Appendix 4
Resilience

Section 1

Introduction

1.1 Our services are vital to all that we do at home, work and play. However, our operating environment is changing, with challenges such as climate change, population growth, rising customer expectations and workforce competition putting increased pressure on our existing systems. ***Our customers have clearly told us that they want us to be more resilient*** by, "*protecting the future water supply and waste service"*.[1]

1.2 Engagement with our key stakeholders and organisations has also provided feedback that it is vital we provide a resilient service both now and in the future for the economy, local communities and the environment.

1.3 Our plan addresses the requirements for increased resilience at a holistic level, considering ***our assets, people, operational and financial resilience***, to ensure we address the challenges we face in a long-term, sustainable manner to build an organisation that not only survives but thrives in conditions of uncertainty.

1.4 Ultimately, providing a resilient service is at the heart of our vision "here for you in a changing world". Our vision demands that we are trusted and have the expertise to provide a safe, dependable service taking into account the hazards, shocks and stresses our business may experience.

1.5 This appendix explains:

- What resilience means to our customers;
- Our approach to resilience;
- Our plan for AMP7;
- How we developed our approach and options to mitigate risks; and
- How we have assured our approach to resilience.
- Directs the reader to other documents within our Business Plan submission for further information on specific issues.

[1] Thames Water, CSD002-PR19-What Customers Want, Message 23

Section 2

Engaging with our customers

2.1 Our customer research, as set out in A2 'Engaging and delivering for our customers'[2] and CSD002 'What customers want,'[3] has revealed that ***our customers expect a safe and dependable water and waste water service***.

2.2 We talked to over 984,000 customers about the services we provide to develop a rounded understanding of our customers' key priorities.[3]

2.3 Due to the significance of our strategic priority to *invest in resilient systems and assets*, we also undertook a focused research regarding operational resilience.[4] This consisted of:

- Five deliberative workshops with household customers;
- Three deliberative workshops with non-household customers; and
- Consulting with an active on-line community of 550 participants, who we regularly use for research purposes.[5]

2.4 Key conclusions from this research revealed:[6]

- The term "resilience" itself does not easily resonate with customers and after testing different phrases, "***protecting the future water supply and waste service***" was preferred by the majority of customers;
- Our customers want us to plan for the future and protect the services from disruption in the short, medium and long-term;
- It is understood that hazards such as extreme weather, terrorism and cyber-crime may be increasingly likely and ***our services should not deteriorate as a result of these hazards***;
- Customer trust Thames Water to be an expert in its field; and
- There was ***a preference towards permanent solutions*** rather than short term mitigation, although it was recognised that short term mitigation may have its place.

2.5 Alongside providing a resilient service, our ***customers expect us to behave in a way that demonstrates corporate and financial responsibility***. We undertook a focused consultation regarding corporate and financial resilience. This consisted of:

- Two deliberative workshops with household customers; and
- One deliberative workshop with non-household customers.

[2] Thames Water, Appendix 2-PR19-Engaging and delivering for our customers
[3] Thames Water, CSD002-PR19-What customers want – consolidated report
[4] Thames Water, TSD019-CR52-PR19-Resilience Deep Dive
[5] Thames Water, Appendix 2-PR19-Engaging and delivering for our customers – Section 3
[6] Thames Water, CSD002-PR19-What customers want – consolidated report – Message 23

2.6 Key conclusions from this research revealed:[7]

- Customers understand corporate and financial resilience as ***behaviour that demonstrates corporate and financial responsibility***, such as having performance linked pay and making information accessible to customers on our financial structures;
- Our customers believe ***Thames Water is managed in a way that reflects their interest***;
- They encouraged us to ***continue to increase our transparency*** through the closure of our Cayman Islands subsidiaries; and
- They want us to reduce future exposure to financial shocks and are particularly interested in us ***reducing the level of gearing[8] in a way that minimises the impact on their bills***.

[7] Thames Water, TSD019-CR66-PR19-Corporate and Financial Responsibility Deep Dive
[8] Based on closing gearing at 31 March 2018 as disclosed in CSD021-Thames Water Annual Report and Annual Performance Report 2017/18

Section 3

Our definition of resilience

3.1 Our approach to resilience fully considers our customer research whilst taking into account changes in public policy, public expectations and the physical environment;

- **Public policy** – as evidenced by DEFRA's National Strategy [9] and the National Infrastructure Commission's National Assessment 2018[10] which both call for a rethink on resilience; and regulatory and ministerial statements regarding the importance of resilience to both customers and the UK economy.
- **Public expectation –** as evidenced in our research, customers expect a service that is personalised, effortless, proactive, with higher expectations regarding service levels and how we engage with our customers and stakeholders. A key priority is to develop plans to maintain our water and wastewater services in order to cope with and recover from increasingly likely and more severe hazards, now and in the future.
- **Physical environment** – our experience of environmental factors that put our existing services under stress.

Table 1: Resilience Challenges – our physical environment

	Challenges
Climate change	Forecasts show that by 2050 summers may be 3ºC hotter and 18% drier on average. Also winter rainfall may increase by 15% on average. Wetter winters and hotter, drier summers with more frequent and intense extreme weather, challenge the ability of our existing systems to cope. This leads to higher incidents of algal blooms and drought.
Population growth	Population of our region is predicted to grow by a further two million by 2045. Greater population density also means more people disrupted by any works.
Ageing infrastructure and urban scale	Our pipes are on average, 80 years old, with 34% of our pipes over 100 years old. 67% of our leaks are under London, making them more challenging, disruptive and costly to access.
Skills and labour affordability	There is a significant skills shortage in science, technology and engineering alongside increasing competition for skills in the SE region and increasing uncertainty about labour markets following Brexit. We also have an ageing workforce with a significant number of our technicians due to retire by the end of AMP7.

[9] DEFRA, TSD289-PR19-The government's strategic priorities and objectives for Ofwat, September 2017
[10] National Infrastructure Commission, and TSD290-National Infrastructure Commission, July 2018

Economy	We are affected by macro-economic conditions and interruptions to our services can have a profound economic impact. Higher prices due to inflation, interest rates, and import duties make day-to-day operations increasingly expensive. The imposition of severe drought measures in response to an extreme drought could cost the London economy up to £330m per day.[11]
Environmental	Our systems are dependent on the environment so are particularly sensitive to the increasingly vulnerable nature of the environment due to climate change, invasive species and more intensive use.

3.2 We therefore consider resilience ***to encompass all forms of disruption to the continuity and quality of service and the quality of the environment.*** This definition is consistent with the Cabinet Office's guidance[12] and Ofwat definition of resilience in the round:[13] '*the ability to cope with, and recover from, disruption, and anticipate trends and variability in order to maintain services for people and protect the natural environment, now and in the future'*.

3.3 Ultimately, resilience means that we are able to:

- Anticipate risks to the delivery of our services to customers and the environment;
- Plan for, minimise and prevent risks from occurring;
- Cope with risks if they do occur without significant disruption to our customers or damage to the environment; and
- Recover quickly, preferably to a more resilient state.

3.4 Our plan is founded on the basis that long term resilience is achieved through ensuring we invest in resilient ***assets*** which are operated and maintained by highly skilled ***people***, using robust ***operational*** systems with the ability to respond and recover, within an organisation that has the ***financial*** resilience to deal with shocks and stresses.

[11] Thames Water, TSD143-PR19-A resilient water supply – adaptation pathways: Case Study, March 2017
[12] Cabinet Office, TSD107-PR19-Keeping the Country Running: Natural Hazards and Infrastructure, Nov 2011
[13] Ofwat, Resilience in the Round, Sept 2017

Section 4

Our resilience plan for PR19

A Introduction

4.1 Our plan considers resilience at a holistic level, considering ***our assets, people, operational and financial resilience***, to ensure we address the challenges we face in a long-term, sustainable manner; and to ensure that we are not only an organisation that survives but thrives in conditions of uncertainty.

4.2 All four aspects are interdependent and it is vital that resilience be considered in the round to ultimately maintain the services our customers expect. For example, if we have a highly skilled workforce, available when they are needed, to proactively maintain assets which are resilient to extreme events, this results in operational resilience which will lead to stronger asset resilience; which will, in turn, have a lower whole life cost resulting in improved financial resilience. The success of these four aspects is dependent on having the right governance and assurance in place to support effective decision making, for more details see Appendix 9 – Delivering trust, confidence and assurance.[14]

4.3 This section summarises what our plan will deliver, the key aspects of resilience across our assets, our people, our operations and finances. We also describe the Performance Commitments we have developed to address key risks to our resilience.

B What our plan will deliver

4.4 When considering our plan through the "lens" of resilience we have identified investment of £2.1 billion towards increasing our level of resilience from AMP6 which comprises: [15]

- £416m on reducing leakage by 15 percent;
- £37m on improving the power resilience to critical sites;
- £180m on enhancing the resilience of our water supply systems in NE London;
- £203m on increasing water resources and the capacity of our distribution systems (inclusive of £31m on developing a new strategic reservoir for the South East);
- £294m on upgrading our treatment works (STW £134m, WTW £160m);
- £389m on building additional capacity at our sewage treatment works;
- £75m on rehabilitating our mains and sewers;
- £209m on reducing the risk of customers flooding in a 1 in 50 year storm;
- £66m on preparing the London Tideway Tunnels to receive storm flows;
- £118m on improving the reliability of our IT systems; and

[14] Thames Water, Appendix 9-PR19-Delivering trust, confidence and assurance
[15] Thames Water. TSD287-PR19-Wholesale Master Sheet

- £127m on improving the security of our sites.

4.5 We have followed Ofwat's guidance[16] and have assessed which of our Performance Commitments ('PCs') enhance our resilience as a basis for the extra spend of £2.1 billion in our plan.

4.6 In order to further disaggregate our resilience spend, we reviewed the specific costs for each PC, categorised as 'base', 'growth', 'quality' and 'enhancement', to identify what element of resilience spend was embedded in each:

- Base resilience (BaseX) – we assessed each component of the overall capital maintenance programme to determine which parts of it improved the level of resilience asset by asset, versus simply maintaining resilience at similar levels.
- Growth – we identified all elements of spend, which increased the capacity of our systems to cope with population growth and increased headroom. It is difficult to definitively differentiate enhancing headroom, and therefore resilience, from the effects of simple volume increases in population growth. We have therefore allocated the full quantum of spend in our resilience investment.
- Quality – we identified spend that delivered specific improvements which reflect rising expectations, both customer and regulatory, where reliance on our existing infrastructure would result in restrictions to supply and a reduction in resilience.
- Enhancement – we identified spend that directly led to improved resilience across systems and assets. An example is the North East London Resilience scheme (see Case Study 1).

4.7 This investment will be used to:

- Protect an additional 20,000 customers from a 1 in 200 year drought by 2025 and all customers by 2030-31;[17]
- Commence the first phase of a multi-AMP approach to provide a resilient water network in North East London which is currently reliant on our treatment works at Coppermills;[18]
- Plan for a new regional strategic reservoir in Oxfordshire;[19]
- Provide additional power resilience at 42 key, power-dependent sites (11 wastewater sites and 31 water sites);[20]
- Invest in our wastewater assets to reduce the risk of pollution events by 30% (when compared to the EA's WISER baseline of 2016);[21]
- Remove 65ha of surface water run-off from our sewer system to create headroom and improve our resilience to climate change;[22]
- Protect 39 of our key wastewater pumping stations at risk from river flooding;[23]

[16] Ofwat, Delivering Water 2020: Our final methodology for the 2019 price review. Dec 2017, page 46-47
[17] Thames Water, CSD005-DW01-PR19-Risk of severe restrictions in a drought, Section 4
[18] Thames Water, CSD006-WNP-04-FE-PR19-CA Resilience &
Thames Water, CSD005-BW12-PR19-Improving system resilience of North East London water supply
[19] Thames Water, PCD4-PR19-Water Resources, Section 3, South East Strategic Reservoir Option
[20] Thames Water, CSD005-DWS01-PR19-Power Resilience, Section 4
[21] Thames Water, CSD005-ES01-PR19-Wastewater Pollution Incidents, Section 4
[22] Thames Water, CSD005-DS02-PR19-Surface Water Management, Section 4

- Improve the reliability of our IT estate to enable a consistent, high level of service;[24] and
- Invest in improving the security of our water supply facilities.[25]

4.8 Detailed information of our proposed asset investments are referenced in Section 3 of our Price Control Documents.[26]

C Asset resilience

4.9 This aspect focuses on our assets and systems to ensure that all asset management decisions are taken on a long-term, strategic ***whole-life cost basis*** to balance maintenance and renewal, whilst ensuring they are designed to cope with more extreme environmental challenges.

4.10 Our operations consist of 93 water systems and 25 waste systems, which are combination of treatment works and distributed geographical networks that provide a service to a collection of customers.

4.11 Therefore, a critical part of our management philosophy is to operate our services using 'systems thinking'. This means making asset investment decisions at a 'system level', ensuring we have the right trade-offs both within and across different systems and the assets within those systems. This is central to our understanding of resilience so that we can define non-traditional, innovative, efficient, long-term solutions to ensure we are making the right investment decisions to deliver the outcomes our customers and stakeholders demand.

4.12 Our approach to resilience is based on four principles:

- Early anticipation and proactive response: anticipate and take proactive actions when considering the entire system that delivers services to our customers;
- Flexibility and adaptability: planning decisions and assumptions need to recognise greater levels of volatility than historically adopted, as expectations are that services remain irrespective of the situation;
- Long-term perspective: the long cycle time associated with the deployment of critical elements of our infrastructure demands a long-term approach; and
- Collaborative working: collaborate with other water companies to ensure our solutions are optimized at a regional and national level.

[23] Thames Water, PCD2-PR19-Wastewater Network Plus, Section 3, Resilience: Sewage Pumping Station Flooding
[24] Thames Water, BPD1-PR19-Business Plan Document, Section 5, Use technology to turn customer insight into action
[25] Thames Water, CSD005-DWS02-PR19-SEMD Securing Our Sites, Section 2
[26] Thames Water, PCD1-PR19-Retail, Section 3
Thames Water, PCD2-PR19-Wastewater Network Plus, Section 3
Thames Water, PCD3-PR19-Bioresources, Section 3
Thames Water, PCD4-PR19-Water Resources, Section 3
Thames Water, PCD5-PR19-Water Network Plus, Section 3
Thames Water, PCD6-PR19-Thames Tideway Tunnel, Section 3

4.13 These principles apply at a systems level, for individual assets, and in how we operate our infrastructure day-to-day. To make decisions on this basis we need to have the right data and information to turn into insight and action – this data needs to connect assets to systems to operations to customers. Traditionally the industry has considered asset classes as individual elements – our plan fundamentally changes this traditional asset planning assumption.

> ***Case Study 1: Applying our Resilience Principles in Practice – North-East London Resilience***
>
> Applying this system-based approach to assessing the resilience of our water systems has identified the significant vulnerability of NE London. We have developed an integrated, multi-AMP network blueprint which will address both the constraints we experience in our current network and put in place improvements to allow our system to meet future demand. The first phase, costing £180m, is further explained in our 'Improving system resilience in our North East London water system' cost adjustment claim.[27]

D Operational resilience

4.14 This theme focuses on our operational management and practices to ensure that we operate our systems continuously in the way they were designed that we respond to incidents in the time and way that our customers expect. Key aspects of our plans are outlined below with further detail identified in Delivering Our 2020-2025 Plan in Section 7 of our Business Plan[28] and Section 3 of our Price Control Documents.[29] We will:

- ***Embed a systems operator capability*** to ensure the effective prioritisation of system interventions and operate our system in a holistic manner that improves customer outcomes.
- ***Overhaul our information systems*** to ensure we have a stable, secure, resilient IT infrastructure which enhances our cyber security and data protection capabilities. The successful operation of our business is highly reliant on IT, and it is therefore vital that we have a modern, reliable, failsafe capability.
- ***Implement a digitally integrated contact functionality*** which will provide a modern, innovative platform that allows customers to communicate with us easily, in a way that they choose and creates operational flexibility within our customer service function.
- ***Create an effective incident response capability*** which takes account of the specific demands of our customers and is underpinned by insight from real-time customer and

[27] Thames Water, CSD006-WNP-04-FE-PR19-CA Resilience, Section 3
[28] Thames Water, BPD1-PR19-Business Plan Document, Section 7
[29] Thames Water, PCD1-PR19-Retail, Section 3
Thames Water, PCD2-PR19-Wastewater Network Plus, Section 3
Thames Water, PCD3-PR19-Bioresources, Section 3
Thames Water, PCD4-PR19-Water Resources, Section 3
Thames Water, PCD5-PR19-Water Network Plus, Section 3
Thames Water, PCD6-PR19-Thames Tideway Tunnel, Section 3

operational data. We need the ability to respond quickly and recover after incidents effectively, with our focus on 'people resilience' to support our service.

- ***Create an agile service delivery operation*** that solves customer issues upfront and, when required, dispatches engineers to resolve issues before the customer needs to make contact.
- ***Commence the digitalisation of all assets*** which connects operational, customer and asset data to provide insight into proactive interventions and to prevent service issues. This functionality will then allow us to forecast events and scenarios so we can adequately prepare for and proactively develop our response.
- ***Build a resilient resource model to operate 24x7x365*** so we are able to respond and recover quickly after extreme events in a way expected by our customers.
- ***Work with our stakeholders to deliver innovative catchment-based solutions*** and reduce the environmental footprint of our operations to ensure our operations are sustainable in the long term.
- ***Build comprehensive Business Continuity and Disaster Recovery Plans***. Although our ambition is to make a step change in the resilience of our services, there is always the risk that we experience an extreme event that although highly unlikely could have significant consequences. We therefore plan to have comprehensive plans in place for these scenarios which go above and beyond our current risk criteria.

E People Resilience

4.15 This aspect of resilience focuses on the skills required to plan, build, operate and maintain our assets in a way that delivers the service to customers and the environment in the most cost efficient way.

4.16 We fully recognise that simply investing in resilient assets can only be successful if we have the skills and people to plan, operate and maintain these assets in a cost efficient, optimal manner. In AMP6 we reorganised the company around the principle of serving customers better, creating a cross-cutting structure that removed previous silos. We have developed a 'people strategy' that will help us achieve our primary objective of being 'here for our customers' and address our skills and labour challenges. Activity in AMP7 will include:

- Delivering a clear capability model that drives a robust recruitment and retention plan for core skills including reward and career paths, led by a Capability Manager;
- Creating the capacity and flexibility within key business units to work 24/7 to meet our customers' needs;
- Building on the core technical capability we commenced in AMP6 with the recruitment of a Chief Engineer, Chief Scientist and IT Specialists; and
- Monitoring and incentivising workforce performance against performance objectives which map to customer journeys.

4.17 In practice, this means bringing more mission-critical technical skills in-house and ensuring we capture and digitise the knowledge and experience of our long-standing employees.

F Financial resilience

4.18 This area of resilience focuses on the company's finances. In our plans we considered the current process and future plans for long-term financial planning, accessible financial reporting and monitoring, and ensuring financial viability of our plans.

4.19 We have considered the financial resilience of our plan over a ten year period to a range of plausible and severe downside scenarios appropriate to the business. In doing so, we have adopted an approach consistent with our yearly statement of long term viability. ***We have concluded that we are financially resilient and able to operate within our financial covenants and maintain sufficient liquidity facilities to meet our funding needs over the ten year assessment period*** if these downsides were to crystallise.[30] This conclusion has been made assuming capital markets continue to operate under normal market conditions.

4.20 We have also considered Ofwat's prescribed downside scenarios (as set out in its final position statement on putting the sector back in balance[31]) which form part of our assessment of financial resilience for business planning purposes. The results of our assessment are detailed in Appendix 6 – Risk and Return. Below is a summary of the key elements of the assessment and the key proposals for AMP7.

4.21 Our approach to financial resilience forms an integral part of our overall plan to rebuild trust and confidence. Our plan comprises the following key components:

- Our plan to ***reduce gearing by 5% from 81.3% to 76.2%*** by the end of AMP7, supporting our position of reducing gearing to the mid-seventies over the medium term;[32]
- Share outperformance against the allowed (ex post) cost of new debt, on a tiered basis;[33]
- A new dividend policy;[34] and
- For a specified list of resilience schemes, we will ***reinvest any associated underspends*** where these are not undertaken in AMP7. An independent assessment will be made of outcomes not delivered and amounts to be reinvested; and this will include consideration of schemes delivered in part or which are delayed beyond 2025.[35]

4.22 Further details of how we will enhance our financial resilience can be found in Appendix 6 – Risk and Return.[36]

[30] Thames Water, CSD021-PR19-Thames Water Annual Report and Annual Performance Report 2017/18
[31] Ofwat, Putting the sector in balance: position statement on PR19 business plans, July 2018
[32] Thames Water, Appendix 6-PR19-Risk and Return, Section C
[33] Thames Water, CSD009-PR19-Finance and financeability, Section 23
[34] Thames Water, Appendix 6-PR19-Risk and Return, Section D
[35] Thames Water, CSD005-BW12-PR19-Improving system resilience of North-east London water supply
[36] Thames Water, Appendix 6-PR19-Risk and Return

G Resilience Performance Commitments

4.23 In order to support our commitment to resilience and hold ourselves to account, we have developed a number of bespoke Performance Commitments which relate to our key operational risks, most notably power resilience, SEMD, surface water management, SoSI, responding to major trunk main bursts, and delivering our NE London systems resilience programme. In line with our objective to increase transparency, we have also introduced Performance Commitments on financial transparency and financial resilience.

4.24 See CSD005 for details of these Performance Commitments.[37]

[37] Thames Water, CSD005-PR19-Detailed Performance Commitments – DWS01, DWS02, DS02, DW02, BW11, BW12, EWS05, and EWS07

Section 5

How have we assessed the risks and options to providing a resilient service?

A Introduction

5.1 There are many challenges the water industry faces both today and in the future, many of which are outlined in Section 3. In order to objectively consider the risks we face and the options to manage them, we considered a number of inputs as part of developing our future plans. These included:

- Lessons learnt from service failures and events in AMP6;
- Customer consultation; and
- External engagement with stakeholders.

5.2 This is underpinned by our risk management framework which outlines our systematic approach to identifying, assessing and responding to risks. This is detailed in CSD032 – Our Approach to Risk.[38] In light of recent events, we are enhancing our current risk management framework to more consistently take account of catastrophic and long-term sustainability risks, and hence make us less vulnerable to increasing variability and severity of disruptions in the future.

B AMP6 events that shaped our plan

5.3 During AMP6 we recognise that we sometimes fell short of the performance expected by our customers which ultimately caused significant disruption to the service provided. If we are to provide a resilient service which is dependable, we must address the underlying drivers of our performance and protect the future water supply and waste service.

5.4 Key events that have shaped our thinking about resilience include:

- ***Trunk Mains bursts in the winter of 2016/17***. There were multiple trunk mains bursts in London which caused significant disruption to the provision of our water service and resulted in customer properties being flooded. Our plan considers how we can reduce the risk of future trunk mains bursts and how we improve our response to increase our asset and operational resilience.
- ***Missing our leakage target in 2015/16 and 2016/17***. Leakage is a key priority for our customers. If we are to maintain a sustainable water supply / demand balance in the long term, a step change is needed to reduce our level of leakage. In AMP7 we will

[38] Thames Water, CSD032-PR19-Our Approach to Risk

target a 15% reduction and develop a plan to reduce leakage by 50% in the long term to improve our asset resilience.[39]

- ***Major IT, data centre and call centre outages***. During 2016 and 2017 we suffered a series of major information system failures, which severely impacted both service and operational delivery. A key facet of our resilience strategy is to provide operational resilience and we will be investing to provide increased reliability of our information systems.
- ***March 2018 Freeze/thaw Event***. In March 2018 we suffered a major incident caused by a rapid thaw after an extended period of cold, which resulted in over 60,000 customers being without water or suffering low pressure.[40] This event revealed that we need to improve our forecasting capability, improve communications, improve real-time insight and improve communication with our customers and stakeholders. These are all key facets of an operationally resilient business.
- ***Significant pollution events***. In 2016 we received the most significant environmental fine imposed by the courts on a water company following a number of pollution events in 2012/13. Although we have learned and implemented the lessons and seen a 63% reduction in pollution events across our network,[41] we recognise there are further improvements needed both on our sewer network and our treatment works, particularly considering the impacts of ageing infrastructure, climate change and population growth.

5.5 These events are discussed in more detail within Section 3 of our Business Plan[42] and not only made a significant contribution to our future resilience plans but also the development of our overall business strategy.

C Customer consultation

5.6 As discussed in Section 2 our consultation process has been extensive and it was clear that our customers want a service that is resilient in the long term. We have engaged our CCG throughout the process and they are confident that we have a good picture of what customers want in the area of resilience from a service level and risks perspective.[43]

5.7 Through our deep dives on operational resilience, we consulted on the nature of hazards that customers expect us to address in our thinking and planning.[44] Our customers selected and ranked six key resilience challenges they perceived as most important for us to address in our plans. These are shown in Table 2.

5.8 Overall, our customers are most concerned about the impact on their service level rather than the specific cause, therefore our in-depth research into customer expectations with regards to service levels and their willingness to pay to maintain or enhance different

[39] Thames Water, PCD5-PR19-Water Network Plus, Section 3, Reducing Leakage
[40] Thames Water, BPD1-PR19-Business Plan Document, Section 3
[41] Thames Water, BPD1-PR19-Business Plan Document, Section 3
[42] Thames Water, BPD1-PR19-Business Plan Document, Section 3
[43] Thames Water Consumer Challenge Group, CCG Response to Ofwat, pg.22 - 24
[44] Thames Water, TSD019-CR52-PR19-Resilience Deep Dive (02/2017)

service levels is an important evidence base for how we objectively assess our plans against their assessment of risk and resilience.[45]

Table 2: Customer Prioritisation of Operational Resilience Challenges

	Flooding	Sustained Cold	Drought / Extreme Heat	Cyber-Crime / Terrorism	Severe Storms	Power Failure
Impact	Most Severe	High Severity	Moderate Severity	Most Severe	Moderate Severity	Moderate Severity
Probability	Very Likely	Very Likely	Moderately Likely	Relatively Unlikely	Relatively Unlikely	Moderately Likely

Source: TSD019–CR52-PR19-Resilience Deep Dive (02/2017)

D External stakeholder engagement

5.9 We actively pursue ideas and best practice from outside the company. Where this doesn't exist, we commission research or set up thematic working groups to address the gaps. Our stakeholders provide an important source of insight into resilience issues and we work with them to pursue ideas and best practice from outside the organisation. These include:

Regional Planning Working in collaboration with Water Resources for the South East (WRSE) to develop a consistent regional plan, evidenced through emerging plans for the South East Strategic Reservoir Option and ongoing discussions on the Severn Thames Transfer.	**Mayor's Infrastructure High-Level Group** We are identifying where future growth will exceed our system capacity and removing barriers to integrated utility working. We have uploaded our water and wastewater delivery programme onto a shared system (Infrastructure Mapping Application), which will enable us and other utilities to identify opportunities for joint working.
Industry Working Groups Water industry fora (such as Water UK, UKWIR, CIWEM and IWA), and international collaborative programmes (such as the SmartWater4Europe project).	**Expert external advisory panels** Expert advisory panels for major projects, including our WRMP and our long-term drainage and wastewater management programme, London 2100.

[45] For more information on our wider research base please see Thames Water, CSD002–PR19-What customers want – consolidated report

Case Study 2: WRMP Advisory Panel

In developing our WRMP19 we gathered water supply and demand management options from a number of sources. Our starting point was to ensure we considered all the options recommended in the government's Water Resources Planning Guidelines.[46] We then reviewed the options identified in WRMP14, and expanded the list by inviting all listed UK water providers and members of our Water Resources Forum (our stakeholder engagement forum) to propose additional ideas. We also advertised in the Official Journal of the European Union to ensure that we 'cast the net' for ideas as widely as possible. This process generated over 200 different options for us to appraise, ranging from cloud seeding to towing icebergs.[47]

Case Study 3: Sustainable Urban Drainage

In AMP7, as part of our ongoing strategy to take the strain off our drains, we will disconnect up to 65 hectares of impermeable land from our drains and sewers, increasing our resilience to climate change and urbanisation.[48] We will achieve this through four lines of activity:[49]

- We will partner with three Lead Local Flood Authorities (LLFA) with low drainage headroom to deliver a range of small to medium-scale projects in the private and public realm;
- Working with LLFAs: We will provide funding to the other 93 local authorities in our area to contribute to the installation of small-scale SuDS schemes in residential areas and open spaces;
- We will install a range of schemes across the lowest 30% of our catchments based on sewer headroom availability, focusing on large-scale SuDS and sewer interception / storage schemes; and
- We will provide funding to third-sector bodies (community and environmental groups) to deliver small-scale SuDS schemes in residential areas.

5.12 As demonstrated above, not only has our consultation with these external organisations helped inform our investment plans, we have also developed innovative, sustainable options to deliver collaborative solutions to our resilience challenges.

[46] DEFRA, TSD096-PR19-Water Resources Planning Guidelines, Dec 2016
[47] Thames Water, CSD023-1-PR19-Water Resources Management Plan, 1 – Appraisal of resource options, and 11 – Appraisal of demand options
[48] Thames Water, CSD005-DS02-PR19-Surface Water Management, Section 4, Our Performance Commitment Level
[49] Thames Water, CSD005-DS02-PR19-Surface Water Management, Section 4, AMP7 Investment Programme – Preferred Option & New Funding Streams

E Our approach to assessing efficient solutions

5.13 We recognise it is vital that any proposals for developing resilient solutions follow a robust business case assessment. This is no different whether it is related to the investment in traditional civil infrastructure ***assets,*** business/IT systems to improve ***operational*** resilience, our ***people*** or amending our approach to the ***financing*** of the business.

5.14 We have a robust gateway process, which ensures that the right decisions are made at the right time to optimise the solution for any business challenge. Our approach to securing the best value for money over the long term is underpinned by four principles: customer need, whole-life cost, systems thinking, and getting it right first time. This is captured in detail within Appendix 7 – Efficiency[50] and the Price Control Documents' Section 3[51] which outlines the five stage process we use for assessing a range of mitigation options.

[50] Thames Water, Appendix 7-PR19-Efficiency, Sections A and C
[51] Thames Water, PCD1-PR19-Retail – Section 3
Thames Water, PCD2-PR19-Wastewater Network Plus, Section 3
Thames Water, PCD3-PR19-Bioresources, Section 3
Thames Water, PCD4-PR19-Water Resources, Section 3
Thames Water, PCD5-PR19-Water Network Plus, Section 3
Thames Water, PCD6-PR19-Thames Tideway Tunnel, Section 3

Section 6

Assuring our approach to resilience

6.1 We recognised through developing our plans that it would be important to gain independent assurance that we have:

- Identified the key resilience risks within our business;
- Plans in place to improve resilience; and
- Plans that will deliver a step change in the resilience of the service we provide to our customers.

6.2 With this aim in mind, we commissioned Arup to undertake an independent resilience maturity assessment based on 22 resilience indicators.[52] Although the framework used by Arup is different from our own approach, this process helped us to benchmark our approach to resilience against best practice from across the industry in the UK and abroad. In particular, it gave us a systematic view of how effective our current systems and processes are at identifying and responding to resilience challenges.

6.3 The Arup review was an important exercise as it benchmarked our resilience against good management practice both within the water industry and across different industries, cities and countries.

6.4 Table 3 summarises the Arup assessment, comparing current levels of resilience with our plans for AMP7 and beyond. The assessment demonstrates that our PR19 plan delivers significant resilience improvements, some of which emerge in AMP8. We will repeat the assessment on a periodic basis and report progress to our Board.

6.5 Please see CSD007 – Resilience Assessment for the full report and definitions of each indicator.

6.6 In conclusion, the independent assessment revealed that in many areas, although we are aware of shortfalls in our resilience maturity compared to benchmarks, our plans ensure that across all elements our organisational resilience improves with clear actions implemented across the business in AMP7 and the potential to deliver industry-leading best practice beyond AMP7.

6.7 It has been agreed with our Board that a regular, independent assessment of our resilience maturity will be undertaken to provide the assurance that the plans proposed are delivering the step change in resilience that this plan requires.

[52] Arup, CSD007-PR19-Resilience Assessment, Section 4

Table 3: Resilience Maturity Assessment

Corporate	Current and ongoing activity	Planned for AMP7	Planned for beyond AMP7
Clear strategic direction	3	4	4
Effective governance and assurance processes	3	4	4
Effective business continuity planning	2	4	4
Comprehensive horizon scanning	3	4	4
Inclusive customer engagement and co-creation	3	4	4
Engaged stakeholders	2	4	4
Active role in the community	3	3	3
Comprehensive health, safety and wellbeing	4	4	4
Collaborative, adaptive organisational culture	2	4	4
Financial			
Financial viability	3	4	4
Protected finances for the regulated business	4	4	4
Sustainable long-term financial planning	3	3	4
Accessible financial reporting	3	4	4
Robust financial monitoring	3	4	4
Operational			
Continuity of service to customers	3	4	4
Robust long-term water resource planning	3	4	5
Robust long-term waste-water planning	3	4	5
Reflective approach to asset based health	3	3	4
Robust, integrated and flexible technology	3	4	4
Innovative, collaborative, naturally resilient approach to risk mitigation	3	3	4
Robust and flexible supply chain management	4	5	5
Diverse, inclusive and future skilled workforce	3	4	4

Scoring Key

5	Leading	Best practice approach with horizon scanning for future changes and clear methods to include these within plans and strategies.
4	Response actioned	Response applied in practice across most of the company, focused on proactive actions to prevent issues before they arise.
3	Response developed	Clear goal with a developed response around most elements. This response has yet to be widely actioned, though pilots may have been undertaken.
2	Aware	Aware of the need to act but actions have not been consistently adopted into process, plans and operational activities. Tends towards reactive action.
1	Unaware	Significant gaps in understanding, processes, plans, strategies and operational activities to achieve this goal.

Source: CSD007-PR19-Resilience Assessment (2018)