South Staffordshire Water

Resilience

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Ove Arup & Partners Ltd
The Arup Campus
Blythe Gate
Blythe Valley Park
Solihull B90 8AE
United Kingdom
www.arup.com

ARUP

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Executive Summary

Arup were appointed by South Staffordshire & Cambridge Water (SSC) to help define resilience and thus guide the company approach to business planning for PR19 and beyond.

The approach taken by Arup in delivering this scope has been collaboration focussed with extensive insights and data having been generated through numerous workshops and semi-structured interviews with SSC staff and board

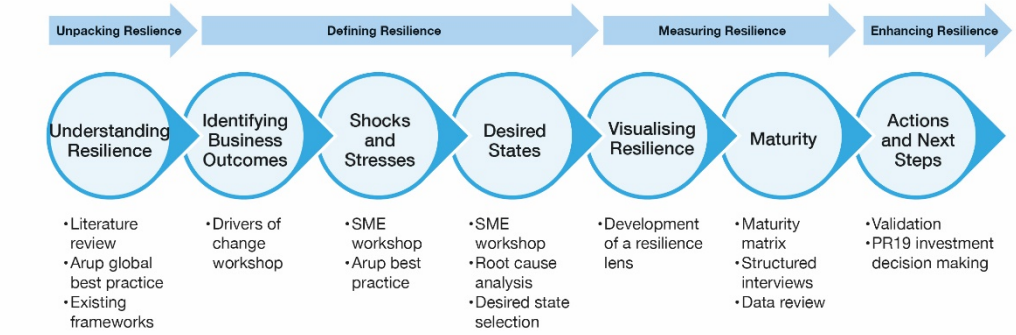


Figure 1 : Overview of the process

members. The process followed is illustrated in the graphic below.

The key elements of the process have been the:

Identification of the business outcomes that are key for SSC

The identification of the desired states that characterise resilience at SSC

The assessment of South Staffs Water (SST) maturity with respect to the desired states

The culmination of the process has been the development of a bespoke resilience lens for SSC through which resilience in the context of the business can be defined and against which the maturity of the business can be measured. The resilience lens is shown below together with the results of an initial maturity assessment.

Figure 2 : SSC priority business outcomes

Figure 3: The resilience lens showing the initial maturity assessment for SST

In developing the lens it is recognised that almost everything that the company does could be included in some way, and so, through the development of this lens the company has focused down on the few, important aspects which represent a resilient SSC – the framework thus creates a ‘lens’ through which selected critical aspects of resilience have been identified.

SSC will be able to use the lens to draw an assessment of how resilient the organisation is now, with the aim of helping prioritise, justify and ensure flexibility of future investments in uncertain times. It will prove effective in generating quantifiable and specific conversations relating to resilience and providing SSC a clear understanding of their current level of resilience and future aspirations. This report presents the proposed final resilience tool and details its development and justification.

The lens and maturity assessment have been developed collaboratively with SSC to reflect the priorities expressed by the company and its staff. It is therefore essential that SSC review the priority business outcomes and desired states utilised in the lens to ensure that they reflect the organisations view of resilience. The initial maturity assessment has been undertaken using a mixture of evidence

and perception informed through our engagement with SSC; the assessment should not be considered as an absolute score and it is important that SSC validate the basis of the assessment.

Whilst the overall lens approach will remain in place, individual elements of focus will evolve and develop as priorities change or investments are completed. The lens thus provides a good overview of the business currently, and will enable ongoing development and improvement over an extended period of time adapting to circumstances and performance changes as required.

1 Introduction

1.1 Background

South Staffs and Cambridge Water (SSC) has developed a supply capability road map (Figure 5), which has been shared with regulators. Within the road map several work streams are currently being progressed. Arup was commissioned to undertake the 'Resilience' work stream the scope of which includes:

- developing a definition and practical framework for South Staffs Water (SST) to use in relation to resilience as part of the wider decision making framework for Long Term Planning as part of PR19 business plan (described in this report)
- developing specific network resilience related options to feed into the PR19 process and decision making tool.

South Staffs has recognised that they need to incorporate a resilience perspective into both their PR19 planning and longer term planning. The focus of this report is to enable a holistic view of resilience for South Staffs to be defined and presented in a framework that enables it to be quantified and actioned in a practical way. To this end, this report covers the output of the first scope item, development of a Resilience Framework.

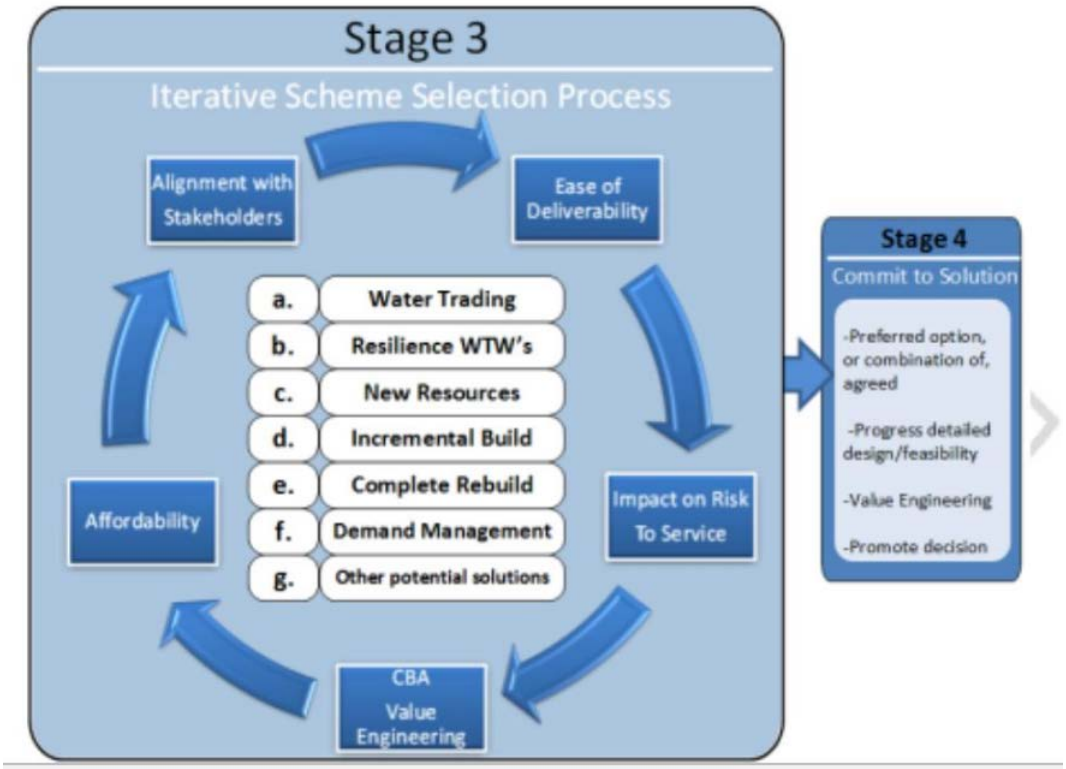


Figure 4 : South Staffs Capability Road Map

1.2 Process Overview

SSC has identified the need for business action to address resilience and has engaged Arup to develop and implement a resilience framework and identify resilience interventions as part of their PR19 programme. Arup has developed a bespoke resilience framework for South Staffordshire which draws upon best practice and provides a practical process for assessing SSC resilience.

The development of the approach to resilience has been undertaken in a highly collaborative way engaging numerous SSC subject matter experts through workshops and semi-structured interviews. The development process is shown in Figure 6. Each step of the process is subsequently described in the report.

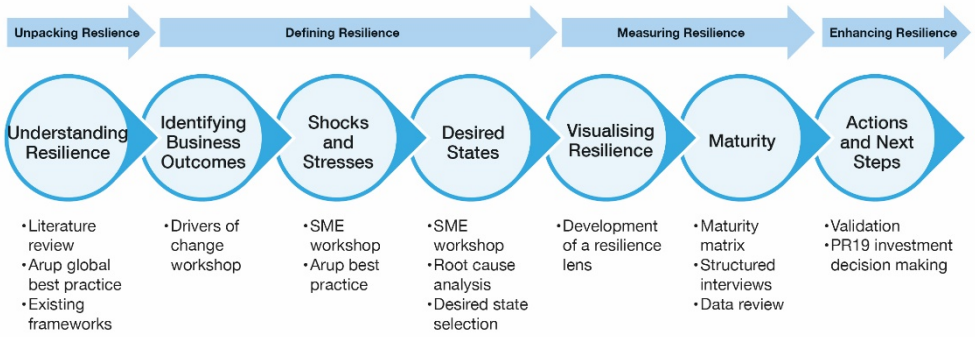


Figure 5 : Overview of the development process

2 Literature Review; Understanding Resilience

2.1 Defining Resilience

We live in a fast changing world, with rising resource consumption and depleting resources, changing demographics and greater demands on infrastructure. Impacts of this are being seen at individual, organisational, city and national levels.

These changes bring increasingly unpredictable risks, pushes systems to their tipping points and drives uncertainty around the impact of hazards and disruptions. Resilient organisations will be those with the ability to survive, recover and thrive in these conditions. Across the globe many organisation and sectors are assessing how to thrive in these unpredictable conditions and as such numerous definitions and indicators are being developed.

Within the English and Welsh water sector, "furthering the objective of resilience" has been placed as an obligation on the regulator, Ofwat, through the 2014 Water Act. In response to this, the Ofwat Resilience Task and Finish Group (2015) provided an analysis of the wider UK resilience landscape and developed a definition of resilience for the water sector.[1]

"Resilience is 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."(Ofwat 2015)

Whilst there are a number of different definitions of resilience, for this framework we have adopted the Ofwat (2015) definition.

2.2 Shocks and Stresses

While traditional risk assessments focus on specific hazards, resilience is increasingly focused on enhancing the performance of a system in the face of multiple hazards. In resilience we accept the possibility that a wide range of events – both shocks and stresses as characterised in Figure 7 – may occur but are not necessarily predictable. Success is being able to cope with a range of uncertain circumstances and to have the flexibility to continue to operate.

Shocks	Disruptive events, which impact the ability to provide a high quality service. In the water industry, acute shocks include sudden events such as floods or cyber attacks
Stresses	Chronic conditions which weaken the function of the organisation of system long-term. Examples highlighted in particular by Ofwat include population growth and climate change. Stresses are also often felt as shocks when they reach a tipping point.

Figure 6 : Characterisation of disruptive events; shocks and stresses

Resilience can be broadly understood to reflect the ability to bounce-back from disruptive events as illustrated in Figure 8. It has become a useful approach for safeguarding confidence and certainty despite increasing uncertainty. The concept of resilience has been widely adopted across organisations, businesses, industries, cities and nations.

[1] http://www.ofwat.gov.uk/wp-content/uploads/2015/12/rpt_com20151201resiliencetaskfinish.pdf

2.3 Low likelihood, high consequence

In the 21st century, the expectations of providers of essential services, such as water, are often onerous and inflexible due to the criticality of these services for a functioning community and economy. Within traditional risk management processes, hazards or disruptive events are assessed based on their likelihood and impact to give each an overall risk level. Mitigation investment is thus prioritised to address high level risks – those with a highest combined likelihood and predicted impact. While this approach is effective, it limits support for initiatives to improve resilience, which are often low likelihood, high impact events and have limited historical data.

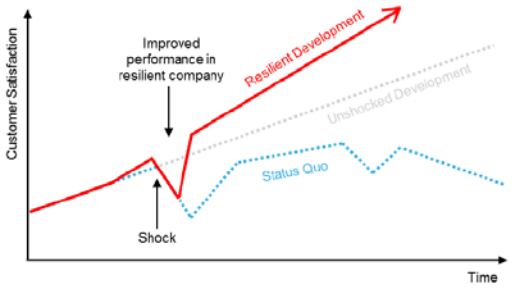


Figure 7 : Impact of resilience on customers

This has led to the emergence of the concept of 'resilience indicators' enabling the prioritisation of investment measures that seek to address highly improbable events with consequences that are unacceptable in today's current context. The approach to resilience therefore goes beyond a simple risk management approach in that it addresses stresses and uncertainty as well as quantifiable and understood risks; this change in approach is illustrated in Figure 9.

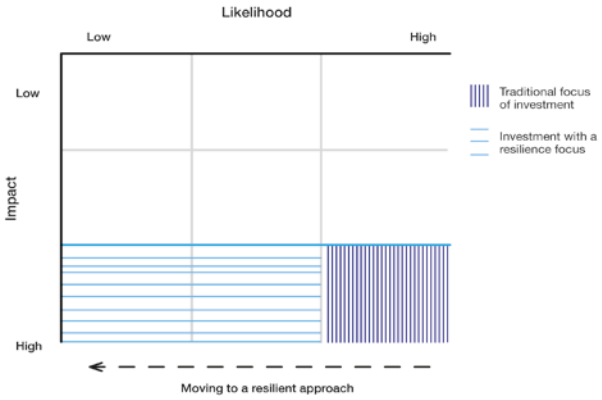


Figure 8 : Moving from risk based investment decision to resilience focussed decisions

In order to maintain a corporate focus on resilience the impact of a resilient approach to investment decision making must also be understood in terms of the benefit it brings an organisation in 'good times' as well as during periods of disruption. This concept is the "Resilience Dividend".

The Resilience Dividend

The term resilience dividend was coined by Judith Rodin (president of the Rockefeller foundation) in her 2015 book of the same name. It describes the ability to secure multiple benefits from each resilience initiative undertaken. These benefits will be felt by a system in times of good, as well as when specific shocks and stresses are felt.

2.4 Resilience in the UK Water and Wastewater Sector

2.4.1 National Strategy

The UK Cabinet Office's 2011 'Keeping the Country Running: Natural Hazards and Infrastructure' report identifies the water sector as one of nine sectors which provide essential services upon which daily life in the UK depends. The loss or compromise of nationally significant water infrastructure would have severe, widespread impact on a national scale and thus ensuring the sector's resilience is a priority for the UK. This report also emphasised the role of regulators in building resilience[2].

2.4.2 Regulator - Ofwat

Ofwat requires water companies to consider resilience in their long term planning for PR19[3]. In 2015, a Task and Finish Group set up by Ofwat reported on the topic with recommendations that were broadly accepted by Ofwat[4]. Whilst there is little specific guidance for how water and wastewater companies are expected to address resilience, it is clear that a set of report recommendations alone will not achieve water sector resilience thus, there is an onus on individual service providers to develop an approach to ensure resilience for their business. The recent Ofwat publication[2] has set out a number of metrics for measuring resilience and better reflecting resilience in outcomes, a summary of which is provided in **Figure 10**. The publication was released in the final stages of this definition report and, therefore it hasn't influenced the approach taken. It requires further analysis to ensure alignment at PR19.

Principle 1 - A better and more integrated understanding of service risks.

Principle 2 – Customer engagement; strong customer engagement is crucial in identifying relevant risks to feed into the assessment.

Principle 3 - A resilience golden thread and greater transparency; the product of the resilience risk assessments should be key to establishing a resilience –focussed business plan and WRMP.

Principle 4 - Broad consideration of intervention options; companies should consider a number of different actions that incorporate both response and recovery.

Principle 5 – Most cost effective solutions with the potential for partnership with other organisations.

Principle 6 – The assessments should inform outcomes and performance commitments based on customer preference and identified future risks.

Principle 7 - Board assurance and sign-off.

Figure 9 : Summary of Ofwat PR19 Approach to Resilience

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61342/natural-hazards-infrastructure.pdf
[3] http://www.ofwat.gov.uk/wp-content/uploads/2015/07/pap_pos20151210towardsresiliencerev.pdf
[4] http://www.ofwat.gov.uk/wp-content/uploads/2015/12/rpt_com20151201resiliencetaskfinish.pdf

2.4.3 Water Companies

UKWIR (UK Water Industry Research) sought to achieve an understanding of resilience priorities and create a robust methodology in their PR14 guidelines publication. They produced a set of informative guidelines rather than a methodology that aimed to focus on systems-based thinking. It provides advice on consultation with customers and stakeholders on how resilience should be discussed and provides examples of good practice approaches. UKWIR recommend that resilience planning and asset management planning must be integrated so that resilience risks are considered together. Two approaches are proposed – a 'bottom-up' and 'top-down' approach. The former describes a resilience assessment focussed on systematic analysis of unrelated hazard events at critical assets that have the potential to trigger system failure. The 'top-down' approach may be more applicable for a large scale system, exposed to a variety of hazards. It relies on assessing the overall performance (including thresholds of capacity, resistance to failure, identified critical assets) of the system and is an iterative process that seeks to identify gaps in resilience. A recommendation is made that the devised guidelines are tested and applied on a number of assets and systems whilst appraising both the 'top-down' and 'bottom-up' approaches. Continual engagement on resilience issues should include sharing guidelines experiences, hazard probabilities and determining how successfully various risk assessment techniques and tools compliment the guidelines.

UKWIR is currently preparing further research papers focussing on the incorporation of resilience measures into PR19, this is due to be published in May 2017.

3 Resilience for South Staffordshire Water

3.1 Background data

The development of the resilience approach for South Staffs water has drawn on a range of best practice frameworks and literature. Sources include:

- Drivers of Change: Water (Arup)
- 100 Resilient Cities Index (Arup and Rockefeller Foundation)[5]
- Cabinet Office Keeping the Nation Running: Natural Hazards and Infrastructure (UK Gov)[3]
- Arup's experience of developing similar frameworks for water companies in the UK

These frameworks present a number of ways of looking at resilience and summaries of a number of these frameworks have been provided in the Appendices.

Our approach to creating a bespoke resilience framework is based on developing a clear understanding of the SSC business drivers and context. The process we have followed is:

Identification of business outcomes; these are the things that SSC must continually deliver upon to be a successful water company

Identification of shocks and stresses; these are the disruptive events that could prevent or diminish SSC's ability to deliver its business outcomes. They are normally characterised by being high consequence but low likelihood events. They are the things that SSC need to be resilient against.

Desired States; a desired state is a positive state of business critical components that, if achieved, would mean an organisation would have a high probability of being able to continue operations or survive a disruptive event with minimal impact. These are things that SSC need to achieve in order to enhance its resilience to disruptive events.

Each of these stages are described below.

3.2 Business Outcomes

The first building block of the resilience approach is to identify the business outcomes that are required; these are the things that SSC must continually deliver upon to be a successful water company.

[5] http://www.arup.com/city_resilience_index

The business outcomes were identified through a series of workshops and interviews with SSC internal stakeholders. These included the use of the bespoke Arup Drivers of Change methodology to help elicit a clear picture of priorities and future scenarios.

An initial drivers of change workshop was held with a group of SSC staff and then repeated with the Executive Board. Workshops were initially, focussed around identifying the most important current and future drivers on the business with these discussions developing into thoughts about how they manifest themselves. The outputs from both of the sessions were compared and aligned to create a defined list of key outcomes. These were then further developed with the Steering Group to reflect SSC current ODIs/key customer outcomes and consolidated into eight business outcomes as shown in Figure 11.

Figure 10 : Eight priority business outcomes

3.3 Shocks and Stresses

Collaborative workshops were held with SSC staff to develop a focussed list of possible disruptive events and long term strains that could be foreseen for SSC. Such events may be sudden short term occurrences (shocks) such as a cryptosporidium outbreak in the River Severn and extreme weather events, or they may be long term trends (stresses) such as population growth and climate change."

"Disruptive events may be sudden short term occurrences (shocks) such as a cryptosporidium outbreak in the River Severn and extreme weather events, or they may be long term trends (stresses) such as population growth and climate change."

Stakeholders were asked to think about external and internal events or occurrences that could result in a material impact on customers or the ability to operate. They considered things that could break the water supply system both now and in the future. A long list of shocks and stresses was developed and collated (see Appendix C: Workshop A). They were variable in scale and detail so were summarised into different types of shocks and stresses, both current and future.

The resultant ideas from the workshop required a process of refinement and analysis to elicit the underlying root causes for each of the shocks and stresses proposed. Each root cause was then interrogated to identify the impact or symptom and any obvious mitigation measures. Each group of shocks or stresses then had a group of underlying causes, underlying symptoms and mitigation options allowing them to be grouped further by their commonalities. These are summarised in Table 1 and more details are provided in the Appendices.

Table 1: Summary of shocks and stresses

Shocks	Stresses
Extreme Weather Event	Reduced water resource yield
Unprecedented peak demand	Market Competition
Failure of critical assets	Political and Economic uncertainty
Failure of critical systems	Increased demand
Raw water source compromised	Deterioration of raw water quality
Deliberate Attack	Poor asset condition
Failure of critical assets	More difficult regulatory requirements
Regulatory Change	Workforce culture
Lack of workforce skills and knowledge	Increased frequency and severity of extreme weather events
Loss of customer goodwill	Loss of customer good will
Regulatory breach	Increase in cost of supply

The shocks and stresses activity was used to help articulate some of the company's biggest challenges. These were then used influence the development of the desired states, as described below.

3.4 Desired States

3.4.1 Summary

A resilient SSC will have certain characteristics which enable it to be able to continue or 'bounce back' quickly and continue to deliver on its key outcomes or core functions in the face of shocks and stresses. These characteristics are described as desired states.

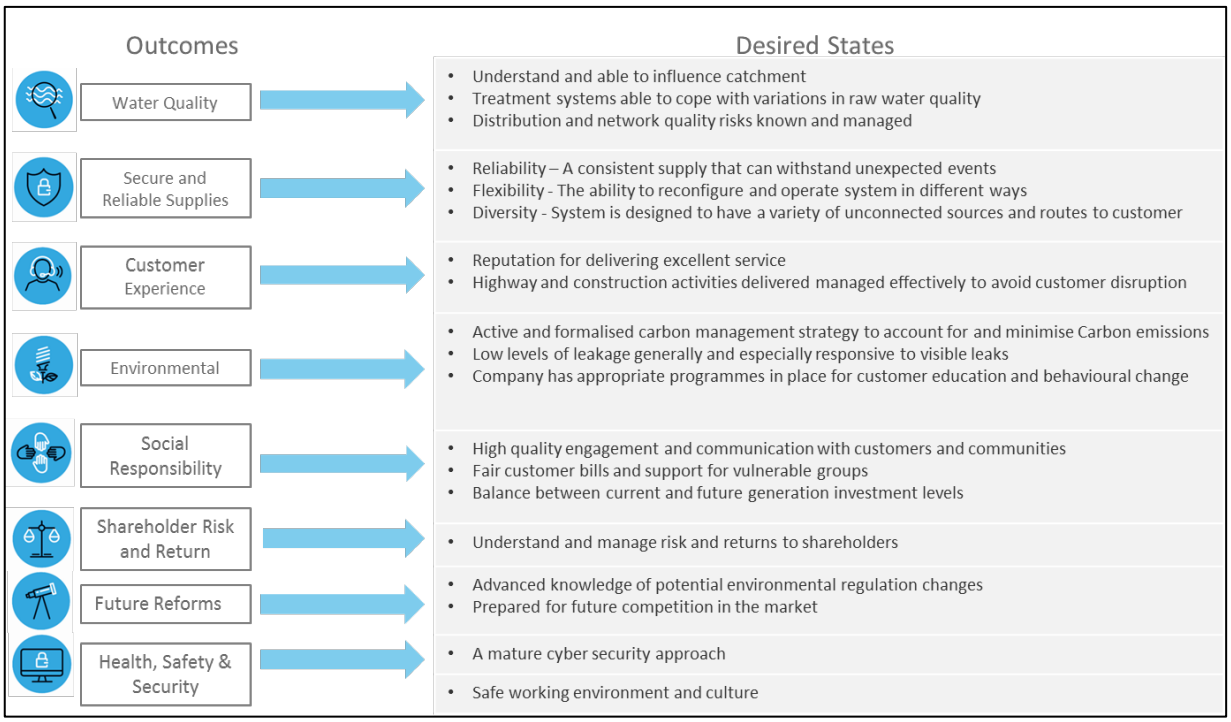
The long list of these desired states was developed through a matrix process to ensure robustness and the inclusion or discrediting of all possible options. The individual indicators (shocks, stresses, root causes, impacts) were grouped and combined into important areas that reflect a resilient organisation. Alongside these workshop outputs, the five SSC key customer outcomes within the business

critical plan have been drawn upon to think about what good should look like. From these sources, a range of 'ideals' was developed that cover the breadth of the business. A defined list of 19 desired states has subsequently been created that are linked to the business outcomes, these are shown in Figure 12.

It should be noted that the desired states are an outcome of a collaborative engagement with SSC and reflect **current challenges.** These are likely to evolve over time as the business and operational environment changes. Desired states should therefore be time limited and updated to reflect the 'ideal' states relevant for the business at any given time. It is recommended that as part of the business planning process the desired states are tested with customers to understand and incorporate their preference.

Further details of each selected desired state are provided in the following sections.

Figure 11: Desired States - characteristics of a resilient SSC



3.4.2 Excellent Water Quality

Understand and are able to influence catchment activities including early warning of raw water quality and deterioration

This desired state describes the importance of understanding major risk activities in the catchment. Having a strong communication link with land owners and users is important for influencing catchment use and influencing land use upstream. It is about having a proactive, well-established, best practise catchment approach that if successful, avoids the need for expensive treatment. Early warning of raw water quality and deterioration highlight the importance of sufficient early warning of problems and potential treatment challenges and the need for appropriate

mitigation, including temporary shutdown of abstraction, use of an alternative intake or bankside storage or changes to the treatment regime / additional treatment for example. In general, upstream pollution monitoring only applies to surface water due to the speed of transfer, however, early warning of aquifer contamination is also useful and so the most mature state includes expanding to groundwater sources.

Treatment systems able to cope with variations in raw water quality

This desired state articulates the need for treatment systems that are fit for purpose both now and into the future with the ability to cope with future challenges. A resilient organisation would have identified a full range of potential future pollutants with appropriate mitigation methods available.

Distribution and network water quality risks known and managed

This highlights the importance of preserving water quality while it is in the distribution network and having the flexibility to be able to move water around the system to satisfy various supply and demands depending on different circumstances. At the most mature level, SSC would ensure that customers are either satisfied with, or don't notice any source blend changes. It also represents the importance of having a customer – centric view of how important taste and odour is to the customer experience. Historically as this has not been a strong regulatory driver, insufficient priority has been given to its importance. In future decisions, however, it needs to be recognised as a significant contributor to the perception and reputation of the company.

3.4.3 Secure and Reliable Supplies

Reliability - A consistent supply that can withstand unexpected events

Ensuring that demand is met no matter what incidents may occur. This describes the degree of reliability of critical assets and levels of unplanned outage and maintenance.

Flexibility - The ability to reconfigure and operate system in different ways

This describes the degree of flexibility to reconfigure the system to respond to events. With a number of different options available, the system is able to bend, adapt and reconstruct another route for operating.

Diversity - System is designed to have a variety of unconnected sources and routes to customer

This desired state was incorporated as it includes the degree of diversity of supplies available. It highlight the importance of having a range of different, unconnected source types such as surface water rivers, impounding reservoirs and groundwater, each of which will have different level of response to drought, heavy rainfall, pollution etc. A resilient organisation would have a variety of source types with the ability to satisfy demand from different combinations.

3.4.4 Customer and Community Experience

Reputation for delivering excellent service

This desired state has been incorporated because of the recognition that wholesale water companies are increasingly reliant on demand side measures where customers respond to requests to change their behaviour. Therefore, a good customer reputation is essential in order to rely on customers carrying out the desired changes. Customers will only honour the commitments that they have made if they are well informed and trust and respect the organisation. If they do trust their water company, they are more likely to engage with messages and change their behaviour accordingly.

Excellent insight and communication with customers and communities

Insight to customer segmentation and behaviour across communities is essential for enabling customer interaction and achieving wide scale participation and mutually beneficial collaboration. The utilisation of new technology is the new norm and is essential for engaging with some segments of communities.

3.4.5 Environmental Responsibility

Active and formalised carbon management strategy to account for and minimise carbon emissions

All responsible companies have to account for their carbon. A resilient company would have a mature and well developed, in depth understanding of both operational carbon and capital (embedded) carbon with a comprehensive carbon reduction plan that is used in decision making and to drive behaviours.

Low levels of leakage generally and especially responsive to visible leaks

If both the water company and customer supports the ideology: *"we'll do our bit, you do your bit"* a good relationship and mutually supportive activities will lead to high levels of trust and legitimacy being developed. This informal contract between a water company and customer can help to save water on the demand side and encourage SSC to respond quickly to reports of leakages on the supply side. A mature and resilient organisation would not only have low levels of actual visible leakage but also react quickly to reports from members of the public to water wasting.

Company has appropriate programmes in place for customer education and behavioural change

Customer behaviour in relation to water is expected to become increasingly more important, with more demand side management options. There is growing evidence that there is a significant difference in behaviour between consumers and consumers and citizens with the latter more prepared to *"do their bit"* to reduce water consumption and help contribute to their local community and environment. High profile education programmes can help encourage customers to understand

their impact on the environment with the aim of encouraging them to respond to messages and requests to change their behaviour. A changing state of mind which helps take customers on a journey through a mind-set of *"I know, I understand, I care"* can help with influencing and delivering tangible behaviour change.

3.4.6 Social Responsibility

High quality engagement and communication with customers and communities

This desired state was included because of the recognition that in order to engage and communicate with every different segment of society, you must first understand what drives them and how they can be effectively engaged. By focussing on quality engagement and having a practical presence in the community, a company can begin to match their engagement and communication style to the customer and community needs. A practical presence in the community involves high level connection and participation amongst all groups of society.

Fair customer bills and support for vulnerable groups

This desired state is included as it is important for a water company to understand its customers and their ability to pay the bill. It is underpinned by the need to build 'trust and legitimacy' by listening to customers and being able to offer support and a range of options for those that are less financially secure.

Balance between current and future generation investment levels

This desired state is included because of the need to balance future investments against the ability for customers to pay. This includes balancing intergenerational costs where future generations are not disadvantaged by decisions taken by the current generation. This describes the importance of considering the bill implication on future generations. If quick-fix, short term decision are made now to keep the costs down, what effect is that going to have on the next generation? To ensure continued service performance, consideration must be given to balancing short, medium and long term customer bill impacts when prioritising investments.

3.4.7 Shareholder Risk and Return

Understand and manage risk and returns to shareholders

Given the large amount of future uncertainty, investors will need the confidence to know that all potential eventualities have been thought about and robust plans have been formulated. A resilient company will be able maximise the stability of its returns to investors at an appropriate value.

3.4.8 Anticipate future reforms

Advanced knowledge of potential environmental regulation changes

SSC recognise that they are in a very changeable market place with the next 5-10 years being particularly significant with a number of new markets, entrants and contestable areas. In other sectors, failure to adequately anticipate and prepare for market reform has resulted in companies losing significant market share or even going out of business as a result of competition (e.g. aviation, banking, energy). This desired state focusses on what the regulator will impose on the company in terms of regulation reform.

Prepared for future competition in the market

How will South Staffs anticipate and prepare for future market changes? Looking at threats and opportunities ahead with good foresight can help the company plan for potential future challenges and create action plans necessary to stay ahead of market reforms and progress in an uncertain world.

3.4.9 Health, Safety and Security

A mature cyber security approach

The water industry already has a well-developed and generally mature approach to physical and personnel security, however, the rapidly emerging threat of Cyber Security requires significant improvement and thus is the key focus of this desired state. Best practice on cyber security describes frameworks that have defence in depth often described in 5 key layers for organisations to follow:

- **Identify** – identify a potential issue
- **Protect** – prevent issue from impacting
- **Detect** – detection to know when issue is occurring
- **Respond** – deal with issue while it's occurring
- **Recover** – deal with aftermath of issue

A resilient organisation will have a mature approach to all these layers with a balance of pro-active and reactive mitigation measures in place that cover technical, people and process related risks when dealing with their cyber security.

Safe working environment and culture

The health and wellbeing of workers is critical for the successful operation and reputation of the company. Zero incidents is an achievable target and one that can be expected of a company that is excelling. Key to achieving this target is a culture of positive behaviours underpinned by policy and initiatives to reinforce and enhance behaviour. Features include:

- Clear visual leadership and prioritisation of Health, Safety and Wellbeing at all levels of the company

- Ensuring competence across the business
- Management of Health and Wellbeing;
- Continuous improvement and performance monitoring
- Monitoring of the organisation’s cultural position

4 The SSC Resilience Lens

4.1 Visualising Resilience

The framework for understanding resilience that has been described in the previous chapter has been developed into a resilience lens. This provides a structured way in which to visualise resilience and subsequently assess the maturity of SSC.

It has been developed in close consultation with SSC and presents a simple yet robust system for assessing overall resilience. It enables SSC to see where they are today, what is most important to them and where they can be in the future, allowing conversations with its customer representatives about investments in resilience for both the next periodic review and longer term planning. The resilience lens is shown in Figure 13 and described below.

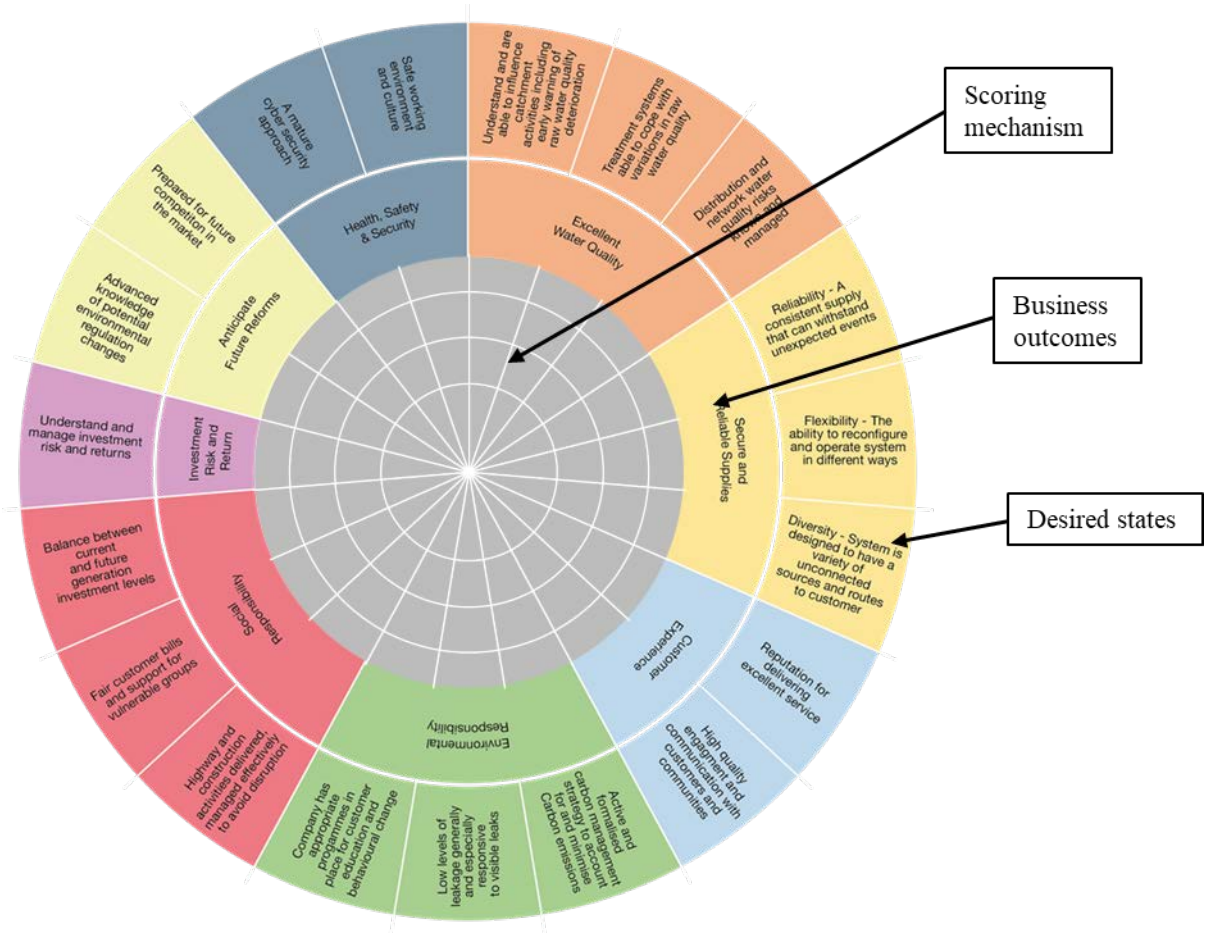


Figure 12 : South Staffs Resilience Lens

The lens is primarily made up of an inner ring, an outer ring and a scoring mechanism:

- The **inner ring** reflects the 8 **key business outcomes** identified collaboratively between Arup and SSC (refer to section 3.2). These are the outcomes that the company believes it must meet in order to be considered successful.
- The **outer ring** of the lens contains the **desired states** that would be present to enhance the resilience of the company (refer to section 3.4). These are the characteristics which enable it to be able to continue or 'bounce back' quickly in the face of disruptive events.
- The inner section is a **scoring mechanism** that enables an assessment of **maturity against the desired states** to be illustrated. The scoring mechanism must be used in conjunction with the maturity matrix which is described in the following sections.

4.2 Measuring Maturity

The ambition of SSC, and the obligation placed on it by the Regulator, is to ensure that the company enhances its resilience through targeted investment in both PR19 and subsequent price reviews. To enable this it is important to understand the resilience baseline of the company and identify areas for improvement.

A maturity matrix has been prepared that can be used to assess the position of SSC with respect to the desired states. The matrix comprises of a set of descriptors to distinguish levels of maturity against each desired state, these descriptors are based around the outputs of the workshops and interviews Arup has undertaken with SSC. Each maturity level is given a score of between one and four with mature being 4 and immature being 1. It should be noted that the maturity matrix enables the identification of areas for potential improvement, it should not be considered an absolute score for each of the desired states. The scoring is also highly dependent upon the descriptors used and it is important that SSC validate that these descriptors reflect the objectives of the business.

Figure 14 below provides an example of the maturity matrix for one desired state, full details of the maturity matrix are provided in the Appendices.

Outcome	Desired States	(Low maturity score) 1	2	3	(Mature score) 4
	Understand and able to influence catchment activities including early warning of raw water quality deterioration	Basic qualitative understanding of existing catchment activities & impact on water quality. Limited or poor relationships with land users. Manual, interval based water quality monitoring. Water quality monitors have a limited number of parameters, modest sensitivity and are unreliable. Surface water quality monitoring only	Good qualitative understanding of existing catchment activities and impact of potential changes in use. Developing relationship with land users. Manual, interval based water quality monitoring with some limited automated systems. Water quality monitors have a few parameters, modest sensitivity and are fairly reliable. Surface water quality monitoring only.	Good understanding of existing catchment activities and their impact on water quality. Some limited quantification of financial benefits of changed catchment activities. Good relationship with land users with some initiatives in place. Water quality monitors have a number of parameters with reasonable sensitivity and reliability. Some limited automated responses in place. Groundwater quality is considered and basic aquifer monitoring in place.	Good understanding and ability to quantify financial benefits of changed catchment activities. Great relationship with land users and a number of advanced initiatives in place. Modern, reliable, multi-parameter, sensitive online monitoring for surface water. Automated response to alert. Ongoing research into emerging technologies for monitoring. Appropriate and selective monitoring of groundwater quality in upstream aquifer.

Figure 13 : Example of the scoring descriptors from the maturity matrix

5 Resilience Maturity

5.1 SST Initial Maturity Assessment

Using data collected through workshops, semi-structured interviews and other sources, Arup have prepared an initial maturity assessment of SSC with respect to resilience. Although this exercise aims to estimate SST's current position, the focus should be placed on addressing areas of resilience that are the most immature rather than absolute scores. The scores provided below, although collaboratively created, must be validated by SST. Details of the maturity scores are provided in the following sections.

Over time, South Staffs will aim to develop an increasingly mature resilience status in all of these areas. However, it is important to remember that with the nature of risk, it is not possible to create an entirely resilient organisation. Some important questions for South Staffs to consider include: What is the timeframe for improving areas of resilience? How will different areas be prioritised? Appropriate awareness of the cost to move between each maturity level should be considered together with the implication on bills and level of customer support.

Figure 14: Resilience maturity of SST (lens)

Outcome	Desired States	(Low maturity score) 1	2	3	(Mature score) 4
Excellent Water Quality	Understand and able to influence catchment activities including early warning of raw water quality deterioration				
	Treatment systems able to cope with variations in raw water quality				
	Distribution and network water quality risks known and managed				
Secure and Reliable Supplies	Reliability - A consistent supply that can withstand unexpected events				
	Flexibilty - The ability to reconfigure and operate system in different ways				
	Diversity - System is designed to have a variety of unconnected sources and routes to customer				
Customer Experience	Delivering excellent service				
	Excellent insight and communication with customers and communities				
Environmental Responsibility	Active and formalised carbon management strategy to account for and minimise Carbon emissions				
	Low levels of leakage generally and especially responsive to visible leaks				
	Company has appropriate programmes in place for customer education and behavioural change				
Social Responsibility	High quality engagement and communication with customers and communities				
	Fair customer bills and support for vulnerable groups				
	Balance between current and future generation investment levels				
Shareholder Risk and Return	Understand and manage risk and returns to shareholders				
Anticipate Future Reforms	Advanced knowledge of potential environmental regulation changes				
	Prepared for future competition in the market				
Health, safety & security	A mature cyber security approach				
	Safe working environment and culture				

5.2 Details of the Maturity Assessment

The following sections provides details of the rationale for the selected maturity scores, these should be validated by SST.

5.2.1 Excellent Water Quality

Understand and able to influence catchment activities including early warning of raw water quality deterioration

Maturity score = 3

A fairly well-developed plan of how to manage the catchment has been established[6] which shows a good understanding of the importance of managing the activities of land owners and farmers. In order to improve water quality and biodiversity, prevent further deterioration of raw water quality and gain a broader understanding of catchment management principles, South Staffs has devised a four stage process: Collaborate, Research, Take action and Educate. At present, there is upstream monitoring on the River Severn, although condition unknown, but currently no groundwater monitoring or upstream aquifer monitoring. Chlorthal has been identified at a number of boreholes resulting in the sites being taken out which contributes to South Staffs score of 3.

Treatment systems able to cope with variations in raw water quality

Maturity score = 1

The main driver of this score is instability of the two major WTW's. Both treatment works have a bacteriological compliance issue, suffering also from clostridia and coliform breakouts. There are currently high levels of aluminium and manganese going into supply (even though the performance is still within the PCV) which contribute significantly to network discolouration issues. High levels of Total Organic Carbon (TOC) also creates a number of problems in the distribution system, particularly the generation of THM's and bio growth within mains which can cause biological activity, chlorine demand and potential taste / odour complaints.

Both the major surface water treatment works have had a number of DWI quality failures and have recently narrowly avoided enforcement action through commitment to short term improvements.

In the Moors Gorse area, yield from a number of boreholes has been reduced due to unexplained taste and odour problems when this water is blended in certain supply zones. The root cause of this problem has not been established nor the treatment works (or network mains) adjusted or modified to mitigate the issue with the result being a reduced deployable output (DO). Further understanding of this issue and proposals to address and improve the situation would be required to score higher on the maturity matrix.

In order to improve maturity there would also need to be a greater level of forward planning in relation to water quality in terms of predicting, quantifying and planning

[6] https://south-staffs-water.co.uk/media/1836/catchment-management-leaflet.pdf

investment strategies to be able to deal with increased peak loadings of current contaminants as well as consideration of potential future, more challenging contaminants.

Distribution and network water quality risks known and managed

Maturity score = 2

SST have analysed and assessed parts of their network that are most at risk of discolouration, predominantly arising from the incomplete surface water treatment but also as a result of mains condition and corrosion potential. The network quality risks have been mapped out and vulnerable points identified.

Although this work has been undertaken, the root causes of many of the symptoms remain unclear and thus true solutions are not in place; for example root causes of discolouration in Hampton Loade supply zones are highly likely to be as a result of inadequately treated source water (high Aluminium / Manganese levels which then oxide to form visible deposits) In addition, corrosion of unlined iron mains further causes discolouration.

Some high risk areas are having the symptoms treated by utilising techniques described as PODDS (prediction [and Control] of discolouration of distribution systems)[7]. These have been implemented on small sections of the network between Hampton Loade and Sedgley.

South Staffs have a clear view of how much water they can transfer from South to north and vice versa through the link main at Barr Beacon and manage potential discolouration issues in this section by maintaining minimum sweetening flows. A new emergency main connection to Severn Trent exists at Barr Beacon (to Perry Barr) but this is understood to be capped off and could not be used without some additional pipework and mains commissioning

The condition and performance of the service reservoirs within the network is understood to be reasonable *(although no specific evidence has been reviewed)* and thus ingress risks and stagnation are not considered in this evaluation. A clear list of service reservoirs would be expected to be held detailing their condition and quality inspection plan and a programme of regular drainage, internal and external inspections and, where appropriate, investment in replacement membranes at periodic intervals.

There does not appear to be systematic consideration of customer taste and odour preferences in relation to blending of source waters, apart from known areas of complaints (e.g. Morse Gorse). A more pro-active and customer sensitive approach would be useful to better characterise the different source waters in terms of customer perception, to identify known risk areas for sensitive customer response, to prepare mitigation actions such as limiting blend ratios and preparing customer communication and education material. A proactive approach would help with managing chlorine levels based on different blending regimes and then selecting and deploying these measures when blending regimes need to be altered (emergency or planned works).

Overall, a range of extra source treatment and managed blending is required to address various taste and discolouration issues and other potential bacteriological water quality issues in the network.

[7] http://podds.co.uk/

5.2.2 Secure and reliable supplies

Reliability – A consistent supply that can withstand unexpected events

Maturity Score = 1

A score of 1 was assigned as a result of both surface water treatment works being in need of improvements. The ageing infrastructure is no longer able to meet the current requirements and as a result additional interim treatment has been installed in the form of UV treatment at Seedy Mill with plans to do the same at Hampton Loade.

A number of boreholes are also out of service for various reasons associated with inadequate treatment given the contaminant challenge that they now face.

It is not entirely clear what form of asset health assessment is in place within South Staffs, but the absence of a clear view strongly suggests a need to improve the assessment, monitoring and recording of the health of critical assets, planned and unplanned outages and performance metrics.

Flexibility - The ability to reconfigure and operate the system in different ways

Maturity Score = 1

Flexibility describes the ability to reconfigure the system and maintain a constant supply to customers. It is understood that SST have a good understanding of the connectivity of the system, particularly the North and South connection at Barr Beacon. However, there are limits to this connectivity including the direction of flow and hydraulic constraints associated with the transfer. In particular, if one of the major works failed it is unlikely that customer service levels could be maintained using the existing network.

It understood that a significant proportion of customers are reliant on a single source. This means that should the source fail, customers are at risk of prolonged supply interruptions. Increasing focus on this measure is possible from Ofwat (referenced in latest resilience consultation) as well as from DEFRA in the SEMD process. South Staffs should consider identifying all communities and customers that are at risk of single source of supply and consider options to systematically work through the potential mitigation measures and reduce risks to customers.

To receive a level 2, SST would need to provide a defined list of critical assets (above a certain threshold of customers affected) and confirm how long they can each be taken out of supply for currently, without affecting customers. This then becomes the baseline for future improvement in flexibility.

Diversity - System is designed to have a variety of unconnected sources and routes to customer

Maturity score = 2

Approximately 80% of SST supply comes from their two major water treatment works. These treatment works are vulnerable to pollution and problems at the River Severn, which affects Hampton Loade, and the River Blythe. If the treatment works go down, the boreholes are unable to take over and keep customers in supply. Although boreholes can be rezoned, there is still limited diversity. To score a level 3 on the maturity matrix, SST would need to bring in an additional source or supply, for which a grid to move water around the system would be necessary. A pipe from Barr Beacon reservoir to Severn Trent that remains unused, could be utilised to pump water into the reservoir. SST have few diverse bulk supplies, limiting their resilience score.

5.2.3 Customer Experience

Reputation for delivering excellent service

Maturity score = 3

The company is currently placed in the upper quartile for SIM performance according to the 2016 annual report[8]. The latest CCW summary report[9] for SST shows customer satisfaction with their water supply peaking at 98% (sample size: 151) with 81% (sample size: 142) of customers agreeing that SST care about the service that they provide to their customers. In order for customers to change their behaviour, a level of trust must be built between the customer and provider. The same report notes the level of trust a customer has in South Staffs which currently sits at 8.19/10 (sample size:151), with 10 being complete trust and 1 being no trust at all.

To score beyond a 3, extensive systems and a strong ownership culture must be evident. One non-regulated service division, Echo, have the ability to scale up the volume of customer calls that can be handled in the event of an incident if necessary, showing a flexibility in customer services.

5.2.4 Environmental Responsibility

Active and formalised carbon management strategy to account for and minimise Carbon emissions

Maturity score = 2

SST have a good understanding of their energy usage by accounting for operational carbon and reporting it. However, this understanding appears to be limited to operational carbon, driven largely by cost. This shows a good understanding of cost management and the ability to minimise cost by minimising power but has yet to be translated into decision making processes. To achieve a higher score, South Staffs need to use this carbon indicator for investment prioritisation. An understanding of embedded carbon requires development, considering the inclusion of logistics, vehicle movements and plastic or concrete creation in their carbon calculations.

Low levels of leakage generally and especially responsive to visible leaks

Maturity score = 2

In the most recent SST business plan leakage reduction targets were not extended or stretched. Whilst it is understandable that further reductions have not been set due to there being no deficit at PR14, this is likely to become unsustainable. Although SST have met their own targets, it is likely that there will be pressure, from internal and external groups, to drive this down further. Currently, SST's level of leakage, taken from WRMP14, sits at 9.8Ml/d.

It is important for SST to be viewed as a water company that addresses visible leaks, as this contributes to the establishment of a good, trustworthy reputation.

Capturing relevant data, including 'average number of days to fix a leak' and 'total volume and number of visible leaks,' may help with setting more ambitious targets and satisfying future concerns over reducing leakage level, particularly with Ofwat. Ofwat have recently

[8] http://www.south-staffordshire.com/downloads/ar2016.pdf
[9] http://www.ccwater.org.uk/wp-content/uploads/2016/06/South-Staffordshire-Water.pdf

highlighted the opportunity to take account of future innovations and find cheaper ways of addressing leakage whilst creating stretch targets[10].

Company has appropriate programmes in place for customer education and behavioural change

Maturity score = 1

To score well in this area, a variety of intervention options are required for customer education with a quantification of the cost and the benefit it will bring to the customer and the company. A sufficient number of customers need to be going through the educational change programme to improve the resilience score for education and behavioural change. South Staffs would benefit from developing the idea of citizenship among their customers rather than purely focussing on customers as consumers.

5.2.5 Social Responsibility

High quality engagement and communication with customers and communities

Maturity score = 1

SST appear to have a high level, coarse understanding of who their customers are with limited messages sent out to them. The main interaction held between the company and the customer is restricted to bill conversations. SST received a score of 1 for this desired state as a deeper understanding of demographics, level of interest and age profile is required if high quality engagement and communication with customers and communities is to be achieved. Developing a more granular understanding of customer and societal segmentation will help with an understanding of what drives different demographics and groups. There is an increasing focus on understanding customer needs in PR19, this includes different types of communication and improving social media presence.

Fair customer bills and support for vulnerable groups

Maturity score = 2

WaterSure is a scheme put in place to assist vulnerable customers. Customers who can benefit from this scheme are "household customers with a water meter that have low incomes and use higher than average amounts of water due to having a large family or medical conditions."[11] The Water Industry Regulations 1999 defines the eligibility criteria for a 'vulnerable' person. The questions include:

1. Are you on a water meter?
2. Are you receiving benefit or tax credits (including housing benefit, income support, working tax credit and pension credit)
3. Either
4. Does anyone in your household have any of the medical conditions that means they use extra water (including desquamation, Crohn's disease, ulcerative colitis and abdominal stoma)?
5. Receive child benefit for three or more children under the age of 19?

[10] http://www.ofwat.gov.uk/wp-content/uploads/2016/11/Consultation-on-the-outcomes-framework-for-PR19.pdf
[11] https://www.south-staffs-water.co.uk/media/1811/customer-charges-scheme-2016-17.pdf

To receive a higher maturity score, SST would need a broad range of options available for vulnerable customers with full utilisation of the Charity Trust. Their current approach requires customer to know that bill support is available. In 2015, only 3% (sample size: 151) of customers were aware of or were on a WaterSure tariff[12]. To improve maturity in this area, there should be a more proactive approach in making this support more widely known and available to those who need it. Alongside this support, SST could benefit from a more innovative support mechanism to ensure that vulnerable customers are supported with their bill payments.

Balance between current and future generation investment levels

Maturity score = 1

SST received a score of 1 from the maturity matrix due to the minimal consideration of the sustainability of the bill impact for future generations. An important balance must be met between investment needs and bill impact. Bills remain low currently as a result of low historic investment levels, but as critical infrastructure ages, renewal investments as well as resilience improvements will need to be phased in an affordable way as well as ensuring that there is not an undue level of deferment for future generations. Evidence of an active consideration of the right level of balance to make across generations is required to demonstrate maturity in this area.

5.2.6 Shareholder Risk and Return

Understand and manage risk and returns to shareholders

Maturity score = 2

There is an assumption that current board level visibility of market reform and investment returns is limited to Ofwat published areas of potential competition / regulatory reform/ financial monitoring framework and that some limited assessment of South Staffs strengths, weaknesses, opportunities and threats has been carried out.

Corporate level risk management is assumed to be in place but limited visibility of the extent of risk or mitigation measures is available to enable a more mature score to be provided.

5.2.7 Anticipate future reforms

Advanced knowledge of potential environmental regulation changes

Maturity score = 2

The score of 2 reflects SST reactive, short term view of regulatory environmental reforms. A defined list of potential environmental regulations coming out of the Water Framework Directive or other environmental legislation is required in order to develop a clear set of potential risks, options and mitigation actions. For example, if emerging pollutants such as pharmaceuticals become an issue then is it clear what treatment strategies or mitigation options could be considered for deployment and how many locations would need to be addressed? Consideration of current PR19 strategic investment decisions should be informed by these risks so that appropriate future- proof treatment choices can be made.

It is also not clear to what degree climate change risk assessment has been carried out or informed strategic decision making. Direct impacts on floods, droughts, severe hot or cold weather as well as third party impacts such as power interruptions, transport system disruption, for example, should be considered.

Prepared for future competition in the market

Maturity score = 2

To score a 4 for maturity for this desired state, SST would need a good understanding of the effects and influence of a changing market place. SST received a score of 2 for this desired state as they have only one clearly developed strategy out of the 5 major market reform areas; non - household Retail, which has a clearly defined strategy, joint venture opportunity and market presence. The other relevant market reforms have received significantly less attention with little evidence of impact analysis and what they mean for South Staffs. Household retail, upstream abstraction and direct procurement require further development and attention (bioresources not considered to be material as significantly outside of current business model).

It does not appear that other than for Non-HH retail, any systematic strategic level scenario planning exercises have been conducted with a range of future scenarios being considered and different strategies that could be deployed being considered to assess no regret decision and potential alternative risk or return options.

Increased maturity levels in this area would enable exploration of realistic boundary conditions, evaluation of the dominant factors, foresight activities that may indicate when states have changed, or trends have formed.

5.2.8 Health, Safety & Security

A mature cyber security approach

Maturity score = 2

SST have some understanding of the 5 key layers of cyber security and a degree of maturity in each of them (Identify, Protect, detect, respond and recover) as well as a strategy of defense in relation to all of them.

Although limited plans have been made for their implementation, increasing attention is being given to this area. More clarity around the 5 key layers is necessary and SST must seek to look beyond a generic understanding of the cyber threat to the company, to think about specific threats to their sites, staff, industrial control systems or processes that may

be at risk. We understand that SST have protection in place in terms of firewalls, anti-viruses, password protection, and some recent awareness campaigns but not necessarily specific understanding of who might want to attack South Staffs or what hackers may be discussing in terms of their vulnerabilities.

In terms of response and recovery capability, it is not clear what level of maturity or preparedness is in place should SST suffer a cyber attack.

An assumption has been made that very little detection monitoring is in place on the ICS network or indeed on the IT network other than periodic review of log files. Therefore it is unlikely that there will be current information on any unauthorised access. (Note: On average it takes ~7 months to detect that a system has been compromised[12]).

Safe working environment and culture

Maturity score = 3

This desired state received a score of 3 as all of the Group Health and Safety milestones for 2015/2016 were met or exceeded[13]. The RIDDOR reportable incident rate has reduced with an 11% improvement on the previous year's rate, the best year to date. Employees have access to occupational health advisors and free advice and counselling, however, a greater focus on public health and wellbeing would increase the maturity score.

A stronger focus on near miss reporting and positive intervention reporting should be adopted to ensure that the RIDDOR incident rate continues to fall.

Comprehensive health and safety plans and proactive near miss reporting can ensure that workplace RIDDOR reportable incidents are minimal. A mature organisation would ensure that safety comes first in all situations and employers must do whatever is reasonable practicable to achieve a safe working environment. Health and safety plans should cover both the workforce and the public and public health and wellbeing will be of increasing importance to the organisation.

[12] PWC Breaches report 2015 (http://www.pwc.co.uk/assets/pdf/2015-isbs-technical-report-blue-digital.pdf)
[13] http://www.south-staffordshire.com/south_staffordshire_plc_csr.asp

6 Conclusions

This report has sought to develop an approach to understanding and measuring the resilience of SSC to feed into the long-term planning as part of the PR19 business plan. With a combination of industry knowledge and collaborative stakeholder engagement, a means to understand and measure the resilience of SSC has been devised; the output of the process is a resilience lens that enables easy visualisation of the organisations maturity with respect to resilience.

The elements selected for the resilience lens were based on a number of workshops, interviews and conversations with key stakeholders. SST's business outcomes and objective were also analysed to create a set of outcomes that currently represent the most important areas of company-level resilience. The stakeholder engagement outputs were narrowed down, prioritised and key 'ideal' states were selected that represent current areas relevance for South Staffs. Some elements of the resilience lens flow through to the Decision Making Framework to help influence investment prioritisation.

The resilience lens that has been developed is flexible and can be adapted and edited to reflect changing understanding of resilience planning in the SSC context. It is recognised that almost everything that the company does could be included in some way, and so, through the development of this lens the company has focused down on a few, important aspects. It is anticipated that in future years these will be updated as different elements reach higher levels of maturity.

The resilience lens will provide a business direction and assist with prioritising areas of resilience that need addressing. As circumstance and performance changes with time, the focus of the resilience lens should be developed and adapted to reflect changing priorities.

Using data available to Arup an initial resilience assessment of SST's current position was undertaken. This demonstrated that the company is performing better in some areas than others. The score is based on perceptions and evidence that has been generated through the study, it should however not be considered a comprehensive assessment, instead it provides a preliminary guide. It is recommended that both the initial assessment and the maturity matrix is validated by key internal stakeholders.

In order to continuously improve the resilience of SSC it is recommended that investment decisions are guided by the extent to which investments will contribute to improvements in the resilience maturity of the company.

Appendix A - Maturity Matrix

Outcome	Desired States	(Low maturity score) 1	2	3	(Mature score) 4
Excellent Water Quality	Understand and able to influence catchment activities including early warning of raw water quality deterioration	Basic qualitative understanding of existing catchment activities & impact on water quality. Limited or poor relationships with land users. Manual, interval based water quality monitoring. Water quality monitors have a limited number of parameters, modest sensitivity and are unreliable. Surface water quality monitoring only	Good qualitative understanding of existing catchment activities and impact of potential changes in use. Developing relationship with land users. Manual, interval based water quality monitoring with some limited automated systems. Water quality monitors have a few parameters, modest sensitivity and are fairly reliable. Surface water quality monitoring only.	Good understanding of existing catchment activities and their impact on water quality. Some limited quantification of financial benefits of changed catchment activities. Good relationship with land users with some initiatives in place. Water quality monitors have a number of parameters with reasonable sensitivity and reliability. Some limited automated responses in place. Groundwater quality is considered and basic aquifer monitoring in place.	Good understanding and ability to quantify financial benefits of changed catchment activities. Great relationship with land users and a number of advanced initiatives in place. Modern, reliable, multi-parameter, sensitive online monitoring for surface water. Automated response to alert. Ongoing research into emerging technologies for monitoring. Appropriate and selective monitoring of groundwater quality in upstream aquifer.
	Treatment systems able to cope with variations in raw water quality	Surface water treatment works can operate at no more than current peak levels of turbidity, cryptosporidium and pesticides etc. Ground water boreholes can only operate at current levels of coliforms etc.	Surface water treatment works can operate at current peak levels of turbidity, cryptosporidium and pesticides with some limited capability of coping with higher levels of raw water deterioration. Ground water boreholes can operate at slightly elevated levels of coliforms. Limited capability to shut the works down.	Surface water treatment works can operate at increased peak levels of a wide range of raw water issues Ground water boreholes can operate at reasonably elevated levels of coliforms. Capability to shut the works down for a reasonable period of time.	Full range of potential future pollutants , raw water deteriorations identified and treatment in place at forecast peak levels. Appropriate mitigation available including shut down/alternative storage
	Distribution and network water quality risks known and managed	No consideration of risks, no risk assessment or management plan. Risks may include but are not limited to ingress at service reservoirs and discolouration in the network. Taste and odour impacts on customers not considered in the operations.	Risks assessed for limited number of service reservoirs and distribution system discolouration. Limited management plan. Water from different sources is mixed but little consideration of the differences in quality or impacts on taste / odour for customers. Reactive management of issues	Risks assessed for most service reservoirs and distribution system discolouration. Basic management plan implemented. Sources mixed and providing a slight variation in quality. Taste /odour variability understood and proactively managed through operations.	Risks assessed for all service reservoirs and distribution system discolouration and comprehensive management plan implemented and regularly tested. Taste / odour variability understood and proactively managed in a customer sensitive manner through operations, planning and design. Similar quality of treated water entering network from a number of sources = a flexible network allowing you to mix sources without affecting quality.

Outcome	Desired States	(Low maturity score) 1	2	3	(Mature score) 4
Secure and Reliable Supplies	Reliability - A consistent supply that can withstand unexpected events	Small disturbances cause major disruptions, high level of unplanned outage and an inconsistent supply/ output. Reactive system only, with lots of unexpected variations. Limited asset health measure in place. Poor asset health.	Some understanding of future potential events that could occur but still reactive Fairly slow recovery from unexpected events, with each requiring bespoke solutions. Moderate understanding of asset-related risks, with moderate asset health; minimal understanding of external influences. Good asset health measure in place.	Moderate understanding of future potential events with some limited pro-active contingency plans in place. Reasonable recovery from unexpected events. Decent understanding of asset-related risks, good asset health. reasonable understanding of external influences.	Small disturbances cause little to no disruption. Minimal outage and a consistent supply/output. Proactive operation with well rehearsed contingency plans in place for a range of potential events and rapid recovery. Comprehensive understanding of asset-related risks with excellent asset health; Comprehensive understanding of external influences on system with communication / education in place to influence / minimise risk.
	Flexibility - The ability to reconfigure and operate system in different ways	Limited scope for reconfiguration of system in the event of loss of major source. Locked up deployable output. Inability to remove most critical assets for more than one day. Unknown number of customers reliant on a single source.	Modest ability to reverse flows or reconfigure network. Critical assets well defined and can all be taken out for up to 2 days with a noticeable effect. Significant number of customers reliant on a single source.	Large scale flow reversals possible in key areas. Some scope for reconfiguring the system to release locked up deployable output. Critical assets well defined and can be taken out for up to 5 days with little effect with plans in place and occasionally exercised. Active programme to gradually reduce customers at risk by reducing customers reliant on a single source.	Highly interconnected network with numerous supply sources and routes to customer and ability to rezone in the event of a major loss of supply. Control systems allow automatic reconfiguration in near real time. Impacts of network connectivity and flows very well understood. All critical assets can be taken out for 1 week at a time and no one is affected at any point throughout the year. Well established and pro-active culture with well rehearsed reconfiguration plans.
	Diversity - System is designed to have a variety of unconnected sources and routes to customer	Reliance on few connected major water sources only for majority of water supply to all customers. Limited alternative source options, limited bankside storage or impounding reservoirs. No significant bulk imports.	Reliance on few major water sources for most of the supply to customers. Some alternative source options from other appropriate geographic or source types. Modest bankside storage or impounding reservoir storage. Modest volumes of bulk import available.	Reliance on several major water sources for most supplies to customers. Several geographic and appropriate source type options available with considerations of economic and practical implications. Reasonable bankside storage and impounding reservoir storage. Reasonably large bulk imports available.	All supply zones have more than one source of supply available. High degree of diversity in appropriate source types and geographic locations with robust economic and practical considerations and plans in place. Considerable bankside storage and impounding reservoir storage.

Customer Experience	Delivering excellent service	Poor customer systems, staff not particularly well trained or knowledgeable. Lower quartile customer satisfaction performance. Systems inhibit sense of ownership, responsibility and ownership from staff. Poor company culture and morale. No significant ability to scale up customer contact demand One size fits all service offerring, no delineation of offering based on need Single channel of engagement with customers.	Middle quartile customer satisfaction performance. Reasonable customer systems, staff are relatively well trained and knowledgeable. Customer contact demand capacity limited with modest scale up only Minor modifications to a one size fits all service offerring A series of conventional channels with little innovation.	upper-mid quartile customer satisfaction performance. Staff have some ownership over issues. Reasonably motivated and knowledgeable staff Customer systems in place are moderately effective Limited ability to scale up customer contact demand Tailoring of the service offering to generic needs of customers Limited range of contemporary channels of engagement reaching the full bredth of customers.	People well trained and motivated. Top quartile customer satisfaction performance. Systems encourage ownership, responsibility and engagement from across the whole supply chain. Great company culture and morale Slick and effective customer systems. Ability to scale up customer contact demand rapidly. Service offerring is tailored to the specific needs of the customer Extensive range of contemporary channels of engagement reaching the full bredth of customers.
	Excellent insight and communication with customers and communities	Company has a very limited understanding of customer views and segmentation and communications are generic and standard. Standard comms technology only. Minimal formal company participation in community.	Company has carried out some detailed customer research and has broad understanding of different customer segments. Communication is targeted to a small degree with some limited community engagement. Minimal use of new technology in limited circumstances.	Company is informed by some detailed customer research with segmentation and tailoring of activities to community needs. Community participation is in place with a few local community contacts. New Technology is widely used at generic level.	Company has a robust and well informed strategy for customer and community engagement and wide scale participation and mutually beneficial collaboration, based on extensive customer research, segmentation, community contacts and targeted communications. New technology is deployed as normal and targeted to meet customer segmentation preferences.
Environmental Responsibility	Active and formalised carbon management strategy to account for and minimise Carbon emissions	Carbon is accounted for but in an unstructured manner with no clear strategy and doesn't influence any decision making.	Operational carbon is accounted for in a structured manner, Reduction is considered within the company but driven by cost considerations only	Consistent carbon accounting for all operational and some embodied carbon. Carbon reduction plan is applied and is occasionally used in periodic investment decision making only.	In depth understanding and accounting for both operational and embodied carbon. Consistent and effective carbon accounting process that influences decision making process on a regular strategic and tactical basis.
	Low levels of leakage generally and especially responsive to visible leaks	Lots of visible leakage and a slow response to wastage, Repairs prioritised purely on economics.	Reasonable high level of visible leakage and a relatively slow response time Public reputation is deemed important but cost is still preferential.	Relatively low levels of visible leakage and a relatively quick response to any waste reported. Public reputation and visibility deemed equally as important as economics.	Extremely low levels of leakage and a rapid response to any waste reported. Greater weighting on public reputation and visibility rather than on economics.
	Company has appropriate programmes in place for customer education and behavioural change	Company has few behavioural change initiatives and limited education programmes in place. No formal measurement of value of engagement / education programmes. Little understanding of costs.	Few, small emerging behavioural change initiatives in place although benefits are not yet quantified. Costs of delivery are approximate and not allocated to specific activities or initiatives.	Company has a a broad strategy for customer education and community engagement, with a few behavioural change initiatives in place Behavioural change measures are in development with some benefits being measured. Costs of delivery programmes are understood	Company has a robust and well informed strategy for customer education and wide scale behavioural change. Behavioural change measures are in place and show tangible benefits delivered. Costs of delivery programmes are well understood and prioritised to deliver maximum benefit.

Outcome	Desired States	(Low maturity score) 1	2	3	(Mature score) 4
Social Responsibility	High quality engagement and communication with customers and communities	Company has a very limited understanding of customer views and segmentation and communications are generic and standard. Standard comms technology only. Minimal formal company participation in community.	Company has carried out some detailed customer research and has broad understanding of different customer segments. Communication is targeted to a small degree with some limited community engagement. Minimal use of new technology limited circumstances.	Company is informed by some detailed customer research, segmentation and tailoring of activities to community needs. Community participation is in place with a few local community contacts. New Technology is widely used at generic level.	Company has a robust and well informed strategy for customer and community engagement and wide scale participation and mutually beneficial collaboration, based on extensive customer research, segmentation, community contacts and targeted communications. New technology is deployed as normal and targeted to meet customer segmentation preferences.
	Fair customer bills and support for vulnerable groups	Little understanding of vulnerable customers with no additional support offered to those who are less financially stable.	Basic understanding of which customers are vulnerable. Some mitigation measures in place available on request.	Good understanding of which customers are vulnerable with broad range of options available and some pro-active promotion.	Good understanding of who is vulnerable and offering a wide range of support for different customers in a pro-active and collaborative approach.
	Balance between current and future generation investment levels	Little or no consideration to future costs; short term perspective considered only	Some modest consideration to impact of short term decisions on longer term customer bills, but limited impact on decision making	Serious consideration of impacts of short term decisions on longer term customer bills. Discussion with customer representatives, but only limited impact on overall bill	Robust and sensitive consideration to the balance between short, medium and long term customer bill impacts to ensure continued service performance. Material impact on bills in short term.
Shareholder Risk and Return	Understand and manage risk and returns to shareholders	Limited visibility for board and investors of business risks and reward potential. Very limited consideration of potential future uncertainties or different futures. Very reactive.	Some risk / reward visibility and management for board and investors. Some consideration of potential future uncertainties or different futures	Visibility of business risks / rewards for short and medium term. Some analysis of future scenarios and uncertainties with potential impacts on investment decisions. Application / awareness of Ofwat financial monitoring framework.	Robust analysis and visibility for board and investors of business risks and rewards in short and medium term. A well developed investment plan based on robust analysis and quantification of potential uncertainties, different future scenarios and no regret decisions with plans in place and confidence on delivery. High level of confidence from investors, in the business and leadership. High degree of confidence from Ofwat based on Financial monitoring framework

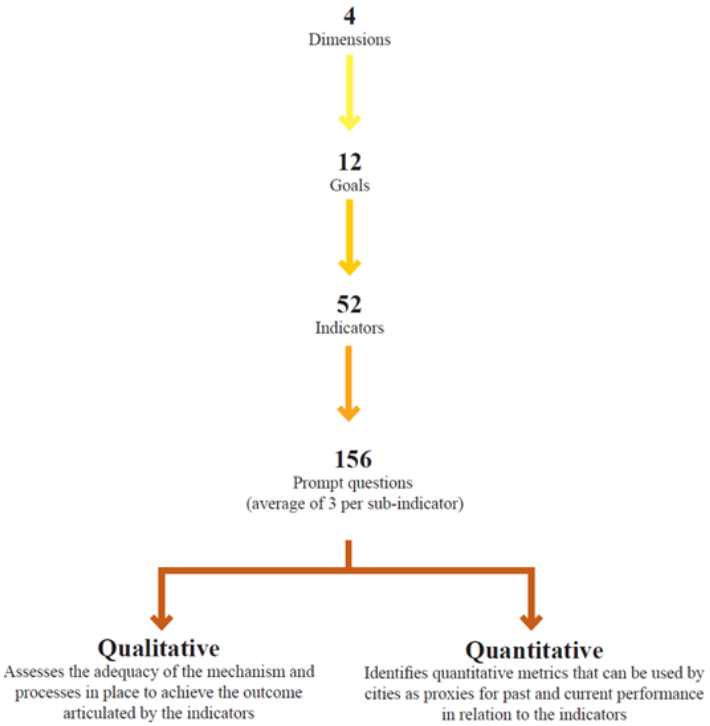
Anticipate Future Reforms	Advanced knowledge of potential environmental regulation changes	Limited view of impending environmental regulation changes and potential future reforms. Limited transactional involvement with the Environment Agency.	Reactive, short term view of regulatory reforms. Relative transactional involvement with the regulator, no ability to influence the EA.	More proactive, longer term view of impending regulatory change. Reasonable relationship with the EA but a limited influence on the regulator. Some response plans in place.	Well established relationship with the EA at a strategic and tactical level and proactive long-term thinking. Relationship at national and local level. regulator with the ability to influence direction Clear road map of impending regulatory reforms. Well developed response plan
	Prepared for future competition in the market	No consideration of impacts of a changing market place. Minimal foresight and little thought about new challenges or future reforms. Limited, short - term relationship with regulator	Impacts of a changing market are considered. Some consideration of new challenges and future reforms.	Reasonably good foresight into potential future challenges and reforms. Some plans in place with basic business models to deploy. Reasonable relationship with Ofwat but a limited ability to influence them.	Good understanding of the effects and influence of a changing market place with an understanding of timescale and company impact. Well established relationship with Ofwat, and ability to influence at a strategic and tactical level. Proactive long-term thinking. Well informed views of possible new challenges and future reforms. Well thought through business models, good insight and foresight with systems ready to deploy and situations change.
Health, safety & security	A mature cyber security approach	Cyber security has little attention, main focus still on physical and personnel security only. No knowledge or implementation of the 5 key layers. Little understanding of the risks of cyber threats an attacks on the company.	Aware of the 5 key layers but limited plans for implementation. Relative awareness of cyber security threats. Cyber security has increasing attention.	Good understanding of 5 key layers. Beginning to implement these layers into their cyber security approach. Good understanding of the risks of potential cyber attacks.	Best practise cyber security in place with a detailed understanding of the risks of potential cyber attacks. Good knowledge, maturity and implementation of the 5 key layers of cyber security - identify, protect, detect, respond, recover.
	Safe working environment and culture	Basic compliance with Health and Safety legislation	Protective equipment and clothing is provided - more advanced health and safety plan for all company sites - Better training and communication to ensure that the workforce are informed. - risks are explained to the workforce and competent person identified who is responsible for each risk.	Clear health and safety plan covering the workforce and the public for all company sites - All workplace incidents and near misses are reported and recorded - all staff are given appropriate health and safety training necessary to their job. -noticiable decrease in the number of RIDDOR reportable incidents. - employees have access to occupational health advisors and advice and counselling. - there is a focus developing on public health and wellbeing. - there is a focus on 'safety first' with regular presentations and refreshers	Best practise health and safety procedures adopted; focus from the top to the bottom of the organisation on creating and maintaining a positive culture and behaviours with respect to Health, Safety and Wellbeing. Regular safety audits and inspections from which actions are monitored, tracked and closed out. Regular staff surveys to monitor, track and action staff culture and behaviours. Zero RIDDOR incidents Zero near misses

Appendix B– Best Practice Resilience Frameworks

Cities Resilience Index (Arup)[14]

Resilience was recognised as a priority for cities. The Cities Resilience Index was developed by Arup with the support of the Rockefeller Foundation. It is a performance based approach, which defines resilience in terms of a city's ability to fulfil its **core functions**. The Index enable cities to "measure and monitor the multiple factors that contribute to their resilience" and its primary purpose is to diagnose resilience strengths and weaknesses and measure relative performance over time. It is not designed to enable comparisons between cities but is intended to provide a "common basis of measurement and assessment to better facilitate dialogue and knowledge-sharing between cities".

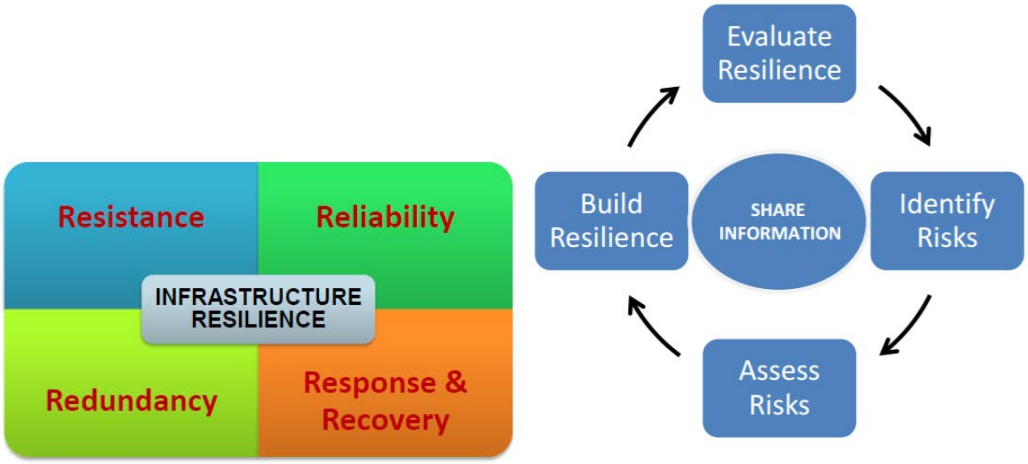
It provides a holistic articulation of city resilience structured around, four dimensions, 12 goals and 52 indicators. These layers were developed based on extensive literature and field research and analysis of, the qualities of resilient cities, the core functions that resilient cities perform and the 'factors' associated with resilient cities. Practically, each city can be assessed against 156 prompt questions (average three per indicator). Each question is scored either qualitatively [based on the adequacy of the mechanism and processes in place to achieve the outcome articulated by the indicator] or quantitatively [using metrics that can on a scale as proxy metrics for a city's current and past performance in relation to the indicators]. These scores are converted to a 1-5 ranking based on guidance of what best and worst looks like.



[14] http://www.arup.com/city_resilience_index

Keeping the Nation Running: Natural Hazards and Infrastructure (UK Gov)[3]

This report provides guidance to infrastructure owners and operators on an approach to building resilience to natural hazards of their assets, networks and systems. Resistance, reliability, redundancy and response and recovery form the components of infrastructure resilience and can be utilised or adopted to different levels. **Resistance** is focused on providing protection, **reliability** describes the ability to operate under a range of conditions, **redundancy** is concerned with the design and capacity (back-up provisions, spare capacity and flexibility and the fourth component aims to enable fast and effective **response and recovery**.



The document describes a 10 step cyclic process which should be repeated continuously in order to create and maintain infrastructure resilience. These steps are described below.

Identify risks

STEP 1: Determine the elements of infrastructure critical to the provision of essential services provided by your organisation.

STEP 2: For your critical infrastructure, identify linkages with other elements of critical infrastructure within your supply chain. Understand Hazards

STEP 3: Using the scenarios in the Natural Hazards Guidance (Guide 1), identify which hazards are of greatest concern to your critical infrastructure and supply chains.

Assess Risks

STEP 4: Understand what level of resilience you have to those hazards through design and service standards.

STEP 5: Using the findings from your investigations into (3) and (4) determine your level of residual risks.

Build Resilience

STEP 6: What is the risk appetite within your organisation? How is resilience of critical infrastructure considered and weighted by the corporate Board in decision making? Does this need to change?

STEP 7: Based on the conclusions of (6) and the principles set out in Section A of this Guide, decide what level of resilience is required and what resilience strategy will be adopted to provide the required level of resilience. Consider if the design of your infrastructure needs to evolve to provide greater resilience to future climates.

STEP 8: Embed organisational resilience at the core of your strategic decision making processes.

STEP 9: Engage with emergency responders for the area over which your organisation supplies essential services.

Evaluate Resilience

STEP 10: Challenge, test and exercise your organisational resilience strategy. Report to your Board, Regulator or Lead Government Department residual vulnerability of any CNI within your remit.

Appendix C – Workshop A, B & 1 Summaries

Workshop A

Workshop A was held with a number of key stakeholders from South Staffs. They were asked to think about external and internal events that could break the system. These included short term shocks that represent unexpected events that impact the network or longer term stresses that build over time. Both current and future risks were considered and a long list was created during the workshop. These shocks and stresses have been grouped below.

Shocks

External Environment
Pollution event and contamination of Blithfield Reservoir
Pollution of River Severn, only Chelmarsh available
Pollution event in River Severn leads to loss of abstraction for more than 1 week
Water Treatment Works failure and contamination of the network
Technology
PLC failure at boosted only zone.
Loss of broadband system which controls assets (SST)
SCADA failure at major sites
Telemetry system failure (CAM)
New technology reveals chemicals in the environment
Loss of digital data that is critical to operations through deliberate or accidental event.
Single source of supply for chemicals and key materials
Own physical assets
Loss of Sedgley Reservoir
Pollution event at Cherry Hinton Reservoirs (Treated storage) (CAM)
Loss of Euston treatment works (CAM critical asset)
Loss of Hampton Loade Treatment Works (SST critical asset)
Loss of Seedy Mill Treatment Works (SST critical asset)
Blithfield dam failure (SST critical asset)
Loss of West Bromwich transfer and Seedy Mill Treatment works in combination
Loss of restriction at Coton booster transfer (CAM critical transfer)
Short term event leading to compromised groundwater quality (E.g. Flash flood leading to increased turbidity in boreholes)
Cryptosporidium risk to Hampton Loade (significant asset). Detection will require boil order.
Failure of Fleam Dyke (CAM critical asset)
Burst in transfer mains north of Bourn
Outage of supply due to maintenance time required to fix an asset following unplanned outages.
Deployable output and/or network constraints due to discolouration risks (Will continue to be an issue in the future)
45" failure, Sedgley Reservoir to West Bromwich booster
Hampton Loade Treatment Works to Sedgley 45" failure
Mains trunk/mains burst
Thetford main failure (Key strategic transfer main for CAM)
Hydraulic constraints in network to move flows to different demand centres (W. Bromwich for SSC, Westley for CAM)
Main failure in line with Crumpwood PS outage

Key people
Limited human resources with key operational and/or technical knowledge
Cultural norm where there is a lack of understanding that what you have is acceptable.
Asset management of the system, issues with lack of people, processes and technology
Lack of knowledge on what SSC/CAM already have and whenever new changes need to be implemented the old process has to be completely unpicked.
Critical processes
Works management systems failure (Maximo)
Multiple source loss in Heydon zone (x 2) due to raw water quality.
Market/Regulatory forces
Water quality parameter change PCV. E.g. NO_3
Step change in available licenced abstractions
Environment Agency restriction on use of licences during drought or Hands Off Flow (HOF). Lack of operational flexibility.
Stakeholder trust
Very tough regulatory determinations
Customer trust
Loss of customer goodwill at times of water stress/drought
Customer do not behave as you expect/want them to in hot period (E.g. Demand is high)
Increased customer calls to SST, poor performance of company perception
Limited/lack of general engagement means low brand awareness. Potential limited influence on customer demand

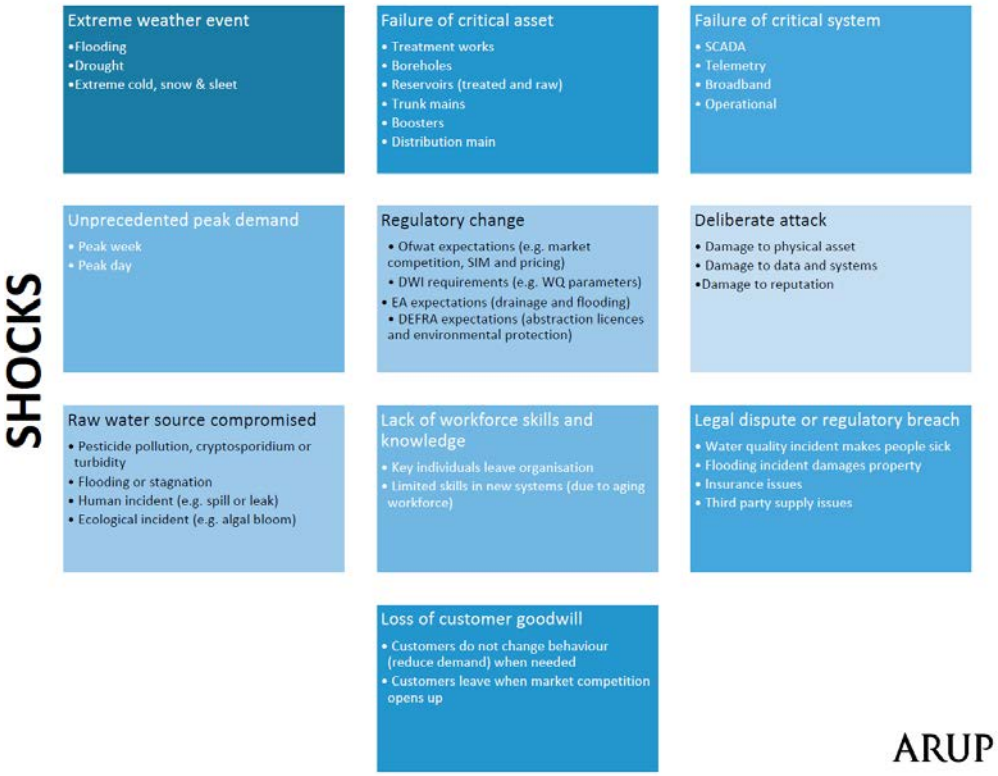
Stresses

External environment
Exceptionally dry summer, an event like 1995 which is a no warning, high impact event. Leads to high demand, stress on DO.
Multi-year drought leads to raw water storage depletion
Weather freeze or Soil Moisture Deficit
Climate change
Population change (Particular for CAM)
Flood risk to SSC and CAM assets from heavy pluvial events.
Power loss as a result of extreme weather/storms and recovery (CAM less robust to this)
Large scale power fluctuations taking out sites requiring manual resets (Linked to lack of resources)
Fluvial flood risk (Crump Wood, Kimber, Priestwood, Slade Heath)
Flooding events due to intense rainfall causing turbidity at multiple sources
Extended hot and sunny weather impacting on demand
Severe cold snaps leading to issues at Hampton Loade, major trunks main/pipe bridges leading to high leakage. Private pipes frozen.
Frequency and severity of drought
Long term yield risk to (chalk) groundwater sources
Invasive species, compromising treatment or river basin transfers (E.g. Algal blooms)
Own physical assets
THM compliance, Seedy Mill/Hampton Loade deprived THM failure
Increasing risk of crypto failures of GW source without treatment protection
Reluctance to release assets for maintenance due to headroom risk
Too many outages for maintenance within select time leads to increased exposure of assets and near misses in in times of high demand (Business risk as currently company does not include unplanned risks)
Technology
Intentional attacks on assets (E.g. Terrorism and cyber attacks)

Key People
Loss of key operational knowledge
New sector requirements/skills (E.g. Retail, Upstream)
Reduction/lack of key staffs to operate assets under semi-automatic/manual conditions
Lack of sufficient resources to run major incident for extended time period or more than are currently
Lack of sufficient resources to correct or address known issues in time (Recovery/robust competition)
Staff capability in new technology (aging workforce)
Own physical assets
Too many outages for maintenance within select time leads to increased exposure of assets and near misses in in times of high demand (Business risk as currently company does not include unplanned risks)
Technology
Intentional attacks on assets (E.g. Terrorism and cyber attacks)
Critical processes
Billing system, life of technology
Obtaining critical customer/data/insight in world of retail/wholesale
Market Forces/Regulatory
Less chance/reluctance to issue drought permits or requirements for more evidence
Expectations of cross company bulk connectivity regulators/customers
Economy impacting upon water demand
Growth of heavy water non-household users (Burton Strategic Growth and Cambridge Businesses)
Agricultural competition for limited water resources
New entrants putting different water supplies into existing networks, upstream competition (Risk to quality, service level assets, volume)
Supplier of last resort involves risk insurance affairs (Third party supply failures)
Changes in market do not support CAPEX and large scale investments
Stakeholder Trust
Cultural acceptance of leakage
Regulatory rules, changes from political changes (E.g. Brexit)
Change of ownership
Customer Trust
Customer trust
Lack of response to water conservation (Social change, domestic competition, metering changes)
Acceptability of more severe restrictions (E.g. Stand pipes)
Scarcity issues driving cultural change to water (In Cambridge region resistance)
Customer behaviour over long term periods (E.g. Maintaining drought behaviour over the long term). Linked to issues with customer goodwill

Shocks and Stresses refinement

Types of shocks



Types of stresses

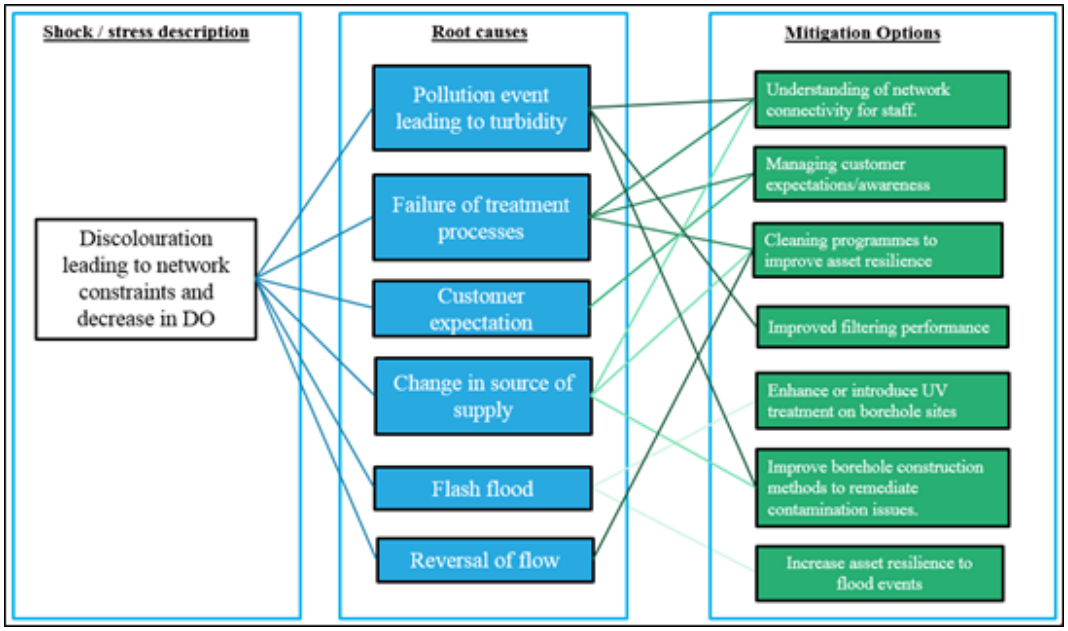
Workshop B

The purpose of this workshop was to test the proposed process for measuring operational resilience. The aim was to work through some South Staffs specific examples whilst seeking to validate the proposed desired states and mitigation options. The following image shows the basic process through which each mitigation options is scored against the desired state.

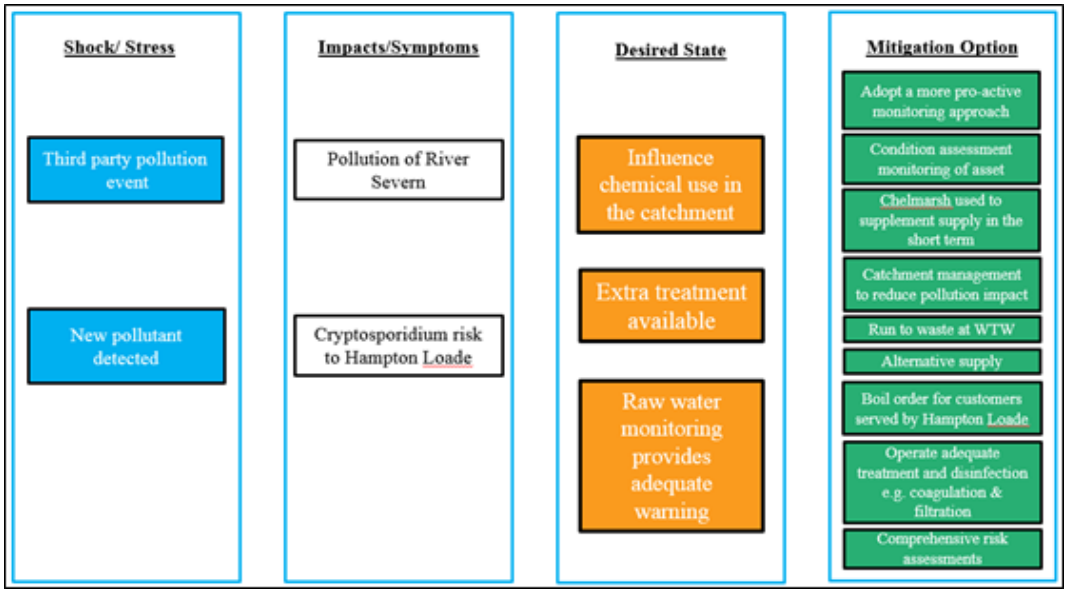
	Mitigation 1	Mitigation 2	Mitigation 3	Mitigation 4	Mitigation 5	Mitigation 6	Mitigation 7
Desired State 1	✓			✓			
Desired State 2	✓	✓		✓			✓
Desired State 3						✓	
Desired State 4	✓			✓	✓	✓	
Desired State 5						✓	✓
Desired State 6		✓	✓	✓			✓
Desired State 7	✓	✓		✓			
TOTAL	**4**	**3**	**1**	**5**	**1**	**3**	**3**

The table above shows that each mitigation options will be scored against each of the desired states. Two different scoring methods were tested during the session, these were a scoring system of 1-3 and a scoring system of ‘low, medium, high.’

The image below shows that the root causes were teased out of each shock and stress (workshop A output) and mapped to a number of potential mitigation options.



The image below shows a slight development with grouped shocks and stresses and the inclusion of associated impacts and symptoms. From the shock/stress and impact, a number of associated desired states were created that describe what a number of 'ideals' that describe a resilient organisation.



Example 3: Loss of groundwater supply — Mitigation Option / Desired State	Improve understanding of network connectivity. Discounted.	Develop alternative supplies. Alternative new works. Import treated water. Import raw water.	Enhance treatment options or introduce UV treatment on borehole sites	Improve asset maintenance regime	Adopt a more pro-active monitoring approach	Increased storage during average conditions	More on site standby boreholes
Influence chemical use in the catchment		Z	Z	Z	Z	Z	Z
Remediate borehole contamination issue. All boreholes fully operational, no ongoing water quality risk.		Z	L	L	Z	Z	L
Treatment that can cope with contaminants							
Protect boreholes from flooding. Flood resilient boreholes.		Z existing H new	Z	L/H	Z	Z	H
Raw water monitoring provides adequate warning. Early warning of pollutants.		Z	Z	Z	L	Z	Z(L)
Maintain potable supply to all customers.		H	L	L	Z	L	L
TOTAL							

This table shows an example of one of the tables that came out of workshop B. The red text shows the additional comments and edits made by the stakeholders. These edits were useful in the validation process of the proposed mitigation options and desired states.

After a review of the method in this workshop, there were a number of comments from stakeholders about what went well and what could be improved. Some of the

areas that required further development included the articulation of the desired states and clearer definitions of desired states, shocks/stresses and mitigation options. The conclusion was that 'Desired States' were a useful model for describing what a resilient South Staffordshire would look like but that the language must be clearer.

Workshop 1: Drivers of Change

This workshop was undertaken with 14 SSC staff from across the organisation to assess the major drivers of change impacting the business. The workshop shop was facilitated by Arup's Drivers of Change cards that led to a selection and prioritisation of major factors and issues for the business. They were encouraged to think about what things will affect their ability to continue to provide a consistent supply to their customers in the future.

The activity was repeated with South Staffs executive board which provided another set of drivers of change. Subsequent discussions explored how these drivers are relevant for South Staffs and through a process of refinement, a defined set of 6 drivers were identified. The table below shoes how the drivers map to the ODI's.