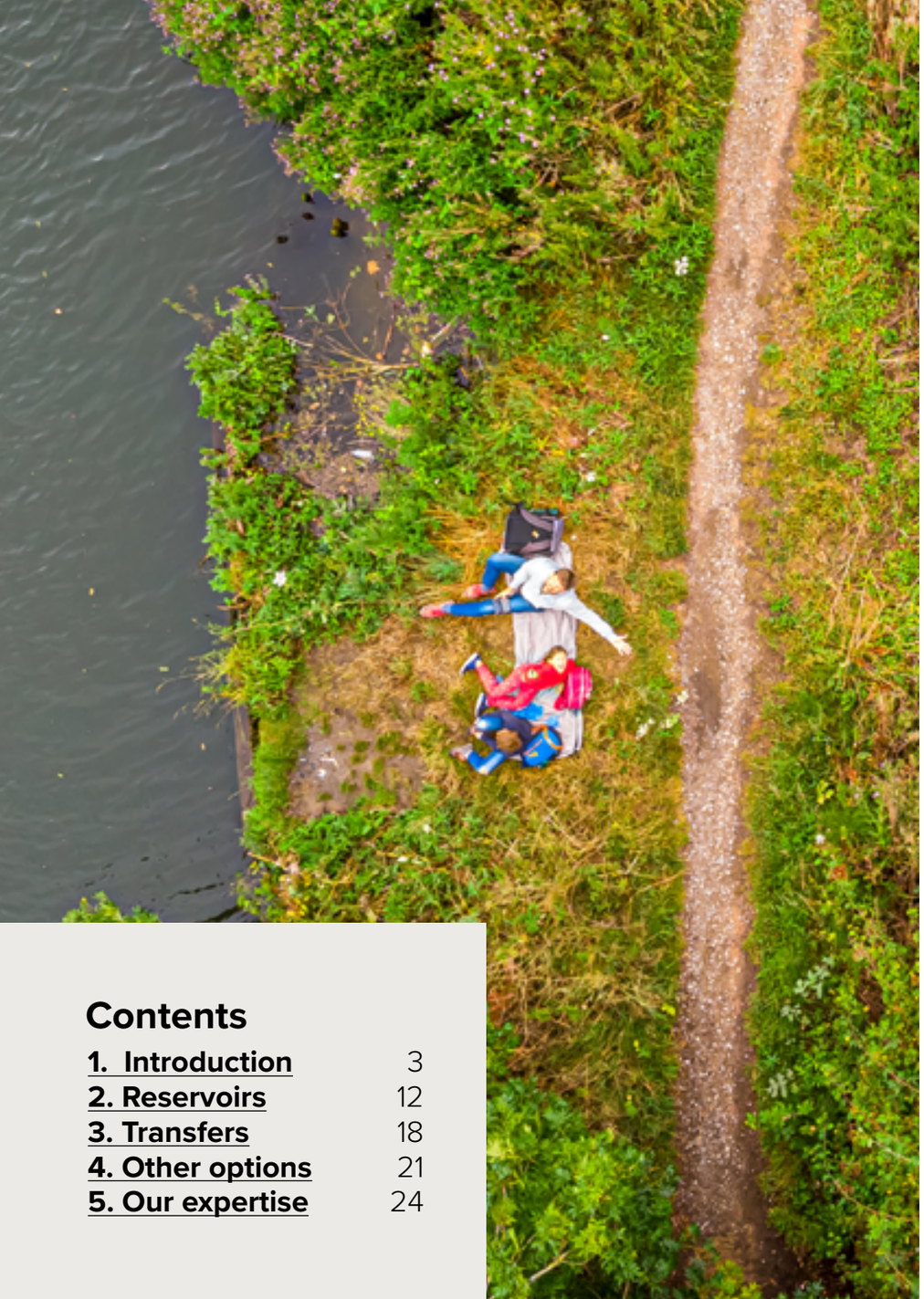
MOTT MACDONALD

Safeguarding England's water future

We're working with English water companies on resource planning and large strategic schemes that will make England's water supplies resilient against drought and shortages for the coming decades



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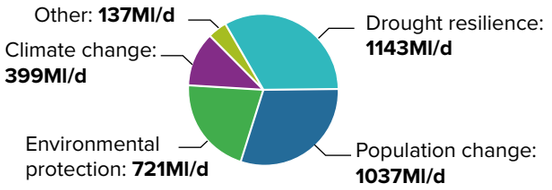
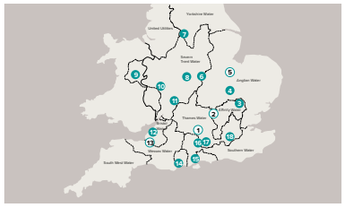
At a glance...

England will require **3,435 ML/d** extra water by **2050**



In response, water companies are developing **18** strategic water resource options



They include **reservoirs, transfers** and **water reuse** schemes

We're working with water companies, regional water resources groups, and regulators to **safeguard England's water future**

1. Introduction

Water in the UK may appear plentiful, but the threat of shortage in the coming decades, especially in the south and east of England, is real. The two main drivers for this are climate change and population growth.

UK water companies have committed to reaching a **1 in 500 year** drought resilience standard by **2050**. This means that the chances of severe water restrictions being needed should be less than **0.2%** in any given year.

The rising temperatures and changing weather patterns associated with climate change are expected to deplete the water available from existing sources in England by as much as 15% by 2050. At the same time, population growth means that there will be a steady increase in demand over the same period, with England requiring 3.4bn extra litres of water per day. The result of these trends is that, within 20 years, we will reach a point described by Sir James Bevan, chief executive of the Environment Agency, as the "jaws of death", where the opposing trend lines meet and demand outstrips supply.

Looking to the 2040s and beyond, we are helping water companies in the water-stressed south and east of England, as well as two regional groups, Water Resources East and Water Resources South East, to plan for water security and resilience. Our contributions include engineering, environmental and water quality advisory, catchment management, project and programme management, stakeholder engagement, cost modelling and investment planning, and more. We have also helped regulators assess options.

Water abstraction to meet human, industrial and agricultural demand is severely stressing and degrading the natural environment. In seeking to bolster supply, it is clear that continued unsustainable abstraction from watercourses and groundwater is not the answer, since it will negatively impact both ecology and the quantity and quality of water available in the future. Many catchments cannot support further abstraction, and indeed, some existing abstractions will need to be reduced to achieve ambitions for a healthier, more biodiverse environment.

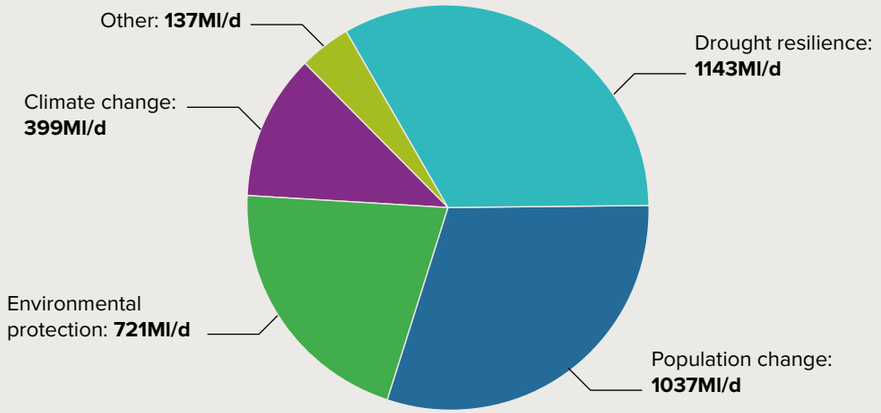
Measures to reduce water demand – including reducing leakage, the use of metering, and promoting efficient water use – will be necessary, but are not sufficient. Additional sources of supply will be needed, and on a large scale. To see the water-scarce south and east of the country through dry spells, new reservoirs providing extra water storage, and water transfer schemes from the more plentiful north and west are needed. Other options involve storing water in aquifers, reusing treated wastewater and seawater desalination.

All these strategic water supply options will take many years to plan and develop, and involve considerable investment; many involve multiple water companies, and need to overcome a host of technical, planning, regulatory and environmental challenges. Since the UK water industry privatisation in 1989, resource planning has been organised along water company lines, which is not conducive to such ambitious schemes.

This has changed in the last five years, as a result of **Water UK's long-term planning framework** (co-authored by Mott MacDonald), the subsequent assessment and recommendations of the **National Infrastructure Commission**, and the **national framework for water resources** set out by the Environment Agency.

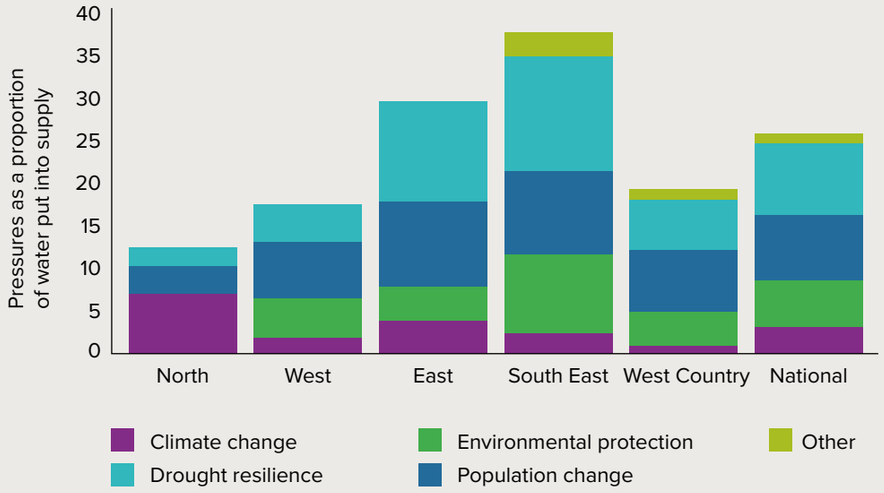
Following the publication of the most recent Water Resource Management Plans in 2019 (WRMP19) it was recognised that regional, multi-stakeholder planning was needed to better understand regional water needs over the next 50 years. Five regional groups (Water Resources North, West, East, South East, and West Country Water Resources) were therefore formed, made up of neighbouring water companies and major users of water (agricultural and industrial) in each region. Water companies are preparing to update their individual plans again in 2024, as part of WRMP24. In parallel, Water Resources groups will produce regional water resilience plans, identifying options that provide the best value to customers, society and the environment – rather than simply the least cost.

By 2050 **Environment Agency modelling** suggests England will require **3,435Ml/d** extra water.



Source: **Environment Agency**

The potential pressures on water needs as a percentage of the volume of water put into supply. (This is to adjust for the scale of the regional groups.)



Strategic Resource Options

The water resource schemes of greatest national importance have been designated Strategic Resource Options (SROs) and are being planned and developed through their own dedicated funding and regulatory assessment process.

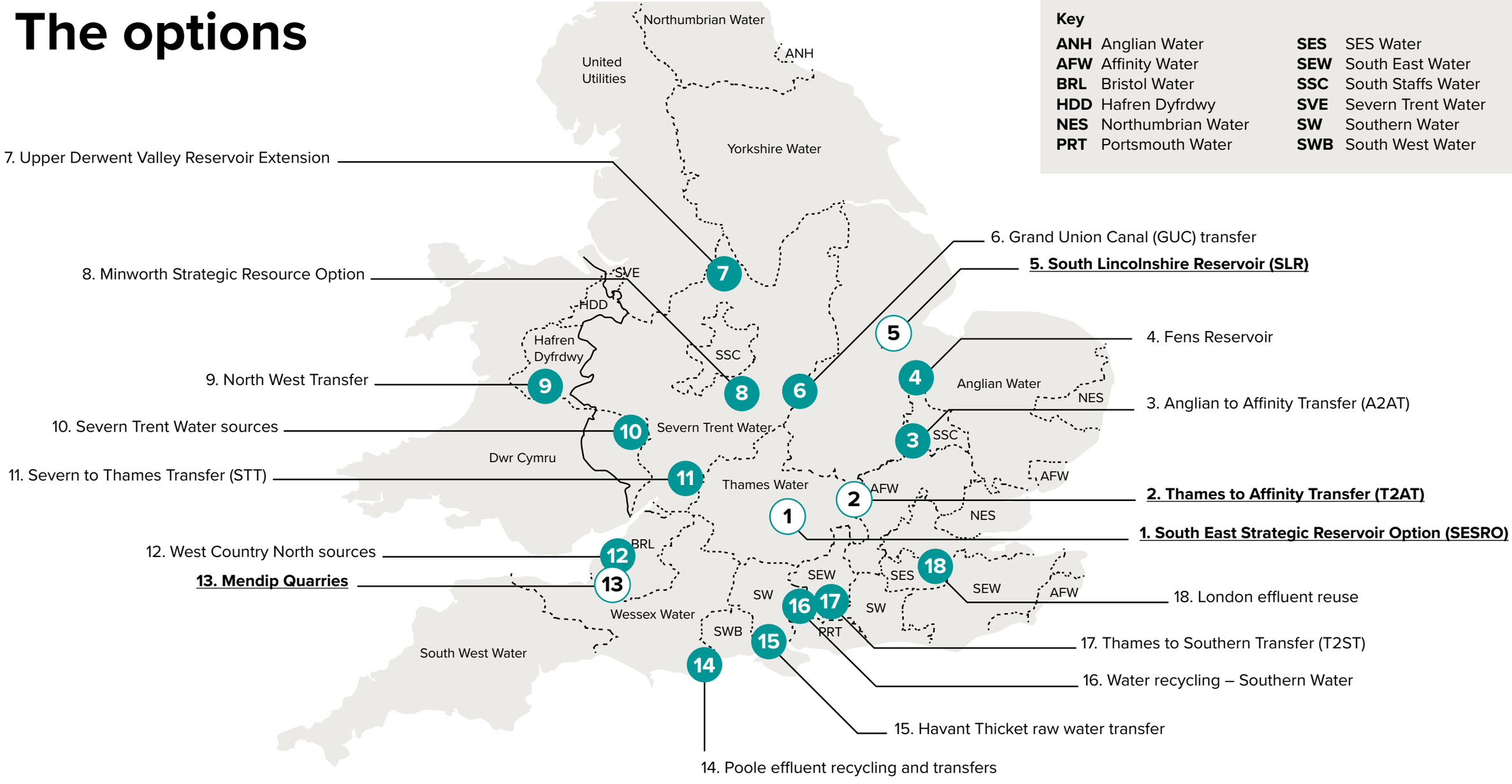
For the first time, the three regulators of the water industry – Ofwat, the Environment Agency and the Drinking Water Inspectorate – have formed a single body to assess the SROs. The Regulators' Alliance for Progressing Infrastructure Development (**RAPID**) will use a gated process to decide which schemes will proceed, considering economic, environmental and water quality factors in the round.

Common environmental and economic metrics are required so that the SROs can be accurately compared. An all-company working group of water companies meets regularly. Its multiple workstreams have produced guidance on cost and carbon estimation, environmental assessment, drinking water quality and other issues.

At the start of 2022 all the SROs had passed through gate one (initial concept design and decision making) and project teams are working towards gate two (detailed feasibility, concept design and multi-solution decision making). Getting this far has been a notable achievement, involving new levels of collaboration between water companies, regulators, partners and stakeholders.

As the options progress in the coming years there will be technical challenges to overcome – design and engineering, water treatment, and environmental protection. Planning, procurement, specification of suitable delivery models, and commercial arrangements governing water transfers will also need to be addressed. However, the water sector is now on the path to water security, long into the future.

The options



Key

ANH	Anglian Water	**SES**	SES Water
AFW	Affinity Water	**SEW**	South East Water
BRL	Bristol Water	**SSC**	South Staffs Water
HDD	Hafren Dyfrdwy	**SVE**	Severn Trent Water
NES	Northumbrian Water	**SW**	Southern Water
PRT	Portsmouth Water	**SWB**	South West Water

Project	Water companies	Project information	Potential deployable output*
1. South East Strategic Reservoir Option (SESRO)	Thames Water, Affinity Water	New bunded reservoir near Abingdon in Oxfordshire, with the potential to interact with multiple transfer solutions.	293Ml/d
2. Thames to Affinity Transfer (T2AT)	Thames Water, Affinity Water	Transfer from River Thames to Affinity Water (considering two options).	90Ml/d
3. Anglian to Affinity Transfer (A2AT)	Anglian Water, Affinity Water	Transfer from a new water source in the Anglian region (options include South Lincolnshire reservoir, Fens Reservoir, or new intake from the River Trent) to the Affinity Water region.	100Ml/d
4. Fens Reservoir	Anglian Water, Cambridge Water	New bunded reservoir in the Fens, with the potential to supply Cambridge Water via transfer.	99Ml/d
5. South Lincolnshire Reservoir (SLR)	Anglian Water, Affinity Water	New bunded reservoir in South Lincolnshire with the potential transfer to Affinity Water.	151Ml/d
6. Grand Union Canal (GUC) transfer	Affinity Water, Severn Trent	Transfer from the Midlands to south-east using the canal network, involving partnership between the companies and Canal & River Trust.	90Ml/d
7. Upper Derwent Valley Reservoir Extension	Yorkshire Water, Severn Trent	Expansion of the three linked reservoirs in the Upper Derwent Valley.	135Ml/d
8. Minworth Strategic Resource Option	Severn Trent Water, Affinity Water	Treated effluent discharged to the River Avon, supporting the River Severn to River Thames transfer, or to the canal network, supporting the Grand Union Canal transfer.	*
9. North West Transfer	United Utilities	In-region transfer from up to 11 sources, enabling release from Vyrnwy reservoir to support the River Severn to River Thames transfer.	*
10. Severn Trent Water sources	Severn Trent Water	Two source options to support the River Severn to River Thames transfer.	50Ml/d
11. Severn to Thames Transfer (STT)	Thames Water, Severn Trent Water	Transfer of water from the lower reaches of the River Severn to the River Thames via a pipeline or restored canal route.	Up to 400Ml/d
12. West Country North sources	Bristol Water, Wessex Water, Southern Water	New Cheddar reservoir and pipeline to Wessex Water; reinforcing the Wessex Water network to maximise the benefit of a transfer from Bristol Water at Newton Meadows; link to Southern Water.	*
13. Mendip Quarries	Wessex Water, South West Water	Repurposing of at least one quarry in the Mendip Hills as a public water supply reservoir, to be filled with groundwater and with water abstracted from the River Avon.	Up to 87Ml/d
14. Poole effluent recycling and transfers	South West Water, Southern Water, Wessex Water	Effluent recycling from Wessex Water's Poole sewage treatment works; transfer to the Southern Water region via the River Stour.	30Ml/d
15. Havant Thicket raw water transfer	Southern Water, Portsmouth Water	Transfer from Portsmouth Water's Havant Thicket reservoir to Southern Water's Otterbourne Water Treatment Works.	61Ml/d
16. Water recycling – Southern Water	Southern Water	Treatment and recycling of final effluent, via an environmental buffer lake and mixing with water from the River Itchen. Full treatment to potable standard at Otterbourne Supply Works.	Up to 75Ml/d
17. Thames to Southern Transfer (T2ST)	Thames Water, Southern Water	Transfer from Thames Water to Southern Water, taking water from existing and new sources. Multiple route options are being considered.	*
18. London effluent reuse	Thames Water	Beckton, Mogden and Teddington WWTW effluent reuse.	Up to 421Ml/d

*Maximum deployable output (DO) as stated in gate one submission documents. Star indicates DO could not be calculated at gate one.

Mott MacDonald's role in water resource planning

We are playing a key role in the English water sector's resource planning in several important ways.

We're helping many individual water companies to think about and plan their resource requirements for the next 25 years or more, as part of the statutory WRMP24 process. These include most of the major water companies in the water-stressed south and east of England: Thames Water, Affinity Water, Southern Water, Essex & Suffolk Water, and Anglian Water.

We're helping Water Resources South East – the regional group that includes Thames, Affinity and Southern – with its programme management, option appraisal, environmental appraisals and its handling of data; and we're supporting Water Resources East (the regional water resources group for Eastern England) with its regional plan too.

We're providing project management, technical expertise, environmental services and drinking water assessments that are helping to shape the development of many of the SROs, at both gate one and gate two. For a summary, see the table on the next page.

We've provided support to RAPID in their assessments of the options that were given an accelerated timeframe; and have worked on behalf of the all-company working group to produce guidance on cost and carbon consistency, water quality and environmental assessment that will help water companies and regulators present and compare the SROs accurately.

"For robust decision-making it will be important to achieve a good level of consistency in the key option information used," says Bill Hume-Smith, technical principal, investment planning at Mott MacDonald. "We have been working with companies to identify areas where greater consistency is needed. And we were appointed by the all-company working group to develop consistent approaches in key areas, including the level of design development, cost estimating, environmental assessment (including water quality modelling), and carbon emissions and mitigation."

For a full list and description of our expertise, see page 24.

Key

- Supported at gate one
- Supported at gate two
- Assurance

Project	Mott MacDonald's roles			
	Project management	Technical engineering	Environmental services	Drinking water risk assessments
Anglian to Affinity Transfer (A2AT)	■	■	■	■ ■
Fens Reservoir	■	■ ■	■ ■	■
Severn to Thames Transfer (STT)		■		
Grand Union Canal (GUC) transfer			■ ■	
London effluent reuse			■	
Mendip Quarries	■	■ ■	■ ■	■ ■
South East Strategic Reservoir Option (SESRO)		■ ■		
South Lincolnshire Reservoir (SLR)	■	■ ■	■ ■	■ ■
Thames to Affinity Transfer (T2AT)		■ ■	■ ■	■ ■
Thames to Southern Transfer (T2ST)	■ ■		■ ■	
West Country North sources		■		■

The RAPID gated process for strategic resource options

Development of water resources solutions must pass through four 'gates' between April 2020 until summer 2024 (gate dates can be changed by agreement, and there may be a gate five after summer 2024 if RAPID believes it is needed). At each gate, RAPID assesses the progress companies are making. If progressing well, and providing there is a good case for continuing to develop the option, companies are allowed funding to develop the solution to the next gate.

1.

Initial concept design and decision making

2.

Detailed feasibility, concept design and multi-solution decision making

3.

Developed design, finalised feasibility, pre-planning investigations and planning applications

4.

Planning applications, procurement and land purchase

Water Resources South East (WRSE)

We were appointed in 2019 as programme manager for WRSE, which is an alliance of the six water companies in the south-east of England: Thames Water, Affinity Water, Southern Water, South East Water, SES Water and Portsmouth Water. WRSE's aim is to secure the water supply for future generations through a collaborative, regional approach. Our role encompasses a large programme of works to produce the next regional resilience plan for water resources in the south-east of England, to extremely challenging regulatory water company deadlines.

Programme management has entailed developing programme structures, financial and delivery reporting, procurement and supply chain management, providing senior water company and regulatory stakeholder management, managing risks and controlling budgets. We have supported WRSE through the technical delivery of the resilience framework, as well as undertaking the options appraisal and environmental assessments for the regional plan.

Water Resources East (WRE)

Eastern England is classified as 'seriously water stressed'. With Water Resources East (WRE) forecasting a supply deficit of some 2300Ml/day by 2050, improving the situation requires collaborative regional planning.

Our resource specialists have worked to incorporate possible future surface and ground water flows, across a range of climate change scenarios, into a regional water resources simulator.

We have developed scenarios examining the environmental benefits of reducing abstraction. And our engineering and environmental teams have developed outline designs and evaluated the carbon, cost and environmental impacts of strategic supply options. All supporting the delivery of a long-term, adaptive, multi-sector water resources plan.

Anglian Water supplies drinking water to 2.5M households and 110,000 businesses in one of the UK's fastest growing regions, with 175,000 new homes to be built by 2025. Our purpose is to ensure long-term environmental and social prosperity for the east of England, while building resilient networks that reduce the risk of drought and flooding.

Water is the lifeblood of our region. Our long-term plan for managing water resources has a strong focus on managing demand, reducing leakage and promoting water efficiency, but it also recognises that at some point significant new infrastructure will be required to ensure we continue to supply enough water to meet the needs of all water users including agriculture, energy, the environment, and our customers.

The scale and complexity of this potential new infrastructure means that we need to start planning now, for the future.

By planning for these solutions ahead of time, they will be 'construction ready' should they be needed. This is called adaptive planning.

Our strategic solutions – which include the South Lincolnshire Reservoir, the Fens Reservoir and the Anglian Water to Affinity Water Transfer – are in their early stages, with key details such as site selection and early concept designs still being progressed.

The next milestone will be submitting more detailed options on the locations of the reservoirs in November this year. These are significant projects and we'll be working closely with local communities as they develop, so we can keep taps running across our region for generations to come.

Hannah Stanley-Jones,
Head of future resources strategy,
Anglian Water

2. Reservoirs

Expertise

- **Carbon management**
- **Dam engineering**
- **Environmental assessments**
- **Hydrology**
- **Project management**
- **Regulatory engagement**
- **Social assessments and stakeholder engagement**
- **Transport and access**
- **Water quality**

Climate, people, place, value: the SRO design principles

The all-company working group has agreed four 'design principles' which are shaping the design of all the SROs. They are:

Climate: Mitigate greenhouse gas emissions and adapt to climate change
People: Reflect what society wants and share benefits widely
Place: Provide a sense of identity and improve our environment
Value: Achieve multiple benefits and solve problems well

New reservoirs are considered a central part of the planning for England's future water resilience, providing large-scale raw water storage which, in tandem with transfer solutions, could keep the taps flowing during months of drought.

The SROs include one new reservoir in the Thames Water region (SESRO), two in the Anglian Water region (Fens Reservoir and SLR), and one in the Wessex Water region (Mendips Quarries). The Havant Thicket Resilience Project – a collaboration between Southern Water and Portsmouth Water – also involves the construction of a new winter storage reservoir, although this project is being developed outside of the SRO process.

No major new reservoirs have been built in the UK since privatisation in 1989. This is primarily due to the cost of their construction and the difficulty of a single water company making the business case for investment. There are also local communities to win over and regulatory and planning hurdles to overcome.

The multi-company nature of the SROs, and the new funding and regulatory environment created by regulators, have made it easier to articulate the business case, while the Planning Act 2008 allowed reservoirs to be designated as nationally significant infrastructure projects (NSIPs), with applications considered at a national level.

Design needs to consider the effect of a reservoir on flood risk across the catchment, and to mitigate it using nature-based as well as engineered solutions. It must also consider multi-sector benefits – ecological, recreational, and economic. Reservoirs can serve as a leisure amenity, with facilities for watersports, walking, fishing and birdwatching. Environmentally, reservoirs involve an enormous change to the nature of a landscape, but the addition of wetlands can create valuable habitats for aquatic and birdlife, resulting in a biodiversity net gain.

Case Study

South East Strategic Reservoir Option (SESRO)

Clients: Thames Water, Affinity Water

The South East Strategic Reservoir Option (SESRO) is a proposed 6.7km^2 area, 150Mm^3 capacity bunded reservoir near Abingdon in Oxfordshire. In WRMP19 it was the chosen option to meet the long term water needs of Thames Water and Affinity Water; it is under review again in WRMP24.

Water would be pumped into the reservoir from the River Thames during periods of high flow, then released back into the Thames during drier periods for re-abstraction further downstream. It could deliver around 290Ml/d to customers in London and the wider south-east.

As part of our risk analysis and stakeholder engagement support to Thames Water during WRMP19, we carried out initial concept design for six possible versions of the reservoir. These included four options with varying reservoir capacity (75Mm^3, 100Mm^3, 125Mm^3 and 150Mm^3) and two dual-phase options which envisaged the reservoir being initially built to a smaller capacity and then expanded at a later date.

After the project was designated as a SRO, Thames Water and Affinity Water were given a maximum development allowance of £121.7M to develop these options through the RAPID gate process.

We were appointed as lead engineer for the water companies' gate one submission, submitted in July 2021. We are working as part of a multidisciplinary team to develop a scheme that will deliver a safe and resilient operational reservoir that provides a biodiversity net gain, minimises climate impacts and provides opportunities for recreation and for people to access nature.

Expertise

- **Carbon management**
- **Dam engineering**
- **Hydrology**
- **Transport and access**

Back to options

Flood risk, rail access and visitor access are key considerations:

1. Flood risk

By updating existing river models we drew interim conclusions about how the reservoir, and the diversion of nearby watercourses necessary for its construction, would affect local floodplains. Using a 1D-2D hydraulic model, we demonstrated a slight reduction in flood risk to Abingdon. Findings provide the project team with greater confidence about the design features that are being developed, which include a shallow excavation on the west side of the reservoir that could be retained as wetlands to carry additional flood water.

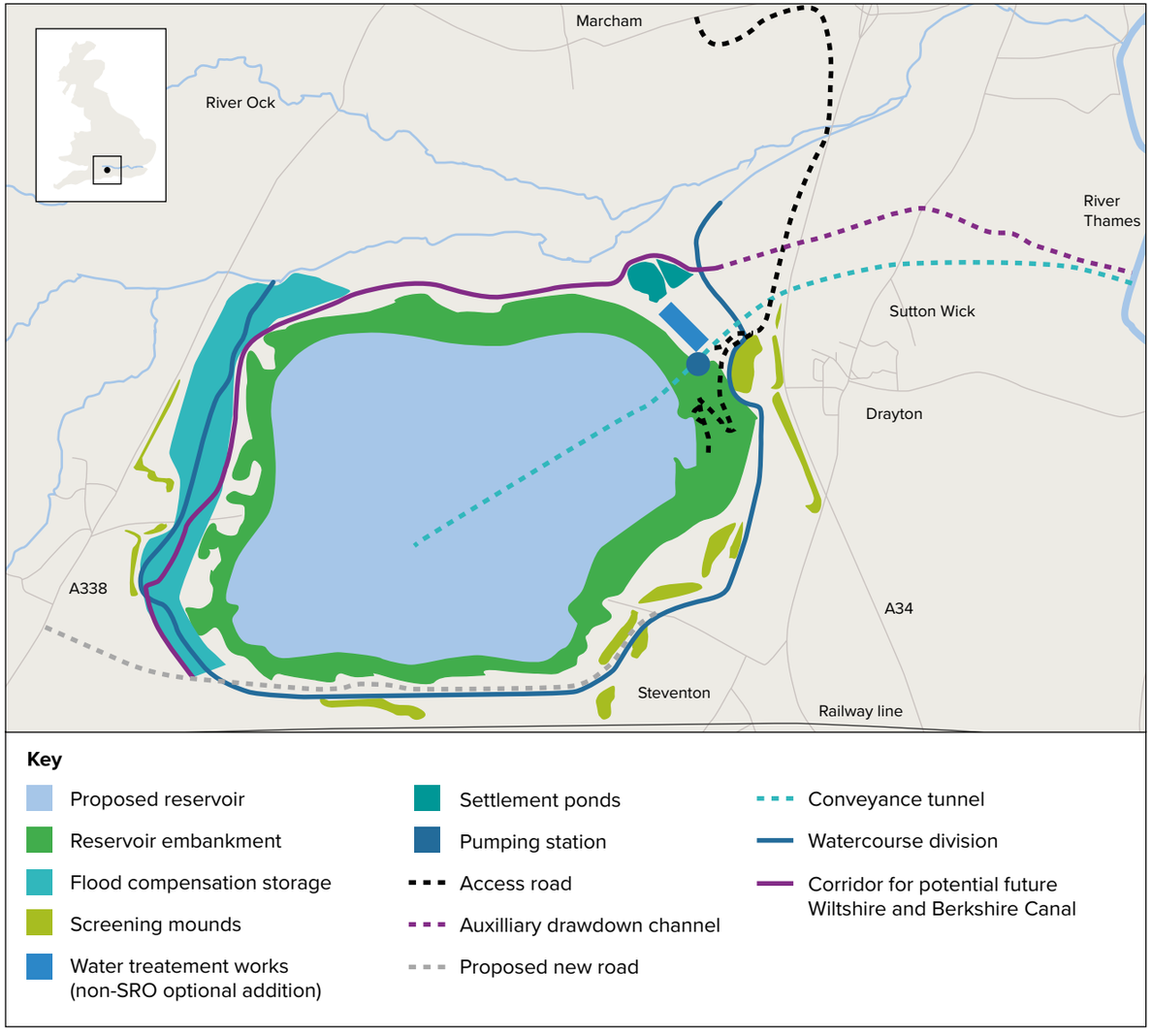
2. Rail access

We carried out a feasibility study to establish whether the necessary material for constructing SESRO could be brought in using freight trains on the existing rail network. Reviewing routes to site, potential network capacity constraints, and using material quantity estimates, we established that a maximum of two trains per day were required. Overall, the analysis has strengthened confidence that the rail network will be able to support construction.

3. Visitor access

A further package of work surrounded the suitability of local road and transport routes for visitors to the reservoir once it is operational. A high-level estimate was made of the number of visitors that the reservoir could attract, and existing roads, public transport routes, cycle routes and public rights of way were then mapped and assessed to test their ability to support the likely visitor numbers. The proposed access roads to the site were reviewed and the designs were altered following engagement with local councils, to create increased separation between junctions and facilitate non-road access to the site.

We also undertook a review of the carbon footprint of the project, identifying carbon hotspots in construction and operation, and ways to reduce emissions. We are continuing to support this project during gate two with further engineering and carbon advisory work. Thames Water and Affinity Water have identified the largest reservoir option (150Mm^3) as their preferred solution, but no formal decision will be made until further feasibility studies and investigations have been carried out and the regional and company water resource management plans have been finalised. If the decision is made to proceed, the reservoir is expected to take 15 years to carry through to completion, including a construction phase of nine years.



Case Study

South Lincolnshire Reservoir (SLR)

Clients: Anglian Water, Affinity Water

Expertise

- **Environmental assessments**
- **Hydrology**
- **Social assessments and stakeholder engagement**
- **Water quality**

Back to options

The South Lincolnshire Reservoir, or SLR, is a proposed new reservoir in Lincolnshire which would supply water to Anglian Water customers, and potentially Affinity Water customers via an associated transfer.

The reservoir system has the potential to deliver wider public and private value across multiple sectors, with benefits including flood protection, support to agri-food, environmental enhancement and improved navigation, in addition to delivering public water supply resilience. We are supporting Anglian Water, in partnership with the Environment Agency and Water Resources East, to identify these opportunities and potential funding streams to support them.

The reservoir's location has not yet been determined, but depending on the design chosen, it will provide over 150Ml/d. The water to fill it will be abstracted from the River Witham (and indirectly from the River Trent) in times of high flow and brought to the newly-constructed reservoir either by pipeline, open water transfer, or a combination of the two.

We were appointed to give project management support and lead the engineering design and environmental impact assessments. Since the reservoir was envisaged from its inception as having multiple uses, our role has involved working with the South Lincolnshire Water Partnership, which represents the range of local and regional stakeholders who will benefit from the reservoir, to meet their needs as well as those of the water companies.

Through workshops, meetings and consultations, we have facilitated collaboration, leading to wide-ranging benefits for stakeholders.

Concept designs

For the gate one submission in July 2021, we drew up three concept design options:

Concept Design 1 is a multi-purpose reservoir 52.5Mm^3 in volume, used for water supply and irrigation, with an adjacent 2.5Mm^3 for flood water storage. Water would be transferred to the reservoir via two pipelines, one from the River Witham and one from the South Forty Foot Drain (SFFD).

Concept Design 2 is a 50Mm^3 reservoir with two separate 0.5Mm^3 bank storage wetlands and five online 0.1Mm^3 spring-fed stream wetlands. Water would be brought from the River Witham via an open water link, 4km long and 6m wide, then along the SFFD for 15.5km and finally to the reservoir via an open water channel extension to the SFFD and a final 3.7km long pipeline with pumped transfer.

Concept Design 3 is a 50Mm^3 reservoir with two 0.5Mm^3 bank storage wetlands, five 0.1Mm^3 spring-fed stream wetlands, an additional 4Mm^3 flood storage reservoir and three 1Mm^3 farming reservoirs. The additional flood storage is designed to provide flood protection along the River Glen and release up to 150Ml/d to the Bourne Eau. Water would be brought from the River Witham via an open water link, as above, and then along the SFFD, which would be widened and deepened along 24.9km of its length to increase its capacity.

Quantifying the benefits

The three designs are being used as a proof of concept of how the scheme can provide wider benefits to the local community beyond public water supply. We used the latest modelling tools, techniques and approaches to quantify the benefits.

Hydrological software was used to model the three design options and establish the irrigation and flood risk benefits of each. We calculated how the different options would fare in a severe flood event – how many centimetres the water level of the river and nearby watercourses would rise. Wetlands and open water channels would benefit the environment by attracting wildlife and boosting ecosystems; they would benefit the local community by adding new opportunities for recreation and attracting visitors. These aspects were quantified for the different options through biodiversity net gain, natural capital and social outcomes, and there was also an assessment of capital and operational carbon.

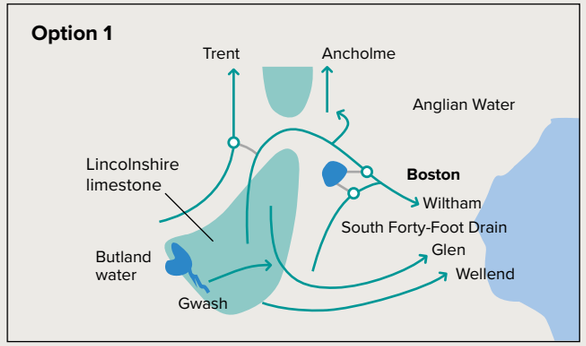
We carried out initial environmental assessments across the three concept design options, in the same way as would be conducted in water resource management plans. These included a habitats regulations assessment, Water Framework Directive and strategic environmental assessment. Since the project involves taking water between two river basins (Trent to Anglian) an additional assessment was made for invasive non-native species.

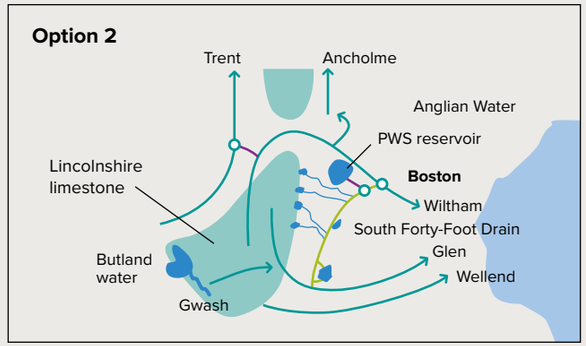
The scheme is progressing to gate two, which will consist of site selection, a decision on concept design and more detailed feasibility work. We will continue to contribute throughout this phase, which is due to be completed in November 2022.

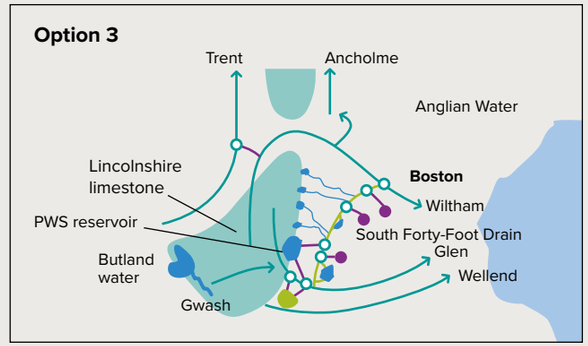
South Lincolnshire Reservoir

Key

- Watercourse
- Wetland
- Intake
- Pipeline
- Open water transfer
- Transfer to be defined
- Existing open channel
- Farming reservoir







Case Study
Mendip Quarries

Clients: Wessex Water, South West Water

Expertise

- **Environmental assessments**
- **Hydraulic engineering**
- **Social assessments and stakeholder engagement**
- **Water quality**

Back to options

Mendip Quarries is a strategic regional resource option which would provide additional water supply in the West Country, and by transfer to the south-east region.

A quarry has been identified in the Mendip Hills in Somerset which could be repurposed at the end of its working life as a reservoir to support regional water supply. The existing restoration plan is for the quarry to fill with groundwater naturally, so the proposed scheme is to use the restored lake for water storage. The quarry has an estimated 28.7Mm^3 useable water storage volume, and whilst this could fill naturally with groundwater, the rate of recharge would be relatively slow. It is proposed that refilling of the reservoir is augmented with water abstracted from the River Avon, near Bristol, during times of high river flow in winter. The reservoir could yield a water resource benefit of between 29Ml/d and 87Ml/d, depending on the terms of the abstraction licence that can be obtained for the River Avon.

Four transfer options were proposed at gate one to serve customers from different regions:

- A treated water transfer to a service reservoir near Warminster (to supply Wessex Water and onward to Southern Water via the West Country North SRO)
- A raw water transfer via the River Stour (to supply Wessex Water and Bournemouth Water)
- A raw water transfer via the Kennet & Avon Canal and the River Thames (to supply Thames Water, South East Water and Affinity Water)
- A raw water transfer to Barrow Reservoir (to supply Bristol Water)

At gate one, we carried out the lead engineering role to help Wessex Water and South West Water explore the feasibility of the reservoir and associated transfers. We also carried out a high-level Water Quality Risk Assessment (WQRA), highlighting the raw water quality considerations that need to be taken into account in the project, including the blending of river and groundwater, and raw water transfers to other water bodies.

We've carried out initial environmental assessments and identified opportunities for wider benefits to be delivered as part of the scheme, including opportunities for biodiversity net gain, positive social outcomes, and improved climate resilience. We're continuing these workstreams in gate two, including project management services and hydrological/hydrogeological modelling to refine the reservoir yield estimates.

In gate two we are developing a flexible programme for the scheme to suit the investment needs of the water companies. Due to the decommissioning date of the identified quarries, construction would not start until AMP9 (2030-35).

3. Transfers

Expertise

- **Carbon management**
- **Environmental assessments**
- **Hydraulic engineering**
- **Hydrogeology**
- **Pipeline design**
- **Project management**
- **Regulatory engagement**
- **Social assessments and stakeholder engagement**
- **Water quality**
- **Water treatment**

With the relative abundance of water in the north and west of England compared to the south and east, transfers of water between water company regions and within regions form an important part of the national water resilience picture.

Water can be transferred either by adding flows to existing watercourses which are then abstracted downstream, or by artificial channels or pipelines, or by a combination of both. To make transfers viable for the water companies and environmentally sustainable, they are being developed alongside source options.

For example, water from SESRO could be transferred to Affinity Water customers via the Thames to Affinity Transfer (T2AT), while a variety of new Severn Trent and United Utilities sources are being developed alongside the potential Severn Thames Transfer (STT).

Where existing watercourses are used as part of the transfer, the siting of new inputs and abstraction points is a key design consideration, as the effect that the new flows will have on erosion, flood risk and biodiversity must be carefully modelled. For pipelines, a key challenge is to minimise the distance water must travel and hence to optimise the construction cost and carbon impact of the project.

For all transfers, water quality is of primary concern. If the characteristics of imported treated water differ from water abstracted from local sources, there may need to be changes to treatment facilities to avoid customer complaints about smell and taste; for raw water transfers, treatment may be required to maintain water quality in the receiving watercourse. Environmental assessments are important to avoid or mitigate any impacts on aquatic life and to prevent the spread of invasive species.

England's network of canals provide an important opportunity to make use of existing infrastructure to move water around at relatively light economic cost and environmental impact. Most notably, the SROs include a transfer along the Grand Union Canal in the Midlands, which would benefit Affinity Water customers.

Expertise

- **Environmental assessments**
- **Project management**
- **Water quality**

Case Study

Thames to Affinity Transfer (T2AT)

Clients: Thames Water, Affinity Water

The Thames to Affinity Transfer (T2AT) is a raw water transfer from the River Thames to Affinity Water's Central supply region, including treatment to potable standard.

It is intended to operate in dry periods to give Affinity Water customers a share of new strategic water resources created in the Thames Water area, specifically the new SESRO reservoir, the Severn to Thames Transfer (STT) and the schemes for water reuse in London. Up to 100Ml/d could enter the Thames (or in the case of the Beckton reuse option, the River Lee) from one or more of these sources, and then be abstracted and conveyed to a treatment works.

The water companies' WRMP19 plans identified the need to investigate and shortlist combinations of transfer routes. We carried out a series of interactive workshops with Thames Water and Affinity Water participants, and a list of 33 possible alternatives was produced.

This list was subjected to a first stage of screening, where any options with technical or environmental 'showstoppers' were screened out, and then a second stage which applied a red-amber-green rating to each option in multiple categories.

As a result of this work, the options were narrowed down to eight possible configurations, which were subject to a much greater level of detailed appraisal. We were appointed to carry out both engineering and environmental assessments of these options ahead of Thames Water's gate one submission to RAPID in July 2021.

Five of the options put forward at gate one assumed additional resource higher up the Thames catchment, either from SESRO or the Severn-Thames Transfer; two of them assumed additional resource from an effluent reuse scheme in west London; and one assumed an additional resource from an effluent reuse scheme in east London. There were 50Ml/d and 100Ml/d alternatives for each of the eight options.

Back to options

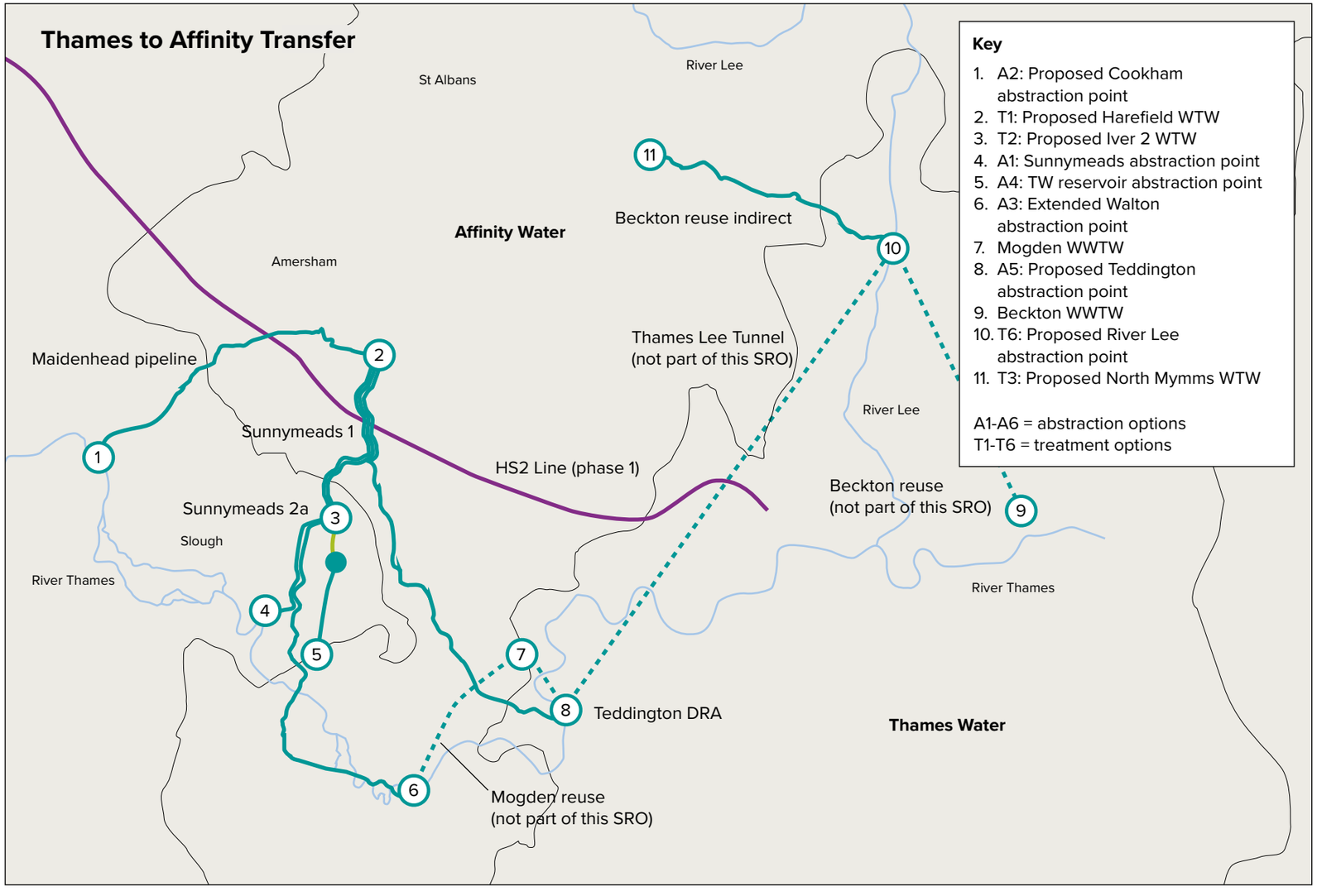
Minimising environmental impacts

Each of the options were subjected to a strategic environmental assessment and a habitats regulation assessment. The options were chosen to avoid sensitive habitats and areas of specific environmental concern.

We adapted the options to use existing infrastructure, avoiding new construction where possible. For example, an existing Affinity Water abstraction point was proposed for two of the options, and using spare capacity in an existing tunnel avoided the need to dig 6km of new pipeline. These were some of the ways we supported the water companies' aspirations for net-zero carbon emissions, and the creation of green-blue infrastructure.

The T2AT is highly interconnected with other strategic resource options – SESRO, the Severn-Thames Transfer and the London Reuse schemes – and the chosen schemes will need to fit together seamlessly when they are inserted into individual water company resource plans for WRMP24 and their associated business plans. We have therefore been in regular contact with the teams working on the other SROs, as well as both clients, to achieve consistency and interoperability.

In its final decision published in December 2021, RAPID confirmed that the option will now be funded to proceed to gate two.



4. Other options

Expertise

- **Carbon management**
- **Environmental assessments**
- **Project management**
- **Regulatory engagement**
- **Water quality**
- **Water treatment**

Water reuse

Indirect water reuse consists of treating wastewater to a high standard, releasing it into a watercourse and then abstracting it soon afterwards for use in the supply of clean water. It is seen by many as preferable to direct water reuse, where wastewater is treated and then directly reused: the latter option is technically feasible but it requires more intensive treatment and is considered higher risk.

For densely-populated urban areas like the south-east of England, indirect water reuse has a number of advantages. Treated wastewater is a relatively reliable and steady source of water; its use preserves rather than depletes natural sources, and it therefore has little impact on the environment compared to other options. The biggest challenges involved are ensuring that treatment processes are thorough and consistent enough to meet quality standards and minimise risk, and achieving this at a reasonable cost.

The first large-scale example of indirect water use by a UK water company was Essex & Suffolk Water's Langford Recycling Scheme in the early 2000s. The last two decades have seen several further schemes proposed and developed, especially in the south and east of England.

Amongst the current strategic options being considered is Thames Water's proposal for effluent reuse in London, which is considering sites at Beckton, Mogden and Teddington with a potential solution capacity of 250Ml/d. Southern Water, Wessex Water, South West Water and Severn Trent are also considering reuse among their source options.

Expertise

- **Carbon management**
- **Desalination**
- **Project management**
- **Regulatory engagement**
- **Social assessments and stakeholder engagement**
- **Water treatment**
- **Water quality**

Examples of our work:

Desalination

We have designed and delivered desalination plants across the world, in countries including Australia, Morocco, Oman, Saudi Arabia, Singapore and the USA.

Desalination

While treatment processes that use sea water or brackish estuary water are common in hotter and drier parts of the world, and there are more than 16,000 desalination plants worldwide, it has until now been little used in the UK. The island of Jersey has a small plant built in 1970, but the first large-scale desalination plant to be built on the mainland was opened by Thames Water in June 2010 at Beckton in East London. The process used there is reverse osmosis, forcing brackish water at high pressure through membranes.

While the boundless availability of sea water represents an advantage for desalination, its main drawback is that it consumes a large of amount of energy, which has corresponding implications for cost and carbon emissions. Another consideration is that purification through reverse osmosis removes almost everything from water, including minerals that make drinking water taste pleasant, and so the water may have to be re-mineralised to meet customer expectations.

Although there are currently no desalination projects among the SROs, water companies in south-east England continue to view desalination as an important option and it is likely to be under further consideration for WRMP24.

Managed aquifer recharge

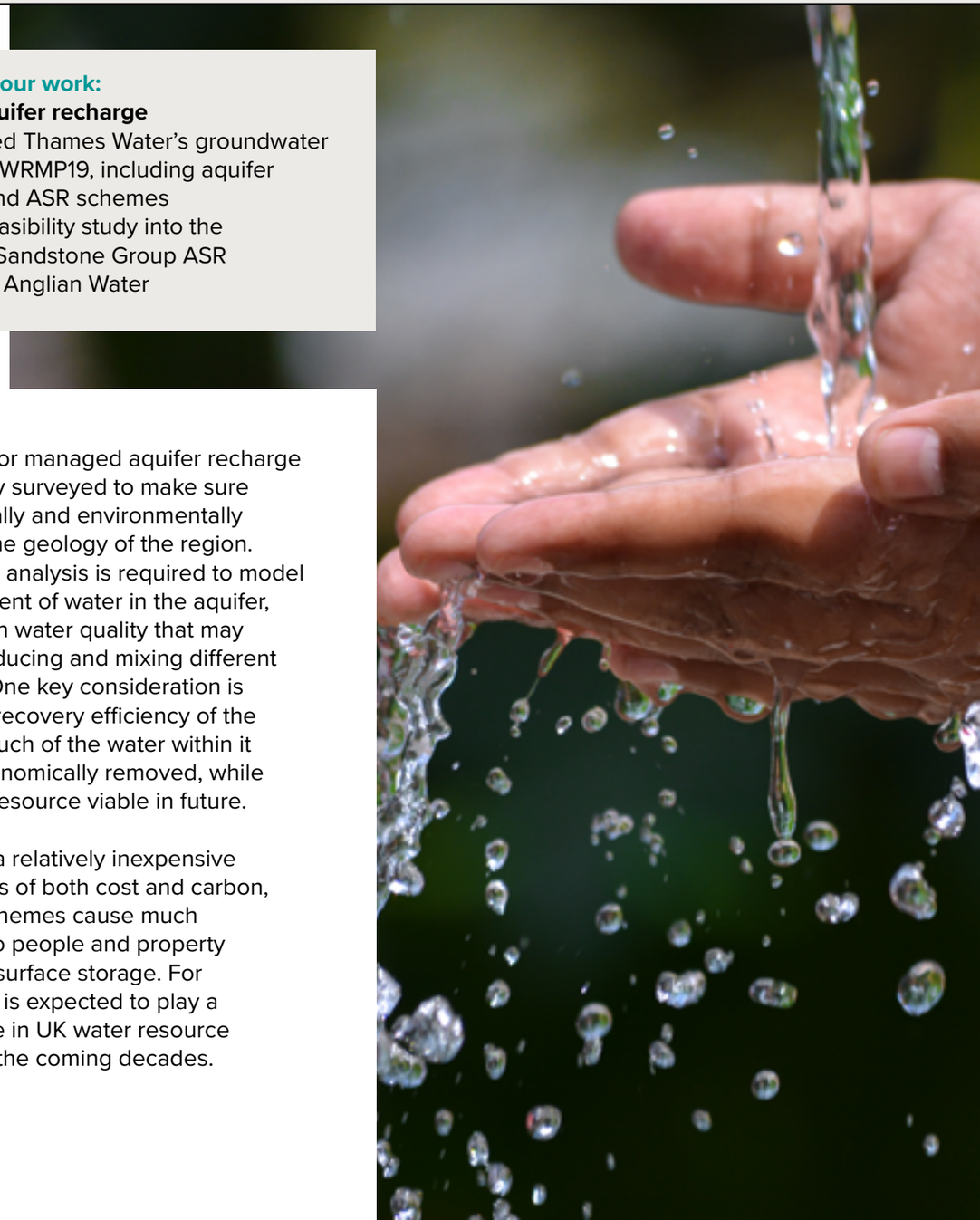
Expertise

- **Carbon management**
- **Environmental assessments**
- **Hydraulic engineering**
- **Hydrogeology**
- **Project management**
- **Regulatory engagement**
- **Social assessments and stakeholder engagement**

Examples of our work:

Managed aquifer recharge

- We reviewed Thames Water's groundwater options for WRMP19, including aquifer recharge and ASR schemes
- We led a feasibility study into the Sherwood Sandstone Group ASR scheme for Anglian Water



Groundwater sources are responsible for around a third of the public water supplies in England, and around three-quarters in the south-east. Aquifers offer a sustainable resource if the amount of water abstracted from them is kept within the limits that can be replenished by rainwater, but these limits are increasingly being tested by the spells of drought that are becoming more common in the UK with climate change. For this reason, the Environment Agency is now reluctant to approve new groundwater schemes or the expansion of existing ones. However, the regulator is supportive of innovative options such as managed aquifer recharge, which is the technique of injecting water into an aquifer, usually via a borehole or well, or sometimes using infiltration ponds.

One valuable form of recharge is aquifer storage and recovery (ASR). Water is injected, then later abstracted again for supply purposes. Water companies can use ASR as a reserve groundwater resource, with the aquifer fulfilling the same role that a reservoir would play on the surface.

UK water companies have used recharge for some time – notably Thames Water's 200Ml/d North London Artificial Recharge Scheme (NLARS) has been operating since the 1990s – but it is not yet widespread. ASR in particular is still in its infancy in the UK. Thames Water is working on a 5Ml/d ASR scheme at Horton Kirby in Kent, and also has plans for a 3Ml/d project at Addington in Greater London. Anglian Water, in partnership with Water Resources East, is currently exploring a 46Ml/d ASR scheme, which would take water from the River Trent and store it within the Sherwood Sandstone Group Aquifer in Lincolnshire. A scheme of this size would have major resilience benefits, as it would be able to keep consumers supplied for up to 18 months during a prolonged drought.

A potential site for managed aquifer recharge must be carefully surveyed to make sure that it is technically and environmentally feasible within the geology of the region. Hydrogeological analysis is required to model both the movement of water in the aquifer, and any effect on water quality that may come from introducing and mixing different source waters. One key consideration is to calculate the recovery efficiency of the aquifer – how much of the water within it is able to be economically removed, while still leaving the resource viable in future.

Groundwater is a relatively inexpensive resource in terms of both cost and carbon, and recharge schemes cause much less disruption to people and property than equivalent surface storage. For this reason, ASR is expected to play a much bigger role in UK water resource management in the coming decades.

5. Our expertise

What Mott MacDonald can do for you

Carbon management: we predict, measure and help minimise the embodied and operational carbon involved in water resources projects.

Dam engineering: we design and supervise new build and remedial works, provide flood mapping, and carry out dam breach analysis.

Desalination: we master plan, design and manage delivery of thermal and reverse osmosis desalination plants; our expertise includes open sea water intakes, screen intakes and pre-treatment.

Environmental assessments: we carry out all forms of environmental impact assessment, including habitats regulation assessments, biodiversity net gain, invasive species assessments, and environmental flow assessments to inform abstraction licence discussions.

Hydraulic engineering: we design pumping stations, boreholes, wells, drains, pipelines and other assets.

Hydrogeology: we model groundwater movements within aquifers and assess suitability for recharge schemes.

Hydrology: we use rainfall-runoff and hydraulic models to carry out catchment and flood modelling, simulating the behaviour of rivers, lakes and estuarine systems.

Pipeline design: we optimise transfer routes, carry out geotechnical analysis, and design pipelines and associated infrastructure.

Project management: we guide projects to success from inception to operation, including design, procurement, due diligence, supervision and contract administration.

Regulatory engagement: we work with companies and regulators to obtain licences and manage investment planning.

Social assessments and stakeholder engagement: we calculate the social outcomes of different project options, and engage and work with stakeholders including communities to achieve accessibility, inclusion, empowerment, resilience and wellbeing.

Transport and access: we evaluate and advise on road and rail access for project sites during construction and for visitors during operation.

Water quality: we model how project design and catchment changes will affect groundwater or surface water quality and design appropriate treatment processes.

Water treatment: we provide process engineering expertise for all sizes of treatment plants, including conventional and innovative technologies.

Opening opportunities with connected thinking.

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