process is because it takes a lot of power and energy to push water through the reverse osmosis membranes. The cleaner the water is, the less fouling of membranes surfaces occurs and so the less energy this takes. Careful consideration has to be given to these pre-treatment stages, and the way the treatment stages are managed also determines how the wastes are managed. Figure 64, Figure 65 and Figure 66 show the breakdown of different treatment areas within the process flow diagram. This helps illustrate how wastes are managed from different parts of the process.

The first stage of the process, pre-treatment, produces wastes that are not dissimilar to those produced by conventional treatment technologies. Water from rapid gravity filter washing and membrane cleaning processes can be passed through clarifiers to recover clean water that can be recycled into the front end of the process the dilute the seawater. This helps reduce operational cost and energy consumption.

The sludge can be further dewatered through a centrifuge where the water is used to dilute the brine discharge and the solids can be disposed to landfill. Because salt is soluble it passes through rapid gravity filters and the ultrafiltration membranes. A well-managed pre-treatment stage will pass water containing salt but very little else to the reverse osmosis desalination stage. This in turn will mean that the waste from the reverse osmosis stage is a relatively small volume can be diluted for discharge to sea.

Pre-treatment

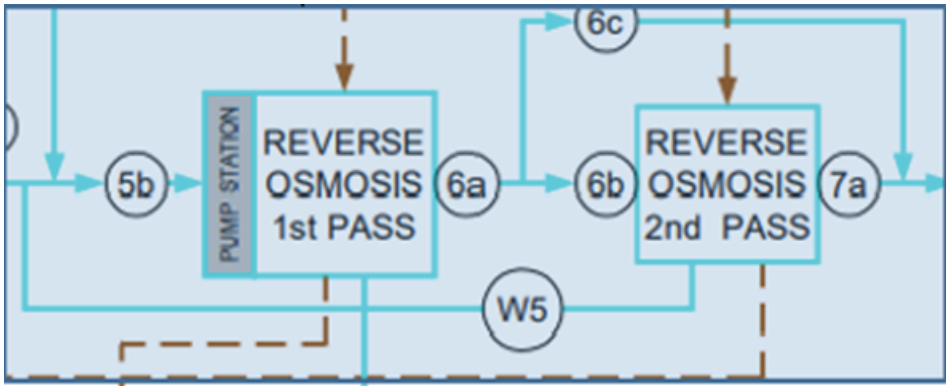
Figure 64 Pre-treatment process



The processes within the pre-treatment stage are similar to those found in conventional water treatment processes, and the waste products from the processes can be dealt with in much the same way. No salt is removed from the water at this stage so waste can be dewatered to recover clean water to go back to the start of the process to aid dilution. This reduces operating cost.

Desalination by reverse osmosis

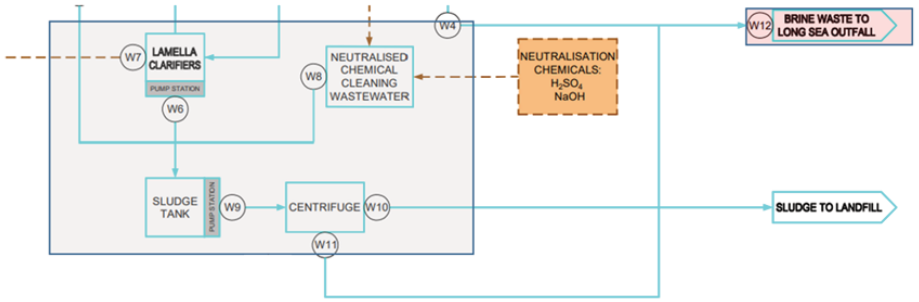
Figure 65 Desalination process



The desalination stage is where the salt is removed from the water. If the pre-treatment stage has been effective, the volume of waste to be disposed from this process can be minimised. By diluting this with water recovered from dewatering of sludge from other parts of the process, the chloride concentration of the brine discharge can be reduced.

Waste management

Figure 66 Waste management process



As described above the waste management element of the process is where solids and liquids are separated. Where possible clear water from dewatered sludge should be utilised to dilute the brine discharge.

Suspended Particulate Matter and Salinity

Suspended Particulate Matter (SPM) is the term that is generally used to describe all solid material, detritus, decaying flaura and fauna suspended in the water column in marine environments. It can be thought of as the equivalent of turbidity in freshwater environments.

A map displaying the annual average levels of SPM in the North Sea can be found on the Cefas website[19].

Suspended Particulate Matter (SPM) is measured in milligrams per litre of water and is an approximation of the amount of material that will need to be removed from seawater in the pre-treatment process of desalination. The satellite image shows the average North Sea SPM. The Southern North Sea has some of the highest SPM levels seen anywhere in the seas surrounding the UK. This highlights the need to select the right form of intake structure and pre-treatment process for long term operability and running cost.

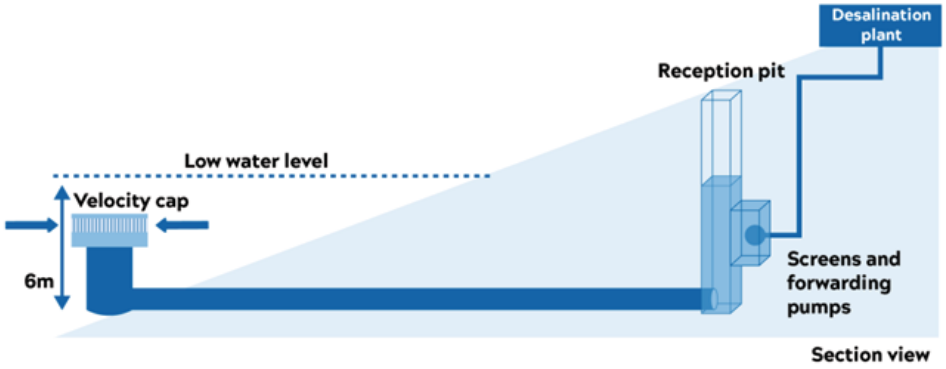
It is worth noting that the area off North East Norfolk has some of the lowest SPM levels in the Southern North Sea. This corresponds to the location of Bacton, one of our selected locations.

Another point to note is that SPM correlates to bathymetry, the measurement of the sea depth. Areas around the Humber, Thames, Suffolk and Essex river estuaries are some of the shallowest waters we have access to, meaning potentially longer intake pipelines may be needed, or alternative intake structures might be more appropriate.

The southern North Sea has some of the most variable levels of salinity on the British coastline, however, it falls within the expected range for standard seawater desalination processes. Again more detail can be found on the Cefas website[20].

Intake structures

Figure 67 Surface intake



A surface intake is a structure situated on the sea floor surface. The structure is fitted with a velocity cap, which is a device to minimise entrainment of organisms, particularly fish. Fish are often drawn into vertical intake structures because they are less well adapted to detect vertical flow. The velocity cap created a horizontal flow pattern which fish

19 Source: Marine Online Assessment Tool (MOAT) published by CEFAS of behalf of DEFRA - UK Marine Monitoring and Assessment Strategy https://moat.cefas.co.uk/ocean-processes-and-climate/turbidity/

20 Source: Marine Online Assessment Tool (MOAT) published by CEFAS of behalf of DEFRA - UK Marine Monitoring and Assessment Strategy https://moat.cefas.co.uk/ocean-processes-and-climate/salinity/

will detect and tend to swim away from. Keeping the fish numbers down in the intake also reduces fish kill and consequently fewer organisms that feed on decaying material.

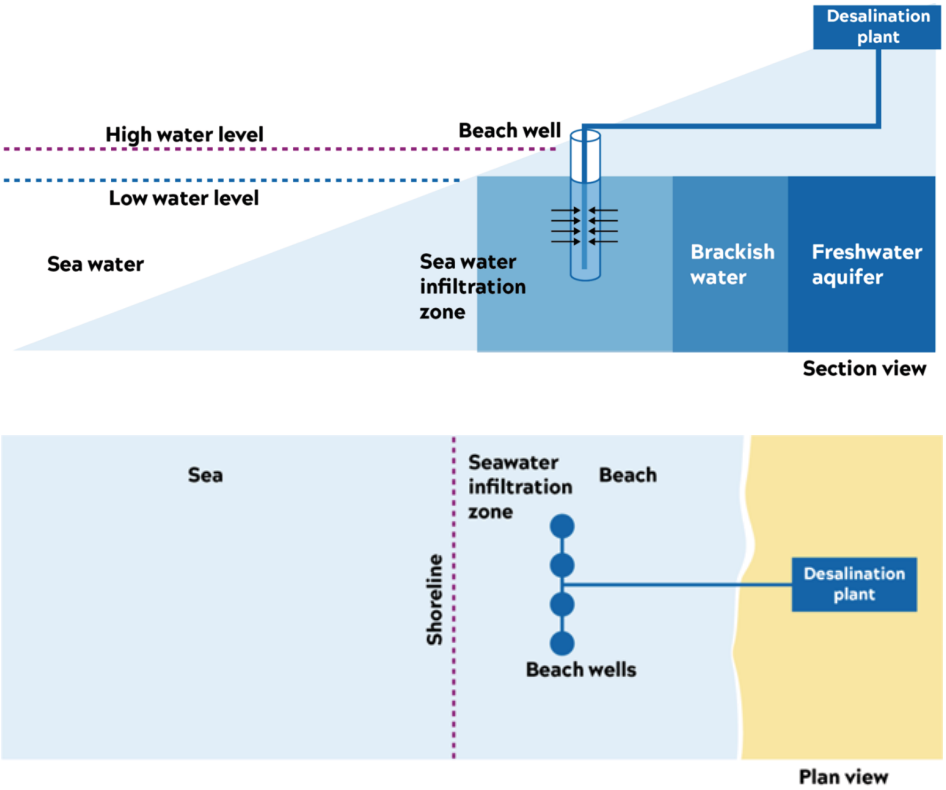
In intake design it is generally accepted the minimum sea water depth required (at lowest tides) is 6 metres. This is to allow 2 metres of the intake structure off the seafloor to minimise intake of suspended material, lifted from the seafloor by turbulence. It also allows 4 metres clearance in the water column above the intake to prevent structural damage from direct wave action.

From the intake structure there is a large diameter pipeline (to minimise friction loss and extend run times between the need to do maintenance cleaning) to a reception pit. The reception pit fills with seawater under gravity at very low velocity, this is so that organisms that passed through the intake structure grill have the opportunity to swim back out of the structure to avoid being drawn into the intake screens. A weak chlorine solution can be dosed into the pipeline to reduce biological growth inside the pipe, which reduces friction loss but also reduces available food sources and makes the intake pipe inhospitable to aquatic life, which reduces accidental harm to them.

From this pit the seawater will pass through intake screen to remove large material that could damage the pumps and it is then pumped to the desalination treatment plant. Note, the pump chamber needs to be below the minimum low tide seawater level to ensure it is always full so that the plant can operate throughout seasonal and diurnal tide patterns.

In discussion with colleagues in Australia with experience of seawater desalination intake operation, they recommend abstracting from as deep as possible. This greatly reduces operating costs as less seabed sediment is mobilised by wave activity and so screening, filtering and membrane cleaning are minimised. Our coastal constraints mean that these opportunities may be limited. This could mean we have to look to other intake types, like beach wells or infiltration galleries.

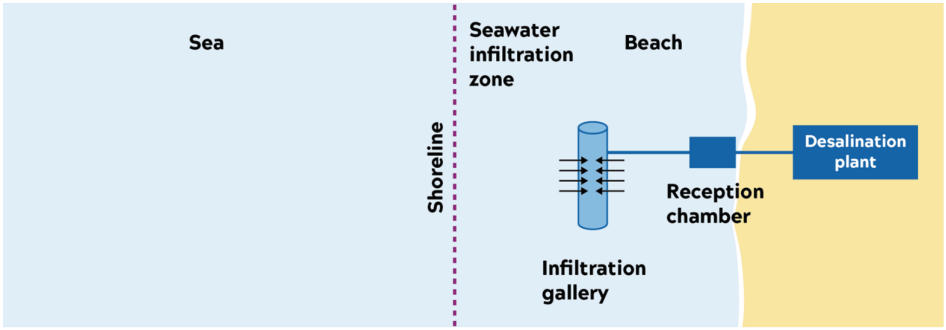
Figure 68 Beach wells



The figures above show beach wells in horizontal section and plan view. A well is drilled into the beach and fills with seawater by natural infiltration. This type of intake can reduce pre-treatment because it provides natural filtration through the beach. How well they perform, their yield and maintenance factors like clogging are dependent on local factors.

Beach wells may be a suitable alternative where a surface intake isn't suitable due to shallow water. This will be assessed on a site by site basis at project planning level if the option is selected.

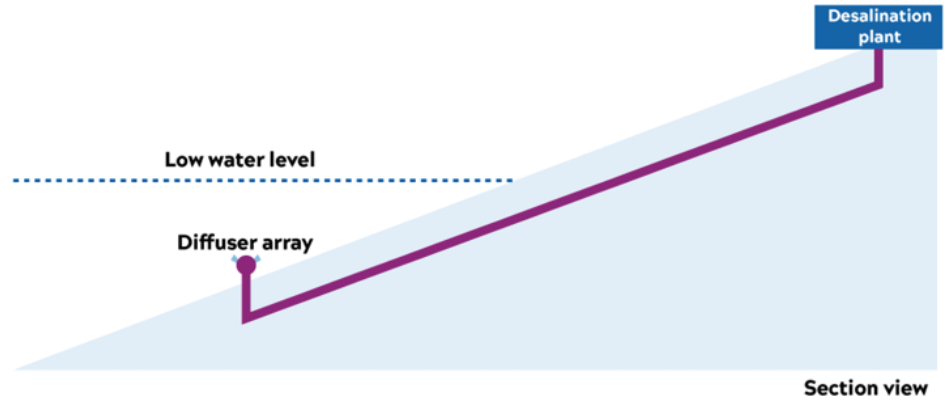
Figure 69 Infiltration gallery

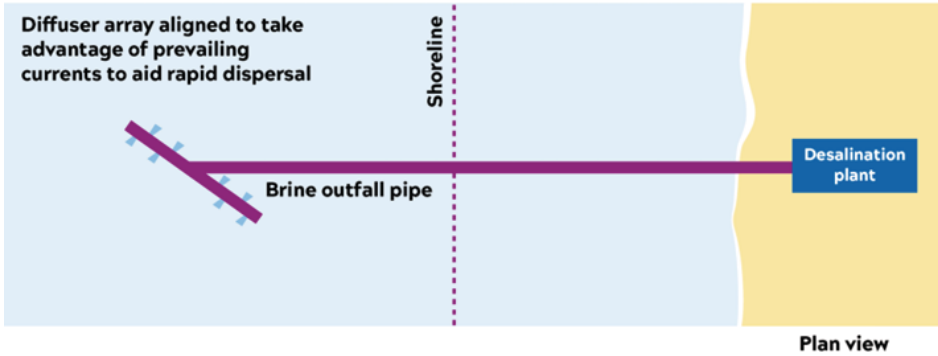


An infiltration gallery works in a similar way to a beach well, in that it relies on natural infiltration of seawater through the beach. The benefit may be that the yield can be higher than beach wells, however, they generally cover a larger area and therefore can be more intrusive during construction.

Outfall structures

Figure 70 Outfall brine diffuser array





The outfall arrangements for a brine discharge would have to be carefully designed to to ensure we minimise potential impacts on ecology. We are working with colleagues from other water companies around the world and expert consultants to ensure we follow best practice and use the most effective methods available.

We will also look into monitoring methods. Below is an example of the kind of monitoring arrangements that could be used. This is taken from an example in Queensland, Australia that was devised by collaboration between the construction and operation companies and the local environmental regulator.

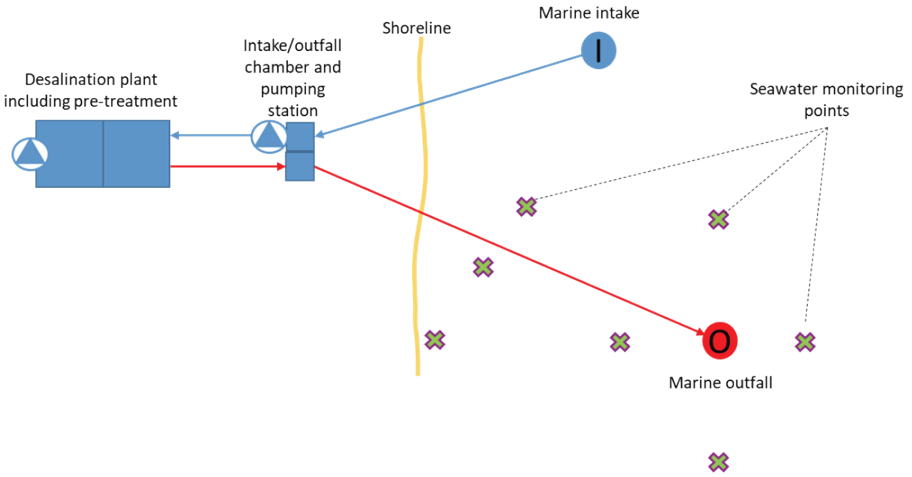


Table 152 Desalination assumptions

Attribute	Description
Water source	North Sea
Deployable output	Assessed at 25,50 and 100 Ml/d
Water quality	We have limited water quality information available for seawater at the moment but, as described above, significant parameters are SPM and salinity. The expected treatment performance is show below Discharge - modelling will be required to assess the full impact of the discharge plume.
Benefit	Desalination options are not impacted by supply forecast scenarios, so WAFU is equal to deployable output
Delivery timescale	Delivery could be achieved within 7 - 10 years. This means the earliest date water could be available for use is 2032

Table 153 Expected treatment performance for desalination

Parameter	Feed	Screening and clarification	UF membranes	Reverse osmosis
Solids (mg/l)	150	32	2	0.08
Dissolved solids (mg/l)	35000	35000	35000	192

7.2 Appendix A: Part 2 Shoreline management plan and land availability risks for desalination

Following the additional screening of desalination options referred to in Section 4 we have 7 remaining suitable locations.

- Mablethorpe
- Bacton
- Caister
- Gt Yarmouth
- Sizewell
- Felixstowe
- Holland on Sea

We have reviewed Shoreline Management Plans[1] in order to inform better decision making when it comes to selecting the most appropriate location.

Policy:

Table 154 Shoreline management plan and policy

Site	Shoreline Management Plan and Policy	Policy	Comments	Risk
Mablethorpe	**SMP3 N & O**	**Flamingborough Head to Gibraltar Point**		
		Present to 2025 - defences will be held in their current position and their flood defence function will be maintained. Defences will be raised to counter sea level rise as required.	No areas identified as suitable are threatened by current policy	Low
		2025 to 2055 - defences will be held in their current position and their flood defence function will be maintained. Defences will be raised to counter sea level rise as required.		
		2055 to 2105 - defences will be held in their current position and their flood defence function will be maintained. Defences will be raised to counter sea level rise as required. Localized managed realignment could be considered to increase defence sustainability, in areas where appropriate.		
Bacton	**SMP6.09**	**Mundesley to Bacton Gas Terminal**		
		Present to 2025 - The policy option from the present day is to allow natural processes to take place, but through a policy of managed realignment to allow for defunct defences to be safely removed. Existing timber revetment and groynes will not be maintained, although these are expected to remain for the	No areas identified as suitable are threatened by current policy	Low

Site	Shoreline Management Plan and Policy	Policy	Comments	Risk
		next 5 to 15 years so will continue to have some impact upon erosion of the cliffs in the short term. There will, however, be loss of agricultural land and also loss of holiday accommodation.		
		2025 to 2055 - No change in policy option, from no active intervention, is proposed. This will ensure that local nature conservation interests are satisfied, although losses would continue.		
		2055 to 2105 - No change in policy option, from no active intervention, is proposed.		
Bacton	**SMP6.10**	**Bacton Gas Terminal**		
		Present to 2025 - The policy option is to continue to protect Bacton gas terminal site, through hold the line.	No areas identified as suitable are threatened by current policy	Low
		2025 to 2055 - The medium-term policy option is to continue to hold the line by maintaining the defences, based upon the assumption that the terminal will still be operational for up to 50 years.		
		The long-term policy option is to continue to hold the line by maintaining the defences, based upon the assumption that the terminal will still be operational for up to 100 years as part of the gas storage scheme.		
Caister on Sea	**SMP6 Policy area 6.15**	**California to Caister-on-Sea**		
		To continue to protect assets, the policy option is to continue to hold the line through routine and reactive maintenance of existing defences, i.e. the rock bund, rock groynes and concrete wall, until failure.	Small area identified as suitable is threatened by policy. Should be adequate alternatives but intake/outfall could be more expensive	Medium
		The long-term aim is to allow a naturally-functioning coast; therefore in the medium-term the policy option is to no longer maintain the existing defences		
		The long-term policy option is to allow shoreline retreat through managed realignment.		
Gt Yarmouth	**SMP6 Policy area 6.17**	**Great Yarmouth**		

Site	Shoreline Management Plan and Policy	Policy	Comments	Risk
		The present-day policy option for this area is to continue to hold the line and protect all built assets within the town.	No areas identified as suitable are threatened by current policy	Low
		The medium-term policy option is to continue defending the frontage beyond the short term, through a policy of hold the line.		
		Due to the high value and extent of socio-economic assets here, the long-term policy option is to continue to hold the line and defend the frontage.		
Sizewell	**SMP7**	**Power Station**		
		The policy is Hold The Line for the short, medium and long term. This includes extending defences for Sizewell C.	No areas identified as suitable are threatened by current policy	Low
Sizewell	**SMP7**	**Minsmere and Sizewell**		
		The long term impact of the plan will be increased flooding to the Minsmere valley. The coast is eroding to the north and this would continue, proving valuable sediment to the system. Erosion across the valley and in the area of Sizewell is significantly less. The plan allows for local management of the main Minsmere frontage but with the long term intent for managed realignment.	Only one location identified and all surrounding areas threatened by the policy	High
Felixstowe	**SMP7**	**Felixstowe**		
		The policy is Hold The Line for the short, medium and long term.	No areas identified as suitable are threatened by current policy. Large areas available as alternatives if policy changes.	Low
Holland on Sea	**SMP8**	**C2 Holland Haven**		
		The current line will be held in the short and medium term 2025 to 2055. Longer term there is a dual policy of either Managed realignment or Hold the line.	No areas identified as suitable are threatened by current policy	Low

Land availability risk

Mablethorpe - SMP3 - Flamingborough Head to Gibraltar Point - Potential location of Mablethorpe desalination approximately lies on the boundary of Policy areas N and O. The land take for a desalination plant would be approximately 6 ha. The area identified as suitable for siting is around 300 ha. **Low risk.**

Bacton - SMP6 - Kelling Hard to Lowestoft - The area identified as potential location for Bacton desalination plant could fall within one of two policy areas; Mudesley to Bacton Gas terminal (6.09) or Bacton Gas Terminal (6.10). The land take for a desalination plant would be approximately 6 ha. The area identified as suitable for siting covers an area of approximately 5 km of coastline. **Low risk**

Caister on Sea - SMP6 - California to Caister-on-Sea. The land take for the option would be around 6ha. The suitable area for siting cover around 100 ha. **Low risk.**

Great Yarmouth - SMP6 - Great Yarmouth town. Land take for this option would be around 14ha. Due to lack of land availability a single site has been identified and the design is for a 2 story treatment facility. **High risk.**

Sizewell - SMP7 - Sizewell Power Station - The land take for the option would be around 6ha. The assumption is that land is available to co-locate with the power station. **Medium risk.**

Sizewell - SMP7 Minsmere to Sizewell - The land take for the option would be around 6ha. Only one location has been identified and all other areas are potentially subject to flooding under current SMP policy**. Medium risk**.

Felixstowe - SMP7 - Felixstowe town. The land take for a desalination plant would be approximately 6 ha. The area identified as suitable for siting is around 300 ha. **Low risk**.

Holland on Sea - SMP8 - Holland Haven/Clacton on sea. The land take for the option would be around 6ha. The suitable area for siting cover in excess of 100 ha. **Low risk.**

Table 155 Summary of risks

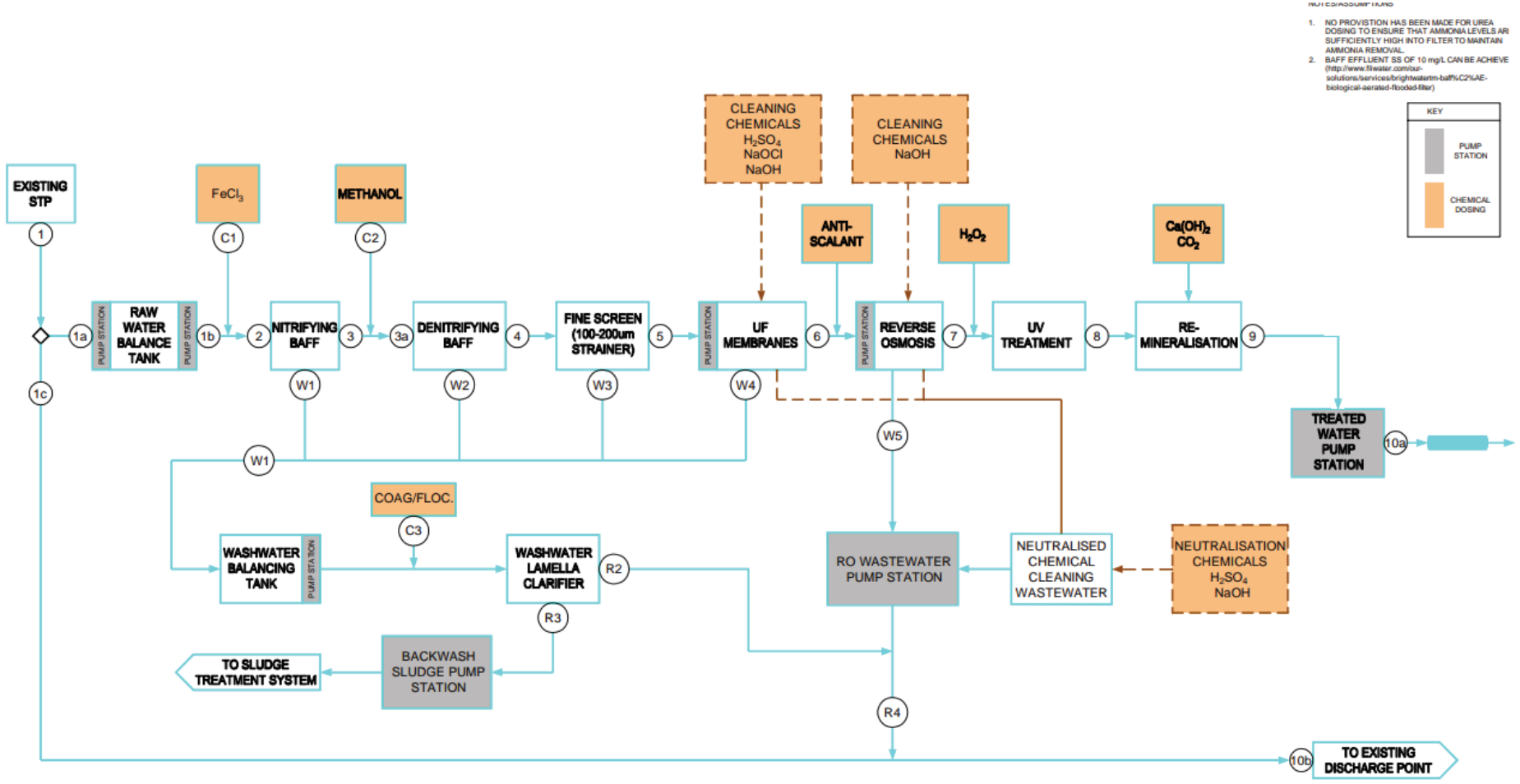
	SMP risk	Land availability risk	Overall risk
Mablethorpe	Low	Low	Low
Bacton	Low	Low	Low
Caister	Medium	Low	Medium
Gt Yarmouth	Low	High	High
Sizewell	High	Medium	High
Sizewell PS	Low	Medium	Medium
Felixstowe	Low	Low	Low
Holland on Sea	Low	Low	Low

While all locations remain technically feasible, Great Yarmouth and Sizewell carry greater risks and challenges in planning.

7.3 Appendix B: Water Reuse

The figure below shows the outline process that has been assumed for all of our water reuse options.

Figure 71 Water Reuse



This is not a process design nor is it a definitive asset list. However, this high level process enabled us to create a mass balance process flow calculation based on water quality information available at the time. It ensured that we have considered the water quality challenges that are likely to be present and that adequate treatment capacity has been considered in the scope of proposed solution.

These mass balance calculations also gave us sufficient credible detail of flow and quality parameters to engage with environmental stakeholders to determine the monitoring and sampling required for further impact and mitigation assessment.

Superficially the water reuse treatment processes outlined within this report can seem similar to desalination, however, there are some fundamental differences. Firstly and most significantly the purpose of the advanced water recycling processes associated with water reuse are intended to condition the water to return it to the environment. This source of water will contribute to an existing natural waterbody or reservoir. By contributing this additional water to these waterbodies, we will be able to abstract an equivalent amount of water from the environment, without that abstraction causing detriment to wetlands, watercourses or groundwater. In some cases we hope it will provide resource to enhance habitats.

At this time, have not defined the pre-treatment for any of our options beyond that outlined in the high-level feasibility study. In every instance we would have to carry out a detailed analysis of the feed water to determine the treatment requirements. This inevitably means we cannot be certain of the downstream processes either.

For the purpose of feasibility study we have assumed that ammonia control will be required as well as additional solids removal. We have also proposed reverse osmosis to prepare the water for transfer to a raw water abstraction for potable use. This may not be the case with high quality final effluents. It is also not yet known whether some final effluent qualities may be suitable to pass through an environmental buffer that could remove the need for complex engineered solutions. We would prefer to pursue lower operational carbon or nature based solutions, where further investigation demonstrates this is suitable.

There will be a waste discharge to the environment from the complex treatment style solutions to water reuse. At inland sources, this will generally be of a similar composition to the existing discharge, but more highly concentrated. We will look at measures to mitigate any impact this may have. At coastal locations the discharge may contain a concentrate of chloride, however, this will be lower than the background seawater salinity and should not present a problem. However, we will consider any potential local impacts this may have.

7.4 Appendix C: Rejection Register

Table 156

Option ID	Option Name	Option type	WRZ	Reason for option rejection
EXC1	Cambs & West Suffolk to Essex Central potable transfer (5 Ml/d)	Internal potable transfer	AWSEXC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
EXC13	Essex Central to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
EXC14	Essex Central to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
EXC16	Essex Central to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
EXC2	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
EXC4	Essex Central to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
EXC5	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	Does not resolve a deficit
EXC6	Cambs & West Suffolk to Essex Central potable transfer (10 Ml/d)	Internal potable transfer	AWSEXC	More direct route promoted
01e-0651	Winter Flows/ review river abstractions	New reservoir	AWSEXC	CAMS/ALS no resource available
02a-1051	South Essex WRZ Transfer	Internal potable transfer	AWSEXC	Alternatives developed
02a-1052	Parkfield - Lt Maplestend	Internal potable transfer	AWSEXC	Alternatives developed

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02a-1053	Bury and Haverhill WRZ transfer	Internal potable transfer	AWSEXC	Alternatives developed
02a-1076	Sudbury WRZ Transfer	Internal potable transfer	AWSEXC	Alternatives developed
02a-1224	Lt Maplestead to Steeple Bumpstead	Internal potable transfer	AWSEXC	Alternatives developed
03b-0624	Halstead Water reuse	Water reuse	AWSEXC	Resource is supporting river flow
03c-0660	Ardleigh WTW Washwater Recovery	Water reuse	AWSEXC	Resource is supporting river flow
04b-0625	Review groundwater group licences	New groundwater	AWSEXC	No long term reliable resource available from groundwater in the region.
RW_123	AWS wastewater reclamation	Water reuse	AWSEXC, AWSEXS, AWSFND, AWSLNB, AWSLNC, AWSLNE, AWSLNN, AWSNAY, AWSNBR, AWSNED, AWSNEH, AWSNHA, AWSNHL, AWSNNC, AWSNTB, AWSNWY, AWSRTC, AWSRTN, AWSRTS, AWSRTW, AWSSUE, AWSSUI, AWSSUS, AWSSUT, AWSSWC	Insufficient information to cost or define DO
RW_128	Reclaimed water transfer outside AWS region	Water reuse	AWSEXC, AWSEXS, AWSFND, AWSLNB, AWSLNC, AWSLNE, AWSLNN, AWSNAY, AWSNBR, AWSNED, AWSNEH, AWSNHA, AWSNHL, AWSNNC, AWSNTB, AWSNWY, AWSRTC, AWSRTN, AWSRTS, AWSRTW, AWSSUE, AWSSUI,	Insufficient information to cost or define DO

Option ID	Option Name	Option type	WRZ	Reason for option rejection
			AWSSUS, AWSSUT, AWSSWC	
EXS13	Holland on Sea floating desalination (seawater) 25 Ml/d	Desalination	AWSEXS	Offshore deslination provides no benefit over onshore options but carry greater risk.
EXS14	Holland on Sea floating desalination (seawater) 50 Ml/d	Desalination	AWSEXS	Offshore deslination provides no benefit over onshore options but carry greater risk.
EXS15	Holland on Sea floating desalination (seawater) 100 Ml/d	Desalination	AWSEXS	Offshore deslination provides no benefit over onshore options but carry greater risk.
EXS1	Colchester WRC direct to Ardleigh Reservoir (with additional treatment)	Water reuse	AWSEXS	Additional potable treatment does not provide any more DO that alternatives without. EXS19 promoted as the alternative.
EXS22	Colchester WRC direct to Ardleigh Reservoir 50:50	Water reuse	AWSEXS	This option was developed to test a 50:50 split with AFW. Subsequently AFW have declined the option.
EXS2	Colchester WRC direct to Ardleigh Reservoir (no additional treatment)	Water reuse	AWSEXS	Drought only option. EXS19 promoted as a BAU alternative.
EXS5	Colchester to Ardleigh Reservoir via the River Colne (with additional treatment)	Water reuse	AWSEXS	Additional potable treatment does not provide any more DO that alternatives without. EXS19 promoted as the alternative.
EXS6	Colchester to Ardleigh Reservoir via the River Colne with no extra treatment	Water reuse	AWSEXS	Additional transfer via the river is not required but adds risk and cost.
20-0643	Innovative options (international examples e.g. sea clouding)	New technology	AWSEXS	Unproven technology, cost and yield
20-0644	Rainwater harvesting	Rainwater harvesting	AWSEXS	Demand management option

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01b-0647	Ardleigh Reservoir	Groundwater enhancement	AWSEXS	Insufficient detail
01c-0648	Ardleigh Reservoir	Groundwater enhancement	AWSEXS	Insufficient detail
01d-0649	Ardleigh Reservoir	New reservoir	AWSEXS	Insufficient detail
01e-0652	Potential options to be investigated.	New reservoir	AWSEXS	Insufficient detail
02a-1048	Wherstead - Horkesley	Internal potable transfer	AWSEXS	Alternatives developed
02a-1058	Sudbury RZ Transfer	Internal potable transfer	AWSEXS	Alternatives developed
02a-1066	Central Essex RZ Transfer	Internal potable transfer	AWSEXS	Alternatives developed
02a-1067	Lt Maplestend - Parkfield	Internal potable transfer	AWSEXS	Alternatives developed
02a-1225	Great Horkesley to Bures WTW	Internal potable transfer	AWSEXS	Alternatives developed
02a-1232	Alton WTW - Great Horkesley WR	Internal potable transfer	AWSEXS	Alternatives developed
02a-1234a	East Suffolk RZ Transfer	Internal potable transfer	AWSEXS	Alternatives developed
02a-1234b	Raydon WTW - Great Horkesley WR	Internal potable transfer	AWSEXS	Alternatives developed
02b-1018	River pant - Abberton	External raw water bulk supply/transfer	AWSEXS	No longer required - superseded by potable transfers which removes the INNS risk
03b-0658	Braintree water reuse	Water reuse	AWSEXS	Resource is supporting river flow
03b-0659-A	Southend water reuse	Water reuse	AWSEXS	Resource is supporting river flow

Option ID	Option Name	Option type	WRZ	Reason for option rejection
04b-0661	Review group licences	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04c-0626	Steeple Bumpstead Central Essex groundwater sources	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04c-0627	Uprating Bures	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04c-0628	Yieldham Abandoned Central Essex WRZ sources back to supply	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04c-0662	Observation boreholes BHs? (storage)	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04c-0663	Ballkerne	New groundwater	AWSEXS	Needed to support Ardleigh reservoir yield
04c-0664	Nutley Road/Braintree	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04c-0665	Tiptree boreholes	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
04e-0666	Braintree boreholes	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.
05-0629	3rd party trade options	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
05-0667	3rd party trade options	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
05-0668	Bradwell	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
05-0669	Colchester/Ipswich industrial study (discharge consents)	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
05-0670	Tilbury/Chelmsford (trades)	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
05-0671	Trade high fluoride water	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
06a-0630	Other rivers identified from CAMS	New surface water	AWSEXS	None
06a-0631	River Blackwater	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0632	River Colne (upstream part)	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0633	River Pant	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0634	River Stour-EOETS	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0672	River Blackwater	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0673	River Colne	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0674	River Pant	New surface water	AWSEXS	CAMS/ALS no resource available
06a-0675	River Stour -	New surface water	AWSEXS	CAMS/ALS no resource available
06a-1241	Colne HOF- Change the HOF	New surface water	AWSEXS	CAMS/ALS no resource available
07-0676	Bradwell	Water reuse	AWSEXS	Option not sufficiently mature to define costs or DO.
08a-0635	Great Horkesley ASR	Aquifer recharge/Aquifer storage recovery	AWSEXS	No raw resource available
08b-0636	Halstead	New technology	AWSEXS	High risk of failure as DO is uncertain.
08b-0678	Braintree	New technology	AWSEXS	High risk of failure as DO is uncertain.
08b-0679	Halstead	New technology	AWSEXS	High risk of failure as DO is uncertain.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
08c-0637	SUDS	Aquifer recharge/Aquifer storage recovery	AWSEXS	High risk of failure due to uncertain DO
08c-0680	SUDS	Aquifer recharge/Aquifer storage recovery	AWSEXS	High risk of failure due to uncertain DO
10b-0638	SUDS	New reservoir	AWSEXS	High risk of failure due to uncertain DO
10b-0681	SUDS	New reservoir	AWSEXS	High risk of failure due to uncertain DO
10c-0682	Does Corner/Environment Agency asset	Licence trading	AWSEXS	CAMS/ALS no resource available
11b-0683	Bradwell	Desalination	AWSEXS	Option not sufficiently mature to define costs or DO.
12a-0684	Ardleigh Colchester Conjunctive Use (Annual GW Licence)	Groundwater enhancement	AWSEXS	Existing supply options optimised and continuously reviewed
12A-0684b	Ardleigh Colchester Conjunctive Use (2 year GW Licences)	Groundwater enhancement	AWSEXS	Existing supply options optimised and continuously reviewed
14-0687	Affinity Water - to continue with Ardleigh Colchester WTW agreement at 70:30	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
14-0688	Ardleigh Agreement - Affinity 80:20 Affinity Water - to amend Colchester WTW agreement at 80:20	Licence trading	AWSEXS	New agreement to move to 50:50 from 2025
14-0689	Cambridge STW reuse (trade with CWC?)	Water reuse	AWSEXS	Cambridge water options
14-0691	Essex and Suffolk Water (EOETs + Layer WTW to Colchester)	Licence trading	AWSEXS	CAMS/ALS no resource available
14-0692	Thames Water (Chigwell?)	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
15-0639	Tankering (rail)	Internal potable transfer	AWSEXS	Rejected due to weather and reliability issues, and due to traffic impacts
15-0640	Tankering (Road)	Internal potable transfer	AWSEXS	Road Tankering rejected due to capacity required would not be feasible via road
15-0693	Tankering (rail)	Internal potable transfer	AWSEXS	Rejected due to weather and reliability issues, and due to traffic impacts
15-0694	Tankering (Road)	Internal potable transfer	AWSEXS	Road Tankering rejected due to capacity required would not be feasible via road
18-0641	Increasing storage at private lakes,	Groundwater enhancement	AWSEXS	None identified as part of the Private Lakes and Reservoir study
18-0695	Increasing storage at private lakes	Groundwater enhancement	AWSEXS	None identified as part of the Private Lakes and Reservoir study
19-0642	MOD sites boreholes Wethersfield	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
20-0696	Innovative options (international examples e.g. sea clouding)	New technology	AWSEXS	Unproven technology, cost and yield
20-0697	Rainwater harvesting	Rainwater harvesting	AWSEXS	Demand management option
2019_ASR01	South Essex WRZ ASR	Aquifer recharge/Aquifer storage recovery	AWSEXS	Unsuitable hydrological conditions
21-0645	EOETs & GOGS review	External raw water bulk supply/transfer	AWSEXS	No long term reliable resource available from groundwater in the region.
21-0646	EOETs optimisation (+ trade with Essex and Suffolk Water)	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.
21-0699	EOETs optimisation (+ trade with Essex and Suffolk Water)	Licence trading	AWSEXS	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
BCTTW_06	ESW trading -Gt Horkesley and Tiptree	Internal potable transfer	AWSEXS	Reviewed regularly - no new option at present
BCTTW_07	Ardleigh raw water transfer	Internal potable transfer	AWSEXS	Under review as drought option. No new supply-side option identified at present
BCTTW_08	Colchester Green Lane water transfer	Internal potable transfer	AWSEXS	Under review as drought option. No new supply-side option identified at present
BCTTW_09	Hanningfield transfer with ESW	Internal potable transfer	AWSEXS	Need to put infrastructure (pipe)in place
CUOS_02	Lexden fluoride blend optimisation	Groundwater enhancement	AWSEXS	Lincence is constraining factor
DES-14A	Desalination Barge moored at Harwich	Desalination	AWSEXS	Offshore deslination provides no benefit over onshore options but carry greater risk.
DES-14b	Harwich floating desalination (sea water)	Desalination	AWSEXS	Offshore deslination provides no benefit over onshore options but carry greater risk.
DRA_13	Yieldham/Balkerne/Inworth River support schemes	New surface water	AWSEXS	CAMS/ALS no resource available
GS_01	Lexden sources	New groundwater	AWSEXS	No long term reliable resource available from groundwater in the region.Water quality constrained (Fluoride) EA approval (part of sustainability reductions)
RW_118	Gt Horkesley -Toggs LA WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
RW_125	Central Essex/South Essex WRZ Reclamation	Water reuse	AWSEXS	None identified
RW_21	Castle Hedingham WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_22	Ardleigh WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
RW_24	Lexden WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
RW_25	Lexden WTW Washwater Recovery	Water reuse	AWSEXS	Not identified as an option in Backwash recovery site by site review
RW_26	Bures WTW Washwater Recovery	Water reuse	AWSEXS	Not identified as an option in Backwash recovery site by site review
RW_27	Bures WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
RW_28	Halstead Parsonage St WTW Washwater Recovery	Water reuse	AWSEXS	Not identified as an option in Backwash recovery site by site review
RW_29	Codham WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
RW_30	Codham WTW Washwater Recovery	Water reuse	AWSEXS	Not identified as an option in Backwash recovery site by site review
RW_33	Petches-Bridge WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
RW_34	Bocking WTW Instrument Recovery	Water treatment works loss recovery	AWSEXS	Issue with reg 31 materials in contact approval
SUP-9	Ardleigh WTW	Water treatment works loss recovery	AWSEXS	Losses already recovered to reservoir
RW_126	Affinity (Brett) WRZ Reclamation	Water reuse	AWSEXS	Resource is supporting river flow

Option ID	Option Name	Option type	WRZ	Reason for option rejection
TAN_01	London Gateway (to Hanningfield in Essex) Tankering	External raw water bulk supply/transfer	AWSEXS	Transport issues
FND13	Fenland WTW backwash water recovery	Water treatment works loss recovery	AWSFND	Cryptosporidium risk from returning concentrates back to works inlet
FND27	Fenland_drought-permit	Drought permits/orders	AWSFND	Provides no DO benefit in planning scenario
FND2	Kings Lynn to Stoke Ferry via river Wissey (no extra treatment at Stoke Ferry WTW)	Water reuse	AWSFND	No benefit without additional potable treatment capacity
FND4	Kings Lynn and West Walton to Stoke Ferry WTW via the River Wissey - no additional treatment at Stoke Ferry	Water reuse	AWSFND	No benefit without additional potable treatment capacity
FND5	Kings Lynn (brackish) 10 Ml/d	Desalination	AWSFND	Unmitigatable risks identified in estuarial and brackish desalination options
FND6	Kings Lynn (brackish) 25 Ml/d	Desalination	AWSFND	Unmitigatable risks identified in estuarial and brackish desalination options
FND7	Kings Lynn (brackish) - power supply from power station (10 Ml/d)	Desalination	AWSFND	Unmitigatable risks identified in estuarial and brackish desalination options
FND8	Kings Lynn (brackish) - power supply from RWE power station (25 Ml/d)	Desalination	AWSFND	Unmitigatable risks identified in estuarial and brackish desalination options
01c-1236	Dredge the cut off channel and use as storage reservoir (weirs at each end) - capture water in the winter period, i.e. storage reservoir	Groundwater enhancement	AWSFND	Very low yield and DO benefit
01c-1237	Raise the ditches in the area (Dyke System) and use as a water storage area	Groundwater enhancement	AWSFND	Very low yield and DO benefit

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01e-0323	Wash Reservoirs	New technology	AWSFND	Brackish water
01e-0842	Any other reservoir identified through CAMS assessment	New reservoir	AWSFND	None identified
02a-0326	North Norfolk Coast WRZ transfer	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-0329	Wash Pipeline from Lincolnshire	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-0396	Wash Pipeline from Lincolnshire	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1032	Kings Delph - Friday Bridge	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1033	Ruthamford North RZ Transfer	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1034	South Fenland WRZ Transfer	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1039	Cambs and West Suffolk WRZ Transfer	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1063	Bradenham WRZ transfer	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02a-1210	Chesterton WR - Friday Bridge	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1229	North Fenland RZ Transfer	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02a-1231	Stoke Ferry to Marham WTW	Internal potable transfer	AWSFND	WRMP19 option. Alternative WRMP24 alternative options developed using improvced modelling methods
02b-0330	Transfer from Lincolnshire (Trent, Witham) via river system	External raw water bulk supply/transfer	AWSFND	Superseded by Lincolnshire reservoir option
02b-1008	Rutland Reservoir - Grafham Reservoir	External raw water bulk supply/transfer	AWSFND	Superseded by Lincolnshire reservoir option
02b-1014	Ely Ouse - Kennet, village	External raw water bulk supply/transfer	AWSFND	Covered by review of EOETS and GOGS
03a-0397	Heacham/Downham Mkt Water Reuse	Water reuse	AWSFND	Resource is supporting river flow
03b-0334	In combination with aquifer recharge options	Water reuse	AWSFND	Immature deveopment
03b-0335	Effluent reuse - small scale other	Water reuse	AWSFND	Resource is supporting river flow
03b-0336	River augmentation options	Water reuse	AWSFND	Resource is supporting river flow
04a-0398	Sedgeford Station or Ringstead abandoned boreholes	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
04b-0338	Review group licences	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
04e-0339	Nitrate removal/revised blending regime	Water treatment works capacity increase	AWSFND	None identified
04e-0340	Relocating existing Marham boreholes (away from the River to reduce impact)	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
05-0341	3rd party trade options (surface water) Polvair and Loke Road	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
05-0342	Bircham Camp borehole	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
05-0343	European interconnector (pipeline from Europe)	International import	AWSFND	Very high risk and very expensive
05-0344	Icebergs	New technology	AWSFND	Unproven technology
05-0346	Industrial reclaimed water - Palm Paper	Water reuse	AWSFND	Option insufficiently developed to model
05-0347	Industrial reclaimed water - British Sugar sites, including closed ones	Water reuse	AWSFND	Resource is supporting river flow
05-0348	Trading options - private groundwater abstractions (food processing, paper industry)	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
05-0400	3rd party trade options	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
05-0401	European interconnector (pipeline from Europe)	International import	AWSFND	Very high risk, technically, politically and environmentally.
05-0402	Icebergs	New technology	AWSFND	Unproven technology
06a-0349	Extend Chalk abstraction	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
06a-0350	Cur-off channel	New surface water	AWSFND	CAMS/ALS no resource available
06a-0351	Gaywood River	New surface water	AWSFND	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06a-0352	River Ely Ouse	New surface water	AWSFND	CAMS/ALS no resource available
06a-0353	North Norfolk Rivers (other)	New surface water	AWSFND	CAMS/ALS no resource available
06a-0354	River Heacham	New surface water	AWSFND	CAMS/ALS no resource available
06a-0355	River Ingol	New surface water	AWSFND	CAMS/ALS no resource available
06a-0356	River Lark	New surface water	AWSFND	CAMS/ALS no resource available
06a-0357	River Nar	New surface water	AWSFND	CAMS/ALS no resource available
06a-0358	River Nene (Wisbech)	New surface water	AWSFND	CAMS/ALS no resource available
06a-0359	River Wissey	New surface water	AWSFND	CAMS/ALS no resource available
06a-0404	North Norfolk Rivers	New surface water	AWSFND	CAMS/ALS no resource available
06a-0405	River Heacham	New surface water	AWSFND	CAMS/ALS no resource available
06a-0542	River Ouse	New surface water	AWSFND	CAMS/ALS no resource available
06a-0543	Cut-off Channel/Stoke Ferry Extension + transfer	New surface water	AWSFND	CAMS/ALS no resource available
06a-0546	River Waveney	New surface water	AWSFND	CAMS/ALS no resource available
06b-0360	New groundwater source	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
06b-0361	Extend Sandringham Sands (Hillington Wellfield)	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
06b-0362	Marham Fen Existing boreholes expansion	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
06b-0363	Secondary groundwater	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
06b-0364	Wellington Wellfield / Denton Lodge expansion	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06b-0406	New groundwater source	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
08a-0365	Chalk	Aquifer recharge/Aquifer storage recovery	AWSFND	Unsuitable hydrogeological conditions. High risk of losing stored water.
08a-0366	Sandringham Sands ASR	Aquifer recharge/Aquifer storage recovery	AWSFND	Unsuitable hydrological conditions
08c-0367	Consider all surface water sources for potential aquifer recharge options (as above).	Aquifer recharge/Aquifer storage recovery	AWSFND	Unsuitable hydrological conditions
10a-0368	New Internal Drainage Board structure	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
10a-0408	New Internal Drainage Board structure	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
10b-0369	SUDS - recharge lagoons	New reservoir	AWSFND	High risk of failure due to uncertain DO
10b-0409	SUDS - recharge lagoons	New reservoir	AWSFND	High risk of failure due to uncertain DO
10c-0370	Ely Ouse Washes Expansion and Control	New reservoir	AWSFND	Superseded by Fens
10c-0371	Wash Barrage	New technology	AWSFND	Uncertain DO
10c-0410	Wash Barrage	New technology	AWSFND	Uncertain DO
11a-0372	Kings Lynn	Desalination	AWSFND	Unmitigatable risks associated with brackish and estuarial desalination
11a-0411	Hunstanton	Desalination	AWSFND	Intake not feasible due to shallow nature of the wash. Abstraction fom groundwater will also be limited due to the risk of GW intrusion and impacts on the wash

Option ID	Option Name	Option type	WRZ	Reason for option rejection
11b-0373	Small scale desalination	Desalination	AWSFND	Option does not provide the required DO
11b-0374	Fenland River Outfalls	Desalination	AWSFND	Unmitigatable risks associated with brackish and estuarial desalination
11b-0376	Fenland Secondary Groundwater	Desalination	AWSFND	Option not appropriate - no secondary groundwater available
12a-0377	Kings Lynn/Marham conjunctive use - amend existing operation	Groundwater enhancement	AWSFND	Insufficient groundwater.
12a-1093	Wissey Fenland Conjunctive Use (existing licence)	Groundwater enhancement	AWSFND	To determine sustainability risks from increased GW abstraction at times of low flows in the Wissey
12b-0378	Increase surface water treatment capacity to utilise high river flows	Groundwater enhancement	AWSFND	Option has high risk of significant outage
13-0379	Multi use reservoir (agriculture)	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
13-0412	Multi use reservoir (agriculture)	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
14-0380	Cambridge Water	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
14-0381	Cambridge Water transfer	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
15-0382	Inland (road / rail) tankering	Internal potable transfer	AWSFND	Weather related reliability issues. Traffic impact
15-0383	Sea tankering (Kings Lynn)	International import	AWSFND	Too far from a viable connection to existing infrastructure
18-0384	Increasing storage at private lakes e.g. Bawsey Lakes	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
18-0385	Sands and Gravel extraction locations e.g. Pentney Lakes	New reservoir	AWSFND	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
19-0387	Other MOD / RAF sites (including RAF Feltwell) Ministry of Defence sites	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
19-0388	RAF Marham boreholes	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
19-0389	RAF West Raynham MOD sites boreholes	Licence trading	AWSFND	Option not sufficiently mature to define costs or DO.
20-0390	Innovative options (international examples e.g. sea clouding)	New technology	AWSFND	Unproven technology, cost and yield
20-0415	Rainwater harvesting	Rainwater harvesting	AWSFND	Demand management option
21-0392	EOETs & GOGS review	External raw water bulk supply/transfer	AWSFND	No long term reliable resource available from groundwater in the region.
BCTTW_21	Kings Lynn-Weston connectivity	Internal potable transfer	AWSFND	Infrastructure in place - areas already stretched in capability
BCTTW_49	East Dereham RZ transfer	Internal potable transfer	AWSFND	Alternatives developed
BTRW_01	Stoke Ferry Extension	External raw water bulk supply/transfer	AWSFND	reliability of cut off channel - EA buy-in to send water further down
CMS_01	CM - Hillington WTW/Grimston WRC sources - farmer partnership (nitrates)	Catchment management	AWSFND	Catchment liaison - non WRMP option
CMS_08	Hillington WTW -Wetland	Catchment management	AWSFND	Potential for sustainability reductions/environmental reductions in next round/water trade-offs
CMS_10	Fenland winter reservoirs	Catchment management	AWSFND	To be investigated through WRE catchment management forums
CMS_22	Old Carr Stream, Stringside Stream and Gadder	Catchment management	AWSFND	To be investigated through WRE catchment management forums

Option ID	Option Name	Option type	WRZ	Reason for option rejection
CMS_23	Gaywood River	Catchment management	AWSFND	To be investigated through WRE catchment management forums
CMS_24	Heacham River	Catchment management	AWSFND	CAMS/ALS no resource available
DES_19	Sea Water Desalination along the coastline of The Wash	Desalination	AWSFND	Unmitigatable risks identified with desalination in The Wash
DES_37	River Nene	Desalination	AWSFND	CAMS/ALS no resource available
DES-56	Sea Water desalination Holkham area (North Norfolk Coast)	Desalination	AWSFND	Intake / outfall not feasible due to coastline conditions
DRA_10	South Fenland Rivers abstraction	New surface water	AWSFND	CAMS/ALS no resource available
NR_07	Feltwell Reservoir	New Reservoir	AWSFND	Superseded by Fens
NR_08	One season storage reservoir	New Reservoir	AWSFND	Superseded by Fens
RESIY_03	Hillington/Grimston licensing	Groundwater enhancement	AWSFND	Licence constraints
RESIY_04	Great Bircham/Fring licensing	Groundwater enhancement	AWSFND	Low flows in River Hitchin - potential use for river support in future
RUPSOS_05	Reinstating Ringstead abandoned boreholes	New groundwater	AWSFND	No long term reliable resource available from groundwater in the region.
RW_74	Hillington -Greensand WTW Instrument Recovery	Water treatment works loss recovery	AWSFND	Issue with reg 31 materials in contact approval
RW_76	Marham GW WTW (nitrate) Instrument Recovery	Water treatment works loss recovery	AWSFND	Issue with reg 31 materials in contact approval
RW_77	Marham GW Washwater Recovery	Water reuse	AWSFND	Resource is supporting river flow
RW_78	Stoke Ferry WTW Instrument Recovery	Water treatment works loss recovery	AWSFND	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_79	Beck Row WTW Instrument Recovery	Water treatment works loss recovery	AWSFND	Issue with reg 31 materials in contact approval
RW_80	Beck Row WTW Washwater Recovery	Water reuse	AWSFND	Innapropriate treatment for washwater recovery
RW_81	Denton Lodge WTW Instrument Recovery	Water treatment works loss recovery	AWSFND	Issue with reg 31 materials in contact approval
RW_82	Grimston STW Instrument Recovery	Water treatment works loss recovery	AWSFND	Issue with reg 31 materials in contact approval
WQS_13	Hillington WTW treatment	Water treatment works capacity increase	AWSFND	Potential for sustainability reductions/environmental reductions in next round/water trade-offs
2019_BT03	Northumbrian Water	Internal potable transfer	AWSHPL	Option not sufficiently mature to define costs or DO.
2019_CU01	Conjunctive use with Northumbrian Water	Groundwater enhancement	AWSHPL	No deficit
2019_DES01	Hartlepool harbour (sea water)	Desalination	AWSHPL	No deficit
2019_DES02	Secondary groundwater	Desalination	AWSHPL	No long term reliable resource available from groundwater in the region.
2019_DRA02	Skerne	New surface water	AWSHPL	CAMS/ALS no resource available
2019_GW01	Teeside boreholes	New groundwater	AWSHPL	No long term reliable resource available from groundwater in the region.
2019_GW02	Mine dewatering	Water treatment works capacity increase	AWSHPL	Immature deveopment
2019_GW03	Secondary groundwater	New groundwater	AWSHPL	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
2019_GW04	Mag limestone	New groundwater	AWSHPL	No long term reliable resource available from groundwater in the region.
2019_IRY02	Hartlepool reservoirs	Groundwater enhancement	AWSHPL	No deficit
2019_NRS01	Purchase existing assets	Licence trading	AWSHPL	Option not sufficiently mature to define costs or DO.
2019_NRS02	On Skerne	New reservoir	AWSHPL	No deficit
2019_NRS03	SUDS	New reservoir	AWSHPL	High risk of failure due to uncertain DO
2019_NRS04	New reservoir	New reservoir	AWSHPL	No deficit
2019_NRS05	Private lakes and gravel pits	New reservoir	AWSHPL	No deficit
2019_OO01	Rainwater harvesting	Rainwater harvesting	AWSHPL	Demand management option
2019_OO02	Innovative options (international examples e.g. sea clouding)	New technology	AWSHPL	Unproven technology, cost and yield
2019_RS01	Northumbrian Water	Licence trading	AWSHPL	Option not sufficiently mature to define costs or DO.
2019_RW01	Northumbrian Water WRCs (trade)	Water reuse	AWSHPL	Resource is supporting river flow
2019_RW02	Teeside industrial effluent	Water reuse	AWSHPL	Resource is supporting river flow
2019_TPO01	Agriculture	Licence trading	AWSHPL	Option not sufficiently mature to define costs or DO.
2019_TPO02	Coal Authorities (Sulphate plume management)	Licence trading	AWSHPL	Option not sufficiently mature to define costs or DO.
2019_TW01	Nordic water	International import	AWSHPL	Generic, some specific variations have been developed further.
2019_TW02	Road	Internal potable transfer	AWSHPL	Road Tankering rejected due to capacity required would not be feasible via road

Option ID	Option Name	Option type	WRZ	Reason for option rejection
2019_TW03	rail	Internal potable transfer	AWSHPL	Rejected due to weather and reliability issues, and due to traffic impacts
2019-DES02	Secondary groundwater	Desalination	AWSHPL	No long term reliable resource available from groundwater in the region.
AT_01	Purchase industry boreholes	Licence trading	AWSHPL	Option not sufficiently mature to define costs or DO. No current deficit - expensive No change in industry at the moment
BCTTW_01	Northumbrian trading	Internal potable transfer	AWSHPL	No current mains connectivity - investment needed for infrastructure Balance only just achieved on blending
BCTTW_02	Northumbrian trading	Internal potable transfer	AWSHPL	No current infrastructure in place
BCTTW_31	Hartlepool-AWS region connectivity	Internal potable transfer	AWSHPL	No deficit
DES-09	Hartlepool	Desalination	AWSHPL	No deficit
RW_120	Dalton Piercy WTW Instrument Recovery	Water treatment works loss recovery	AWSHPL	Issue with reg 31 materials in contact approval
WQS_11	Hartlepool RO	Water treatment works capacity increase	AWSHPL	No deficit Expensive
CMS_19	Kennett - Lee Brook	Catchment management	AWSLNB	To be investigated through WRE catchment management forums
LNC12	Trent trade with new water treatment works	Licence trading	AWSLNC	This option is similar to LNC11 in benefit but carries more planning risk so rejected in favour of the alternative.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
LNC13	Trent trade with new WTW and Storage	Licence trading	AWSLNC	Insufficient information about storage suitability on site but this offers no advantave over other Trent trade options.
LNC1	Canwick WRC to the Hall via River Trent (additional treatment at Hall WTW)	Water reuse	AWSLNC	Loss of effluent discharge to Witham would require compensation transfer from Trent. No overall WAFU benefit to WRZ
LNC20	South Humber bank desalination (seawater) collocated with SHB Power Station (10 Ml/d)	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC21	South Humber bank desalination (seawater) 10 Ml/d	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC22	Lincolnshire Central non-potable to potable treatment (10 Ml/d)	New surface water	AWSLNC	CAMS/ALS no resource available
LNC23	Lincolnshire Central non-potable to potable treatment (31 Ml/d)	New surface water	AWSLNC	CAMS/ALS no resource available
LNC24	Lincolnshire Central non-potable to potable treatment (50 Ml/d)	New surface water	AWSLNC	CAMS/ALS no resource available
LNC26	Canwick reuse, Sherwood ASR, Hall extension	Water reuse	AWSLNC	Loss of effluent discharge to Witham would require compensation transfer from Trent. No overall WAFU benefit to WRZ
LNC27	Canwick reuse, Staythorpe con, Hall extension	Water reuse	AWSLNC	Loss of effluent discharge to Witham would require compensation transfer from Trent. No overall WAFU benefit to WRZ
LNC2	Canwick WRC to the Hall via River Trent (no additional treatment at Hall WTW)	Water reuse	AWSLNC	Loss of effluent discharge to Witham would require compensation transfer from Trent. No overall WAFU benefit to WRZ

Option ID	Option Name	Option type	WRZ	Reason for option rejection
LNC3	South Humber bank desalination (seawater) collocated with SHB Power Station (25 Ml/d)	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC4	South Humber bank desalination (seawater) collocated with SHB Power Station (50 Ml/d)	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC5	South Humber bank desalination (seawater) 27 Ml/d	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC6	South Humber bank desalination (seawater) 50 Ml/d	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC7	Desalination (brackish) on Trent between Gainsborough and the Humber (10 Ml/d)	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
LNC8	Desalination (brackish) on Trent between Gainsborough and the Humber (25 Ml/d)	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
20-0838	Innovative options (international examples e.g. sea clouding)	New technology	AWSLNC	Unproven technology, cost and yield
4E-25	Blending sources licence review (Dunston)	Water treatment works capacity increase	AWSLNC	System optimised - no benefit identified.
01b-0001	Cadney Carrs reservoir	Groundwater enhancement	AWSLNC	The current pumps meet the licence capacity, so this does not provide and DO benefits.
01b-0002	Easton unused reservoir	Groundwater enhancement	AWSLNC	Does not provide DO required during low flows
01b-0003	Hall reservoir	Groundwater enhancement	AWSLNC	Option would require further storage to make use of higher abstractions. See CLN2
01b-0004	Stoke Rochford	Groundwater enhancement	AWSLNC	Screened out - does not provide DO required in a drought

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01c-0005	Cadney Carrs Reservoir	Groundwater enhancement	AWSLNC	Cadney carrs 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 Cadney with information on the TWA scheme operation to estimate the R. Ancholme flows. Therefore, it is not a reliable option for WRMP19.
01c-0006	Easton unused reservoir	Groundwater enhancement	AWSLNC	Not feasible due to results of the bathymetric surveys
01c-0007	Hall Trent WTW bankside storage	Groundwater enhancement	AWSLNC	Not feasible due to results of the bathymetric surveys
01c-0008	Stoke Rochford	Groundwater enhancement	AWSLNC	Not feasible due to results of the bathymetric surveys
01e-0003	Hall reservoir	New reservoir	AWSLNC	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.
01e-0009	Recommission existing reservoir (Stoke Rochford)	New reservoir	AWSLNC	Insufficient detail
01e-0010	Cadney extension	New reservoir	AWSLNC	CAMS/ALS no resource available
01e-0011	Easton (recommission) Recommission unused reservoir	New reservoir	AWSLNC	Small yield with significant uncertainty about reliability under future climate change scenarios. Significant water quality risks in Upper Witham catchment

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01e-0012	Pumped storage reservoir (source any river in Central Lincs)	New reservoir	AWSLNC	CAMS/ALS no resource available
01e-0013	Toft Newton Extension	New reservoir	AWSLNC	CAMS/ALS no resource available
02a-1219	Bourne RZ Transfer	Internal potable transfer	AWSLNC	Final planning scenario - transfer would be <5Ml/d and not part of a strategic route therefore rejected.
02a-1220	Central Lincolnshire RZ Network improvements from North to South South Humber Bank WRZ to Central Lincolnshire WRZ Transfer	Internal potable transfer	AWSLNC	Alternatives developed
02a-1221	Westgate tower to Bracebridge Heath WR	Internal potable transfer	AWSLNC	Required option-sizes refined, costings and capacities updated
02a-1222	Central Lincolnshire RZ Transfer	Internal potable transfer	AWSLNC	Alternatives developed
02b-0014	Grantham canal (flow reversal)	External raw water bulk supply/transfer	AWSLNC	Scheme screened out due to: 1. 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. 2. High risk of failure - Technical: Rehabilitation of a disused canal to transfer flows is likely to require extensive canal repair. 3. High risk of failure - Technical: Pre-treatment may be required to protect existing habitat along the canal. 4. 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.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02b-0015	Kidby canal	External raw water bulk supply/transfer	AWSLNC	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 Winterton Homes WTW to treat the river water quality - Ecological implications on the canal
02b-0016	Severn Trent Water - groundwater into Trent	External raw water bulk supply/transfer	AWSLNC	This is considered as part of the Trent working group and trading options but GW is subject to sustainability losses so not an option.
02b-1010	Toft newton - Short Ferry	External raw water bulk supply/transfer	AWSLNC	New or replacement transfer added after March 17 review
03b-0017	Marston Water reuse	Water reuse	AWSLNC	Resource is supporting river flow
03b-0018	Sleaford Water reuse	Water reuse	AWSLNC	Resource is supporting river flow
03b-0020-B	Scunthorpe water reuse	Water reuse	AWSLNC	Resource is supporting river flow
03c-0021-a	Saltersford WTW Washwater Recovery	Water reuse	AWSLNC	Resource is supporting river flow
03c-0021-b	Elsham WTW Washwater Recovery	Water reuse	AWSLNC	Resource is supporting river flow
04b-0022	Review group licences	New groundwater	AWSLNC	No long term reliable resource available from groundwater in the region.
04c-0024	Bath springs (existing but not used) Existing unused sources	New groundwater	AWSLNC	WFD assessment - no additional resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
05-0026	Lincoln WRC effluent into Trent (Severn Trent WRC)	Water reuse	AWSLNC	Resource is supporting river flow
05-0027	Acquire Trent Witham Ancholme Transfer	External raw water bulk supply/transfer	AWSLNC	Part of Trent resource strategy
05-0028	Icebergs	New technology	AWSLNC	Unproven technology
05-0029	Agriculture Potatoes (groundwater)	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
05-0030	Power stations - cooling water, boiler feed (Brigg) - 3 power stations in Yorkshire Water region	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
05-0031	Power stations (Brigg) + 3 power stations in Yorkshire Water region	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
05-0032	Sugar beet (Bardney)	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
05-0033	Tata Steel (groundwater)	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
06a-0034	Fossdyke	New surface water	AWSLNC	CAMS/ALS no resource available
06a-0035	Cringlebrook	New surface water	AWSLNC	CAMS/ALS no resource available
06a-0036	River Don	New surface water	AWSLNC	CAMS/ALS no resource available
06a-0037	Humber	New surface water	AWSLNC	Brackish water
06a-0038	River Trent	New surface water	AWSLNC	CAMS/ALS no resource available
06a-0039	River Slea	New surface water	AWSLNC	CAMS/ALS no resource available
06a-0040	River Till	New surface water	AWSLNC	CAMS/ALS no resource available
06a-0041	River Witham	New surface water	AWSLNC	Lincolnshire reservoir
06a-0043	Ancholme	New surface water	AWSLNC	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06b-0044	New sources	New groundwater	AWSLNC	No long term reliable resource available from groundwater in the region.
06b-0045	Decommissioned Power station sources	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
06b-0046	Lincolnshire limestone (new source)	New groundwater	AWSLNC	No long term reliable resource available from groundwater in the region.
06b-0047	Secondary groundwater	New groundwater	AWSLNC	No long term reliable resource available from groundwater in the region.
08a-0049	Lincolnshire limestone	Aquifer recharge/Aquifer storage recovery	AWSLNC	Unsuitable hydrological conditions
08b-0050	River Trent	New technology	AWSLNC	CAMS/ALS no resource available
08c-0051	Flood storage	Aquifer recharge/Aquifer storage recovery	AWSLNC	Unsuitable hydrological conditions
08c-0052	Lincolnshire limestone	Aquifer recharge/Aquifer storage recovery	AWSLNC	Unsuitable hydrological conditions
08c-0054	SUDS (road drainage)	Aquifer recharge/Aquifer storage recovery	AWSLNC	High risk of failure due to uncertain DO
10b-0056	SUDS	New reservoir	AWSLNC	High risk of failure due to uncertain DO
10c-0057	Flood storage	New reservoir	AWSLNC	Unsuitable hydrological conditions
10c-0058	Trent flood storage	New reservoir	AWSLNC	Superseded by Lincolnshire res and Hall extension
11b-0060	Secondary groundwater	Desalination	AWSLNC	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
11b-0061	Tidal Trent	Desalination	AWSLNC	Unmitigatable risks identified in estuarial and brackish desalination options
11b-0190	Nottinghamshire Secondary groundwater	Desalination	AWSLNC	Option not appropriate - no secondary groundwater available
12a-0062	Optimise conjunctive use of existing surface water and groundwater resources.	Groundwater enhancement	AWSLNC	System DO modelled in Aquator so the benefits of optimal conjunctive use are already included in supply forecast
12a-1092	Lincoln Trent Conjunctive Use	Groundwater enhancement	AWSLNC	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.
12b-0063	Increase surface water treatment capacity to utilise high river flows	Groundwater enhancement	AWSLNC	Superseded by Lincolnshire/ Hall/ Trent Trade options
12b-0064	Trent Witham Ancholme enhancements with ASR	Groundwater enhancement	AWSLNC	Covered by other TWA options
12b-0145	Elsham/Grimsby TWA Conjunctive Use	Groundwater enhancement	AWSLNC	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.
13-0065	Agriculture	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
13-0066	Environment Agency's Toft Reservoir	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
14-0068	Severn Trent Water - new and increasing existing	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
14-0069	Yorkshire via Humber bridge	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
14-0070	Yorkshire Water- new	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
15-0072	Canal	Internal potable transfer	AWSLNC	Small DO. Risk to navigation in drought - reliability issues related to third party
15-0073	Rail	Internal potable transfer	AWSLNC	Rejected due to weather and reliability issues, and due to traffic impacts
15-0074	Road tankering	Internal potable transfer	AWSLNC	Road Tankering rejected due to capacity required would not be feasible via road
18-0075	Increasing storage at private lakes	New reservoir	AWSLNC	None identified as part of the Private Lakes and Reservoir study
18-0076	Environment Agency 's Toft Reservoir	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
18-0077	Gravel pits south of Hykeham	New reservoir	AWSLNC	Superseded by Lincolshire res and Hall extension
18-0078	Trent gravels	New reservoir	AWSLNC	Superseded by Lincolshire res and Hall extension
19-0079	RAF/MOD boreholes	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
20-0080	Innovative options (international examples e.g. sea clouding)	New technology	AWSLNC	Unproven technology, cost and yield
20-0081	Rainwater harvesting	Rainwater harvesting	AWSLNC	Demand management option
ALT_03	Sugar beet (Bardney) -3rd party option	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.
ALT_05	Manor Farm Groundwater Source (Wavetide Ltd)	Licence trading	AWSLNC	Option not sufficiently mature to define costs or DO.30km transfer/ tankering would be required to AWS supply area

Option ID	Option Name	Option type	WRZ	Reason for option rejection
BCTTW_04	Severn Trent trading with Saltersford area	Internal potable transfer	AWSLNC	no bulk water from Severn Trent in this area
BCTTW_12	SPA-Grantham via Elsham	Internal potable transfer	AWSLNC	Superseded by alterative WRMP24 developed transfers
BCTTW_13	SPA-Dunston/Sutterton	Internal potable transfer	AWSLNC	Superseded by alterative WRMP24 developed transfers
BCTTW_20	Yorkshire Water-North Lincolnshire Via Humber-Trade	Internal potable transfer	AWSLNC	Expensive
BCTTW_22	Waddingham WTW reinforced connectivity	Internal potable transfer	AWSLNC	Need for investment - limited connectivity at the moment - main to Caistor is intermittent
BCTTW_27	South Lincolnshire Reservoir-Saltersford-transfer	Internal raw water transfer	AWSLNC	Alternative potable options developed
CMS_02	CM - Dunston GW sources - nitrates	Catchment management	AWSLNC	Small capacity sites
CMS_03	CM - Branston WTW- nitrates	Catchment management	AWSLNC	Already actioned by catchment liaisonSmall capacity sites
CMS_07	CM - Hall WTW - farmer partnership (nitrates)	Catchment management	AWSLNC	Already actioned by catchment liaison
CMS_14	Sugar beet (Bardney) -3rd party option	Catchment management	AWSLNC	Option not sufficiently mature to define costs or DO.
CMS_28	River Slea	Catchment management	AWSLNC	CAMS/ALS no resource available
CMS_29	Barlings Eau - Welton Beck & Nettleham Beck	Catchment management	AWSLNC	To be investigated through WRE catchment management forums
CMS_30	Witham Limestone Aquifer - Scopwick Beck	Catchment management	AWSLNC	To be investigated through WRE catchment management forums
DES 51	Cloves Bridge	Desalination	AWSLNC	Unmitigatable risks associated with brackish and estuarial desalination

Option ID	Option Name	Option type	WRZ	Reason for option rejection
NR_02	Ancholme multi-usage reservoirs	New reservoir	AWSLNC	Superseded by Lincolshire res and Hall extensionWater Quality
NR_09	Ancholme Reservoir	New reservoir	AWSLNC	Superseded by Lincolshire res and Hall extension
RESIY_12	Newton on Trent licensing	Groundwater enhancement	AWSLNC	Moving forward potentially balance cuts at Eleksley - no new supply
RW_100	Winterton Holmes WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_101	Aswarby WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_102	Clay Hill WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_103	Elsham WTW (non potable) Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_104	Elsham WTW (potable) Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_105	Newton on Trent WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_106	Hall WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_132	Sugar beet (Bardney) -3rd party option	Water reuse	AWSLNC	Option not sufficiently mature to define costs or DO.
RW_96	Welton WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_97	Saltersford WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_98	Billingborough WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
RW_99	Barrow WTW Instrument Recovery	Water treatment works loss recovery	AWSLNC	Issue with reg 31 materials in contact approval
SUP-10	Saltersford WTW	Water treatment works loss recovery	AWSLNC	Losses already recovered to reservoir
SUP-11	Elsham WTW	Water treatment works loss recovery	AWSLNC	Losses already recovered to reservoir
SUP-7	Hall WTW	Water treatment works loss recovery	AWSLNC	Backwash recovery already in place
LNE10	Desalination barge moored offshore with a pipeline coming onshore at Mablethorpe (100 Ml/d)	Desalination	AWSLNE	Offshore deslination provides no benefit over onshore options but carry greater risk.
LNE13	Lincolnshire East drought permit (Covenham)	Drought permits/orders	AWSLNE	Provides no DO benefit in planning scenario
LNE2	Ingoldmells to Covenham via Rive Eau (no additional treatment at Covenham)	Water reuse	AWSLNE	No benefit without additional potable treatment capacity
LNE8	Desalination barge moored offshore with a pipeline coming onshore at Mablethorpe (25 Ml/d)	Desalination	AWSLNE	Offshore deslination provides no benefit over onshore options but carry greater risk.
LNE9	Desalination barge moored offshore with a pipeline coming onshore at Mablethorpe (50 Ml/d)	Desalination	AWSLNE	Offshore deslination provides no benefit over onshore options but carry greater risk.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
WQS_01	Hall nitrate removal plant	Water treatment works capacity increase	AWSLNE	AMP7 scheme Investment - licence restrictions in Newton (Grove)
01b-0082	Covenham reservoir	Groundwater enhancement	AWSLNE	Current pumping capacity meets current licence so further capacity is not an option.
01c-0083	Covenham	Groundwater enhancement	AWSLNE	Not feasible due to results of the bathymetric surveys
01e-0085	Covenham extension	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
01e-0086	River Welland Washes	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
01e-0087	New small reservoirs from new sources above (Revesby, Miningsby)	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
02a-1218	Ruthamford North WRZ Transfer	Internal potable transfer	AWSLNE	Alternatives developed

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02b-0088	Grantham canal (flow reversal)	External raw water bulk supply/transfer	AWSLNE	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.
02b-1204	Rutland Reservoir - South Lincolnshire Reservoir	Internal raw water transfer	AWSLNE	Water is connected via potable network so SLR could support rutland by using SLR for supply and saving Rutland, superseding the longer raw water transfer
03b-0091-A	Boston water reuse	Water reuse	AWSLNE	Resource is supporting river flow
03b-0092	Horncastle water reuse	Water reuse	AWSLNE	Resource is supporting river flow
03b-0093	Louth water reuse	Water reuse	AWSLNE	Resource is supporting river flow
03b-0095	Spalding/Bourne water reuse	Water reuse	AWSLNE	Resource is supporting river flow
04b-0097	Maximising Northern Chalk (Littlecoates etc)	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
04b-0098	Review group licences	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
04e-0099	Blending sources licence review	Water treatment works capacity increase	AWSLNE	WFD assessment - no additional resource available
05-0101	Agriculture (Witham, Blankney estates)	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
05-0102	Batemans brewery	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
05-0103	Butlin's (groundwater, effluent)	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
05-0104	Killingholme power station + Sutton Bridge	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
05-0105	Killingholme sludge (waste stream from Elsham)	Water reuse	AWSLNE	Resource is supporting river flow
05-0107	Agriculture Potatoes (groundwater)	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
05-0109	Tata Steel (groundwater)	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
06a-0042	South Forty foot Drain	New surface water	AWSLNE	Lincolnshire reservoir
06a-0110	Chalk streams	New surface water	AWSLNE	CAMS assessment shows no water available
06a-0111	River Nene	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0112	River Welland	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0113	Louth Canal	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0114	River Bain	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0115	River Barlings	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0116	River Great Eau	New surface water	AWSLNE	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06a-0117	River Glen	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0118	River Humber	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0119	River Lud	New surface water	AWSLNE	CAMS/ALS no resource available
06a-0120	River Witham	New surface water	AWSLNE	Lincolnshire reservoir
06b-0121	Blow wells	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
06b-0122	New sources (chalk)	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
06b-0123	Elsham sandstone	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
06b-0124	Lincolnshire limestone (new source)	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
06b-0125	Roach and Carstone,	New groundwater	AWSLNE	CAMS assessment indicates that no water is available for consumptive abstraction.
06b-0126	Secondary groundwater	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
06b-0127	Spilsby	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.
08a-0128	Splisby	Aquifer recharge/Aquifer storage recovery	AWSLNE	Unsuitable hydrological conditions
08b-0129	Bain	New technology	AWSLNE	Uncertain DO
08b-0130	Witham	New technology	AWSLNE	Uncertain DO

Option ID	Option Name	Option type	WRZ	Reason for option rejection
08c-0131	Flood storage	Aquifer recharge/Aquifer storage recovery	AWSLNE	Unsuitable hydrological conditions
08c-0132	SUDS (road drainage)	Aquifer recharge/Aquifer storage recovery	AWSLNE	High risk of failure due to uncertain DO
10a-0055	Internal Drainage Boards (IDBs) - South Forty Foot Drain	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
10a-0133	Internal Drainage Boards (South Forty Foot Drain - Lincs waterway)	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
10b-0134	SUDS	New reservoir	AWSLNE	High risk of failure due to uncertain DO
10c-0135	Flood storage	New reservoir	AWSLNE	Unsuitable hydrological conditions
10c-0136	Flood storage (Lower Witham, Boston Barrier)	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
10c-0137	Nene washes	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
10c-0138	Northcoates Lagoons	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
11b-0141	Secondary groundwater	Desalination	AWSLNE	No long term reliable resource available from groundwater in the region.
11b-0375	Inland (Wisbech) desal	Desalination	AWSLNE	Water quality envelope would require complex operating regime
12a-0143	East Lincolnshire Conjunctive Use	Groundwater enhancement	AWSLNE	Insufficient surface water to generate a benefit
12a-0144	Optimise conjunctive use of surface water and groundwater resources.	Groundwater enhancement	AWSLNE	Current pumping capacity meets current licence so further capacity is not an option.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
13-0146	Agriculture	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
15-0151	Rail	Internal potable transfer	AWSLNE	Rejected due to weather and reliability issues, and due to traffic impacts
15-0152	Road tankering	Internal potable transfer	AWSLNE	Road Tankering rejected due to capacity required would not be feasible via road
18-0153	Increasing storage at private lakes	Groundwater enhancement	AWSLNE	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 abstracition allowed if there is no hydraulic connection with surface water features in the Lincs Limestone, Lincs Chalk, or Spilsby Sandstone.
18-0154	Bains gravels	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
18-0155	Tallington Lakes	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
19-0156	RAF/MOD boreholes	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
20-0157	Innovative options (international examples e.g. sea clouding)	New technology	AWSLNE	Unproven technology, cost and yield
20-0158	Rainwater harvesting	Rainwater harvesting	AWSLNE	Demand management option
20-0159	Reduce evaporation in reservoirs	Groundwater enhancement	AWSLNE	Unproven technology, cost and yield

Option ID	Option Name	Option type	WRZ	Reason for option rejection
AR_01	Aquifer recharge LittleCoates	Aquifer recharge/Aquifer storage recovery	AWSLNE	Unsuitable hydrological conditionsAbility to bring it back to supply limited
AT_02	Purchase private assets in northern chalk	Licence trading	AWSLNE	Option not sufficiently mature to define costs or DO.
BCTTW_23	Sutterton connectivity	Internal potable transfer	AWSLNE	Limited opportunities for deployment.
BCTTW_28	South Lincolnshire Reservoir-Manby/Maltby and Mumby transfer	Internal potable transfer	AWSLNE	Licence constraints
BCTTW_30	Northern chalk sources connection to Barrow	Internal potable transfer	AWSLNE	Licence constraints
CMS_27	East Glen River and West Glen	Catchment management	AWSLNE	No option identified at regional level
CMS_31	Grimsby Ancholme Louth Chalk (Northern Chalk)	Catchment management	AWSLNE	No option identified at regional level
DES_01	Covenham Desalination	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
DES_02	Humber desalination	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
DES_26	Skegness to Thedelthorpe (multiple options)	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
DES_40	Sandilands	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
DES_41	Trusthorpe Onsough Drain (Mablethorpe)	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination

Option ID	Option Name	Option type	WRZ	Reason for option rejection
DES_42	Louth Canal @ Teteny Lock	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
DES-02	Covenham sea water desalination	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
DES-39	Brackish Water Desalination at Anderby Creek drainage channel	Desalination	AWSLNE	Unmitigatable risks associated with brackish and estuarial desalination
NR_01	LittleCoates winter reservoir	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension Ability to bring it back to supply limited - need for investment
NR_06	Maltby/Manby/Mumby raw water storage	New reservoir	AWSLNE	Superseded by Lincolnshire res and Hall extension
RESIY_02	Haconby/West Pinchbeck licensing	Groundwater enhancement	AWSLNE	Water quality issues Balance take with Pinchbeck Jockey where sustainability reductions are in place Issues at high rates
RESIY_13	Wilsthorpe/Tallington licensing	Groundwater enhancement	AWSLNE	Limited headroom on licence - moving forward, used to balance cuts at Bourne
RESIY_14	Hubbards Hills/Raithby/Grimoldby/Manby licensing	Groundwater enhancement	AWSLNE	Limited headroom going forward
RESIY_15	LittleCoates seasonal licensing	Groundwater enhancement	AWSLNE	Licence reviewed and included in 'North Lincolnshire Alterative' solution, so not available for other uses
RUPSOS_02	Goxhill source	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RUPSOS_03	Barnoldby WTW reinstatement	New groundwater	AWSLNE	No long term reliable resource available from groundwater in the region.Small site Expensive water
RW_01	Littlecoates WTW	Water reuse	AWSLNE	Resource is supporting river flow
RW_134	Humber CCS/Hydrogen Hub	Water reuse	AWSLNE	Resource is supporting river flow
RW_85	West Pinchbeck WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_86	Weelsby WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_87	Waddingham WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_88	Maltby Le Marsh WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_89	Driby WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_90	Covenham WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_91	Candlesby WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_92	Bourne WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_93	Fordington WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_94	Raithby WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
RW_95	Mumby WTW Instrument Recovery	Water treatment works loss recovery	AWSLNE	Issue with reg 31 materials in contact approval
TAN_03	Hull Tankering	International import	AWSLNE	Transport issues
WQS_12	Louth WRC treatment optimisation	Water treatment works capacity increase	AWSLNN	Under review with Covenham optionsMetaldehydes banned but would remain in catchments for several years still
02a-1056	Central Lincolnshire WRZ (Lincoln) transfer	Internal potable transfer	AWSLNN	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.
02a-1223a	Central Lincolnshire WRZ Transfer	Internal potable transfer	AWSLNN	Alternatives developed
02a-1223b	Gainsborough WR to Grove WR	Internal potable transfer	AWSLNN	Alternatives developed
02b-0161	Chesterfield canal	External raw water bulk supply/transfer	AWSLNN	High risk of failure for technical and sustainability reasons
02b-0162	Severn Trent Water - groundwater into Trent	External raw water bulk supply/transfer	AWSLNN	No option identified at regional level
02b-0163	Severn Trent Water WRCs into Trent (Scunthorpe WRC)	External raw water bulk supply/transfer	AWSLNN	No option identified at regional level
03b-0164	Newark water reuse	Water reuse	AWSLNN	Resource is supporting river flow
03b-0165	Retford water reuse	Water reuse	AWSLNN	Resource is supporting river flow

Option ID	Option Name	Option type	WRZ	Reason for option rejection
04b-0166	Review group licences	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.
04c-0023	Grove (source)	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.
04c-0167	Gainsborough (existing borehole not in use)	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.
04c-0168	Recommission Grove abandoned WTW	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.
04c-0787	Bartlow (Existing polluted groundwater source) Westoe Farm	Water treatment works capacity increase	AWSLNN	Insufficient detail
05-0170	Gainsborough Water reuse (Severn Trent WRC)	Water reuse	AWSLNN	Resource is supporting river flow
05-0171	Coal mine dewatering	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
05-0172	Decommissioned Power station sources	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
05-0175	Power stations - cooling water, boiler feed	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
05-0176	Sugar beet (Newark)	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
06b-0178	New sources	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.
06b-0179	Secondary groundwater	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06b-0180	Sherwood sandstone (new source)	New groundwater	AWSLNN	No long term reliable resource available from groundwater in the region.
08b-0182	River Idle	New surface water	AWSLNN	CAMS/ALS no resource available
08b-0183	River Poulter	New surface water	AWSLNN	CAMS/ALS no resource available
08b-0184	River Trent	New surface water	AWSLNN	CAMS/ALS no resource available
08c-0185	Flood storage	Aquifer recharge/Aquifer storage recovery	AWSLNN	Unsuitable hydrological conditions
08c-0186	Sherwood sandstone	Aquifer recharge/Aquifer storage recovery	AWSLNN	Generic option for this aquifer. One specific option taken forward. No others identified.
08c-0187	SUDS (road drainage)	Aquifer recharge/Aquifer storage recovery	AWSLNN	High risk of failure due to uncertain DO
10c-0188	Flood storage	New reservoir	AWSLNN	Unsuitable hydrological conditions
12A-1091	Retford/Everton Trent Conjunctive Use	Groundwater enhancement	AWSLNN	Sustainability risks from increased GW abstraction at times of low flows in the Trent
12b-0192	Increase surface water treatment capacity to utilise high river flows	Groundwater enhancement	AWSLNN	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.
13-0193	Agriculture	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
14-0194	Opportunity with all options	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
14-0195	Severn Trent Water - new and increasing existing	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
14-0196	Yorkshire Water- new	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
15-0197	Boat on Trent (Gainsborough)	Internal potable transfer	AWSLNN	Insufficient information to develop scheme. Preliminary analysis has determined that the tankers are too large to be transported to Gainsborough. More details in the Supply Option Development Report.
15-0198	Canal	Internal potable transfer	AWSLNN	Small DO. Risk to navigation in drought - reliability issues related to third party
15-0199	Rail	Internal potable transfer	AWSLNN	Rejected due to weather and reliability issues, and due to traffic impacts
15-0200	Road tankering	Internal potable transfer	AWSLNN	Road Tankering rejected due to capacity required would not be feasible via road
18-0201	Gravel pits north of Retford Idle Valley	New reservoir	AWSLNN	Superseded by Lincolshire res and Hall extension
20-0202	Innovative options (international examples e.g. sea clouding)	New technology	AWSLNN	Unproven technology, cost and yield
20-0203	Rainwater harvesting	Rainwater harvesting	AWSLNN	Demand management option
ALT_02	Sugar Beet (Newark)-3rd party option	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
AT_04	Purchase private assets Retford	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
BCTTW_05	Review current export to Severn Trent	Internal potable transfer	AWSLNN	Reviewed
BCTTW_14	SPA- Everton/Gainsborough	Internal potable transfer	AWSLNN	Alternatives developed

Option ID	Option Name	Option type	WRZ	Reason for option rejection
CMS_13	Sugar Beet (Newark)-3rd party option	Catchment management	AWSLNN	Option not sufficiently mature to define costs or DO.
CMS_32	River Poulter from Millwood Brook to River Maun	Catchment management	AWSLNN	To be investigated through WRE catchment management forums
CMS_33	River Idle from Maun/Poulter to Tiln and River Idle from Ryton to Trent	Catchment management	AWSLNN	CAMS/ALS no resource available
JR_01	Industry trading Retford	Licence trading	AWSLNN	Option not sufficiently mature to define costs or DO.
RESIY_01	Gainsborough licensing	Groundwater enhancement	AWSLNN	Growth in the area water quality issue (The Avenue/turbidity) - Lee Road (Hydrocarbon) not well connected
RW_131	Sugar Beet (Newark)-3rd party option	Water reuse	AWSLNN	Option not sufficiently mature to define costs or DO.
RW_83	Gainsborough New WTW Instrument Recovery	Water treatment works loss recovery	AWSLNN	Issue with reg 31 materials in contact approval
RW_84	Everton WTW Instrument Recovery	Water treatment works loss recovery	AWSLNN	Issue with reg 31 materials in contact approval
WQS_09	Everton treatment	Water treatment works capacity increase	AWSNAY	Insufficient detail
03b-0423	Aylsham water reuse	Water reuse	AWSNAY	Resource is supporting river flow
05-0431	Heinz (North Walsham)	Licence trading	AWSNAY	Option not sufficiently mature to define costs or DO.
14-0456	Essex and Suffolk trade (24 inch main North Walsham)	Licence trading	AWSNAY	Option not sufficiently mature to define costs or DO.
BCTTW_35	Norwich and the Broads Transfer	Internal potable transfer	AWSNAY	Alternatives developed

Option ID	Option Name	Option type	WRZ	Reason for option rejection
BCTTW_36	Happisburgh Transfer	Internal potable transfer	AWSNAY	Constrained by licence
BCTTW_37	North Norfolk Coast Transfer	Internal potable transfer	AWSNAY	Constrained by licence
DRA_08	Blickling Lakes abstraction	New surface water	AWSNAY	CAMS/ALS no resource available
RESIY_06	North Walsham/Royston Bridge licensing	Groundwater enhancement	AWSNAY	Limited yield on North Walsham borehole
RW_54	North Walsham WTW Instrument Recovery	Water treatment works loss recovery	AWSNAY	Issue with reg 31 materials in contact approval
RW_55	Aylsham WTW Instrument Recovery	Water treatment works loss recovery	AWSNBR	Issue with reg 31 materials in contact approval
01e-0525	West Bradenham (Wissey feeder streams)	New reservoir	AWSNBR	CAMS/ALS no resource available
02a-0474	North Norfolk Coast RZ transfer	Internal potable transfer	AWSNBR	Constrained by licence
02a-1037	Norwich and the Broads RZ Transfer	Internal potable transfer	AWSNBR	Alternatives developed
02a-1054	Thetford RZ Transfer	Internal potable transfer	AWSNBR	Alternatives developed
06a-0548	River Wissey	New surface water	AWSNBR	CAMS/ALS no resource available
08c-0553	Bradenham/ Pickenham	Aquifer recharge/Aquifer storage recovery	AWSNBR	Unsuitable hydrological conditions
14-0560	Euston WTW (with Cambridge Water)	Licence trading	AWSNBR	Option not sufficiently mature to define costs or DO.
20-0819	Rainwater harvesting	Rainwater harvesting	AWSNBR	Demand management option

Option ID	Option Name	Option type	WRZ	Reason for option rejection
BCTTW_38	East Dereham RZ transfer	Internal potable transfer	AWSNBR	Alternatives developed
BCTTW_39	Wymondham RZ transfer	Internal potable transfer	AWSNBR	Alternatives developed
BCTTW_40	East Harling RZ Transfer	Internal potable transfer	AWSNBR	Alternatives developed
RESIY_07	Carbrooke licensing	Groundwater enhancement	AWSNBR	Limited licence available
RW_117	West Acre River Road WRC Instrument Recovery	Water treatment works loss recovery	AWSNBR	Issue with reg 31 materials in contact approval
RW_47	North Pickenham WTW Instrument Recovery	Water treatment works loss recovery	AWSNBR	Issue with reg 31 materials in contact approval
CMS_18	Tuddenham Stream and Cavenham Stream	Catchment management	AWSNBR	WINEP programme
RW_72	West Bradenham (new) WTW Instrument Recovery	Water treatment works loss recovery	AWSNBR/AWSNWY	Issue with reg 31 materials in contact approval
RW_73	West Bradenham WTW Washwater Recovery	Water reuse	AWSNED	Enhanced version of option identified.
03b-0531	Attleborough, Wymondham, Dereham, Swaffham water reuse	Water reuse	AWSNED	Resource is supporting river flow
04a-0532	Rushall/Bunwell (water available for trading - 9 Ml/d available??)	Licence trading	AWSNED	Option not sufficiently mature to define costs or DO.
04b-0534	Review group licences	New groundwater	AWSNED	No long term reliable resource available from groundwater in the region.
05-0537	Norfolk Rural Industry	Licence trading	AWSNED	Option not sufficiently mature to define costs or DO.
05-0539	Trade effluent review	Water reuse	AWSNED	Resource is supporting river flow

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06a-0547	River Wensum	New surface water	AWSNED	CAMS/ALS no resource available
08c-0554	SUDS	Aquifer recharge/Aquifer storage recovery	AWSNED	High risk of failure due to uncertain DO
15-0561	Tankering (rail)	Internal potable transfer	AWSNED	Rejected due to weather and reliability issues, and due to traffic impacts
15-0562	Tankering (road)	Internal potable transfer	AWSNED	Road Tankering rejected due to capacity required would not be feasible via road
19-0566	RAF / Ministry of Defence boreholes	Licence trading	AWSNED	Option not sufficiently mature to define costs or DO.
20-0567	Innovative options (international examples e.g. sea clouding)	New technology	AWSNED	Unproven technology, cost and yield
21-0569	EOETs & GOGS review	External raw water bulk supply/transfer	AWSNED	No long term reliable resource available from groundwater in the region.
BCTTW_41	Fenland RZ transfer	Internal potable transfer	AWSNED	Alternatives developed
BCTTW_42	Bradenham RZ Transfer	Internal potable transfer	AWSNED	Alternatives developed
BCTTW_43	Norwich and the Broads RZ Transfer	Internal potable transfer	AWSNEH	Alternatives developed
RW_53	Beetley WTW Washwater Recovery	Water reuse	AWSNEH	Enhanced version of option identified.
04b-0533	East Harling/Quidenham existing borehole optimisation	New groundwater	AWSNEH	No long term reliable resource available from groundwater in the region.
05-0535	Banham Zoo borehole	Licence trading	AWSNEH	Option not sufficiently mature to define costs or DO.
06a-0541	Little Ouse - subject to CAMS assessment (Riddlesworth)	New surface water	AWSNEH	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06b-0549	East Harling Existing abstraction	New groundwater	AWSNEH	No long term reliable resource available from groundwater in the region.
06b-0550	Extend Chalk abstraction (e.g. boreholes at and near Riddlesworth)	New groundwater	AWSNEH	No long term reliable resource available from groundwater in the region.
BCTTW_44	Bradenham RZ Transfer	Internal potable transfer	AWSNEH	Alternatives developed
BCTTW_45	Harleston RZ Transfer	Internal potable transfer	AWSNEH	Alternatives developed
BCTTW_46	Wymondham RZ transfer	Internal potable transfer	AWSNEH	Alternatives developed
BCTTW_47	Thetford RZ Transfer	Internal potable transfer	AWSNHA	Alternatives developed
BCTTW_48	Cambs & West Suffolk Transfer (WRMP19 Ixworth)	Internal potable transfer	AWSNHA	Alternatives developed
02a-1235	Norwich to Ludham - NTB-HPB Transfer (NEP option) Norwich & the Boards WRZ to Happisburgh WRZ Transfer	Internal potable transfer	AWSNHA	Alternatives developed
02b-0421	Broads options	External raw water bulk supply/transfer	AWSNHA	Not feasible - no resource options
02b-0422	Dilham Canal	External raw water bulk supply/transfer	AWSNHA	High risk of failure for technical reasons. Disproportionate cost to benefit.
06b-0445	Secondary Groundwater Use (e.g. at Ludham)	New groundwater	AWSNHA	No long term reliable resource available from groundwater in the region.
BCTTW_33	Norwich to Ludham East Ruston Connectivity	Internal potable transfer	AWSNHL	Initial proposed link at capacity by the end of AMP7

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_48	Ludham WTW Instrument Recovery	Water treatment works loss recovery	AWSNHL	Issue with reg 31 materials in contact approval
05-0540	Two Sisters Poultry (Halesworth)	Licence trading	AWSNHL	Option not sufficiently mature to define costs or DO.
08a-0551	Effluent reuse	Aquifer recharge/Aquifer storage recovery	AWSNHL	Rejected due to WQ issues - WFD no deterioration
10b-0555	SUDS	New reservoir	AWSNHL	High risk of failure due to uncertain DO
14-0559	Essex and Suffolk (treated)	Licence trading	AWSNHL	Option not sufficiently mature to define costs or DO.
20-0568	Rainwater harvesting	Rainwater harvesting	AWSNHL	Demand management option
2019_BT01	Norwich and the Broads RZ Transfer	Internal potable transfer	AWSNHL	Final planning problem - no deficit in South Norfolk Rural requiring a transfer
2019_BT02	North Norfolk Rural RZ transfer	Internal potable transfer	AWSNHL	Final planning problem - no deficit in South Norfolk Rural requiring a transfer
BCTTW_50	Wymondham RZ transfer	Internal potable transfer	AWSNHL	Alternatives developed
BCTTW_51	Norwich & the Broads RZ Transfer	Internal potable transfer	AWSNHL	Alternatives developed
BCTTW_52	East Harling RZ Transfer	Internal potable transfer	AWSNHL	Alternatives developed
RW_57	Bunwell WTW Washwater Recovery	Water reuse	AWSNHL	Enhanced version of option identified.
RW_58	Rushall WTW Instrument Recovery	Water treatment works loss recovery	AWSNHL	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
NNC1	Fenland to North Norfolk Coast potable transfer (10)	Internal potable transfer	AWSNNC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
NNC2	Norfolk Bradenham to North Norfolk Coast potable trasnfer (10)	Internal potable transfer	AWSNNC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RW_60	Rushall Bio Unit at RUSHWS STW Instrument Recovery	Water treatment works loss recovery	AWSNNC	Issue with reg 31 materials in contact approval
RW_61	Bunwell WTW Instrument Recovery	Water treatment works loss recovery	AWSNNC	Issue with reg 31 materials in contact approval
01e-0322	North Norfolk Rivers (winter storage)	New reservoir	AWSNNC	CAMS/ALS no resource available
01e-0393	North Norfolk Rivers (winter storage)	New reservoir	AWSNNC	CAMS/ALS no resource available
01e-0416	Norfolk Valleys options	New reservoir	AWSNNC	CAMS/ALS no resource available
01e-0417	Winter storage reservoir	New reservoir	AWSNNC	CAMS/ALS no resource available
02a-0418	Fenland WRZ transfer	Internal potable transfer	AWSNNC	Alternatives developed
02a-0419	Norfolk Rural WRZ transfer	Internal potable transfer	AWSNNC	Alternatives developed
02a-0527	Norwich and the Broads WRZ Transfer	Internal potable transfer	AWSNNC	Alternatives developed
03b-0424-A	Cromer water reuse	Water reuse	AWSNNC	Resource is supporting river flow
03b-0425	Fakenham/North Walsham WRC reuse	Water reuse	AWSNNC	Resource is supporting river flow
04b-0426	Review group licences	New groundwater	AWSNNC	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
05-0427	Bacton Gasworks	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
05-0428	European interconnector (pipeline from Europe)	Internal potable transfer	AWSNNC	Significant risks with pipeline
05-0429	Fakenham Laundries borehole	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
05-0430	Food processing in Fakenham and North Walsham	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
05-0432	Icebergs	New technology	AWSNNC	Unproven technology
05-0433	McCartneys borehole	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
05-0434	Other industrial reclaimed water (see 3rd party options)	Water reuse	AWSNNC	Resource is supporting river flow
05-0435	Other private abstractors	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
06a-0437	Tidal waters (brackish) North Norfolk Rivers	New surface water	AWSNNC	CAMS/ALS no resource available
06a-0438	River Bure	New surface water	AWSNNC	CAMS/ALS no resource available
06a-0439	River Glaven	New surface water	AWSNNC	CAMS/ALS no resource available
06a-0440	River Stiffkey	New surface water	AWSNNC	CAMS/ALS no resource available
06a-0441	River Wensum	New surface water	AWSNNC	CAMS/ALS no resource available
06a-0442	The Broads - Hickling, Barton, Horning (Ant, Bure, Thurn)	New surface water	AWSNNC	CAMS/ALS no resource available
06b-0443	Extend Chalk abstraction	New groundwater	AWSNNC	North Norfolk groundwater may be available, but screened out due to risk of saline intrusion.
06b-0444	Extend Crag abstraction	New groundwater	AWSNNC	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
08a-0448	Source from effluent re-use	Aquifer recharge/Aquifer storage recovery	AWSNNC	Unsuitable hydrological conditions
08a-0449	Small schemes	Aquifer recharge/Aquifer storage recovery	AWSNNC	Unsuitable hydrological conditions
08b-0297	Houghton	New technology	AWSNNC	High risk of failure as DO is uncertain, and there are potential environmental risks.
08c-0450	Local recharge/flood management systems e.g. Glaven to support Sheringham abstraction	Aquifer recharge/Aquifer storage recovery	AWSNNC	Uncertain DO. Water quality concerns
10b-0451	SUDS type local schemes - with artificial recharge	Aquifer recharge/Aquifer storage recovery	AWSNNC	High risk of failure due to uncertain DO
11b-0453	Coastal desalination network (small scale)	Desalination	AWSNNC	Option does not provide the required DO
13-0454	Management of Broads resource	Licence trading	AWSNNC	WFD risk
13-0455	Multi-use reservoirs (agriculture)	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
14-0457	Essex and Suffolk River abstractions	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
15-0458	Inland (road / rail) tankering	Internal potable transfer	AWSNNC	Weather related reliability issues. Traffic impact
15-0459	Sea tankering	International import	AWSNNC	Too far from a viable connection to existing infrastructure
18-0460	Increasing storage at private lakes	Groundwater enhancement	AWSNNC	None identified as part of the Private Lakes and Reservoir study
18-0461	Sands and Gravel extraction locations	New reservoir	AWSNNC	No others identified as part of the Private Lakes and Reservoir study

Option ID	Option Name	Option type	WRZ	Reason for option rejection
18-0462	Private reservoirs / lakes e.g. Blickling, Thorpe Market Antingham	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
18-0564	Private reservoirs / lakes e.g. storage on the River Glaven	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
18-0565	Sands and Gravel extraction locations e.g. Beetley/ Middleton Lakes on the River Wensum	New reservoir	AWSNNC	CAMS/ALS no resource available
19-0463	RAF Sculthorpe (near Fakenham) Ministry of Defence site boreholes	Licence trading	AWSNNC	Option not sufficiently mature to define costs or DO.
20-0464	Innovative options (international examples e.g. sea clouding)	New technology	AWSNNC	Unproven technology, cost and yield
20-0465	Rainwater harvesting	Rainwater harvesting	AWSNNC	Demand management option
CMS_11	Managed wetland	Catchment management	AWSNNC	To be investigated through WRE catchment management forumsSensitivity of the streams in dry periods
DES_03	Sizewell desalination	Desalination	AWSNNC	Intake/ outfall unfeasible due to shoreline conditions
DES_04	Hornsea Three Offshore Wind Farm desalination (near Sheringham)	Desalination	AWSNNC	Intake/ outfall unfeasible due to shoreline conditions
DES_05	Vanguard Offshore Wind Farm desalination	Desalination	AWSNNC	Intake/ outfall unfeasible due to shoreline conditions
DES_06	Sea Water desalination - colocation with East Anglian Offshore Wind Farm infrastructure	Desalination	AWSNNC	Intake/ outfall unfeasible due to shoreline conditions
DES_25	Sheringham - Newgate/Blakeney	Desalination	AWSNNC	No licence available
RESIY_05	Houghton St Giles licensing	Groundwater enhancement	AWSNNC	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_65	Sheringham WTW Instrument Recovery	Water treatment works loss recovery	AWSNNC	Issue with reg 31 materials in contact approval
RW_68	Houghton St Giles WTW Instrument Recovery	Water treatment works loss recovery	AWSNNC	Enhanced version of option identified.
RW_69	Houghton St Giles WTW Washwater Recovery	Water reuse	AWSNNC	Washwater recovery already in place
NTB11	Desalination barge moored offshore with a pipeline coming onshore at Bacton (25 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB12	Desalination barge moored offshore with a pipeline coming onshore at Bacton (50 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB13	Desalination barge moored offshore with a pipeline coming onshore at Bacton (100 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB14	Desalination barge moored offshore with a pipeline coming onshore at Caister (25 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB15	Desalination barge moored offshore with a pipeline coming onshore at Caister (50 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB16	Desalination barge moored offshore with a pipeline coming onshore at Caister (100 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB23	Great Yarmouth Sea Tankering	International import	AWSNTB	Too far from a viable connection to existing infrastructure
NTB2	Water Reuse at Caister Pump Lane WRC with outfall received on the River Wensum. With water treatment extension at Heigham WTW	Water reuse	AWSNTB	Not an AW option. Being developed by E&S water in line with regional strategy

Option ID	Option Name	Option type	WRZ	Reason for option rejection
NTB5	Desalination barge moored offshore with a pipeline coming onshore at Great Yarmouth (25 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB6	Desalination barge moored offshore with a pipeline coming onshore at Great Yarmouth (50 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB7	Desalination barge moored offshore with a pipeline coming onshore at Great Yarmouth (100 Ml/d)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
NTB8	Norfolk and the Broads WTW backwash water recovery	Water treatment works loss recovery	AWSNTB	Supernatant recovery from membrane filtration plant already in place. Membrane supplier recommends against returning GAC backwash water due to risk of carbon fines damaging or blocking membrane pores.
RW_70	Lyng Forge WTW Washwater Recovery	Water reuse	AWSNTB	Unsuitable location, however, could be considered for non-household (Site is adjacent to a golf course).
RW_71	Mattishall WTW Washwater Recovery	Water reuse	AWSNTB	Yield would be insignificant. Purpose of pits is bankside storage for pre-treatment
01b-0466	Costessey Pits development (lining)	Groundwater enhancement	AWSNTB	Reservoir built for managing water quality risk - not suitable for resource development
01b-0467	Increase reservoir yield through maximising abstraction licences, amending intakes, utilising dead storage etc	Groundwater enhancement	AWSNTB	Not feasible due to results of the bathymetric surveys
01c-0468	Costessey reservoirs	Groundwater enhancement	AWSNTB	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01d-0469	Costessey Pits extension (dredging / deepen)	New reservoir	AWSNTB	No deficit
01d-0470	New Reservoir	New reservoir	AWSNTB	Option superceded by Fens Reservoir options
01d-0776	Essex Reservoir	New reservoir	AWSNTB	Strumpshaw Fen is a designated site
01e-0471	Excess winter groundwater option e.g. Strumpshaw	New reservoir	AWSNTB	Continuity between Pits and river likely to constrain yield. Groundwater source.
01e-0472	Costessey Pits extension	New reservoir	AWSNTB	CAMS/ALS no resource available
01e-0522	Waveney Valley	New reservoir	AWSNTB	CAMS/ALS no resource available
01e-0523	Wensum	New reservoir	AWSNTB	Final planning problem - no surplus in North Norfolk Coast WRZ to transfer
02a-0528	North Norfolk Coast transfer	Internal potable transfer	AWSNTB	Alternatives developed
02a-1036	Bradenham RZ transfer	Internal potable transfer	AWSNTB	INNS risk of these river transfers
02b-0843	Great Ouse - Wensum transfer (pipeline),	Internal raw water transfer	AWSNTB	Final planning problem - no deficit in Norwich and the Broads WRZ to require such a large transfer
02b-1206	Fenland (new reservoir) - Norwich and the Broads	Internal raw water transfer	AWSNTB	Final planning problem - no deficit in Norwich and the Broads WRZ to require such a large transfer
02b-1207	Fenland (new reservoir) - River Wensum	Internal raw water transfer	AWSNTB	Resource is supporting river flow
03a-0476-A	Lowestoft Water Reuse	Water reuse	AWSNTB	Resource is supporting river flow
03a-0477-A	Norwich Water Reuse	Water reuse	AWSNTB	Option not sufficiently mature to define costs or DO.
05-0480	3rd party trade options	Licence trading	AWSNTB	No options identified

Option ID	Option Name	Option type	WRZ	Reason for option rejection
05-0481	Review discharge consents	Licence trading	AWSNTB	No resource available due to Habitats Regulations
05-0482	Essex and Suffolk Water transfer from the Broads	External raw water bulk supply/transfer	AWSNTB	Option not sufficiently mature to define costs or DO.
05-0483	Cambridge Water	Licence trading	AWSNTB	Option not sufficiently mature to define costs or DO.
05-0536	Cantley (British Sugar)	Licence trading	AWSNTB	CAMS/ALS no resource available
06a-0484	River Tas	New surface water	AWSNTB	CAMS/ALS no resource available
06a-0485	River Tud	New surface water	AWSNTB	Not resilient as CAMS assessment shows that water is only available during Q50 and Q30
06a-0486	River Wensum at Heigham	New surface water	AWSNTB	CAMS/ALS no resource available
06a-0487	River Yare (tidal and non-tidal)	New surface water	AWSNTB	CAMS/ALS no resource available
06a-0544	River Tas	New surface water	AWSNTB	No long term reliable resource available from groundwater in the region.
06b-0488	Extend Chalk abstraction	New groundwater	AWSNTB	No long term reliable resource available from groundwater in the region.
06b-0489	Postwick existing borehole optimisation	New groundwater	AWSNTB	No long term reliable resource available from groundwater in the region.
06b-0490	Extend Sands and Gravels / Crag abstraction (Kirby Cane)	New groundwater	AWSNTB	No long term reliable resource available from groundwater in the region.
06b-0491	Heigham Norwich WTW boreholes	New groundwater	AWSNTB	No water available. Presumption against new groundwater abstractions

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06b-0492	Ringland perched ponds	New groundwater	AWSNTB	CAMS assessment indicates that no water is available for abstraction.
06b-0493	Shotesham borehole	New groundwater	AWSNTB	No long term reliable resource available from groundwater in the region.
06b-0494	Strumpshaw (winter option)	New groundwater	AWSNTB	No long term reliable resource available from groundwater in the region.
06b-0495	Tas Valley boreholes (winter option)	New groundwater	AWSNTB	Resource is supporting river flow
07-0496	Sizewell	Water reuse	AWSNTB	Option not sufficiently mature to define costs or DO.
07-0497	Sizewell with Essex and Suffolk Water	Licence trading	AWSNTB	Uncertain DO. Water quality concerns
08a-0498	Water reuse	Aquifer recharge/Aquifer storage recovery	AWSNTB	Unsuitable hydrological conditions
08a-0499	Chalk option (e.g. at Costessey)	Aquifer recharge/Aquifer storage recovery	AWSNTB	Uncertain DO
08b-0500	Wensum gravels	New technology	AWSNTB	Uncertain DO
08c-0501	Flood water management	Aquifer recharge/Aquifer storage recovery	AWSNTB	Unsuitable hydrological conditions
08c-0502	Bland Road, Marlingford, Colney etc. existing source with aquifer recharge	Aquifer recharge/Aquifer storage recovery	AWSNTB	Uncertain DO
10b-0503	SUDS	New reservoir	AWSNTB	High risk of failure due to uncertain DO

Option ID	Option Name	Option type	WRZ	Reason for option rejection
10c-0504	Yare / Gt. Yarmouth flood options	New reservoir	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
11a-0505	Cantley (brackish river water or groundwater)	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
11b-0506	Norwich and the Broads - Small schemes	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
11b-0557	Bungay Desal	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
12a-0507	Wensum Norwich Conjunctive Use	Groundwater enhancement	AWSNTB	Option not sufficiently mature to define costs or DO.
13-0509	Agricultural reservoirs	Licence trading	AWSNTB	Weather related reliability issues. Traffic impact
15-0510	Road / rail tankers	Internal potable transfer	AWSNTB	CAMS/ALS no resource available
18-0512	Gravel Pit development (Lyng Forge) - Wensum	New reservoir	AWSNTB	None identified as part of the Private Lakes and Reservoir study
18-0513	Private lakes and gravel pits identified above.	Groundwater enhancement	AWSNTB	CAMS/ALS no resource available
18-0514	Bowthorpe Lakes	New reservoir	AWSNTB	CAMS/ALS no resource available
18-0515	Taverham Lakes - Wensum	New reservoir	AWSNTB	Option not sufficiently mature to define costs or DO.
18-0517	Private lakes e.g. UEA Broad	Licence trading	AWSNTB	Unsuitable surface water.
18-0518	Whitlingham Broad	New reservoir	AWSNTB	Unproven technology
20-0519	Innovative options (international examples e.g. sea clouding)	New technology	AWSNTB	Unproven technology, cost and yield
20-0520	Rainwater harvesting	Rainwater harvesting	AWSNTB	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
ALT_01	Cantley (British Sugar)-3rd party option	Licence trading	AWSNTB	Alternatives developed
BCTTW_19	Wymondham RZ transfer	Internal potable transfer	AWSNTB	Alternatives developed
BCTTW_53	East Dereham RZ transfer	Internal potable transfer	AWSNTB	Alternatives developed
BCTTW_54	Harleston RZ Transfer	Internal potable transfer	AWSNTB	Option not sufficiently mature to define costs or DO.
CMS_12	Cantley (British Sugar)-3rd party option	Catchment management	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
DES_07	Gt Yarmouth Desalination - seawater	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
DES_08	Gt Yarmouth Desalination - brackish water	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
DES_13a	Desalination Barge moored at Lowestoft Harbour	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
DES-08a	Great Yarmouth (Brackish)	Desalination	AWSNTB	Offshore deslination provides no benefit over onshore options but carry greater risk.
DES-08d	Desalination Barge moored at Great Yarmouth Harbour	Desalination	AWSNTB	Unmitigatable risks associated with brackish and estuarial desalination
DES-55	Brackish desalination on the river Yare / Waveney between Great Yarmouth, Reedham and St Olaves	Desalination	AWSNTB	CAMS/ALS no resource availableSensitivity of water bodies
DRA_01	Seasonal abstractions in the Broads	New surface water	AWSNTB	CAMS/ALS no resource available
DRA_06	Norfolk lakes abstraction	New surface water	AWSNTB	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
DRA_07	Gunton Hall lakes abstraction	New surface water	AWSNTB	CAMS/ALS no resource available
DRA_09	Increased seasonal abstraction at Costessey	New surface water	AWSNTB	CAMS/ALS no resource availableSensitivity CAMS review
DRA_11	Broads abstraction at Wroxham	New surface water	AWSNTB	CAMS/ALS no resource available
JR_02	ESW boreholes in the Broads	Licence trading	AWSNTB	No long term reliable resource available from groundwater in the region.
RUPSOS_06	Costessey chalk boreholes	New groundwater	AWSNTB	No long term reliable resource available from groundwater in the region.
RUPSOS_07	Strumpshaw seasonal operation	New groundwater	AWSNTB	Option not sufficiently mature to define costs or DO.
RW_130	Cantley (British Sugar)-3rd party option	Water reuse	AWSNTB	Issue with reg 31 materials in contact approval
RW_35	Costessey East Hills WTW Instrument Recovery	Water treatment works loss recovery	AWSNTB	Innapropriate treatment for washwater recovery
RW_36	Costessey East Hills WTW Washwater Recovery	Water reuse	AWSNTB	Issue with reg 31 materials in contact approval
RW_37	Postwick WTW Instrument Recovery	Water treatment works loss recovery	AWSNTB	Innapropriate treatment for washwater recovery
RW_38	Postwick WTW Washwater Recovery	Water reuse	AWSNTB	More difficult as higher pollutant load
RW_39	Mousehold WTW nitrate removal plant - Washwater Recovery	Water reuse	AWSNTB	Issue with reg 31 materials in contact approval
RW_40	Little Melton Watton Road WTW Instrument Recovery	Water treatment works loss recovery	AWSNTB	Innapropriate treatment for washwater recovery
RW_41	Little Melton Watton Road WTW Washwater Recovery	Water reuse	AWSNTB	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_42	Kirby Cane WTW Instrument Recovery	Water treatment works loss recovery	AWSNTB	Site assumed to be closing in 2030
RW_43	Kirby Cane WTW Washwater Recovery	Water reuse	AWSNTB	Issue with reg 31 materials in contact approval
RW_44	Heigham WTW Instrument Recovery	Water treatment works loss recovery	AWSNTB	Innapropriate treatment for washwater recovery
RW_45	Riddlesworth Ix WTW STW Washwater Recovery	Water reuse	AWSNWY	Issue with reg 31 materials in contact approval
RW_46	Mattishall WTW Instrument Recovery	Water treatment works loss recovery	AWSNWY	No surface water source nearby
08a-0552	High Oak ASR	Aquifer recharge/Aquifer storage recovery	AWSNWY	Alternatives developed
BCTTW_55	West Bradenham Transfer	Internal potable transfer	AWSNWY	Alternatives developed
BCTTW_56	East Harling RZ Transfer	Internal potable transfer	AWSNWY	Alternatives developed
BCTTW_57	Harleston RZ transfer	Internal potable transfer	AWSNWY	To be investigated through WRE catchment management forums
CMS_25	River Tiffey and Hackford Watercourse	Catchment management	AWSNWY	Issue with reg 31 materials in contact approval
RW_49	High Oak WTW Instrument Recovery	Water treatment works loss recovery	AWSNWY	Issue with reg 31 materials in contact approval
RW_50	Old Buckenham-Abbey Road WTW Instrument Recovery	Water treatment works loss recovery	AWSNWY	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RTC6	Ruthamford West to Ruthamford Central potable transfer (100 Ml/d)	Internal potable transfer	AWSRTC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTC7	Ruthamford West to Ruthamford Central potable transfer (50 Ml/d)	Internal potable transfer	AWSRTC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RW_51	Watton WTW Instrument Recovery	Water treatment works loss recovery	AWSRTC	Issue with reg 31 materials in contact approval
RW_52	Carbrooke New WTW Instrument Recovery	Water treatment works loss recovery	AWSRTC	Alternatives developed
02a-1215	Ruthamford South RZ transfer	Internal potable transfer	AWSRTC	Alternatives developed
02a-1228b	Ruthamford West RZ Transfer	Internal potable transfer	AWSRTC	Potential risk of impacting downstream licences (Clapham WTW) and storage (Grafham Reservoir). Low DO and potentially not cost effective. Lake has limited storage potential as water only available 30% of the time.
18-0316	Private lakes and gravel pits	Licence trading	AWSRTC	Unsuitable surface water.
18-0317	Milton Keynes balancing lakes	New reservoir	AWSRTC	Unproven technology
20-0750	Innovative options (international examples e.g. sea clouding)	New technology	AWSRTC	Unproven technology, cost and yield
20-0751	Rainwater harvesting	Rainwater harvesting	AWSRTC	To be investigated through WRE catchment management forums
BCTTW_34	Adenham and Redlodge connectivity from March	Internal potable transfer	AWSRTC	Alternatives developed
CMS_05	CM - Barrow WTW- nitrates	Catchment management	AWSRTC	Already actioned by catchment liaison

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RTN18	Mablethorpe desalination - treatment	Desalination	AWSRTN	Unmitigatable risks identified in estuarial and brackish desalination options
RTN19	Mablethorpe desalination - treatment	Desalination	AWSRTN	Unmitigatable risks identified in estuarial and brackish desalination options
RTN20	Mablethorpe desalination - treatment	Desalination	AWSRTN	Unmitigatable risks identified in estuarial and brackish desalination options
RTN23	Ruthamford South to Ruthamford North potable transfer (50 Ml/d)	Internal potable transfer	AWSRTN	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTN24	Ruthamford South to Ruthamford North potable transfer (100 Ml/d)	Internal potable transfer	AWSRTN	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTN25	Lincolnshire Bourne to Ruthamford North potable transfer (20 Ml/d)	Internal potable transfer	AWSRTN	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTN2	Peterborough Flag Fen to direct to Rutland Water / Wing WTW - No treatment at Wing WTW	Water reuse	AWSRTN	No benefit without additional potable treatment capacity
RTN32	Ruthamford North drought permit (Hollowell and Ravensthorpe)	Drought permits/orders	AWSRTN	Provides no DO benefit in planning scenario
RTN33	Ruthamford North drought permit (pitsford)	Drought permits/orders	AWSRTN	Provides no DO benefit in planning scenario
RTN3	Peterborough Flag Fen to Rutland / Wing via River Nene (with additional treatment at Wing WTW)	Water reuse	AWSRTN	Very low DO relative to cost. RTS1 promoted as an alternative.
RTN4	Peterborough Flag Fen to Rutland / Wing via River Nene (without additional treatment)	Water reuse	AWSRTN	No benefi without additional potable treatment capacity

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RTN5	Boston Area (brackish) desalination (10 Ml/d)	Desalination	AWSRTN	Unmitigatable risks identified in estuarial and brackish desalination options
RTN6	Boston Area (brackish) desalination (25 Ml/d)	Desalination	AWSRTN	Unmitigatable risks identified in estuarial and brackish desalination options
RTN7	Little Barford Declined T&T transfer to Rutland	Licence trading	AWSRTN	Uncertainty over long term availability of resource
CMS_26	Broughton Brook	Catchment management	AWSRTN	Licence constraints
RESIY_11	Sandhouse licensing	Groundwater enhancement	AWSRTN	Issue with reg 31 materials in contact approval
RW_107	Sandhouse WTW Instrument Recovery	Water treatment works loss recovery	AWSRTN	Require investment
WQS_02	Optimised treatment at Sandhouse WTW	Water treatment works capacity increase	AWSRTN	100% natural catchments - no significant additional resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01b-0204	Maximise refill opportunity for Ravensthorpe & Hollowell	Surface water enhancement	AWSRTN	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 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.
01b-0205	Reduces the Gwash Glen transfer and releases from Rutland	Surface water enhancement	AWSRTN	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.
01b-0206	Pitsford reservoir	Surface water enhancement	AWSRTN	High risk of failure, and potential DO from reduction in dead storage not thought to be significant.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01b-0207	Reduce dead storage - Pitsford	Surface water enhancement	AWSRTN	High risk of failure, and potential DO from reduction in dead storage not thought to be significant.
01b-0208	Reduce dead storage - Ravensthorpe & Hollowell	Surface water enhancement	AWSRTN	High risk of failure, and potential DO from reduction in dead storage not thought to be significant.
01b-0209	Reduce dead storage - Rutland Water	Surface water enhancement	AWSRTN	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 at Empingham along.
01b-0210	Wansford Existing Nene pumps (Rutland) to Rutland Water - maximise refill opportunities	Surface water enhancement	AWSRTN	Not feasible due to results of the bathymetric surveys
01c-0212	Dredging - Pitsford	Surface water enhancement	AWSRTN	Very small increase in yield relative to cost. Logistically difficult to implement as reservoir would need to br drawn down to low level during the project, which could take several seasons. Risk outweighs the benefit.
01c-0213	Pitsford reservoir	Surface water enhancement	AWSRTN	Not feasible due to results of the bathymetric surveys
01c-0214	Dredging - Ravenshtorpe & Hollowell	Surface water enhancement	AWSRTN	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.
01c-0215	Ravensthorpe & Hollowell Reservoirs	Surface water enhancement	AWSRTN	Not feasible due to results of the bathymetric surveys

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01c-0216	Dredging - Rutland Water	Surface water enhancement	AWSRTN	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.
01c-0217	Rutland water	Surface water enhancement	AWSRTN	Superseded by Lincolnshire reservoir option
01d-0084	South Lincolnshire reservoir	New reservoir	AWSRTN	Superseded
01d-0217-T2	River Trent-Rutland Water	External raw water bulk supply/transfer	AWSRTN	Superseded by Lincolshire res
01d-0218	Manton Valley Reservoir	New reservoir	AWSRTN	Superseded by Lincolshire res
01d-0219	New reservoir from new sources identified in direct river abstraction	New reservoir	AWSRTN	Superseded by Lincolshire res
01e-0220	Canal reservoirs (Naseby, Silby)	New reservoir	AWSRTN	Option not sufficiently mature to define costs or DO.
01e-0231	Acquiring Eye brook reservoir	Licence trading	AWSRTN	Alternatives developed
02a-1026	Pitsford Reservoir - Boughton WR	Internal potable transfer	AWSRTN	Alternatives developed
02a-1217	South Lincolnshire RZ Transfer	Internal potable transfer	AWSRTN	Alternatives developed
02a-1226	Pitsford WTW - Ling WR	Internal potable transfer	AWSRTN	Alternatives developed
02a-1227	Pitsford WTW- Hannington WR	Internal potable transfer	AWSRTN	Alternatives developed
02a-1230	Emneth Hungate to Friday Bridge	Internal potable transfer	AWSRTN	option is already being built

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02a-1233	Pitsford supply option from Ruthamford North network improvements	Internal potable transfer	AWSRTN	Alternatives developed
02a-1238	South Fenland RZ Transfer	Internal potable transfer	AWSRTN	Does not resolve the problem
02a-1241	Cease exporting raw water from Rutland Water to Grantham. Treat water at Rutland. Grantham would need another resource to support this option.	Groundwater enhancement	AWSRTN	Alternatives developed
02b-0206-T3	Canal transfer via Grand Union to R. Nene for abstraction to Pitsford	External raw water bulk supply/transfer	AWSRTN	No resource available at present. AFW SRO
02b-0206-T4	Canal transfer via Grand Union to R. Nene for abstraction to Pitsford with Severn Trent Water Reuse	External raw water bulk supply/transfer	AWSRTN	CAMS assessment shows that flow is not available at any point during the year
02b-0217cii	River Welland, Tinwell - River Nene for Rutland abstraction	External raw water bulk supply/transfer	AWSRTN	Option from CRT - needs further water quality and drought resilience investigations prior to being included in the plan
02b-0222	Leicester groundwater via Grand Union canal	External raw water bulk supply/transfer	AWSRTN	Not modelled-supply and demand data deemed option not required
02b-1031	South Lincolnshire Reservoir - Rutland Reservoir	Internal raw water transfer	AWSRTN	Water is connected via potable network and proposed transfers that provide further resilience
02b-1200	Grafham reservoir - Pitsford reservoir	Internal raw water transfer	AWSRTN	Resource is supporting river flow
03c-0227	Pitsford WTW Washwater Recovery	Water reuse	AWSRTN	Resource is supporting river flow
03c-0228	Rutland WTW - backwash water reuse	Water reuse	AWSRTN	Resource is supporting river flow
03c-0228-a	Wing WTW Washwater Recovery	Water reuse	AWSRTN	Resource is supporting river flow

Option ID	Option Name	Option type	WRZ	Reason for option rejection
03c-0228-b	Morcott WTW Washwater Recovery	Water reuse	AWSRTN	Washwater recovery already in place
04c-0229	Limestone - recommission sources	New groundwater	AWSRTN	No long term reliable resource available from groundwater in the region.
04c-0230	Ravensthorpe Existing source	New groundwater	AWSRTN	Option not sufficiently mature to define costs or DO.
05-0232	3rd party trade options	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
05-0233	Carlsberg	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
05-0234	Canal River Trust (CRT)	Licence trading	AWSRTN	Resource is supporting river flow
05-0235	Industrial reclaimed water	Water reuse	AWSRTN	Resource is supporting river flow
05-0236	Tata	Water reuse	AWSRTN	Option not sufficiently mature to define costs or DO.
05-0237	Tata steel	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
05-0238	Weetabix	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
06a-0239	Grand union canal	New surface water	AWSRTN	CAMS/ALS no resource available
06a-0240	River Gwash	New surface water	AWSRTN	CAMS/ALS no resource available
06a-0241	River Nene	New surface water	AWSRTN	CAMS/ALS no resource available
06a-0242	River Welland	New surface water	AWSRTN	CAMS/ALS no resource available
06a-0243	Lower Welland Nene (Brackish)	Desalination	AWSRTN	Unmitigatable risks associated with brackish and estuarial desalination
06b-0244	Leicester groundwater	New groundwater	AWSRTN	Generic option for this aquifer. One specific option taken forward. No others identified.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
08a-0048	Sherwood Sandstone Drought Resilience Scheme	Aquifer recharge/Aquifer storage recovery	AWSRTN	Unsufficient information available
08a-0245	Potential locations	Aquifer recharge/Aquifer storage recovery	AWSRTN	Uncertain DO
08b-0246	Upper Nene gravels	New technology	AWSRTN	Uncertain DO
08c-0247	SUDS	Aquifer recharge/Aquifer storage recovery	AWSRTN	High risk of failure due to uncertain DO
10a-0248	Internal Drainage Boards	Licence trading	AWSRTN	Uncertain DO
10b-0249	SUDS	New reservoir	AWSRTN	High risk of failure due to uncertain DO
12A-0305	Grafham Meppershall Conjunctive Use	Groundwater enhancement	AWSRTN	Impact of introducing groundwater supply and groundwater-zone demand into system were modelled
12B-0250a	Rutland South Lincs Conjunctive Use	Groundwater enhancement	AWSRTN	Ruthamford system already connected to Bourne and systems work conjunctively already.
12b-0250-Option B	Rutland Bourne Conjunctive Use (2 year GW Licences)	Groundwater enhancement	AWSRTN	No significant groundwater resources are available
12b-0251	Increase surface water treatment capacity to utilise high river flows	Groundwater enhancement	AWSRTN	Option not sufficiently mature to define costs or DO.
14-0252	Cambridge Water	Licence trading	AWSRTN	No resource available
14-0253	Severn Trent - potable trades	Licence trading	AWSRTN	No new trade options or opportunities identified.
14-0254	STW WRCs - Leicester, Rugby, Melton Mowbray	Water reuse	AWSRTN	No new cross boundary reuse options or opportunities identified.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
15-0255	Rail	Internal potable transfer	AWSRTN	Rejected due to weather and reliability issues, and due to traffic impacts
15-0256	Road	Internal potable transfer	AWSRTN	Road Tankering rejected due to capacity required would not be feasible via road
18-0257	Private lakes and gravel pits	New reservoir	AWSRTN	Superseded by Lincolshire res
18-0259	Gravel pits - Northampton	New reservoir	AWSRTN	Option not sufficiently mature to define costs or DO.
18-0386	Private Reservoirs / Lakes e.g. Mepal	Licence trading	AWSRTN	Unproven technology
20-0260	Innovative options (international examples e.g. sea clouding)	New technology	AWSRTN	Unproven technology, cost and yield
20-0261	Rainwater harvesting	Rainwater harvesting	AWSRTN	Demand management option
2019_RS02	Severn Trent Water - raw water trades (ANG6c)	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
2019_RS03	Severn Trent Water - raw water trades (ANG6d)	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
2019_RS04	Severn Trent Water - raw water trades (ANG7c)	Licence trading	AWSRTN	Option not sufficiently mature to define costs or DO.
BCTTW_29	Wilsthorpe-Peterborough transfer	Internal potable transfer	AWSRTN	Alternatives developed
CMS_04	Pillsgate WTW-Wetland	Catchment management	AWSRTN	High risk of failure due to undertain DO. Potential water quality issues.
DRA_04	Grafham water abstraction	New surface water	AWSRTN	CAMS/ALS no resource available
NR_05	Saltersford raw water storage	New reservoir	AWSRTN	No additional resource. Existing assets improved under drought scheme.
R1	Crowlands (North) Reservoir	New reservoir	AWSRTN	Superseded by Lincolnshire res

Option ID	Option Name	Option type	WRZ	Reason for option rejection
R6	Rutland Reservoir	New reservoir	AWSRTN	Superseded by Lincolnshire res
RW_108	Tallington WTW Instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW_109	Pitsford WTW Instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW_110	Grafham WTW Instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW_111	Etton WTW instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW_112	Morcott WTW Instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW_113	Wing STW instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW_114	Etton WTW Washwater Recovery	Water reuse	AWSRTN	Innapropriate treatment for washwater recovery
RW_119	Ravensthorpe WTW Instrument Recovery	Water treatment works loss recovery	AWSRTN	Issue with reg 31 materials in contact approval
RW-206	Great Billing (Northampton)	Water reuse	AWSRTN	Resource is supporting river flow
RW-211	Corby	Water reuse	AWSRTN	Resource is supporting river flow
R10	Staughton Reservoir	New reservoir	AWSRTN	Insufficient information
RW_124	Severn Trent Reclamation	Water reuse	AWSRTN, AWSLNC/AWSLNN	Insufficient information
RTS1	Ruthamford North to Ruthamford South potable transfer (10 Ml/d)	Internal potable transfer	AWSRTS	Does not resolve a deficit

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RTS11	Ruthamford North to Ruthamford South potable transfer (50 Ml/d)	Internal potable transfer	AWSRTS	Does not resolve a deficit
RTS12	Ruthamford North to Ruthamford South potable transfer (100 Ml/d)	Internal potable transfer	AWSRTS	Does not resolve a deficit
RTS18	Ruthamford West to Ruthamford Central potable transfer (100 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS19	Ruthamford North to Ruthamford South potable transfer (50 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS2	Ruthamford North to Ruthamford South potable transfer (10 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS20	Ruthamford North to Ruthamford South potable transfer (100 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS3	Ruthamford Central to Ruthamford South potable transfer (70 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS4	Ruthamford Central to Ruthamford South potable transfer (50 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS5	Ruthamford Central to Ruthamford South potable transfer (100 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS6	Ruthamford Central to Ruthamford South potable transfer (200 Ml/d)	Internal potable transfer	AWSRTS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTS7	New Little Barford WTW	Licence trading	AWSRTS	Uncertainty over long term availability of resource

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RTS8	Ruthamford South WTW backwash water recovery	Water treatment works loss recovery	AWSRTS	Water Quality. Cryptosporidium risk from returning concentrates back to works inlet
RTS9	Little Barford Declined T&T	Licence trading	AWSRTS	Uncertainty over long term availability of resource
SUP-1	Wing WTW	Water treatment works loss recovery	AWSRTS	Losses already recovered to reservoir
WQS_03	Improved treatment at Wing STW	Water treatment works capacity increase	AWSRTS	Treatment works losses recovered to reservoir
WQS_04	Pitsford WTW treatment	Water treatment works capacity increase	AWSRTS	Current assets optimised to age and condition
WQS_10	Improve Pillsgate WTW	Water treatment works capacity increase	AWSRTS	Current assets optimised to age and condition
01b-0266	Reduce dead storage Grafham Water	Groundwater enhancement	AWSRTS	High risk of failure, and potential DO from reduction in dead storage not thought to be significant.
01b-0267	Maximise refill opportunity for reservoirs (Grafham etc)	Groundwater enhancement	AWSRTS	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.
01c-0270	Dredging - Grafham Water	Groundwater enhancement	AWSRTS	Not feasible due to results of the bathymetric surveys

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01c-0271	Grafham Water	Groundwater enhancement	AWSRTS	Very small increase in yield relative to cost. Logistically difficult to implement as reservoir would need to br drawn down to low level during the project, which could take several seasons. Risk outweighs the benefit.
01d-0272	Ruthamford South New Reservoir	New reservoir	AWSRTS	Superseded by Lincolnshire res
01e-0273	Clapham reservoir	New reservoir	AWSRTS	Superseded by Lincolnshire res
02a-1007	Ruthamford North RZ Transfer	Internal potable transfer	AWSRTS	Alternatives developed
02a-1062	Brickhill Copse- Sundon	Internal potable transfer	AWSRTS	Not modelled-supply and demand data deemed option not required
02a-1205	Affinity reverse transfer to Ruthamford South WRZ (trading Great Ouse Water Act)	Licence trading	AWSRTS	Option not sufficiently mature to define costs or DO.
02a-1216a	Meppershall WTW- Grafham WTW	Internal potable transfer	AWSRTS	Not modelled-supply and demand data deemed option not required
02a-1216b	Grafham WTW - Ampthill WR	Internal potable transfer	AWSRTS	Required option- refined, costings and capacities updated
02a-1216c	Meppershall WTW - Ampthill WR	Internal potable transfer	AWSRTS	Required option- refined, costings and capacities updated
02a-1237	Ruthamford Central RZ Transfer	Internal potable transfer	AWSRTS	Alternatives developed
02b-0276	Grand Union to Great Ouse	External raw water bulk supply/transfer	AWSRTS	AFW SRO - potential for future option
02b-1078	Pitsford reservoir - Grafham reservoir	Internal raw water transfer	AWSRTS	Water is connected via potable network and proposed transfers that provide further resilience
02b-1079	Ruthamford North WRZ via existing infrastructure	Internal potable transfer	AWSRTS	No longer required - superseded by potable transfer

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02b-1208	Rutland to Ouse, Offord (for subsequent partial transfer to Grafham and remainder to flow to Fenland)	External raw water bulk supply/transfer	AWSRTS	Option breaches unalterale planning constraint, and is not promotable on sustainability
02b-1209	Ouse, Offord - Grafham	External raw water bulk supply/transfer	AWSRTS	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
03a-0278	Huntingdon water reuse	Water reuse	AWSRTS	Resource is supporting river flow
03b-0279	Milton Keynes water reuse	Water reuse	AWSRTS	Resource is supporting river flow
04a-0280	Pulloxhill Existing sources	New groundwater	AWSRTS	No long term reliable resource available from groundwater in the region.
04a-0281	Maximising licences (Oolite/Woburn sands)	New groundwater	AWSRTS	WFD assessment - no additional resource available
05-0282	3rd party trade options	Licence trading	AWSRTS	Option not sufficiently mature to define costs or DO.
05-0284	Eon, Little Barford	Licence trading	AWSRTS	Option not sufficiently mature to define costs or DO.
05-0285	Industrial reclaimed water	Water reuse	AWSRTS	Resource is supporting river flow
06a-0286	Clapham (peak only) - Grafham/Offord Group Licence (peak only)	New surface water	AWSRTS	CAMS/ALS no resource available
06a-0287	Ouse - existing Thornborough abstraction River Ouse - existing intake	New surface water	AWSRTS	Scheme is part of the rejected Foxcote recommissioning option
06a-0288	Ouse (Brownshill)	New surface water	AWSRTS	CAMS/ALS no resource available
06a-0289	River Flit	New surface water	AWSRTS	CAMS/ALS no resource available
06a-0290	River Ivel	New surface water	AWSRTS	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06a-0291	River Ouzel	New surface water	AWSRTS	CAMS/ALS no resource available
06b-0292	Charles Wells Bedford	New groundwater	AWSRTS	CAMS/ALS no resource available
06b-0293	Clapham Abandoned boreholes	New groundwater	AWSRTS	No long term reliable resource available from groundwater in the region.
06b-0294	new sources - Greensands, Clophill, Leighton Buzzard, Leighton Linslade	New groundwater	AWSRTS	No long term reliable resource available from groundwater in the region.
08a-0295	Greensand ASR	Aquifer recharge/Aquifer storage recovery	AWSRTS	Unsuitable hydrological conditions
08b-0296	Clapham infiltration system	New technology	AWSRTS	Uncertain DO
08b-0298	River Gravels - Brampton	New technology	AWSRTS	Uncertain DO
08c-0299	SUDS - Greensand - Ampthill/Flitwick	Aquifer recharge/Aquifer storage recovery	AWSRTS	Uncertain DO
08c-0300	SUDS - Greensand - Biggleswade	Aquifer recharge/Aquifer storage recovery	AWSRTS	High risk of failure due to uncertain DO
08c-0301	SUDS - Greensand - Leighton Buzzard	Aquifer recharge/Aquifer storage recovery	AWSRTS	High risk of failure due to uncertain DO
08c-0302	SUDS - Greensand - Shefford	Aquifer recharge/Aquifer storage recovery	AWSRTS	High risk of failure due to uncertain DO
10a-0303	Internal Drainage Boards	Licence trading	AWSRTS	High risk of failure due to uncertain DO
10b-0304	SUDS	New reservoir	AWSRTS	Uncertain DO

Option ID	Option Name	Option type	WRZ	Reason for option rejection
12a-0306	Great Ouse Water Act (GOWA) operating rules - review	New surface water	AWSRTS	High risk of failure. Complexity of waterway operating regime makes DO uncertain and unreliable.
12a-0307	River support - conjunctive use	Groundwater enhancement	AWSRTS	River support has to be available for its primary purpose therefore DO is uncertain and unreliable.
12b-0308	Increase surface water treatment capacity to utilise high river flows	Groundwater enhancement	AWSRTS	No significant groundwater resources are available
14-0310	Cambridge Water- to St Ives/Huntingdon	Licence trading	AWSRTS	No resource available
14-0312	Thames Water- Mursley	Licence trading	AWSRTS	Option not sufficiently mature to define costs or DO.
14-0313	Thames Water reservoir	Licence trading	AWSRTS	Option not sufficiently mature to define costs or DO.
15-0314	Rail	Internal potable transfer	AWSRTS	Rejected due to weather and reliability issues, and due to traffic impacts
15-0315	Road	Internal potable transfer	AWSRTS	Road Tankering rejected due to capacity required would not be feasible via road
18-0318	Wyboston Lakes	New reservoir	AWSRTS	Superseded by Lincolnshire res
20-0319	Innovative options (international examples e.g. sea clouding)	New technology	AWSRTS	Unproven technology
20-0320	Rainwater harvesting	Rainwater harvesting	AWSRTS	Unproven technology, cost and yield
2019_IRY01	Reduce dead storage Ruthamford South Reservoir	Groundwater enhancement	AWSRTS	Opportunity addressed by re-commissioning of reservoir option
BCTTW_03	Trading/export to Affinity in Hitchin/Baldock area	Internal potable transfer	AWSRTS	No options identified at regional level

Option ID	Option Name	Option type	WRZ	Reason for option rejection
BCTTW_11	Cambridge Water export from Grafham	Internal potable transfer	AWSRTS	Alternatives developed
BCTTW_24	Meppershall Connectivity	Internal potable transfer	AWSRTS	Resolved
BCTTW_25	Grafham WTW-Bedford- Transfer	Internal potable transfer	AWSRTS	Reduce capability at Grafham
BCTTW_26	Bedford-southern boreholes connectivity	Internal potable transfer	AWSRTS	No deficit
CMS_06	CM - Ruthamford-farmers partnership (nitrates)	Catchment management	AWSRTS	Nitrate plans are managed through catchment liaison partnerships
DRA_02	Abstraction from canals	New surface water	AWSRTS	CAMS/ALS no resource available
DRA_03	Recommissioning of Foxcote STW	New surface water	AWSRTS	Probably incorrectly named option
DRA_05	Bedford water abstraction	New surface water	AWSRTS	CAMS/ALS no resource available
DRA_12	Pumping upgrade at Offord	New surface water	AWSRTS	CAMS/ALS no resource available
NR_03	Meppershall/Dunton raw water storage	New reservoir	AWSRTS	Unsuitable as these are groundwater treatment works
NR_04	Bedford raw water storage	New reservoir	AWSRTS	Superseded by Lincolnshire res
R2	Great Bradley Reservoir	New reservoir	AWSRTS	Superseded by Lincolnshire res
R8	Grafham Reservoir	New reservoir	AWSRTS	Insufficient information
RESIY_10	Pulloxhill licensing	Groundwater enhancement	AWSRTS	Licence constraints
RW_115	Newspring WTW STW Instrument Recovery	Water treatment works loss recovery	AWSRTS	Issue with reg 31 materials in contact approval
RW_116	Pulloxhill WTW Instrument Recovery	Water treatment works loss recovery	AWSRTS	Issue with reg 31 materials in contact approval

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_121	Bedford WTW Instrument Recovery	Water treatment works loss recovery	AWSRTS	Issue with reg 31 materials in contact approval
RW_122	Dunton WTW Instrument Recovery	Water treatment works loss recovery	AWSRTS	Issue with reg 31 materials in contact approval
RW-207	Bedford	Water reuse	AWSRTS	Resource is supporting river flow
RW-208	Chalton	Water reuse	AWSRTS	Resource is supporting river flow
RW-210	Martson	Water reuse	AWSRTS	Resource is supporting river flow
RW-214	Cotton Valley (Milton Keynes)	Water reuse	AWSRTS	Resource is supporting river flow
RTW3	Foxcote/Fosscott Reservoir	New reservoir	AWSRTW	Very low yield and complex water quality issues.
RTW5	Ruthamford Central to Ruthamford West potable transfer (50 Ml/d)	Internal potable transfer	AWSRTW	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RTW6	Ruthamford Central to Ruthamford West potable transfer (100 Ml/d)	Internal potable transfer	AWSRTW	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RW-215	Huntingdon (Godmanchester) to Grafham Reservoir	Water reuse	AWSRTW	Resource is supporting river flow
WQS_05	Grafham WTW treatment	Water treatment works capacity increase	AWSRTW	Current assets optimised to age and condition
WQS_06	Nitrate removal plant at Bedford WTW	Water treatment works capacity increase	AWSRTW	Combined in WRMP24 preferred option RTS21 - Clapham surface water treatment enhancement
WQS_07	Upgrade Meppershall WTW	Water treatment works capacity increase	AWSRTW	Current assets optimised to age and condition
01c-0268	Dredging - Ruthamford West reservoir	Groundwater enhancement	AWSRTW	Not feasible due to results of the bathymetric surveys

Option ID	Option Name	Option type	WRZ	Reason for option rejection
01c-0269	Foxcote Reservoir	Groundwater enhancement	AWSRTW	Foxcote is within an environmentally sensitive area - high risk of failure due to WFD deteriration from recommissioning reservoir
01e-0264	Recommission Ruthamford West Reservoir WTW	New reservoir	AWSRTW	Very low yield and complex water quality issues.
01e-0274	Ruthamford West Reservoir reservoir extension	New reservoir	AWSRTW	Very low yield and complex water quality issues.
02a-1059	Ruthamford North RZ Transfer	Internal potable transfer	AWSRTW	Alternatives developed
SHB6	Desalination (seawater) on the South Humber Bank feeding the non potable network (10 Ml/d)	Desalination	AWSSHB	Unmitigatable risks identified in estuarial and brackish desalination options
SHB7	Desalination (seawater) on the South Humber Bank feeding the non potable network (25 Ml/d)	Desalination	AWSSHB	Unmitigatable risks identified in estuarial and brackish desalination options
SHB8	South Humber Bank desalination NP	Desalination	AWSSHB	Unmitigatable risks identified in estuarial and brackish desalination options
02a-1060	Ecton WB - Salcey WR	Internal potable transfer	AWSSHB	Alternatives developed
02a-1228a	Salcey WR -Deanshanger	Internal potable transfer	AWSSHB	Alternatives developed
20-0727	Innovative options (international examples e.g. sea clouding)	New technology	AWSSHB	Unproven technology
20-0728	Rainwater harvesting	Rainwater harvesting	AWSSHB	Unproven technology, cost and yield
2019_DRA01	River Ouse - existing abstraction	New surface water	AWSSHB	CAMS/ALS no resource available
SUE10	Desalination barge moored offshore with a pipeline coming onshore at Felixstowe (100 Ml/d)	Desalination	AWSSUE	Offshore deslination provides no benefit over onshore options but carry greater risk.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
SUE11	Orwell Estuary desalination (25 Ml/d)	Desalination	AWSSUE	Unmitigatable risks identified in estuarial and brackish desalination options
SUE12	Orwell Estuary desalination (50 Ml/d)	Desalination	AWSSUE	Unmitigatable risks identified in estuarial and brackish desalination options
SUE19	Essex and Suffolk Water to East Suffolk potable transfer (10 Ml/d)	External potable bulk supply/transfer	AWSSUE	Unmitigatable risks identified in estuarial and brackish desalination options
SUE26	Suffolk East drought permit (Alton)	Drought permits/orders	AWSSUE	Provides no DO benefit in planning scenario
SUE2	Ipswich Cliff Quay direct to Alton Reservoir (with no additional and abstraction treatment at Alton)	Water reuse	AWSSUE	No benefi without additional potable treatment capacity
SUE4	Ipswich Cliff Quay to Alton via River Gipping (no additional abstraction or treatment at Alton)	Water reuse	AWSSUE	No benefit without additional potable treatment capacity
SUE8	Desalination barge moored offshore with a pipeline coming onshore at Felixstowe (25 Ml/d)	Desalination	AWSSUE	Offshore deslination provides no benefit over onshore options but carry greater risk.
SUE9	Desalination barge moored offshore with a pipeline coming onshore at Felixstowe (50 Ml/d)	Desalination	AWSSUE	Offshore deslination provides no benefit over onshore options but carry greater risk.
NR10	Fosscott Reservoir	New reservoir	AWSSUE	No yield as standalone option.
11b-0142	Multiple Effect Distillation (MED) at the South Humber Bank	Desalination	AWSSUE	Heat source no longer exists
DES_27a	Desalination Barge moored at Immingham Harbour - transfer to Elsham	Desalination	AWSSUE	Offshore deslination provides no benefit over onshore options but carry greater risk.
DES_27b	Desalination Barge moored at Immingham Harbour - transfer to non potable hub	Desalination	AWSSUE	Offshore deslination provides no benefit over onshore options but carry greater risk.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
DES_43	North / East of Immingham Port	Desalination	AWSSUE	Unmitigatable risks associated with brackish and estuarial desalination
DES_45	Brackish desalination on Ancholme	Desalination	AWSSUE	Unmitigatable risks associated with brackish and estuarial desalination
01b-0570	Alton Water	Groundwater enhancement	AWSSUE	Unreliable long term
01c-0572	Alton Water dredging	Groundwater enhancement	AWSSUE	Not feasible due to results of the bathymetric surveys
01c-0573	Alton dam raising	Groundwater enhancement	AWSSUE	Not feasible due to results of the bathymetric surveys
01e-0574	Suffolk Valleys	New reservoir	AWSSUE	CAMS/ALS no resource available
02a-1049	Horkesley - Wherstead	Internal potable transfer	AWSSUE	Essex and Suffolk to develop North Suffolk reservoir. This option would compete for the same resource. No benefit to AW or regionally.
02a-1069	Sudbury WRZ Transfer	Internal potable transfer	AWSSUE	Alternatives developed
02a-1211a	Great Horkesley WR - Raydon WTW	Internal potable transfer	AWSSUE	Alternatives developed
02a-1211b	South Essex WRZ Transfer	Internal potable transfer	AWSSUE	Alternatives developed
02a-1236a	Lt. Welnetham - Semer	Internal potable transfer	AWSSUE	Alternatives developed
02a-1236b	Bury and Haverhill WRZ Transfer	Internal potable transfer	AWSSUE	Alternatives developed
02b-1238	Raw water transfer between Alton and Ardleigh	Internal raw water transfer	AWSSUE	Doesn't give resilience. And higher risk than potable South Essex to East Suffolk Transfer
03a-0578-A	Ipswich Water Reuse	Water reuse	AWSSUE	Alternatives developed

Option ID	Option Name	Option type	WRZ	Reason for option rejection
03c-0579	Alton WTW Washwater Recovery	Water treatment works loss recovery	AWSSUE	Resource is supporting river flow
04b-0580	Review group licences	New groundwater	AWSSUE	No long term reliable resource available from groundwater in the region.
04c-0581	Great Wenham Abandoned East Suffolk WRZ sources back to supply	New groundwater	AWSSUE	No long term reliable resource available from groundwater in the region.
04c-0582	Waddling Duck/Woodbridge/Kirby Rise/Baylham/Rushmere/Newborn Springs	New groundwater	AWSSUE	No long term reliable resource available from groundwater in the region.
05-0583	Icebergs	New technology	AWSSUE	Unproven technology
05-0584	Old sugar beet factory	Licence trading	AWSSUE	Option not sufficiently mature to define costs or DO.
05-0585	Suffolk Water Park (A14-Baylham)	Licence trading	AWSSUE	Option not sufficiently mature to define costs or DO.
06a-0586	Bucklesham Mill River - licence maximisation	New surface water	AWSSUE	CAMS assessment shows no water available and current operation of licence is only under drought conditions. Increase in abstraction at Bucklesham will affect WFD no deterioration
06a-0587	River Stour - trade with Essex and Suffolk Water (Ardleigh or Alton via EOETs)	New surface water	AWSSUE	CAMS/ALS no resource available
06a-0588	River Brett	New surface water	AWSSUE	CAMS/ALS no resource available
06a-0589	River Deben	New surface water	AWSSUE	CAMS/ALS no resource available
06a-0590	River Fynn	New surface water	AWSSUE	CAMS/ALS no resource available
06a-0591	River Orwell	New surface water	AWSSUE	CAMS/ALS no resource available
06a-0800	River Gipping (West Suffolk)	New surface water	AWSSUE	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06b-0592	Felixstowe peninsula	New groundwater	AWSSUE	High risk of saline intrusion in this region.
06b-1243	Use of gravel pits along the Gipping valley to support Bramford and Baylham existing abstractions (and Sproughton)	New groundwater	AWSSUE	No long term reliable resource available from groundwater in the region.
07-0446	Sizewell Nuclear PS (with ESW)	Licence trading	AWSSUE	No resrouce available in neighbouring resource zones. Poor, small bore connectivity. Water quality mixing issues.
07-0447	Sizewell with ESW	Licence trading	AWSSUE	No resrouce available in neighbouring resource zones. Poor, small bore connectivity. Water quality mixing issues.
07-0593	Sizewell	Water reuse	AWSSUE	Resource is supporting river flow
08b-0596	Ipswich	New technology	AWSSUE	Uncertain DO
08b-0597	Woodbridge	New technology	AWSSUE	Uncertain DO
08b-0598	Felixstowe	New technology	AWSSUE	High risk of failure as DO is uncertain, and there are potential environmental risks.
08c-0599	Ipswich WRC (Stowmarket, Felixstowe, Woodbridge)	Aquifer recharge/Aquifer storage recovery	AWSSUE	Unsuitable hydrological conditions
08c-0600	SUDS	Aquifer recharge/Aquifer storage recovery	AWSSUE	Uncertain DO
10a-0601	IDBs-Suffolk Holistic group	Licence trading	AWSSUE	High risk of failure due to uncertain DO
10b-0602	SUDS	New reservoir	AWSSUE	Uncertain DO
11b-0604	Other coastal locations	Desalination	AWSSUE	High risk of failure due to uncertain DO

Option ID	Option Name	Option type	WRZ	Reason for option rejection
12a-0605	Optimise use of Alton resources and back off Colchester Chalk	Groundwater enhancement	AWSSUE	Ardleigh with Colchester chalk is favoured over Alton
12b-0606	Alton Ipswich Conjunctive Use (Annual GW Licence)	Groundwater enhancement	AWSSUE	Existing assets optimised to licence.
12B-0606b	Alton Ipswich Conjunctive Use	Groundwater enhancement	AWSSUE	EA unlikely to approve 2-year GW licence due to environmental damage
14-0607	Affinity East	Licence trading	AWSSUE	Option not sufficiently mature to define costs or DO.
14-0813	Essex and Suffolk - Abberton Trilogy	Licence trading	AWSSUE	Option not sufficiently mature to define costs or DO.
15-0608	Tankering (Road)	Internal potable transfer	AWSSUE	Road Tankering rejected due to capacity required would not be feasible via road
15-0609	Sea tanker to Felixstowe Port transfer to Alton WTW (TBC by AW) [AW scheme name: Tankering (sea)]	International import	AWSSUE	Felixstowe port not suitable. Harwich developed instead.
15-0814	Tankering (rail)	Internal potable transfer	AWSSUE	Rejected due to weather and reliability issues, and due to traffic impacts
15-0815	Tankering (Road)	Internal potable transfer	AWSSUE	Road Tankering rejected due to capacity required would not be feasible via road
15-1078	Felixstowe Sea Tankering - pipelines to East Suffolk RZ	International import	AWSSUE	Felixstowe port not suitable. Harwich developed instead.
18-0610	Private lakes and gravel pits identified above	Groundwater enhancement	AWSSUE	None identified as part of the Private Lakes and Reservoir study
18-0611	Baylham - Gipping Valley	New reservoir	AWSSUE	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
18-0612	Gravel Pit exploitation (Claydon/Sproughton/Blakenham) - Gipping Valley	New reservoir	AWSSUE	Low yield benefit in conjunction with Alton
19-0613	HMS Gangas (Shotley)	New groundwater	AWSSUE	No long term reliable resource available from groundwater in the region.
19-0614	Other MOD sites (Wattisham)	Licence trading	AWSSUE	Option not sufficiently mature to define costs or DO.
20-0615	Innovative options (international examples e.g. sea clouding)	New technology	AWSSUE	Unproven technology
20-0616	Rainwater harvesting	Rainwater harvesting	AWSSUE	Unproven technology, cost and yield
20-0818	Innovative options (international examples e.g. sea clouding)	New technology	AWSSUE	Unproven technology
21-0617	EOETs & GOGS review	External raw water bulk supply/transfer	AWSSUE	Unproven technology, cost and yield
21-0618	EOETs optimisation (+ trade with Essex and Suffolk Water)	External raw water bulk supply/transfer	AWSSUE	Option not sufficiently mature to define costs or DO.
BCTTW_16	Raydon SPA reinforcement	Internal potable transfer	AWSSUE	No option identified at regional level
CMS_09	CM - Westerfield BHs - farmer partnership (nitrates)	Catchment management	AWSSUE	Already actioned by catchment liaison
CUOS_01	Baylham nickel blend optimisation	Groundwater enhancement	AWSSUE	Existing abstractions optimised - licence constraining
DES_12a	Desalination Barge moored at Felixstowe Harbour	Desalination	AWSSUE	Unmitigatable risks associated with brackish and estuarial desalination
GS_02	Raydon sources	New groundwater	AWSSUE	No long term reliable resource available from groundwater in the region.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RW_04	Alton WTW Instrument Recovery	Water treatment works loss recovery	AWSSUE	Issue with reg 31 materials in contact approval
RW_05	Alton WTW Sample taps Recovery	Water reuse	AWSSUE	Issue with reg 31 materials in contact approval
RW_06	Whitton WTW Instrument Recovery	Water treatment works loss recovery	AWSSUE	Issue with reg 31 materials in contact approval
RW_07	Whitton WTW Washwater Recovery	Water reuse	AWSSUE	Not identified as an option in Backwash recovery site by site review
RW_08	Baylham WTW Washwater Recovery	Water reuse	AWSSUE	Not identified as an option in Backwash recovery site by site review
RW_09	Belstead WTW Instrument Recovery	Water treatment works loss recovery	AWSSUE	Issue with reg 31 materials in contact approval
RW_10	Belstead WTW Washwater Recovery	Water reuse	AWSSUE	Not identified as an option in Backwash recovery site by site review
RW_11	Pettistree WTW Instrument Recovery	Water treatment works loss recovery	AWSSUE	Issue with reg 31 materials in contact approval
RW_12	Pettistree WTW Washwater Recovery	Water reuse	AWSSUE	Not identified as an option in Backwash recovery site by site review
RW_129	East Suffolk WRZ Reclamation	Water reuse	AWSSUE	None identified
CMS_17	River Linnet	Catchment management	AWSSUE	WINEP programme
06b-1239	Surface water abstraction	Desalination	AWSSUE	CAMS assessment shows no water available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
SUS1	Cambs and West Suffolk to Suffolk Sudbury (7 Ml/d)	Internal potable transfer	AWSSUS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
SUS2	Cambs and West Suffolk to Suffolk Sudbury (10 Ml/d)	Internal potable transfer	AWSSUS	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
RW_13	Rushbrooke BHs Washwater Recovery	Water reuse	AWSSUT	Not identified as an option in Backwash recovery site by site review
RW_14	Ixworth WTW Washwater Recovery	Water reuse	AWSSUT	Not identified as an option in Backwash recovery site by site review
RW_18	Winston WTW Instrument Recovery	Water treatment works loss recovery	AWSSUT	Issue with reg 31 materials in contact approval
RW_19	Winston WTW Washwater Recovery	Water reuse	AWSSUT	Not identified as an option in Backwash recovery site by site review
RW_31	Semer WTW Instrument Recovery	Water treatment works loss recovery	AWSSUT	Issue with reg 31 materials in contact approval
RW_32	Semer WTW Washwater Recovery	Water reuse	AWSSUT	Not identified as an option in Backwash recovery site by site review
SUP-8	Alton WTW	Water treatment works loss recovery	AWSSUT	No DO benefit
01e-0521	Thetford Forest	New reservoir	AWSSUT	CAMS/ALS no resource available
02a-1072	Bury and Haverhill RZ transfer	Internal potable transfer	AWSSUT	RZ No longer exists
02a-1073	North Norfolk Rural RZ transfer	Internal potable transfer	AWSSUT	RZ No longer exists

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02a-1240b	Stanton reservoir - Barnham cross	Internal potable transfer	AWSSUT	Alternatives developed
CMS_20	Le Hogue Road - Feckenham Tributary	Catchment management	AWSSUT	WINEP programme
SWC10	Cambs and West Suffolk to Cambs and West Suffolk potable transfer (10 Ml/d)	Internal potable transfer	AWSSWC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
SWC11	Cambs and West Suffolk to Cambs and West Suffolk potable transfer (10 Ml/d)	Internal potable transfer	AWSSWC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
SWC12	Essex Central to Cambs and West Suffolk potable transfer (10 Ml/d)	Internal potable transfer	AWSSWC	Developed to test feasibility. Technically feasible but rejected in favour of preferable route.
03a-0530	Thetford Water Reuse	Water reuse	AWSSWC	Resource is supporting river flow
05-0538	Thetford/Eye Power Stations reuse	Water reuse	AWSSWC	Resource is supporting river flow
06a-0545	River Thet	New surface water	AWSSWC	CAMS/ALS no resource available
14-0558	Cambridge Water	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
20-0839	Rainwater harvesting	Rainwater harvesting	AWSSWC	Demand management option
21-0620	GOGS (Thet/Little Ouse)	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
BCTTW_32	Cambridge Water-Thetford-Trade	Internal potable transfer	AWSSWC	Expensive - Cambridge also have sustainability reductions
JR_03	MOD Boreholes in Thetford Forest	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.Nitrate issues at Lakenham and Elvedon
02a-1015	Kennet, village - Kirtling Green	Internal potable transfer	AWSSWC	EOETS-related links that were in WRE but are not in scope of WRMP RWT section

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02a-1038	Fenland WRZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1040	Newmarket RZ transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1041	Newmarket WRZ transfer	Internal potable transfer	AWSSWC	RZ No longer exists
02a-1042	Bury and Haverhill WRZ transfer	Internal potable transfer	AWSSWC	RZ No longer exists
02a-1043	Ely WRZ transfer	Internal potable transfer	AWSSWC	RZ No longer exists
02a-1044	Bury and Haverhill WRZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1045	Rushbrooke - Little Saxham	Internal potable transfer	AWSSWC	Alternatives developed
02a-1046	Little Welnetham - Rushbrooke	Internal potable transfer	AWSSWC	Alternatives developed
02a-1047	Wherstead - Little Welnetham	Internal potable transfer	AWSSWC	Alternatives developed
02a-1050	South Essex WRZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1055	Thetford WRZ Transfer	Internal potable transfer	AWSSWC	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.
02a-1057	Sudbury WRZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1064	Cheveley WRZ transfer	Internal potable transfer	AWSSWC	RZ no longer exists

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02a-1065	Newmarket WRZ transfer	Internal potable transfer	AWSSWC	RZ no longer exists
02a-1065a	Little Saxham - Rushbrooke - Lt Welnetham	Internal potable transfer	AWSSWC	Not modelled-supply and demand data deemed option not required
02a-1068	Central Essex WRZ Transfer	Internal potable transfer	AWSSWC	Surplus is <5Ml/d and not part of a strategic trasnfer route.
02a-1070	Bury and Haverhill RZ transfer	Internal potable transfer	AWSSWC	Final planning scenario - no deficit in Sudbury
02a-1071	Cheveley WRZ transfer	Internal potable transfer	AWSSWC	RZ no longer exists
02a-1074	South Essex RZ Transfer	Internal potable transfer	AWSSWC	Final planning scenario - no deficit in Sudbury
02a-1077	Central Essex RZ Transfer	Internal potable transfer	AWSSWC	Final planning scenario - no deficit in Sudbury
02a-1212a	East Suffolk WRZ transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1212b	Semer WTW - Little Welnetham WR	Internal potable transfer	AWSSWC	Alternatives developed
02a-1213	Ruthamford North RZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1214	Ruthamford South WRZ transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1239a	Thetford WRZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed
02a-1239b	Ixworth (Stanton Res) - lt Welnetham	Internal potable transfer	AWSSWC	Alternatives developed
02a-1240a	Bury and Haverhill WRZ Transfer	Internal potable transfer	AWSSWC	Alternatives developed

Option ID	Option Name	Option type	WRZ	Reason for option rejection
02b-0702	Trent to Rutland to Fenland transfer (Fenland res) (and storage)	External raw water bulk supply/transfer	AWSSWC	Alternatives developed
02b-1016	River Stour - River Pant/Blackwater	External raw water bulk supply/transfer	AWSSWC	Alternatives developed
03a-0784	Bury St Edmunds Water reuse	Water reuse	AWSSWC	Resource is supporting river flow
03a-0785	Haverhill Water reuse	Water reuse	AWSSWC	Resource is supporting river flow
03b-0703	Ely water reuse	Water reuse	AWSSWC	Resource is supporting river flow
03b-0733	Newmarket Water reuse	Water reuse	AWSSWC	Resource is supporting river flow
03b-0757	Cheveley water reuse	Water reuse	AWSSWC	Resource is supporting river flow
03b-0826	Sudbury Water reuse	Water reuse	AWSSWC	Resource is supporting river flow
04a-0704	St Helena/others Ely groundwater	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
04b-0705	Review group licences	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
04c-0788	Ixworth unused borehole no 3 (W Suffolk)	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
04c-0789	Little Welnethan (W Suffolk) Bury St Edmunds groundwater sources	New groundwater	AWSSWC	WFD assessment - no additional resource available
05-0706	3rd party trade options	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0708	Mepal gravel pit development (Ely)	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
05-0709	Review discharge consents	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0734	3rd party trade options	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0735	Internal Drainage Boards	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0736	Jockey club (Newmarket)	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0737	Review discharge consents	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0758	3rd party trade options	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0759	Review discharge consents	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0790	3rd party trade options	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0791	Chicken factory	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0792	Forestry commission	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0793	Green King/ Paul's Malt/ British Sugar	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
05-0794	Review discharge consents	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0795	Rougham WRC (Bury St Edmunds)	Water reuse	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0796	Sugar beet factory	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0797	Vegetable producers	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0827	3rd party trade options	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
05-0828	Review discharge consents	Licence trading	AWSSWC	No new options or opportunities identified that are sufficiently well developed to define DO and cost.
06a-0710	Bedford drain/Forty foot drain	New surface water	AWSSWC	CAMS/ALS no resource available
06a-0711	Cut-off channel	New surface water	AWSSWC	CAMS/ALS no resource available
06a-0712	Great Ouse (Ely)	New surface water	AWSSWC	CAMS/ALS no resource available
06a-0713	Little Ouse	New surface water	AWSSWC	CAMS assessment indicates that only a small quantity of water is available during winter
06a-0714	River Cam	New surface water	AWSSWC	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)

Option ID	Option Name	Option type	WRZ	Reason for option rejection
06a-0738	River Cam	New surface water	AWSSWC	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)
06a-0739	River Kennett (Newmarket)	New surface water	AWSSWC	CAMS/ALS no resource available
06a-0798	River Lark	New surface water	AWSSWC	CAMS assessment shows that water not available in the Lark .
06a-0799	Little Ouse	New surface water	AWSSWC	CAMS assessment indicates that only a small quantity of water is available during winter
06a-0801	River Sapiston	New surface water	AWSSWC	CAMS/ALS no resource available
06a-0802	River Thet	New surface water	AWSSWC	CAMS assessment shows that only a small quantity of water is available during winter.
06a-0829	River Stour (Sudbury)	New surface water	AWSSWC	CAMS/ALS no resource available
06b-0740	New groundwater source	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
06b-0760	Groundwater source	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
06b-0830	New groundwater resource	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
06b-1240	Surface water treatment of River Stour near Haverhill	Water treatment works capacity increase	AWSSWC	CAMS/ALS no resource available
06b-1242	Ampton Lake waterbody as a source of water near Bury	New surface water	AWSSWC	CAMS/ALS no resource available

Option ID	Option Name	Option type	WRZ	Reason for option rejection
08a-0803	Bury St Edmunds ASR	Aquifer recharge/Aquifer storage recovery	AWSSWC	Poor hydrogeological setting with significant unconfined features indicate high risk of losing stored water.
08b-0715	Little Ouse	New technology	AWSSWC	High risk of failure as DO is uncertain, and there are potential environmental risks.
08b-0804	Floodplain Ixworth	New technology	AWSSWC	Uncertain DO
08b-0805	Little Ouse	New technology	AWSSWC	High risk of failure as DO is uncertain, and there are potential environmental risks.
08c-0716	SUDS	Aquifer recharge/Aquifer storage recovery	AWSSWC	High risk of failure due to uncertain DO
10a-0717	Environment Agency flood protection scheme (artificial recharge)/Internal Drainage Boards	Licence trading	AWSSWC	High risk of failure due to uncertain DO
10a-0742	Environment Agency flood protection scheme (artificial recharge)/Internal Drainage Boards	Licence trading	AWSSWC	Uncertainty over any additional DO compared to a normal reservoir. Currently evaluating opportunities using Black Sluice
10a-0762	Environment Agency flood protection scheme (artificial recharge)/Internal Drainage Boards	Licence trading	AWSSWC	High risk of failure due to uncertain DO
10b-0718	SUDS	New reservoir	AWSSWC	High risk of failure due to uncertain DO
10b-0743	SUDS	New reservoir	AWSSWC	High risk of failure due to uncertain DO
10b-0763	SUDS	New reservoir	AWSSWC	High risk of failure due to uncertain DO
10b-0832	SUDS	New reservoir	AWSSWC	High risk of failure due to uncertain DO

Option ID	Option Name	Option type	WRZ	Reason for option rejection
12a-0808	Conjunctive use combined with a transfer from another WRZ	Groundwater enhancement	AWSSWC	High risk of failure due to uncertain DO
13-0719	Large scale Agricultural reservoirs	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
13-0744	Large scale Agricultural reservoirs	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
13-0764	Large scale Agricultural reservoirs	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
13-0809	Large scale Agricultural reservoirs	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
13-0833	Large scale Agricultural reservoirs	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
14-0720	Cambridge Water	Licence trading	AWSSWC	As part of the Ouse Working Group options were not identified for specific trades in Ely.
14-0721	EOETS/storage	Licence trading	AWSSWC	As part of the Ouse Working Group options were not identified for specific trades in Ely.
14-0745	Cambridge Water	Licence trading	AWSSWC	As part of the Ouse Working Group options were not identified for specific trades in Ely.
14-0765	Cambridge Water	Licence trading	AWSSWC	As part of the Ouse Working Group options were not identified for specific trades in Ely.
14-0810	Affinity (East and Central)	Licence trading	AWSSWC	No resource available, therefore rejected
14-0811	Cambridge WRC reuse pumping to River Stour	Water reuse	AWSSWC	Cambridge WRC provides flow to river Great Ouse
14-0812	Cambridge Water	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
15-0722	Tankering (rail)	Internal potable transfer	AWSSWC	Rejected due to weather and reliability issues, and due to traffic impacts
15-0723	Tankering (road)	Internal potable transfer	AWSSWC	Road Tankering rejected due to capacity required would not be feasible via road
15-0746	Tankering (rail)	Internal potable transfer	AWSSWC	Rejected due to weather and reliability issues, and due to traffic impacts
15-0747	Tankering (Road)	Internal potable transfer	AWSSWC	Road Tankering rejected due to capacity required would not be feasible via road
15-0766	Tankering (rail)	Internal potable transfer	AWSSWC	Rejected due to weather and reliability issues, and due to traffic impacts
15-0767	Tankering (Road)	Internal potable transfer	AWSSWC	Road Tankering rejected due to capacity required would not be feasible via road
15-0834	Tankering (rail)	Internal potable transfer	AWSSWC	Rejected due to weather and reliability issues, and due to traffic impacts
15-0835	Tankering (Road)	Internal potable transfer	AWSSWC	Road Tankering rejected due to capacity required would not be feasible via road
18-0724	Increasing storage at private lakes	Groundwater enhancement	AWSSWC	None identified as part of the Private Lakes and Reservoir study
18-0725	Private reservoirs / lakes	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
18-0748	Increasing storage at private lakes	Groundwater enhancement	AWSSWC	None identified as part of the Private Lakes and Reservoir study
18-0749	Private reservoirs / lakes	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
18-0768	Increasing storage at private lakes	Groundwater enhancement	AWSSWC	None identified as part of the Private Lakes and Reservoir study
18-0769	Private reservoirs / lakes	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
18-0816	Increasing storage at private lakes e.g. Livermere Lakes	New reservoir	AWSSWC	CAMS/ALS no resource available
18-0817	Private reservoirs / lakes	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
18-0836	Increasing storage at private lakes	Groundwater enhancement	AWSSWC	None identified as part of the Private Lakes and Reservoir study
18-0837	Private reservoirs / lakes	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
19-0726	MOD (Mildenhall, Lakenheath, Feltwell) sites	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
20-0770	Innovative options (international examples e.g. sea clouding)	New technology	AWSSWC	Unproven technology
20-0771	Rainwater harvesting	Rainwater harvesting	AWSSWC	Unproven technology, cost and yield
21-0729	EOETs & GOGS review	External raw water bulk supply/transfer	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0752	EOETs & GOGS review	External raw water bulk supply/transfer	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0772	EOETs & GOGS review	External raw water bulk supply/transfer	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0773	River Colne with a trade with Essex & Suffolk Water via Ely Ouse Essex Transfer Scheme (EOETS)	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.

Option ID	Option Name	Option type	WRZ	Reason for option rejection
21-0774	GOGS (Lodes Granta)	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0820	EOETs & GOGS review	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0821	EOETS plus additional storage	Groundwater enhancement	AWSSWC	Covered by review of EOETS and GOGS
21-0822	GOGS (Thet, Little Ouse)	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0840	EOETs & GOGS review	External raw water bulk supply/transfer	AWSSWC	No long term reliable resource available from groundwater in the region.
21-0841	EOETS/storage	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
22-0775	River Lark Recirculation Scheme	Water reuse	AWSSWC	Resource is supporting river flow
ALT_04	Green King/Paul's Malt/British Sugar -3rd party option	Licence trading	AWSSWC	Option not sufficiently mature to define costs or DO.
BCTTW_10	Cambridge Water trading	Internal potable transfer	AWSSWC	Management and control
CMS_15	Green King/Paul's Malt/British Sugar -3rd party option	Catchment management	AWSSWC	Option not sufficiently mature to define costs or DO.
CMS_16	River Lark	Catchment management	AWSSWC	CAMS/ALS no resource available
CMS_21	River Sapiston and Stowlangtoft Stream	Catchment management	AWSSWC	To be investigated through WRE catchment management forums
GS_03	Relocate Wixoe	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
RESIY_08	Sudbury W'dhall Rd/ GT Cornard Blackhouse Lane licensing	Groundwater enhancement	AWSSWC	Need to link to connectivity option

Option ID	Option Name	Option type	WRZ	Reason for option rejection
RESIY_09	Etton/Northborough licensing	Groundwater enhancement	AWSSWC	Licence constraints
RUPSOS_01	Barton boreholes	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
RUPSOS_04	Inworth sources	New groundwater	AWSSWC	No long term reliable resource available from groundwater in the region.
RW_02	Kedington Haverhill WTW Instrument Recovery	Water treatment works loss recovery	AWSSWC	Issue with reg 31 materials in contact approval
RW_03	Gt Wratting WTW Instrument Recovery	Water treatment works loss recovery	AWSSWC	Issue with reg 31 materials in contact approval
RW_133	Green King/Paul's Malt/British Sugar -3rd party option	Water reuse	AWSSWC	Option not sufficiently mature to define costs or DO.
RW_15	Barnham WTW Washwater Recovery	Water reuse	AWSSWC	Resource is supporting river flow
RW_16	Tuddenham WTW Washwater Recovery	Water reuse	AWSSWC	Resource is supporting river flow
WQS_08	Barrow WTW upgrade	Water treatment works capacity increase	AWSSWC	Current assets optimised to age and condition
RW_127	Cambridge Water area Reclamation	Water reuse	AWSSWC	Resource is supporting river flow

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