ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE
Business Case for Sustainable Infrastructure

Sustainability and Resilience in the Plan of Thames Water Utility Ltd.

Water Resources Management Plan 2019

Prof. S.N. Pollalis, E. Marinou

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Prof. S.N. Pollalis prepared this case study with researchers at The Zofnass Program as the basis for research and class discussion rather than to illustrate either effective or ineffective handling of the design, the construction, or an administrative situation.

The authors would like to thank Steve Robertson, former CEO, TWUL; Tom Bolton, Head of Corporate Finance, TWUL; James Sawyer, Finance Manager, TWUL; Andrew Cottrell, Regulation Manager, TWUL; Tim Coles, Head of Commercial and Procurement, TWUL; Anthony Purcell, Commercial Manager, TWUL; Mark Cooper, Metering Manager, TWUL; Timothy Mcmahon, Head of Water Networks, TWUL; Chris Lambert, Supply Demand Senior Technical Advisor, TWUL; Giovanni Cialdino, Investment Professional, Wren House Infrastructure Limited.

In June 2019, Ofwat, the Water Services Regulation Authority, was ready to respond to the April 2019 revised submission of the 2020-2025 Water Management Plan of Thames Water Utility Ltd (TW). In September 2018, TW had submitted the first draft of the Water Management Plan and Ofwat had responded on January 31, 2019, with TW responding back in April 2019.

The response of Ofwat would determine how the company should proceed with its proposed sustainability and resilience plan.[1] Was it effective? Was it efficient? What would be the financial implications on the water bills to Thames Water's consumers, the residents of most of London and the Thames Valley? Was the proposed plan justified and how would it be perceived by the public opinion?

According to the working definitions of the Zofnass Program:

- "Sustainability improves the quality of human life while living within the carrying capacity of supporting eco-systems." *IUCN/UNEP/WWF. Caring for the Earth: A Strategy for Sustainable Living. (Gland, Switzerland: 1991).*
- Resilience is the ability to handle and bounce back on anticipated or unexpected stresses and shocks.

According to the US Corp of Engineers, "a sustainable project must be resilient; a resilient project is not necessarily sustainable."

INTRODUCTION

Thames Water (TW) is a privately-owned utility company, the largest water service provider in the United Kingdom, serving almost 25% of the population of England and Wales. It supplies 2.7 Mm^3/day of potable water and treats 4.4 Mm^3/day of sewage.[2] TW's area of operation is the Thames Valley that sits mostly within the Thames River Basin, almost 10% of the area of England and Wales. Due to its area of service, which includes most of London, TW plays a decisive role in the UK's water industry, coping with both population growth and climate change.

UK water companies are regulated by (a) the Water Services Regulation Authority (Ofwat),[3] (b) the Environment Agency (EA),[4] and (c) the Drinking Water Inspectorate (DWI).[5] In recent

1 One more cycle of submittal and response was allowed until September 2019 and then the decision of Ofwat could be appealed by TW.

2 These figures correspond to 600 Mgd (Megagallons per day) of fresh water and 1,000 Mgd of sewage.

3 The Water Services Regulation Authority is the economic regulator for the water sector in England and Wales. It sets limits on the charges that the water companies make for their services.

4 The Environment Agency seeks to maintain and improve the quality of "untreated" water in England and Wales. It is concerned with the quality of fresh surface and underground water along with marine and estuarial waters and strives to prevent/reduce the threat of water contamination.

5 The Drinking Water Inspectorate is a regulator that acts on behalf of the Secretary of State for DEFRA and the National Assembly of Wales. It assesses the wholesomeness of water supplies and undertakes technical audits of water suppliers to examine all aspects of water quality, treatment, and monitoring. The DWI requires each

years, resilient and sustainable planning, as well as a comprehensive program for the engagement of key stakeholders and the community, have been required by the regulators. According to the National Infrastructure Commission (NIC), the UK faces serious risks of future water shortages, especially in the drier south and east.[6] NIC states that the government should ensure increased drought resilience[7] by enhancing the capacity of the water supply system.[8] The new requirement for "Resilience in the Water Industry" asks for resilience for the 100-year drought condition. There is a statutory requirement for the UK's water utility companies to prepare a Water Resources Management Plan (WRMP)[9] and a drought plan every five years. The Environment Agency gives utility companies specific Water Resources Planning Guidelines to follow, signed off in collaboration with Ofwat and DWI. The guidelines request measures to meet climate change,[10] population growth, and "sustainability reductions,"[11] referring to reducing/ stopping abstraction of water[12] where the environment is deteriorating.

1. WATER RESOURCES MANAGEMENT PLAN 2019

TW's draft Water Resources Management Plan of 2019 (dWRMP19) addresses the growing water needs by adopting a regional perspective taking into consideration options to transfer

water supplier to submit quality data on a monthly basis for scrutiny. Where necessary, the DWI can require a company to implement schemes to improve water quality and will monitor their progress.

6 NIC calculated future water balances considering a range of droughts. The analysis assumed no further action beyond those listed in the previous Water Resources Management Plan for 2014 (WRMP14). The baseline demand was assumed to be the "business as usual" scenario to calculate the supply/demand balance for each water company. The analysis showed that six water companies, serving almost 40% of the English population, would experience water deficits during a drought that has a one in four chance of occurring at least once between now and 2050, as would ten companies (serving almost 60% of households) during a drought with a one in seven chance of occurring between now and 2050 (National Infrastructure Commission, "Preparing for a Drier Future," p. 18).

7 In the United Kingdom, a prolonged period of abnormally low rainfall is defined as 15 consecutive days with daily precipitation totals of less than 0.2mm (TW Trading and Procurement Code, V1, May 2016).

8 National Infrastructure Commission, "Preparing for a Drier Future: England's Water Infrastructure Needs," April 2018, p. 3.

9 A Water Resources Management Plan is a water company's long-term plan for managing its supply-demand balance. It has been placed on a statutory basis, which allows each water company to set out how it will meet water demand for the next 25 years and deal with factors such as changes in climate and population. Current draft Water Resources Management plan considers projections until year 2100.

10 UK Water Industry Research (UKWIR) was set up in 1993 by the UK water industry (UKWI) to provide a framework for the procurement of a common research program for the UK's water operators on "one voice" issues. The research program is currently divided into the following topic areas: climate change; customers; drinking water quality and health; environmental quality; program management; regulation; sewerage; sludge and waste management; toxicology; wastewater treatment; water mains and services; leakage; and water resources (https://ukwir.org/page/$HOzG1n0!/~undefined).

11 These are reductions in licensed abstraction that are required by the EA to provide environmental improvements. EA together with DEFRA have set a target for 90% of surface water bodies and 77% of groundwater bodies to be in good ecological status by 2021, as a result of water resources (DEFRA, "Regulation of the Water Industry, Eighth Report of Session 2017–19," p. 8).

12 Abstraction is the licensed removal of water from the natural environment. It is regulated by the EA, which provides licenses to anyone taking or transferring more than 20,000 lt/day. There are approximately 19,000 abstraction licenses in the UK of which 1,400 are for public water supply. The rest are for agriculture (1%), industries, and electricity production (70%) (DEFRA, "Regulation of the Water Industry, Eighth Report of Session 2017–19," p. 7).

water from across the region and beyond the UK's borders. TW has coordinated with other water companies[13] across England and Wales, towards planning for resilience for a best value for money. The document presents a "Preferred Plan" for new water supply schemes for the period 2020–2100.[14] TW also produced a Fine Screening Report (FSR)[15] to propose a set of water supply options.

As suggested by NIC, TW follows the "twin-track"[16,17] approach to ensure resilience and robustness. In its preferred plan the company proposes: (a) demand management measures; and (b) new water resources. According to TW: "in the long term, when demand management of water use can no longer keep pace with the increasing deficit, the plan turns to strategic resource development for the SE region."[18] For the management of water demand, TW has set a target to reduce water consumption from 142 liters/person/day to 121 in 2045 and 117 in 2099, through:

- Reduction of leakage by 15% by 2025 and 50% by 2050; leakages are both in the company's and the customers' networks
- Installation of smart meters and sharing of the data with customers, and
- Water efficiency measures, such as the Smart Home Visits Program.

Demand management is favored by customers. However, "demand management measures alone will not guarantee uninterrupted water supply."[19] According to NIC, "even with ambitious actions to reduce demand, additional supply infrastructure will be needed." In addition to the above, the company committed to a material reduction in network leakage.[20]

Together with the demand management measures, TW's plan proposes a combination of short-term schemes (up to 2030):

- Combination of groundwater development and small resource schemes.
- Water trading with external organizations:[21]

[13] Some of the neighboring companies have asked TW to provide water to them in the future, which their customers would pay for, so their needs have been taken under consideration as well.

[14] New government guidelines support more long-term planning by water companies.

[15] The FSR was put out for public consultation, which ended on October 31, 2016.

[16] The Commission concluded that a twin-track approach is required that combines demand management (including leakage reduction) with long-term investment in supply infrastructure.

[17] The "twin-track approach" to water strategy was found in 2005–06 to be the best way to strike an appropriate balance between water resource development and demand management in England and Wales. According to the Secretary of State's principal guidance to Ofwat, as part of PR04: "the Government's twin-track approach for water supply requires demand management options, such as fostering behavioral change, use of new technologies and controlling leakage, to be fully deployed before new supply side measures are adopted." According to the EA, the Twin-Track Approach takes a balanced view, seeking the efficient use of water while bringing forward timely proposals for resources development where and when appropriate" (Water Management, 8th Report of Session 2005–06, Volume I: Report. House of Lords, Science and Technology Committee, pp. 26–28).

[18] dWRMP19, Section 11, p. 1.

[19] DEFRA and HM Government, "Future Water: The Government's Water Strategy for England," Ministerial Foreword, p. 9.

[20] Around 2,900 Ml/day (20%) of water put into the public supply is lost through leakage (National Infrastructure Commission, "Preparing for a Drier Future," p. 11).

[21] To trade and share water, TW is working with United Utilities (UU), Severn Trent (ST), Welsh Water (WW), the regulator, the EA, and Natural Resources Wales (NRW) to look at the potential for an intraregional untreated water transfer.

And long-term new water supply options:

- the South East Strategic Reservoir Option (SESRO), a regional storage and transfer hub (to be built by 2037) that will gradually provide 294 Ml/d, including 100 Ml/d to Affinity Water.
- the Severn-Thames Transfer (STT) (to become operational in the 2080s)

- Reduce leakage – 15% reduction
- Continue to install smart meters – 700,000 meters
- Help customers use less water – over 400,000 smart home visits
- Develop new groundwater sources in London
- Buy surplus water from other organizations
- Plan a new water transfer via Oxford Canal for use from 2030
- Plan to develop Deephams reuse plant by 2030 and initiate work on SESRO

Short-term proposals summary (5-year plan), according to the dWRMP19

- Ongoing program of leakage reduction and promotion of water efficiency
- SESRO in Oxfordshire by 2037
- Extension of trading agreement with Essex and Suffolk Water
- Severn-Thames transfer in the 2080s

Long-term proposals summary (80-year plan), according to the dWRMP19

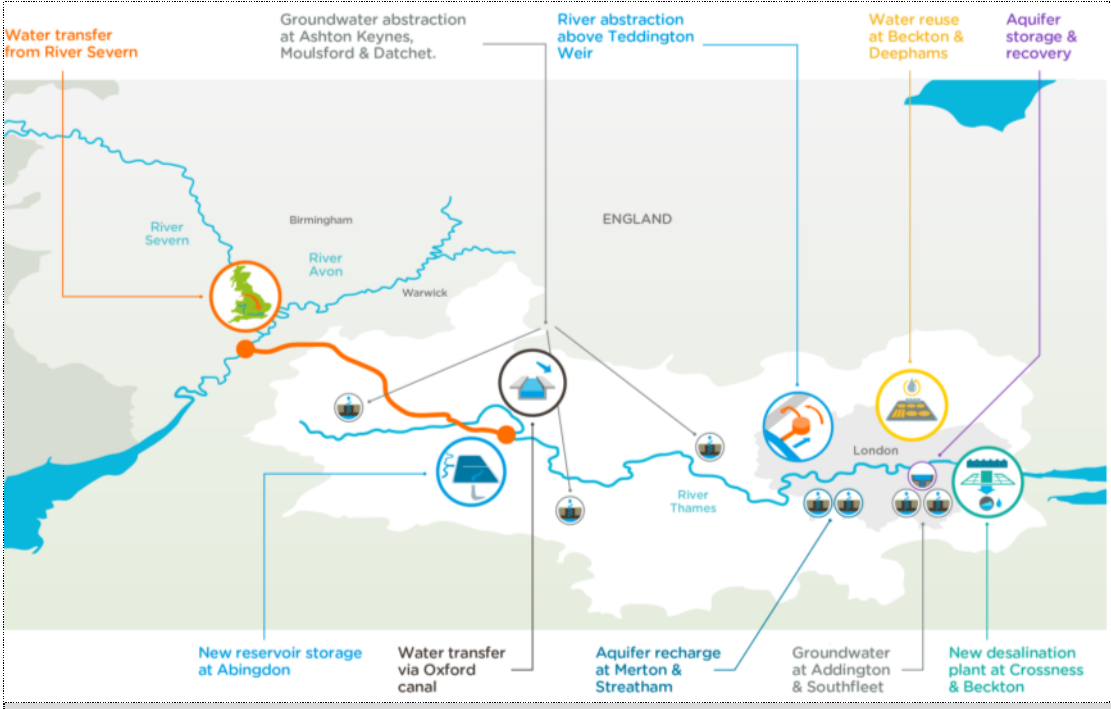

Fig.1: *Overview of all the additional water supply options*

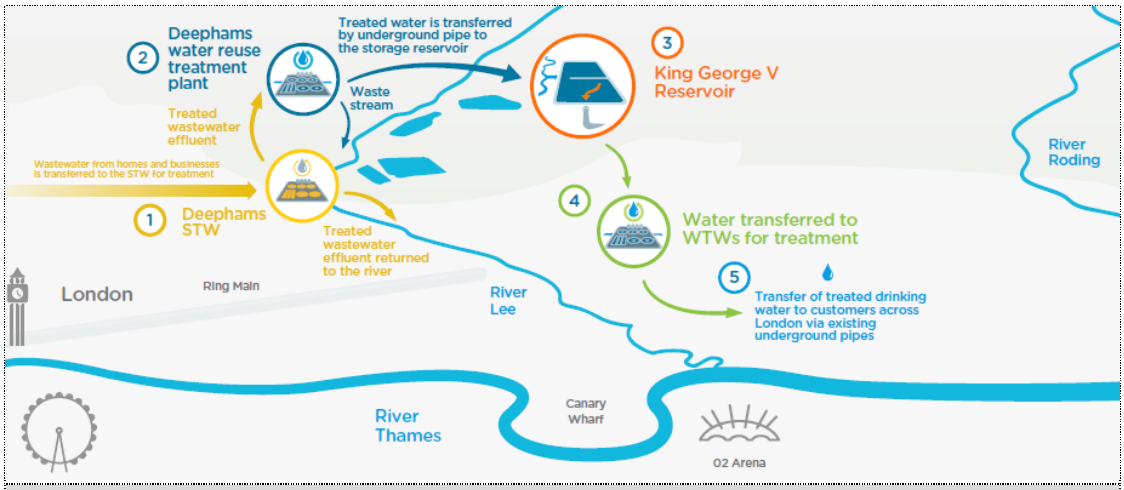

Fig.2: *Water reuse scheme – effluent reuse plant at Deephams*

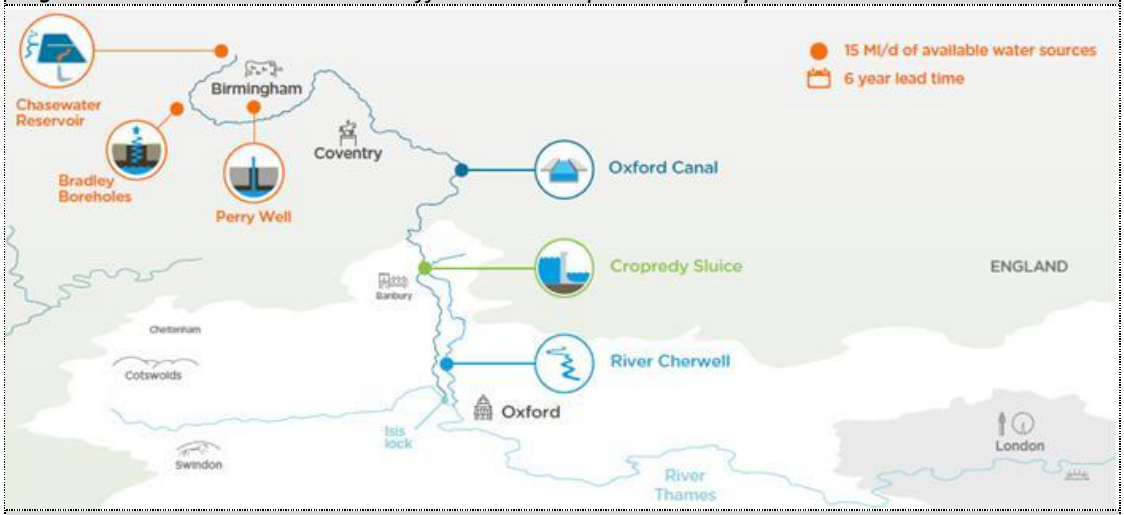

Fig.3: *Local water schemes and transfers*

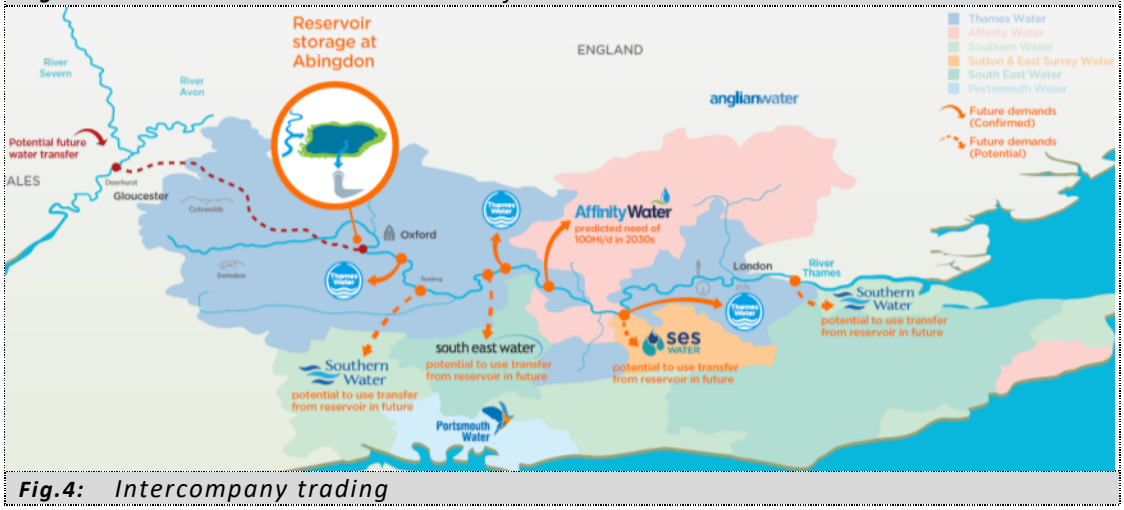

Fig.4: *Intercompany trading*

2. DEMAND MANAGEMENT MEASURES

There is a moral duty to reduce per capita consumption. Thus, water companies may institute water pricing, requiring those who waste water to pay more. For a given 5-year period, each water company's revenue is determined by Ofwat in real terms at the beginning of the period.

Company revenues are linked to required level of investment and efficient costs to operate the business and not to water consumption. In case of over/underspending, companies' revenues are corrected in the subsequent period to be regulated, in line with Ofwat methodologies.

2.1 Smart metering

A Governmental guidance with pressing targets for water demand reduction is on the way. Smart customer metering is at the heart of reducing demand, in multiple ways. TW invests in additional measures, such as improving customers' understanding of their contribution to leakage, then testing/fixing pipes/appliances in domestic/commercial properties. Antony Owen, Head of Water Resources, Supply & Demand Agent of Thames Water, mentions "… as seen in the last 10 years, metering reduces domestic water usage by 17%.[22] Today, TW continues to increase metering coverage, with approximately 40% of domestic properties metered, and with a growing number using smart meters."

TW's approach to smart metering

Smart metering was one of TW's projects as part of the Green Bond framework.[23] The company started a compulsory smart metering program[24] for all the properties it serves, and is installing a radio network[25] using advanced meter readers technology.[26] The company spends annually £70 million on smart metering including upfront engagement costs.[27] At the beginning of the 2020-2025 investment period, TW will have 34% of its customers on a metered supply. TW plans for data capturing with a frequency of 24 reads/day that will allow for almost real-time analysis of water use. Through the installation of 300,000 smart meters by 2020, and a total of 700,000 by 2025,[28] TW expects to reach 75–80% coverage[29] of properties.

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22 According to the NIC, conventional metering can reduce demand by around 15%, and smart meters are expected to increase this to about 17% and help identify leaks (National Infrastructure Commission, "Preparing for a Drier Future," p. 12).

23 The framework under which TW and its subsidiaries can issue Green Bonds. The Green Bond Framework ("the Framework") supports the financing of the company's water and wastewater recycling projects related to the environmentally sustainable management of natural resources and land use, as well as climate adaptation. (https://corporate.thameswater.co.uk/-/media/Site-Content/Corporate-Responsibility/CRS-2017-18/HWDB/Case-studies/Our-Green-Bond-Framework.pdf)

24 TW services a designated water-stressed area and has the right to compulsory metering. Totex approval by the regulator is a legal requirement. Customers ultimately will pay for smart metering, but TW's capital investment program allows it not to charge for the installation of the meter itself.

25 The network is split into district metered areas (DMAs), which is an added benefit.

26 As of 4 years ago, 35% of TW's customers were measured using either dump meters or advanced meter readers. The company was used to dealing with about 2.5 million meter reads per year: one or two reads per customer per year purely for billing purposes. Now, with about 340,000 smart meters that TW has installed in the last 3 years, they are receiving over 7 million meter reads per day.

27 Engagement costs are greater than the meter itself. (Mostly in London where the meters have to be installed inside each property (mostly flats), there is a lot engagement work to be done upfront to get customers to take time off from their work and let TW staff into the property.)

28 BP20-25, Section 8, p. 65.

29 Universal metering would reduce average water bills, but some customers would end up paying more than they do now. Large families might be worse off with a meter, but this is consistent with the fact that they

2.2 Leakage reduction

The EA indicated that water companies should invest in infrastructure to address leakage instead of increasing abstraction (supply) to respond to rising water demand. The Consumer Council for Water (CCWater) stated that "consumers are discouraged from becoming more water efficient because they believe that companies should be doing more to tackle levels of leakage."[30] NIC supports that "an ambitious long-term strategy to reduce leakage would help encourage action by customers and incentivise technological innovation, which in turn should drive down the costs of managing leaks."[31] Additionally, NIC points out that "analysis by water companies and Ofwat suggest that it would be cheaper to use more water than to reduce leakage further." Reducing leakage is expensive, and "fewer than 1/3 of the water companies have included a 15% leakage reduction by 2025 in their draft planning tables."[32] Leakage reduction costs are uncertain as long as the condition of the distribution network is unknown, and the points/times of leakage are not easily spotted.[33]

TW's approach to leakage, per September 2018 Business Plan, submitted as the 5-year plan (2020-2025), and dWRMP19

Reducing leakage is a priority for TW customers, making it a strong commitment for the company. TW takes a holistic approach to leakage management, with an eye to affordability and maintaining balance between additional costs of locating and repairing leaks and the impact on customers' bills. Having missed the leakage target in 2015–16 and 2016–17, the company has put out a detailed recovery plan committing additional funding for activities including leakage reduction and repair, advanced detection technologies, pressure management, and more investment in improving understanding and accounting for water use by installing more smart meters. The company has set the required target of a 15% reduction (97 Ml/d)[34] in its AMP7 within the next 5 years (2020–2025).[35] Then, according to the dWRMP19, the company is planning to reduce leakage by 50% by 2050 (around 270 Ml/d).[36,37]

consume more water. More than half of households likely to have a lower income saw a reduction in their bill (partly related to reductions in consumption). However, the average (mean) bill for households likely to have a lower income rose by around £10 per year. This implies that losses for those households that did pay more outweighed savings among the households that paid less, even though there were more of the latter group. Assistance for lower-income households that might be worse off with metering is therefore likely to be most effective if it is well targeted. (National Infrastructure Commission, "Preparing for a Drier Future," p. 23.)

30 DEFRA, "Regulation of the Water Industry, Eighth Report of Session 2017–19," September 2018, p. 11.

31 National Infrastructure Commission, "Preparing for a Drier Future," p. 11.

32 National Infrastructure Commission, "Preparing for a Drier Future," p. 26.

33 Water companies are required to consider systematic rollout of universal smart metering to identify and address leakage.

34 dWRMP19, Section 0, p.48

35 "Due to missing the target in 2016/17 with leakage increasing over the year and each future year's target being more challenging, this recovery plan does not see us meeting our WRMP14 leakage targets fully until 2019/20. However, this plan will ensure we are back on track for AMP7, and it forms a key part of the base plan for the draft WRMP19." (dWRMP19, Appendix M: Leakage, p. 5.)

36 dWRMP19, Section 0, p.48

37 The company is "committed to a package of measures in relation to managing and communicating our leakage reduction performance as part of our undertaking to Ofwat for the purpose of section 19 WIA 1991." https://www.ofwat.gov.uk/investigation-thames-waters-failure-meet-leakage-performance-commitments

Leakage reduction will be achieved through better detection of leaks both on the customers side and in the company network.[38] The TW network is, on average, 80 years old and 67% of its leaks are under the streets and buildings in London, making them challenging, costly, and disruptive to access and repair.[39] Replacement and refurbish of mains will reduce leakage and stop further deterioration. The company also invests heavily in innovative new leak detection technologies such as satellite detection,[40] drones,[41] and acoustic loggers.[42]

	Minimising leak occurrence (consistently)	Understanding where leakage is (quickly and accurately)	Locating leaks (quickly, accurately and efficiently)	Repairing leaks (quickly, efficiently, to quality, with minimal interruption to supply)
Maintaining leakage level	• Pumping regimes • Surge vessels • Variable speed pumps • Managing commercial customer demand • Pressure Management Valve (PRV) and Pressure Management Area (PMA) maintenance work • Network reconfiguratin to meet new customer demand • Mains replacement to offset deterioration	• Network meter verification • Maintain customer meters • Maintain District Metered Area (DMA) meters • Install loggers on new customers • Maintain DMAs and Flow Monitoring Zone (FMZ) bounaries and function sets • Network meter repair and replacement • Maintain commercial loggers	• Reactive and recovery leakage surveys • Run step tests • Correlation survey and sound • Gas detection • Sahara surveys and lekage investigations • Seepage investigations • Maintain waste areas and meters	• Capacity planning, job planning and dispatch • Wastage fixes • Valve maintenance • Traffic management and streetworks • Repairs on visible leaks, active leaks and customer side leaks and fast reinstatements • Special focus on fast repair of visible leaks • Trunk main repairs
Reducing leakage	• New PMA schemes • Network reconfiguration to reduce pressures • Mains replacement to enhance asset	• Improve network metering • Improve DMA operability as part of DMA Enhancement • Sub- divide DMAs as part of DMA Enhancement • Integrate use of smart meters	• Special surveys • Campaigns management and burst sectorisation • Join up acoustic logger data with DMA flows	• Reduce repair times

Fig.5: *TW's holistic approach to leakage management (dWRMP19, Appendix M)*

2.3 Water efficiency

TW plans to work with its customers to save approximately 40 Mlt/d of water by 2020, through new water efficiency measures. The company will support its 400,000 domestic customers and 34,000 business customers[43] with:

1. the Smart Home/Business Visits program;[44] and

[38] Approximately one quarter of leakage is estimated to be from leaks on customers' own supply pipes/appliances (dWRMP19, Appendix M: Leakage, p. 5).

[39] BP20-25, Appendix 4, p. 5.

[40] "Satellite leakage detection uses thermal and infrared imaging signatures from satellites to identify areas where the ground temperature is significantly different to the surrounding area to indicate the potential location of a leak" (dWRMP19, Appendix M: Leakage, p. 10).

[41] "Aircraft and drone technology is similar to satellite leak detection, in that it uses thermal and infrared imaging techniques to identify the possible location of a leak, but with the difference that it can be targeted to a specific main, in real time. This approach is primarily being tested on trunk mains." (dWRMP19, Appendix M: Leakage, p. 10.)

[42] These listen to the water going through the pipe and help narrow down the area where the leak may be.

[43] BP20-25, Section 8, p. 65

[44] In the Smart Home/Business Visits context, once the TW analytics department detects a continuous water flow or high usage, TW staff visits the property (household or business) to inform the customer and check the appliances. They provide assistance to each property primarily by assessing water use, the efficiency of the water machines and the usage patterns. (If they find a number of leaking taps, toilets, etc., then the company

2. incentives and rewards that the company will create for both households (e.g., rewards for customers who use less water) and developers (e.g., install non-potable water systems for toilet flushing). TW customers will save water, money, and energy for heating water.

Through the cooperation of TW with the Government, measures were adopted for new and existing buildings to promote non-potable water consumption, such as through reuse of shower water. The company works with developers and pressure groups towards incorporating the new water standards into the building standards.[45] For existing properties, measures are taken to continuously nudge customers, via letters and emails, to go to the TW website and check their usage or educate themselves on water use patterns and charges and what they can do to use water efficiently. TW is providing new faucets, shower timers, and efficient toilet systems that use less water.[46]

3. NEW WATER SUPPLY OPTIONS

NIC has assessed the additional capacity needed by the UK's water system[47] and proposes a combination of options: reservoirs, transfers, reuse, desalination. In February 2019, Ofwat's first assessment on TW's Business Plan for 2020–2025[48] allows £151 million in funding "to facilitate the development of strategic water resources options for the south and southeast of England to ensure that appropriate regional solutions can be taken forward in future investment plans." The regulator also stated that water companies should work together to undertake detailed feasibility studies and planning.

will send a plumber to fix them. Additionally, if the customer is having incredibly long showers which puts the electricity and power bills up.)

45 From 2008: "The joint Communities and Local Government department (CLG) and Defra policy statement on water efficiency in new buildings announced that the Government will amend the Building Regulations to include a requirement for a minimum standard of water efficiency in new homes. The requirement will be in the form of a calculated whole building performance standard set at 125 liters per day (l/p/d). This will ensure that all new homes have fittings with a good standard of water efficiency, while retaining flexibility in the way overall performance is achieved. New requirements on water efficiency will be introduced into Building Regulations at the same time as any changes to improve the safety of hot water systems and to update the supporting technical guidance." CLG has also issued the Code for Sustainable Homes, a national voluntary standard for the sustainable design and construction of new homes. (DEFRA and HM Government, "Future Water: The Government's Water Strategy for England," Ministerial Foreword, p. 25.)

46 According to DEFREA's 2008 report "Future Water" (p. 31): "All water companies offer water efficient devices either free of charge or at a subsidized rate. These include Cistern Displacement Devices (e.g. Hippos, Save-a-Flush), Water butts, Trigger hose attachments, Domestic/commercial water audits, Free supply pipe repair/replacement (in most cases). In addition, all water companies have water saving information on their websites, along with information in bills and literature."

47 "The government should ensure that plans are in place to deliver additional supply and demand reduction of at least 4,000 Mlt/day. […] According to the projections the costs to maintain current levels of resilience relying on emergency measures for droughts are between £25b–£40b, whereas for proactive long-term resilience improvements, it ranges between £18b–£21b. […] Whilst the costs of proactive long-term resilience improvements roughly scale with additional capacity, the costs of emergency measures rise more dramatically for the most extreme events." (National Infrastructure Commission, "Preparing for a Drier Future," pp. 7–9.)

48 Submitted in September 2018.

3.1 The reservoir supply option

The South East Strategic Reservoir Option (SESRO) with 150,000 Ml storage capacity, is one of the two alternative options for long-term resilience of the Thames Valley water supply. SESRO will capture storm water from the wetter west of the South East Region to meet the growing needs of Swindon and Oxford, using the River Thames as a natural natural conveyance route to transfer water. SESRO could make affordable water available year-round, supporting the reduction/abortion of abstraction from vulnerable chalk streams. This strategic project is promoted for joint ownership by TW and Affinity Water.[49] It would supply the WRSE untreated water needs of Affinity Water (100 Ml/d in 2037) and potentially of South East Water. Both companies have existing intakes on the River Thames. TW's Business Plan 2020–2025[50] includes £31 million for planning the SESRO, as part of a planned £203 million investment in increasing water resources and the capacity of distribution systems.[51]

The effect of climate change[52] in the region is also being studied in collaboration with the North West and the River Severn area. A study report is put together and has been agreed with UU and ST to ensure the required volume of water. EA pressures for "a hands-off load," an amount of water in the River Severn that is not allowed to be touched. Furthermore, EA guidelines ask water companies to look at their costs and benefits every 25 years. TW asked the regulators for a 25-year minimum period so that the reservoir's benefits can be considered through the reservoir's 80-year operating period.[53]

[49] Affinity Water is the company supplying water to Hertfordshire, Kent, and Essex.
[50] Submitted in September 2018.
[51] BP20-25, Appendix 4, p. 7.
[52] Going forward, the risk of drought is likely to greatly increase. The way the UK is split up, the impact of drought further north is less and the South East region is at most risk.
[53] In the case of a reservoir, which takes 15–17 years to build, less than 10 years remain for its benefits to be accrued.

Fig.6: *Concept design for the South East Strategic Reservoir Option (2009)*

3.2 Water transfer and trading supply options

Transfers move water from areas with surplus to those where it is needed. According to NIC, transfers enhance resilience because "they increase optionality around further supply options," but they could also spread invasive species and pathogens. As a result, transfer options need to be considered on a case-by-case basis. In terms of costs, NIC presents the option of water transfer as a "positive cost-benefit case for greater transfers and water trading." Ofwat has introduced financial incentives to encourage companies to trade.[54] Currently, transfers make up about 4% of the UK's total water supply.

A more dynamic and transparent market should be encouraged, allowing a wider range of options to be identified and lower costs for customers. NIC points out that "the decision needs to be made at a different level. [...] It is likely to need strengthened regional approaches and perhaps an independent national framework. Ofwat has already developed the 'direct procurement' mechanism for large infrastructure projects which could form the basis of more open and transparent competition ensuring all options for significant additional supply capacity can be considered."[55] The regulators ask for new supply opportunities beyond UK

[54] If a company wants to apply for the trading incentive, it needs to have and comply with a Trading and Procurement Code that has been approved by Ofwat.

[55] Ofwat is expected to launch a competitive process by the end of 2019, complementing the PR19, with the aim of providing at least 1,300 Ml/day through (i) a national water network and (ii) additional supply infrastructure by the 2030s. (National Infrastructure Commission, "Preparing for a Drier Future," pp. 10–11.)

borders to be considered, pushing water companies to bilateral water trade through interregional transfer options.

The Severn-Thames Transfer (STT) option

Regionally, transfer options are part of TW's long-term plan.[56] TW's long-term STT option[57] would add a further step, taking water to the River Severn from Lake Vyrnwy before transferring it on to the Thames. TW proposed to build a pipe to a point downstream of the River Severn. Before distributing the water in the Deerhurst region, TW would put in place treatment works to remove the silt, as that region is in the lower part of River Severn and River Avon.

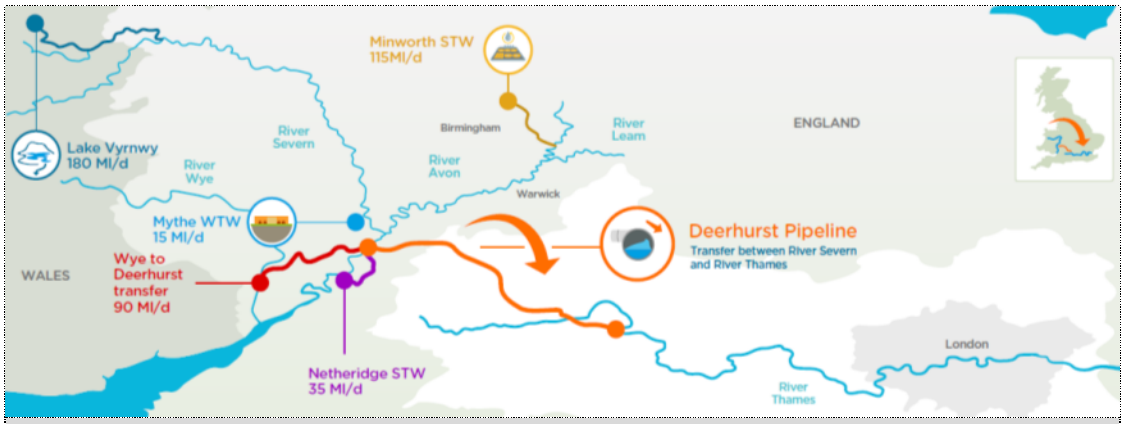


Fig.7: *Water transfer from the River Severn*

3.3 The DPC approach

The direct procurement for customer (DPC) option[58] is a framework set by Ofwat to competitively tender for a third party to design, build, finance, operate, and maintain large infrastructure assets exceeding a Totex of £100 million. The competitively appointed provider (CAP) becomes the owner of the new asset.[59] Potential DPC schemes include resilience schemes, reservoirs, reuse works, desalination and water treatment works, as well as water

[56] The STT was found not to be required for the water needs of the Thames Valley area before 2039.

[57] According to the plan, from 2083 onwards the scheme will include:
- 300 Ml/d pipeline transfer between Deerhurst on the River Severn and Culham on the River Thames, including treatment for invasive non-native species,
- 90 Ml/d of support from Vyrnwy reservoir provided by UU,
- 60 Ml/d of which would be released into tributaries of the Upper Severn and 30 Ml/d of which would be provided to Severn Trent Water to offset their abstractions further downstream,
- 15 Ml/d of support from ST at Mythe in Gloucestershire,
- 35 Ml/d of support from ST's Netheridge sewerage treatment works in Gloucestershire.

[58] A guidance introduced as part of the next asset management period (PR19) with the potential to provide significant benefits for customers by promoting innovation and enabling capital and operational cost savings as well as a reduction in financing costs (https://www.ofwat.gov.uk/publication/1810-direct-procurement-customers-dpc-setting-expectations-high-quality-well-evidenced-case/).

[59] Ofwat has given the guidance under a contract period of about 25 years (interview with Anthony Purcell, TW Commercial Manager).

transfer schemes. Ofwat has set out a range of potential tender models[60] based on the stage of the project's lifecycle when the CAP undertakes the process. To conclude the best DPC option for each proposed scheme, each water company (the appointee) must deliver to Ofwat an assessment of suitability[61] for delivery via DPC. The allocation of the technical risks/issues for the potential DPC projects within their project lifecycle are summarized in the following table. According to KPMG's report for Ofwat, "the core principle of allocating risk among the appointee, the CAP and the end customer should be to allocate risk to the party best placed to manage the risk."

Key Risks in Project Life Cycle	Stakeholder			Comments
	Appointee	CAP	Consumer	
1. Solution Development				
Data	✓		✓	— Allocation of early design and solution development risks likely to be similar under DPC to existing models. Especially for later tender models. — Early tender model may allow some greater sharing of risk with CAP.
Uncertainty	✓		✓	
Constraints	✓	✓	✓	
2. Planning				
Land purchase and site risk	✓		✓	
Environmental and social risk			✓	
Planning / Consent permission	✓		✓	
Third Party Consideration	✓	✓	✓	
3. Design				
Design process		✓	✓	— Allocation of design risks likely to be similar under DPC to existing models. Especially for later tender models. — Early tender model may allow some greater sharing of risk with CAP.
Design for construction	✓		✓	
Design for maintenance	✓		✓	
Resource availability and expertise	✓	✓		
Change in design required due to external influences	✓	✓	✓	
Materials and plant		✓		
4. Delivery				
Time and cost overrun risk		✓	✓	— Allocation of construction or delivery risks to the CAP from the appointed company is anticipated under the DPC model but assumed to generally be a direct transfer.
Resource availability of contractors		✓	✓	
Unforeseen ground or existing building conditions		✓	✓	
Third party claims		✓	✓	— Some opportunity for risk transfer from customers may be possible in the competitive tender process albeit that this is likely to be priced in the bid. — We assume that some re-openers to CAP revenue continue for material changes that are outside of management control (see section 4).
Subcontractor default / bankruptcy		✓		
Poor project management		✓		
Commissioning overruns		✓		
Availability of facilities	✓	✓	✓	
Legislative / regulatory change	✓		✓	
5. Operation				
Service performance risk	✓	✓	✓	— Allocation of operational risks to the CAP from the appointed company is anticipated under the DPC model but some service related risks may be difficult to transfer where they relate to statutory obligations. — Some opportunity for risk transfer from customers may be possible in the competitive tender process albeit that this is likely to be priced in the bid. — We assume that some re-openers to CAP revenue continue for material changes that are outside of management control (see section 4).
Resource or input risk		✓	✓	
Demand risk		✓	✓	
Maintenance risk		✓	✓	
External and third party impact		✓		
6. Transfer				
Asset condition and performance at handback	✓	✓		— Introduction of DPC model creates new asset transfer and hand-back risk which we assume is shared across appointed company and CAP. DPC contract would need to include requirements for asset transfer and hand-back.
7. Tender model specific risks				
Procurement failure	✓		✓	— Assume procurement risk is faced by both companies and customers where this results in delays or cost increases.

[60] In the "early" model, the CAP undertakes the project at the option appraisal/initial design stage. In the "late" model, the CAP undertakes it at the planning stage, in the "very late" option the CAP provides only the financing and operation of the new asset, and finally in the "split" option the project is tendered in two stages, an initial design/planning stage and a later construction, financing, and operation stage.

[61] This assessment includes a value for money assessment (VfM), economic appraisals, assessment of each DPC model and its associated risks, a commercially feasibility study of the proposed approach to DPC, and financial forecasts of the Capex, Opex, and revenue of each DPC option.

Fig.8: *Potential risk allocation under the DPC model ("Direct Procurement for Customers: Technical Review," by KPMG LLP for Ofwat, December 2017)*

SESRO as a DPC project

TW has developed a series of tests to identify projects that could benefit from the DPC procurement method.[62] Among those most suitable are the SESRO and the STT. SESRO is considered a priority and has been put forward in the company's Business Plan for 2020–2025 [63]. If DPC is approved by the regulator for SESRO, TW will pay for the costs of the preparatory works (site acquisition and planning). Afterwards, TW will be the client of the third party, guaranteeing through the company's RCV allocation that it will buy an amount of water according to a specific timetable and price. TW is working on how the detailed payment method mechanism for such projects would operate.

According to KPMG's report, a reservoir to be selected as a DPC project should be subject to the following criteria:

Stakeholders & Obligations	Interaction points	Capacity & outputs	Failure
A reservoir will require extensive engagement with a range of stakeholders during the initial stages of the project life cycle, each with their unique agenda and concern. E.g. DWI, EA, Consumer Groups, Environmental Pressure and Lobby Groups etc. Types of challenges include desire for companies to demonstrate alternate means of meeting supply demand balances via leakage reduction. Some of the concerns of these stakeholder groups will best be managed by the license holder, for example land rights. Reservoirs have statutory requirements that must be strictly managed throughout its operational life. Failure to comply with any statutory requirements will be the responsibility of the license holder.	In their simplest form reservoirs typically only have one point from which water is drawn but they can be used as storage and water is often pumped into them during dry periods from elsewhere on the network. Have limited interaction points but there are relationships between these and other network assets i.e. reservoirs impact other assets and downstream also impact them.	The volume of water in the reservoir can be easily assessed/ communicated. Usage of these assets are subject to variation depending on a range of factors such as demand and weather. However modelling for various scenarios is mature with long range forecasts complemented with frequently revised forecasting for the short term. The use of such modelling can be utilized for effective management of usage.	Quality failures are generally well understood, but can be complex to manage and in some cases may require mitigation that extend beyond the reservoir itself, adding complexity. A quality incident at the reservoir will have implications for other downstream assets which need to be managed. Catastrophic failure (e.g. the reservoir embankment bursting) is more complex, however, risk models do exist.

The CAP bears risks. As designed, the CAP will only start receiving payment for the delivery of the asset upon completion of certain milestones, and a delay in construction will impact the CAP's cash flow. TW is working closely with the market to understand how palatable that risk is, in terms of Capex. In terms of the quality output, TW looks at contracting service levels and expectations as part of the contract with CAP.[64]

[62] These tests include: (1) a minimum Totex threshold of £80 million is set over the contract term, (2) the project is sufficiently discrete for the market to offer a procurement solution, (3) there is a strong "customer value" argument for a DPC approach, and (4) the market is able to effectively finance a DPC project (BP20-25, Section 11, p. 88).

[63] Submitted in September 2018.

[64] TW will have the contract and the communication with the CAP. Therefore, Ofwat will continue to regulate TW as an organization and then the utility will manage the CAP as a contracted provider to them.

Project finances

In terms of economic modeling (Capex and Opex efficiency, financing efficiency), TW works with Deloitte to support industry benchmarks for the reservoir option. Deloitte recommended a percentage range for Capex and Opex, which TW adopted as part of the company's schemes, in line with what Ofwat proposed as standard assumptions for capital net present value (NPV) of DPC.[65] The standards are: duration of contract, cost of equity, cost assumptions, the 10% Capex efficiency and 10% Opex efficiency (mostly energy efficiency). Then there are additional bid costs, procurement costs, etc.

4. A DECISION TO BE MADE

TW's WRMP19 addressed a range of water resilience options for an optimal solution to its customers and the environment over the long term. Options include hard infrastructure (reservoir, transfers, network upgrades), soft infrastructure (metering, leaks repairing, efficient appliances), user-oriented measures (change of behavior, trust, engagement), and improved contingency planning.

A simplified economic model was prepared based on public data by the case writers to estimate the cost of the proposed work for sustainability and resilience to the customers.[66] Exhibit A shows the assumptions of the case writers and the change in monthly bill per household for each option, assuming an equal change for all households. The projections are presented in real 2017/2018 GBP terms (British Pounds, 1 GBP equals US$1.3 on Nov/1/2019). WACC and runoff rates are reset every 5 years. The runoff determines what percentage of the asset will be re-paid by customers every year. For example, a run-off rate of 1% assumes that 1% of the unpaid portion of the investment is repaid every year and therefore after 100 years 36.6% of the original investment will still need to be repaid [36.6%=(1-1%)^100]. The higher the run-off the quicker the investment is re-paid by customers to TW. The preference is to set the runoff of the reservoir, as Ofwat mentions, for "intergenerational fairness," i.e., several generations should pay.

The response of Ofwat would determine on how to proceed.

[65] According to the Initial Assessment of Business Plans (IAP), Ofwat looked all the DPC responses and then tried to align things like operational Efficiency, capital efficiency and the Present Value (PV) calculation.

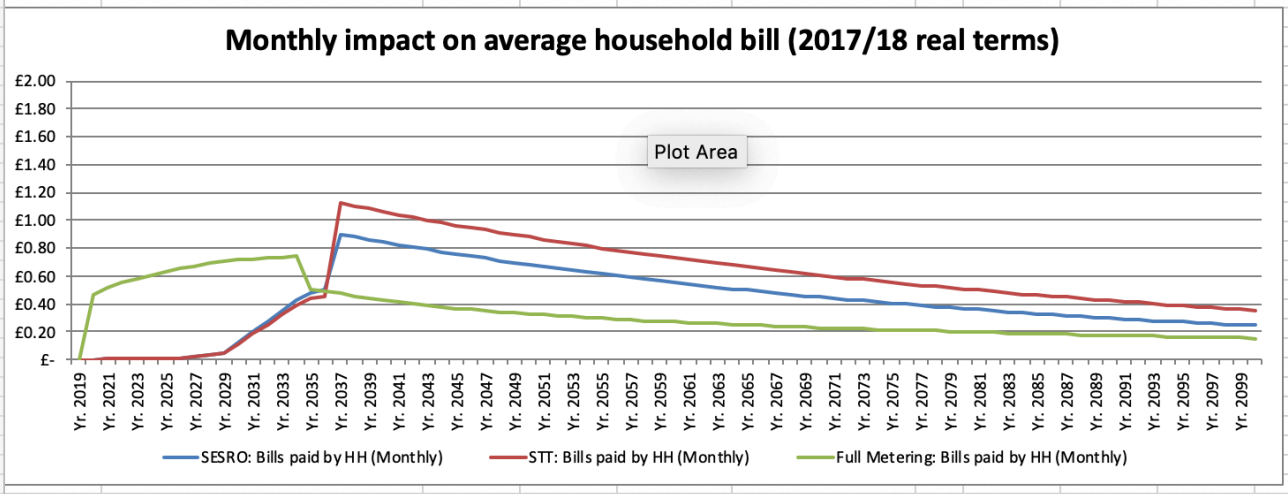
[66] The sole purpose of the simplified economic model is for teaching this case study and should not be quoted and does not reflect the actual conditions.

ACRONYMS – GLOSSARY

AMP	*Asset management plan (for a 5-year cycle)*
CAP	*Competitively appointed provider*
Capex	*Capital expenditure (cost)*
CCWater	*Consumer Council for Water (a statutory consumer body for water and wastewater consumers in England and Wales)*
DEFRA	*Department of Environment, Food and Rural Affairs (UK Government department responsible for the water sector)*
DMA	*District metered area*
DPC	*Direct procurement for customers*
DWI	*Drinking Water Inspectorate*
EA	*Environment Agency (regulator for the natural environment in England)*
EIA	*Environmental impact assessment*
Ml/d	*Megaliters per day*
NPV	*Net present value*
NIC	*National Infrastructure Commission*
Opex	*Operating expenditure (cost)*
PCC	*Per capita consumption (= total consumption / total population)*
PR19	*Price Review 2019 (price controls for the period 2020–2025)*
RCV	*Regulatory capital value*
SE	*South East region of England*
SEA	*Strategic environmental assessment*
SESRO	*South East Strategic Reservoir Option*
ST	*Severn Trent Water Company*
STT	*Severn-Thames Transfer*
Totex	*Total expenditure (Capex + Opex)*
TW	*Thames Water Utilities Limited (statutory water and wastewater company responsible for the public water supply and wastewater networks in Greater London and the Thames Valley)*
UU	*United Utilities Water Company*
WRMP	*Water resources management plan (a water company's long-term plan for managing its supply-demand balance; it has been placed on a statutory basis, which allows each water company to set out how it will meet water demand up to 2035 and deal with factors such as changes in climate and population)*

Exhibit A

	A	B	C	D	E	F	G
1			Input		Comments		
2	General						
3		WACC - AMP7	2.2%				
4		WACC - AMP8+	2.2%				
5		% of TW revenues paydby household	76.1%		See Note		
6		# of HH	3,600k		See Note		
7		growth in HH	1.3%		See Note		
8							
9	SESRO and STT						
10		Assumed run-Off	1.0%		Assumed.	% to be paid after 100 years:	37%
11		Run-off start	Yr. 18				
12							
13	Metering						
14		Assumed run-off for metering	8.0%				
15		Average cost of installing a meter	£753		See Note - From PAI		
16		% of HH customers metered as of 2020	c. 50.0%		As per Case Study		
17		target metered population	c. 80.0%		As per Case Study		
18		Cost of Replacement (compared to all-in installation cos	40.0%		Assumed.		
19		Avg Duration of meter	15 years		Assumed.		
20							



Assumptions | SESRO Profile | STT Profile | Metering | Bill Comparison | +