

SA WATER WATER MAIN MANAGEMENT INDEPENDENT REVIEW

Final Report vs 1.0 – 30th August 2019

Ref: CB9010



EXECUTIVE SUMMARY

The SA Water Board commissioned this independent review into SA Water's approach to water main management. The review was to assess and identify how well SA Water's asset management and operational approach aligns with international leading practice and to identify opportunities for improvement.

This review was completed through a mix of independent analysis and discussions with SA Water and Allwater staff, who responded constructively and enthusiastically to this review and we would like to extend our thanks to all SA Water and Allwater personnel who contributed to this review.

After the Paradise water main break in 2016, SA Water responded with the development of a strategy to both reduce the number of water main breaks and to support customers suffering through their impacts. This has resulted in SA Water's asset management and operational approach having been developed significantly over the last few years, including substantial additional investment. As a result, SA Water now leads the world in some areas of its practices.

Analysis of historical performance concluded that:

- SA Water compares favourably on both the rate of water main breaks and the amount of leakage when compared to Australian and international peers, being in the best performing quartile for both measures. All water utilities have water main breaks that impact on customers and result in water loss, and SA Water is no exception. In fact, attempting to reduce the number of water main breaks too far is considered uneconomic.
- Even though SA Water met 5 of its 6 ESCOSA targets last year for attendance and restoration of main breaks, its performance on 'Average Duration of an Unplanned Interruption' (a non ESCOSA target) does not compare favourably with peers and has been getting worse for several years.

Of the 24 capability areas examined, 7 were found to be leading, 15 were found to be typical and there were only 2 areas where SA Water's approach did not compare favourably with peers. SA Water's capabilities to prevent and predict water main breaks, and to minimise the impact of these breaks once they have occurred, are similar to peers in Australia, UK and Europe in many areas and leading in others.

The area (support to customers post water main breaks) where SA Water was most criticised after the Paradise event, is now considered a strength, which is a significant turnaround over the last few years. SA Water's use of modelling tools to link total investment needs with failure rates, technology deployed on the CBD smart water network to identify main breaks before they occur, and the management of asset information are also considered to be leading practice. A shift away (for small

diameter reticulation mains) from a traditional renewal approach, where the oldest assets are replaced, towards renewal of those water mains that have the greatest repeat interruption on customers is positive.

The two areas where SA Water's capabilities compare less favourably with its peers are resource management (where a more strategic approach to management of resources is required) and investment optimisation (which examines the business case and justification of investments). Opportunities to improve in both these areas will require a more integrated organisational approach.

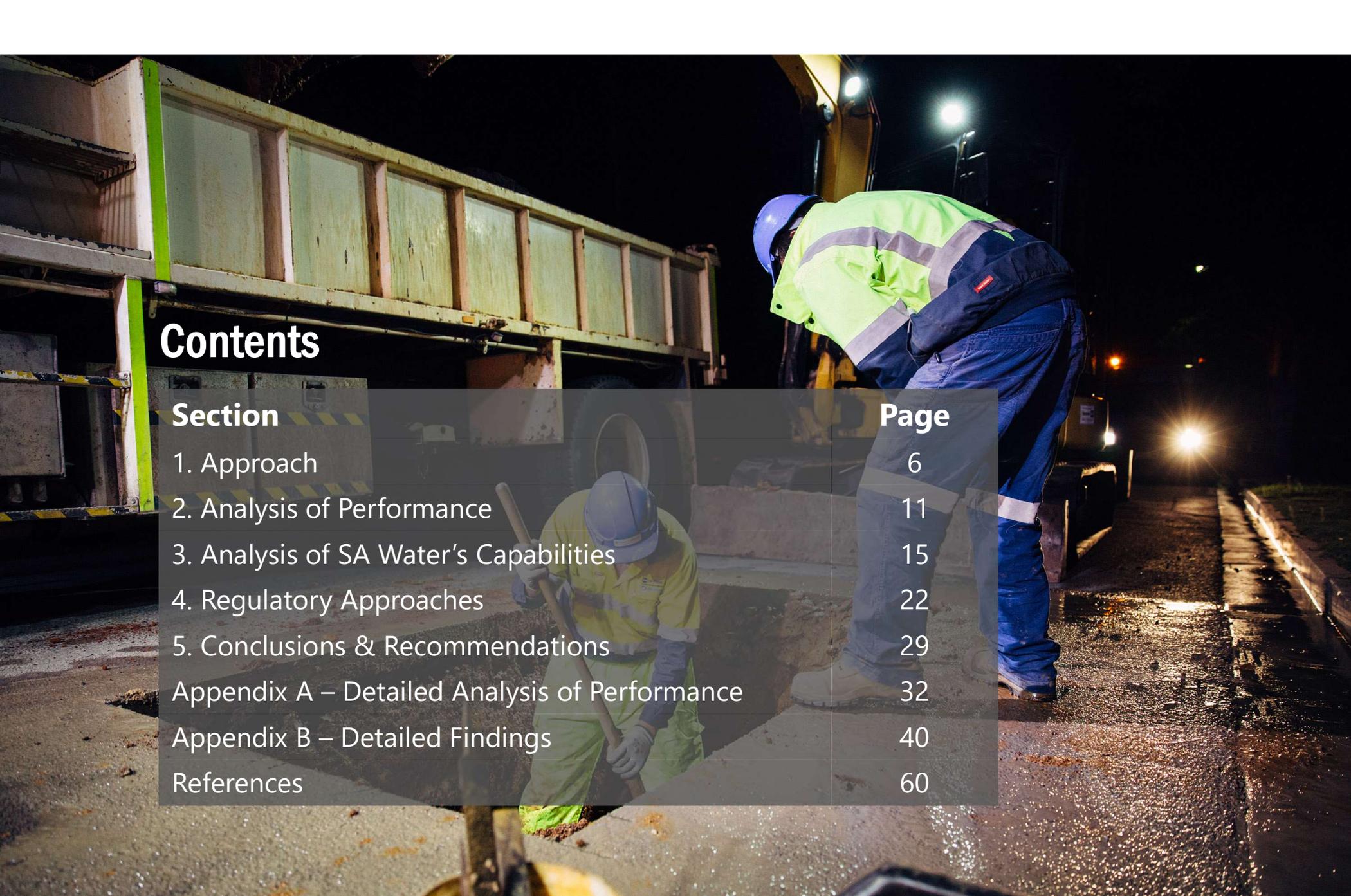
A draft (not yet finalised or submitted to ESCOSA) business case to reduce the number of customers with repeat interruptions (substantiated by a customer willingness to pay study) was examined in detail. The business case was found to include multiple disconnects between the customer willingness to pay study (shown in itself to be a leading practice) and the resulting proposal for more investment.

SA Water's focus has been primarily on achieving ESCOSA targets which is a statutory obligation it must meet. However, these are aligned to customer response times and less so on driving investment to reduce total community impact including total customer minutes off supply and impact on road users. Experience in the UK and other Australian States has shown that more demanding measures focused on total community impact will deliver better outcomes to stakeholders.

The strategic recommendations from this review are:

- Develop a more demanding objectives and incentive regime aligned more closely to total community impact similar to those adopted in the UK and Victoria.
- Develop an end-to-end value chain (including supply chain) to minimise the disconnects in the business (both within SA Water and the interface with Allwater) and to ensure the 'line of sight' from all activities back to customer needs is visible and effective.
- Engender a more demanding culture that provides internal challenge and ongoing assurance throughout the value chain.
- Continue to develop innovative ways of reducing the total community impact of water main breaks through improved processes, work practices and further deployment of SA Water's smart water network.

Additional potential opportunities for improvement are identified in the body of this report. SA Water is already addressing many of these, but it is recommended that all potential opportunities are reviewed and prioritised in light of this review.



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THIS IS AN INDEPENDENT REVIEW ON BEHALF OF THE SA WATER BOARD

Use of the report

This report was prepared solely for the Board of SA Water for the purpose of undertaking an independent review into SA Water's approach to water main management. The objective of the review was to assess and identify how well SA Water's current asset management and operational approach aligns with international best practice in the water sector, with asset infrastructure intensive utility businesses more broadly and identify where opportunities for improvement may be considered.

We disclaim any assumptions of responsibility for any reliance on this report to any persons or users other than the Board and Management of SA Water, or for any purpose other than that for which it was prepared.

Inherent limitations

AMCL has undertaken this independent review and prepared this report based on the methodology proposed by AMCL and based on information presented by SA Water. The findings in this report are therefore based on this information and wherever possible this information is validated with evidence but this is not possible 100% of the time.

As such, AMCL shall not be held liable for loss or damage to third parties due to reliance on the information contained in this report.

Independence

AMCL has based findings within this report independently of any commercial interest.

AMCL's assessment processes ensure that all observations and findings are independently verifiable. Where findings introduce an unavoidable conflict of interest, the nature of the relevant commercial interest has been clearly identified and is not contingent on any ongoing commercial commitment or ongoing relationship between SA Water and AMCL.



APPROVAL				
Version	Date	Compiled by	Reviewed by	Authorised by
Final vs 1.0	30th August 2019	R. Edwards / B. Marshall	Ian Pibworth	Richard Edwards
AMCL File Ref:373-013				

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C = Current version			

AMENDMENT HISTORY		
Version	Sections	Amendment Details
Draft A	All	Initial Findings for SA Water factual accuracy review.
Draft 1.0	All	Revised Findings including SA Water factual accuracy review feedback.
Draft 2.0	Exec Summary, Section 2, App A, B	Minor updates based on SA Water factual accuracy review feedback
Final vs 1.0	Minor edits	Minor updates to correct formatting / typos

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SECTION 1

Approach



ASSESSMENT METHODOLOGY

We assessed and compared the practices of SA Water against leading practices in nine capability areas, selected to reflect what was considered appropriate to undertake this review.

The core capability (No. 5) leveraged a conceptual bow-tie model that included each of the factors that can contribute to a water main break, as well as the business processes used to respond to water main breaks.

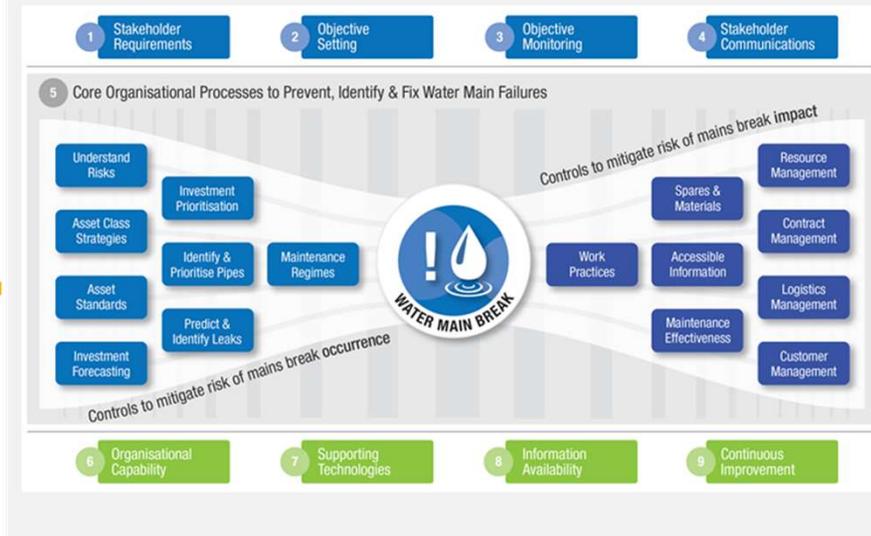
We assessed SA Water's maturity against each of these capabilities areas and provided an assessment score against a maturity index.

This review included all water mains, however, we focused more effort on understanding the management of trunk mains as they represent the greatest risk for SA Water and cause the majority of the publicised water main breaks.

1. Understand SA Water Main Breaks Core Processes (on-site)



2. Understand SA Water Capability and Control Maturity (on-site)



3. Compare to Our Knowledge of Leading Practices within Water & Other Industries & Prepare Draft Report (off-site)



4. Validate & Present Findings with SA Water (on-site)

SA WATER ASSESSED AGAINST THE FOLLOWING CAPABILITY AREAS

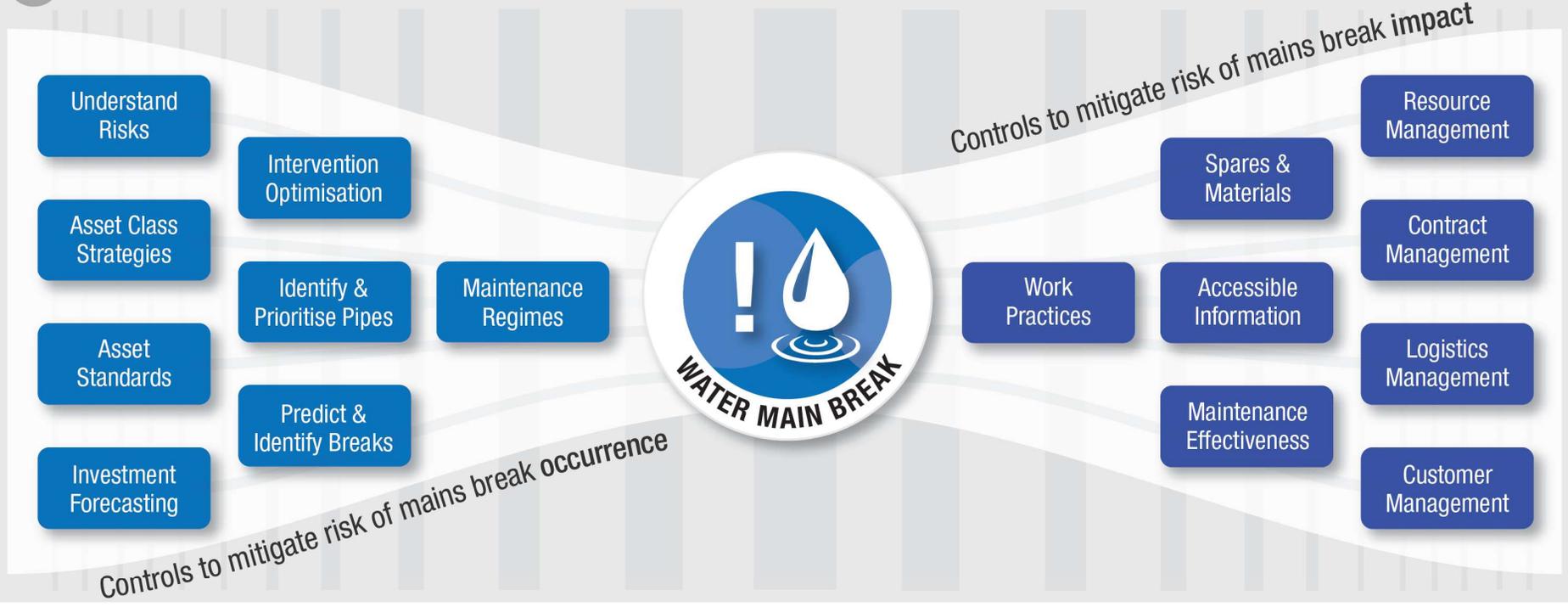
1 Stakeholder Requirements

2 Objective Setting

3 Objective Monitoring

4 Stakeholder Communications

5 Core Organisational Processes to Prevent, Identify & Fix Water Main Failures



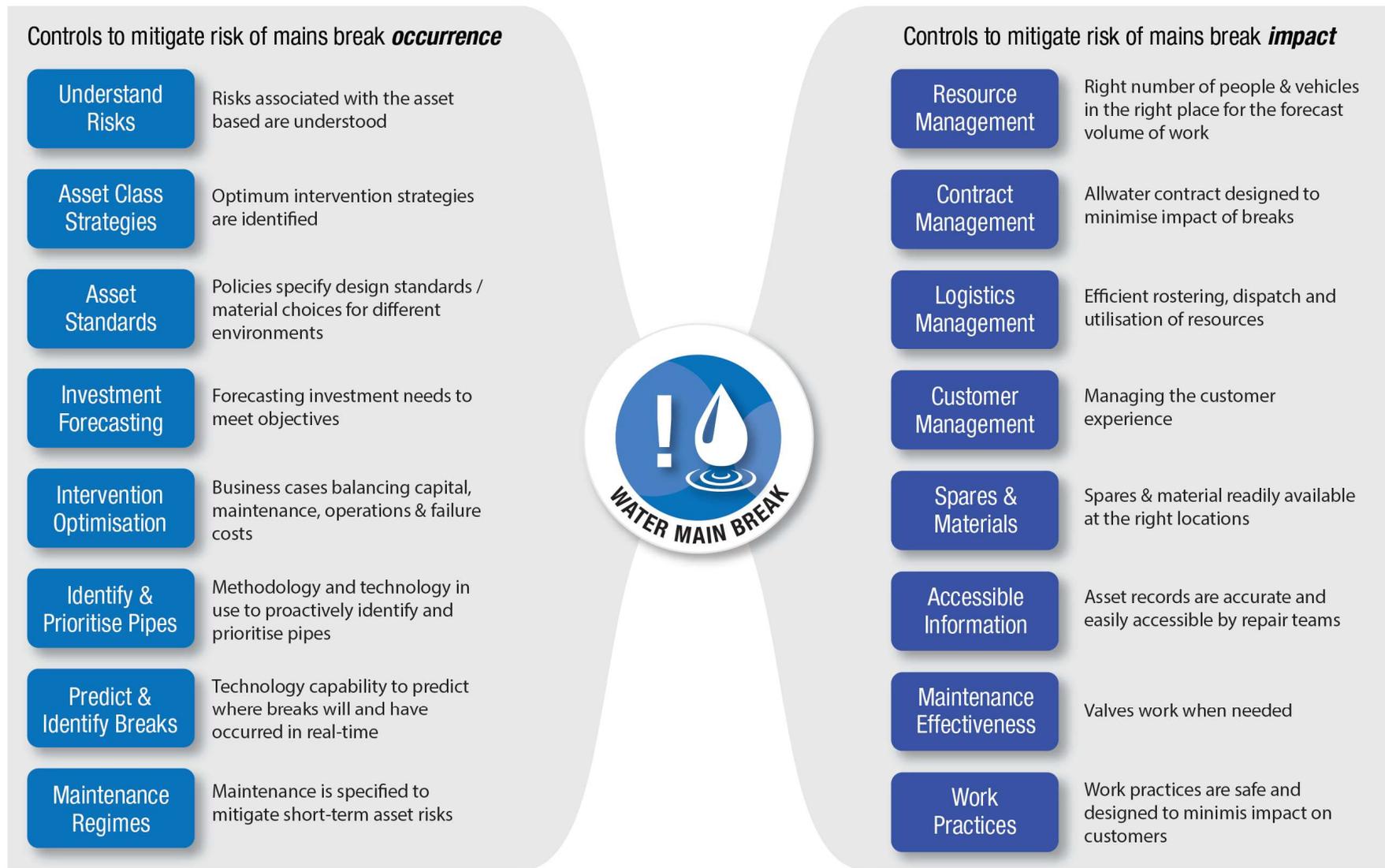
6 Organisational Capability

7 Supporting Technologies

8 Information Availability

9 Continuous Improvement

BOW TIE CAPABILTY AREAS IN MORE DETAIL



REVIEW TEAM



Technical Lead
Richard Edwards

Richard has 30 years asset management experience and is the immediate past Institute of Asset Management. He has led asset management projects globally including water, rail, energy in the UK, Australia, Asia and North America.



United Kingdom
Chris Newsome

Chris has 30+ years in UK water utilities and until recently was the Executive Director (Asset Management) at Anglian Water. He is the current President of the Institute of Asset Management.



Technical Support
Brenton Marshall

Brenton has 20 years asset management experience in the water, energy and rail sectors. Brenton has worked with many of the water and electricity utilities in Australia.



Europe
Helena Alegre

Helena has been at the forefront of research in best practice water mains asset management for the last 30 years. She has extensive insights into the best practices used across Europe.

SECTION 2

Analysis of Performance - Summary

Refer Appendix A for detailed assessment

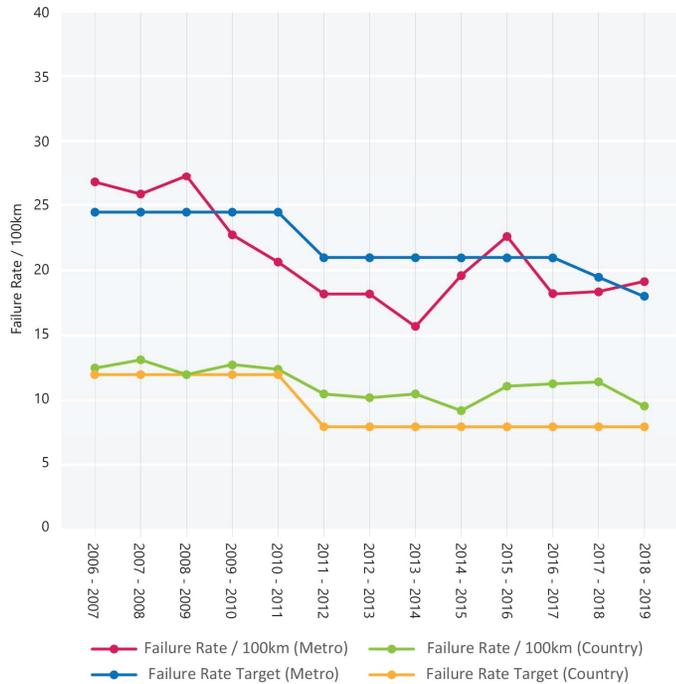


ANALYSIS OF HISTORICAL FAILURE DATA

	2018-19 Compared to Australian & International Peers	Trend
Water Main Breaks Breaks / 100km (non ESCOSA target)		 Reticulation  Trunk Mains  Major Pipelines
Non-revenue Water Infrastructure Leakage Index (non ESCOSA target)		
Restoration with ESCOSA timeframes 99% compliance with ESCOSA Targets		
Average Duration of an Unplanned Interruption Weighted average number of minutes to restore supply (non ESCOSA target)		

PERFORMANCE – BREAKS & LEAKAGE

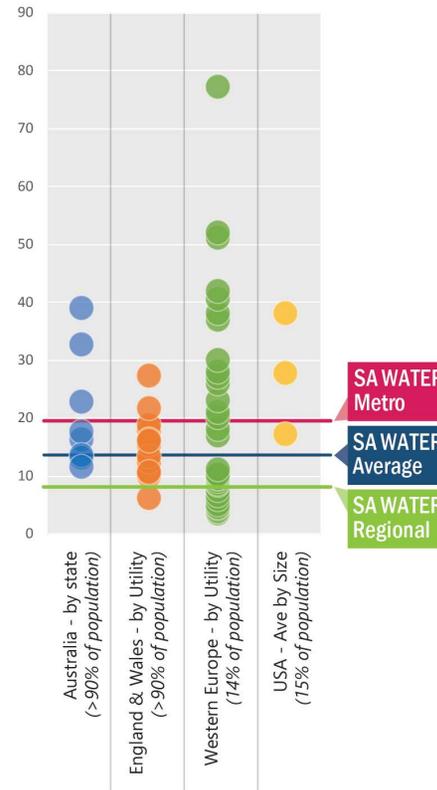
Annual Number of Failures in the Network (Metro vs. Regional)



Source: SA Water

Over the last 15 years the number of water main breaks has been reducing, but is above SA Water’s own targets in both regional and metropolitan areas for the most recent year. In 2018-19 SA Water had 13.6 breaks / year / 100km which compares favourably with Australian and international peers. However, break rates in the Adelaide metropolitan area are significantly higher at 19.2 breaks / year / 100km.

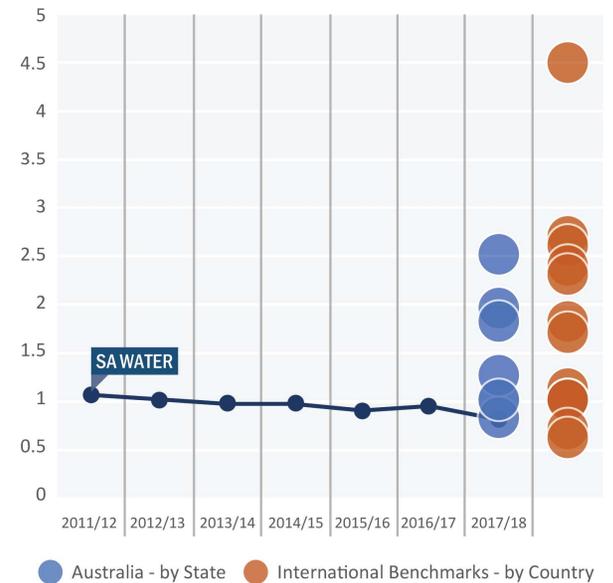
Water Main Breaks (Number/Year/100km)



Sources:

1. "National performance report 2017-18: urban water utilities, Bureau of Meteorology
2. "Service Delivery Report 17/18", Water Services Regulation Authority (Ofwat)
3. "Learning from International Best Practices – 2018 Water & Wastewater Benchmark", European Benchmarking Co-operation
4. "Water Main Break Rates In the USA and Canada: A Comprehensive Study", March 2018, Utah State University

Infrastructure Leakage Index



Sources:

1. SA Water
2. www.leakssuite.com
3. "National performance report 2017-18: urban water utilities, Bureau of Meteorology

SA Water performs favourably for Non-Revenue Water (including leakage), compared to both Australian and International peers and has been improving over the last 7 years as measured by the Infrastructure Leakage Index.

PERFORMANCE – RESPOND AND REPAIR

ESCOSA Targets – Metro

	2014/15	2015/16	2016/17	2017/18	2018/19	Target
Water Event Attendance	99%	99%	99%	98%	99%	99%
Water Quality Response	97%	98%	97%	97%	97%	96%
Water Service Restoration	98%	97%	98%	99%	99%	99%

Source: SA Water

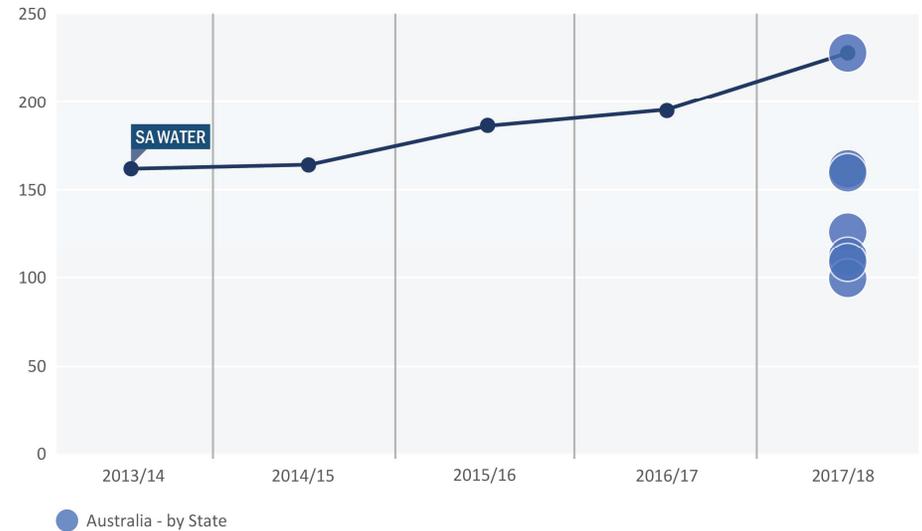
ESCOSA Targets – Regional

	2014/15	2015/16	2016/17	2017/18	2018/19	Target
Water Event Attendance	99%	99%	99%	99%	99%	99%
Water Quality Response	100%	100%	99%	100%	99%	96%
Water Service Restoration	98%	99%	99%	99%	98%	99%

Source: SA Water

SA Water achieved 5 out of the 6 ESCOSA targets for water main management in 2018-19 and performance has been improving over the last 5 years – in particular in the metropolitan area.

Average Duration of Unplanned Interruption (Minutes)



Source: Derived from National performance report 2017-18: urban water utilities, Bureau of Meteorology data. Calculated based on a weighted average by water main length.

In terms of average duration of an unplanned interruption, SA Water ranked 65th out of 71 Australian water utilities in 2017-18, Adelaide was the worst performing major urban centre in Australia and South Australia is the worst performing State in Australia. Performance has been deteriorating over the last 5 years.

SECTION 3

Analysis of SA Water Capabilities - Summary

Refer Appendix B for detailed assessment



ASSESSMENT OVERVIEW

This section contains a summary of the maturity of each of the nine capability areas, key observations and potential opportunities.

The assessment has been structured to align with the assessment methodology outlined earlier in this report. A detailed assessment of each of these capability areas is included in Appendix A.

ASSESSMENT INDICATORS

Throughout this review the following indicators are used to assist the reader understand the relative maturity of SA Water against its global peers for both water utilities and other utilities. These have been assigned based on the knowledge and experience of the review team, along with the research undertaken.



Some concerns with SA Water's approach and does not compare favourably with Australian or International Peers. Significant opportunities identified.



Fair degree of confidence in SA Water's approach and it aligns with typical practice when compared to Australian and International Peers. Some opportunities identified.

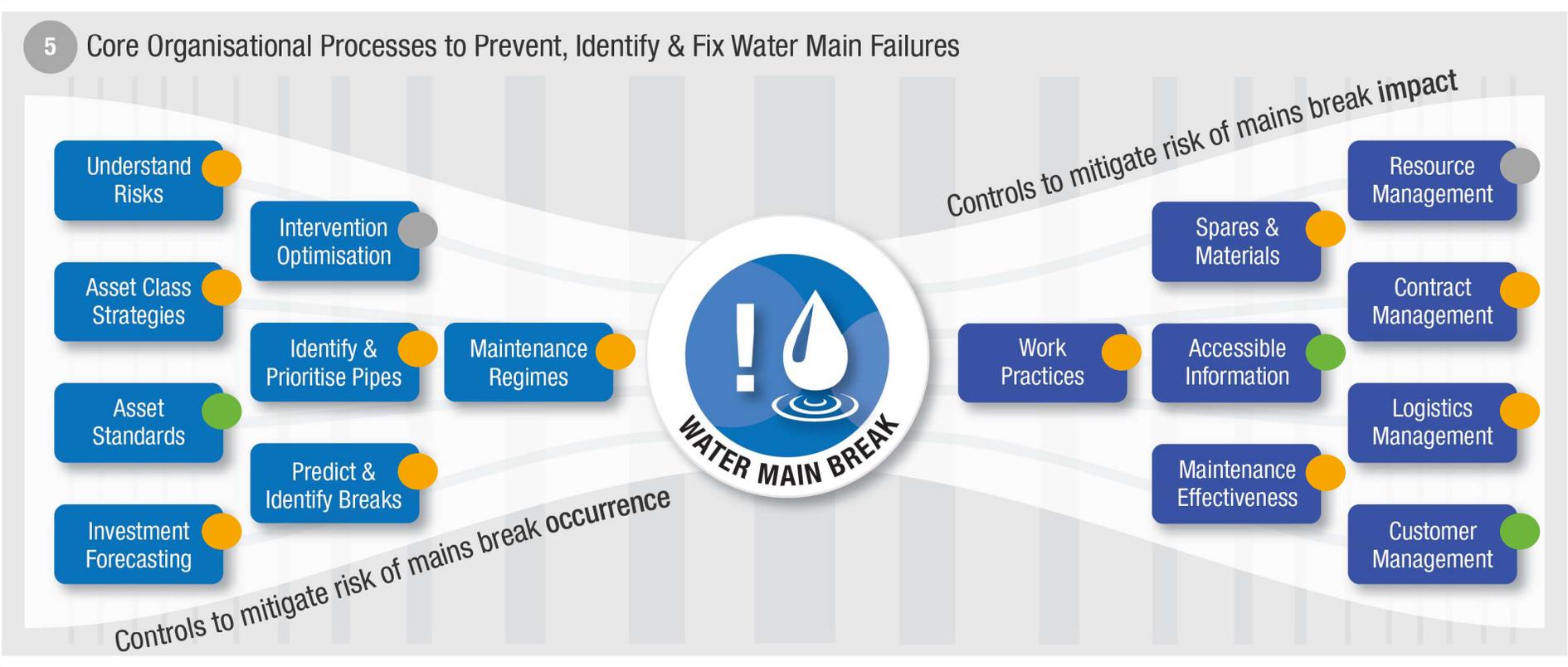


High degree of confidence in SA Water's approach and is similar to leading practice when compared to Australian and International Peers. Minor opportunities identified.

SUMMARY OF FINDINGS

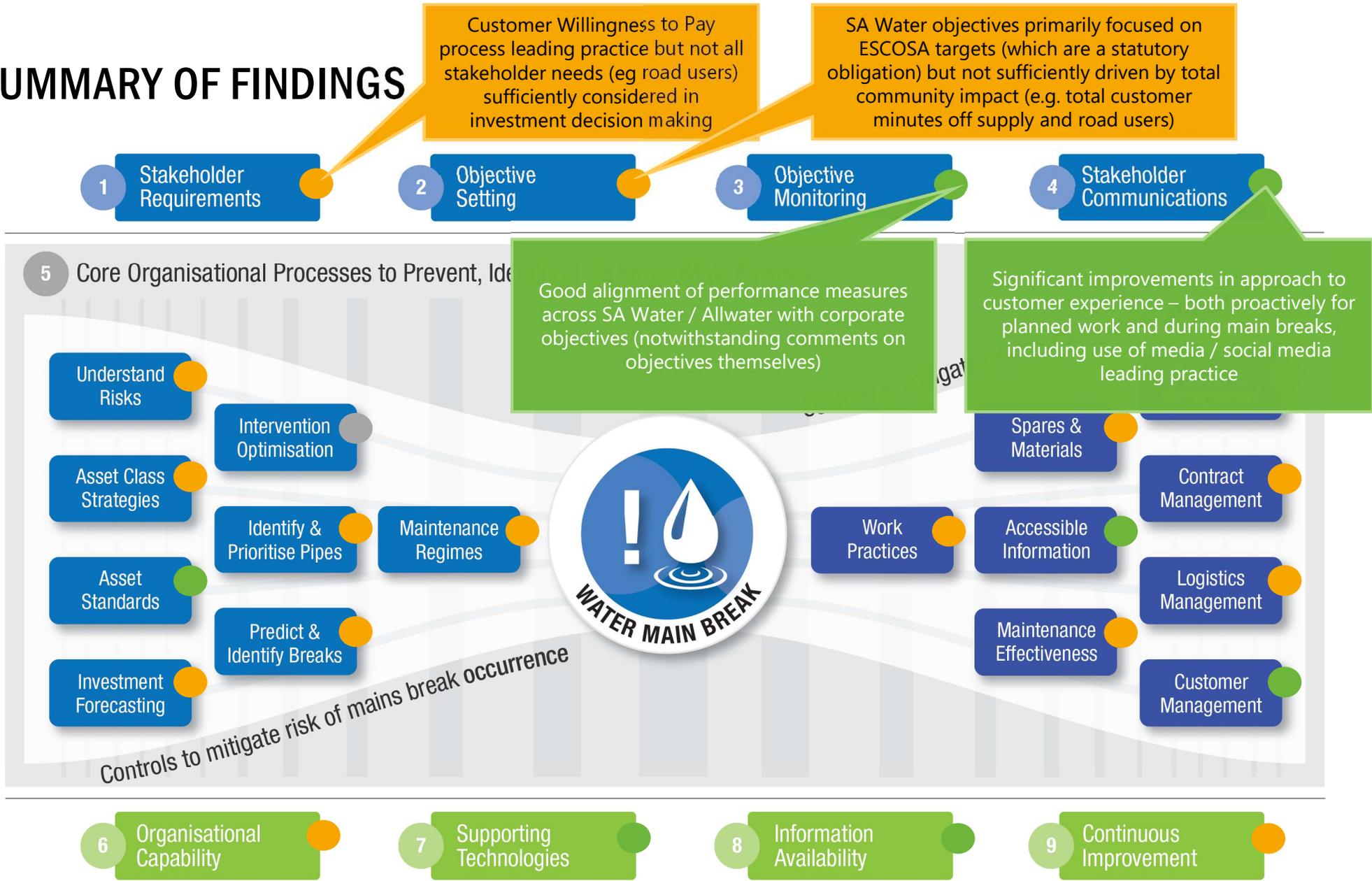
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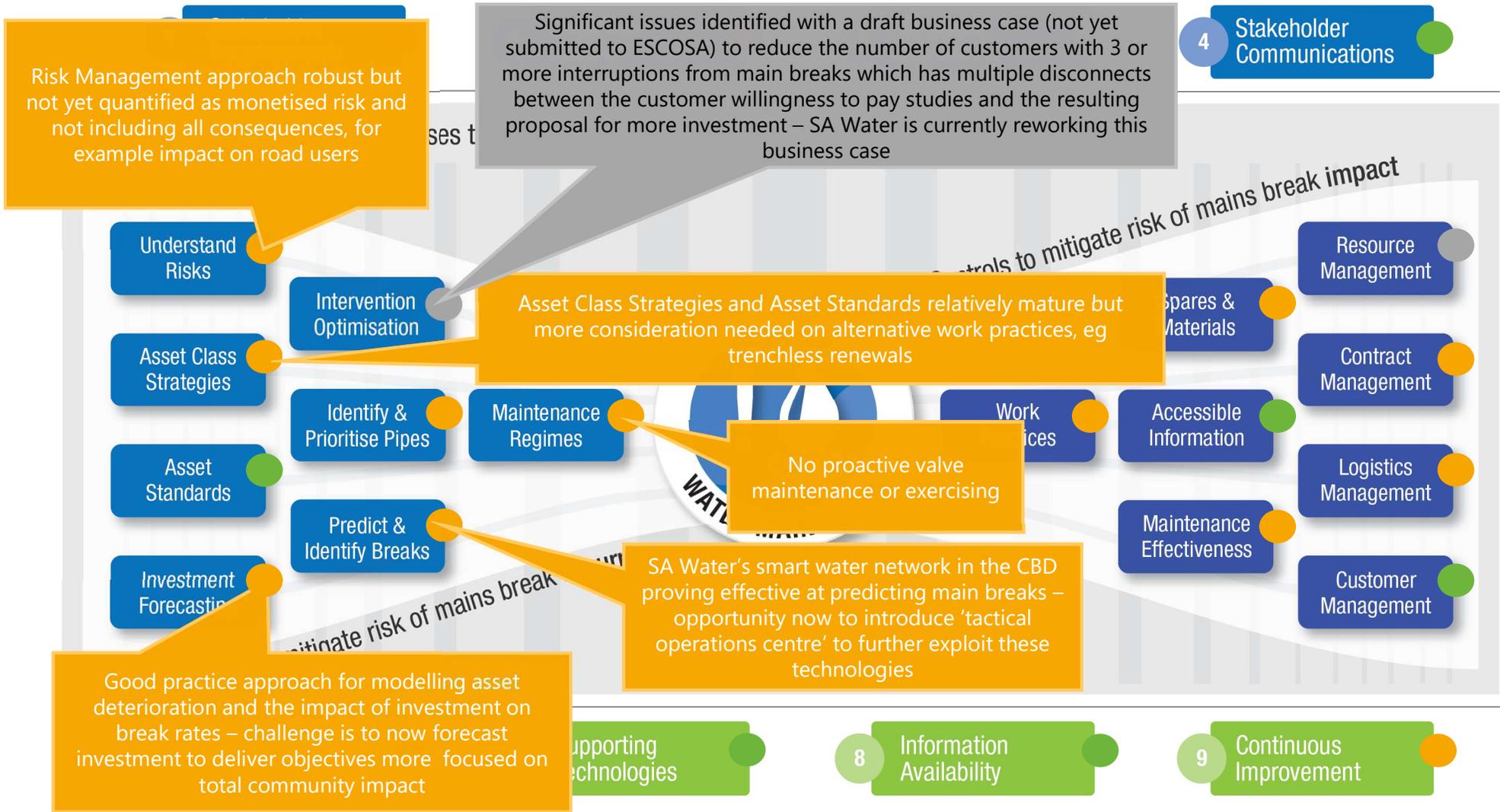


- 6 Organisational Capability
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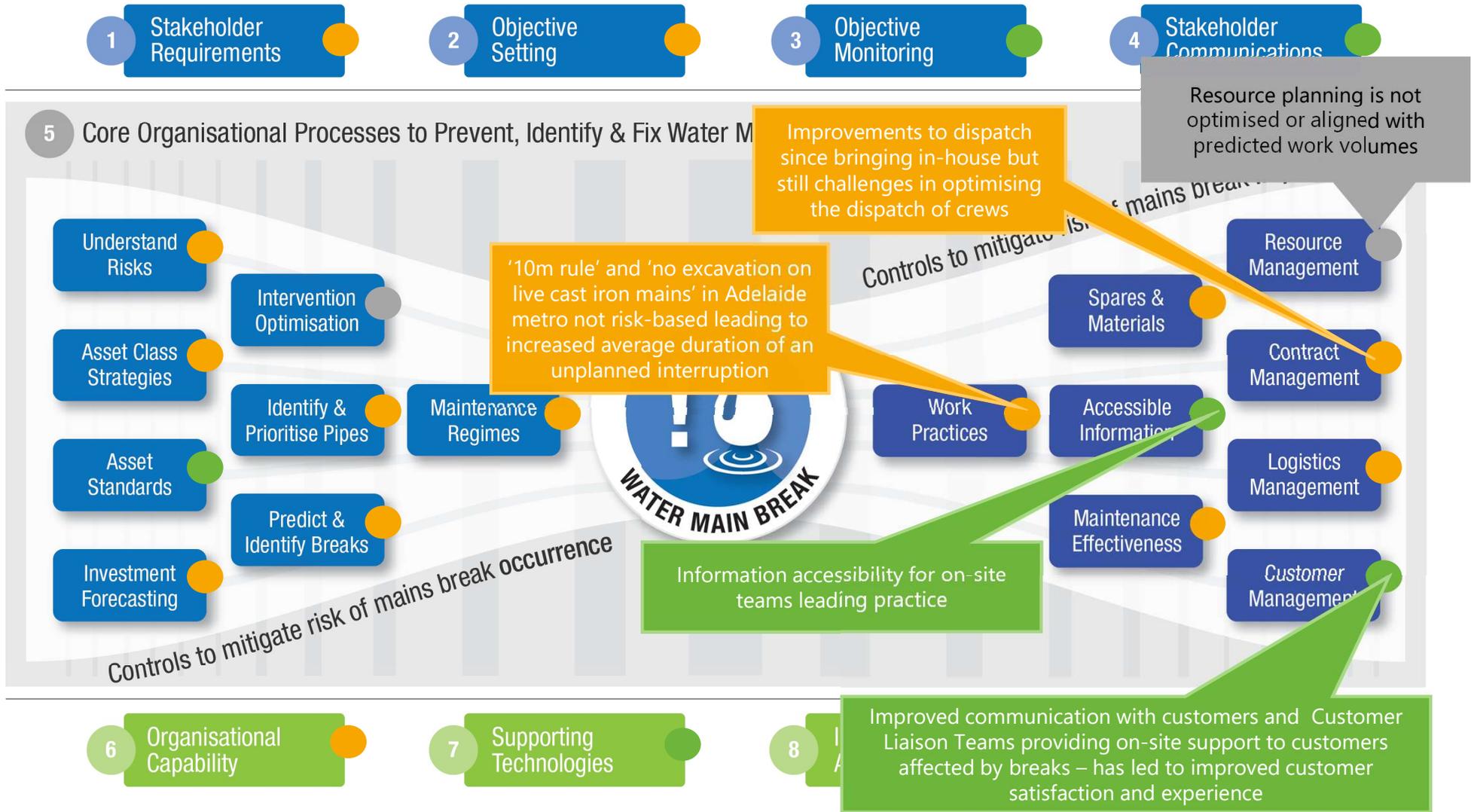
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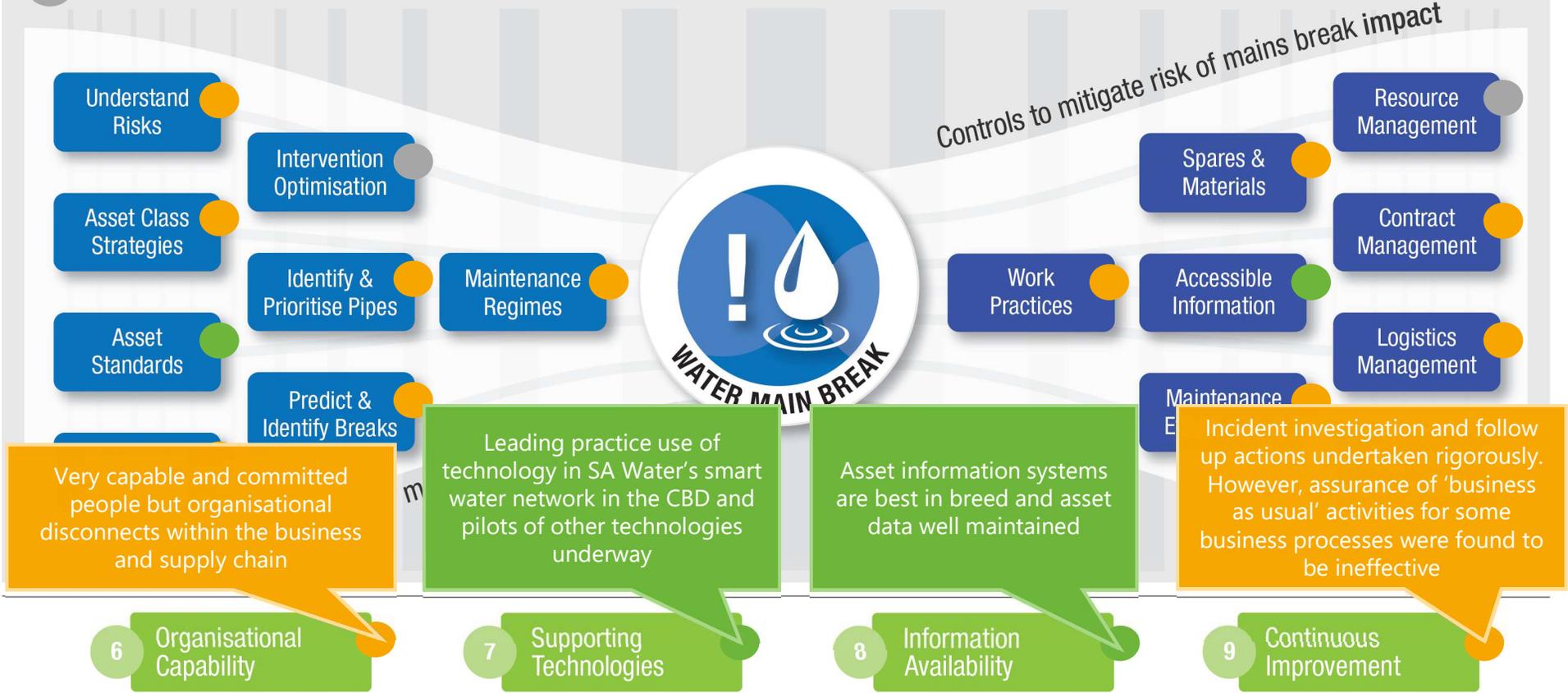
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SECTION 4

REGULATORY APPROACHES



LEADING PRACTICE REGULATION IN EUROPE

International Comparisons of Water Sector Performance is a report that compares the performance of the water sector in England and Wales since 1990 with that of key comparator countries, specifically France, Ireland, Italy, Spain and Germany. It examined the performance of six metrics.

Water quality - how good is the water that comes out of the taps

The quality of wastewater treatment - for which we've used secondary treatment processes as a proxy

Customer service

Non-revenue water - the amount of water 'lost' in the system through leakage, faulty meters or unauthorised use

The charge of water and wastewater to customers

The total cost to run the service per person

This report concluded that:

The water sector in England & Wales has outperformed those in France, Ireland, Italy and Spain since 1990 in terms of the most important service indicators. In five out of the six measures, the water sector is either the top performer or the most improved. In the sixth measure – the quality of sewage treatment – England & Wales is the second best performer. There is a strong case for stating that the England & Wales regulated system delivers the best value for money of all the utility sectors in this study. The model has driven up standards and increased efficiency.

Source: "International Comparisons of Water Sector Performance", Global Water Intelligence

OFWAT – APPROACH TO AMP 7



'At PR14, companies set their own performance commitments, which led to a number of similar, but not identical, definitions. As a result, it was more difficult to compare companies' performance than it would have been using measures with common definitions'

'It also became clear that it would be beneficial for these core performance commitments to be common for all companies, with common definitions for AMP 7'.

These commitments have significant financial rewards / penalties in the form of Outcome Delivery Incentives (ODIs).

At PR19, Ofwat's approach to ODIs will better align the interests of company management and investors with those of customers. ODIs should be financial rather than reputational as the default. Companies' ODIs should also be in period as the default. Any end-of-period ODIs should impact companies' revenue as the default. Companies can deviate from the default if they provide good reasons supported by evidence.

Companies can propose enhanced outperformance payments for frontier-shifting performance improvements, which must be accompanied by underperformance penalties for very poor performance.

Ofwat will not cap the total amount a company can earn from ODIs and are setting an indicative range of $\pm 1\%$ to $\pm 3\%$ of Return on Regulated Equity (RoRE) for financial ODIs.

Source: Delivering Water 2020, Ofwat, December 2017

OFWAT MEASURE OF WATER SUPPLY INTERUPTION

Water supply interruption is an indicator of the resilience of the water network, in particular how well a company can recover from an incident. This measure has been a key driver for innovation in the UK Water industry.

It is defined as:

'supply interruptions greater than three hours (expressed in minutes per property)'

It is calculated as:

$(\sum (\text{minutes} \times \text{connections without water}) / \text{total number of connections}) - 3 \text{ hours}$

Water supply interruption takes into account the number of customers affected and targets are set for each water company in England & Wales.

There are very significant penalties / rewards for over and under achieving these targets through the ODIs. This has resulted in significant innovation in the restoration of supply to customers, whereas traditionally the focus would have been on how quickly the fault could be repaired.

An example of this is the use of line stops and over-landers which have become a widespread and efficient practice for restoring service to customers whilst repairs are still being carried out.

Company Name	Commitment		Performance
	2017-18	2019-20	2017-18 Actual
Anglian Water	12.00	12.00	7.40
Bristol Water	12.80	12.20	73.70
Dee Valley Water	0.20	0.20	0.07
Northumbrian Water	5.56	5.00	5.23
Portsmouth Water	5.00	5.00	4.17
Bournemouth Water	4.40	4.40	0.70
SES Water	0.20	0.20	0.05
South East Water	12.00	12.00	44.60
Southern Water	9.00	9.00	16.90
South Staffs & Cambridge Water	10.00	10.00	8.53
Severn Trent Water	10.80	8.00	34.29
South West Water	0.23	0.20	0.37
Thames Water ⁽¹⁾	0.13	0.13	0.21
United Utilities Water	12.00	12.00	13.09
Dwr Cymru	12.00	12.00	43.40
Wessex Water	12.00	12.00	12.30
Yorkshire Water	12.00	12.00	6.96

(1) weighted minutes over 4 hours for Thames Water only

Source: "Service Delivery Report 17/18", Water Services Regulation Authority (Ofwat)

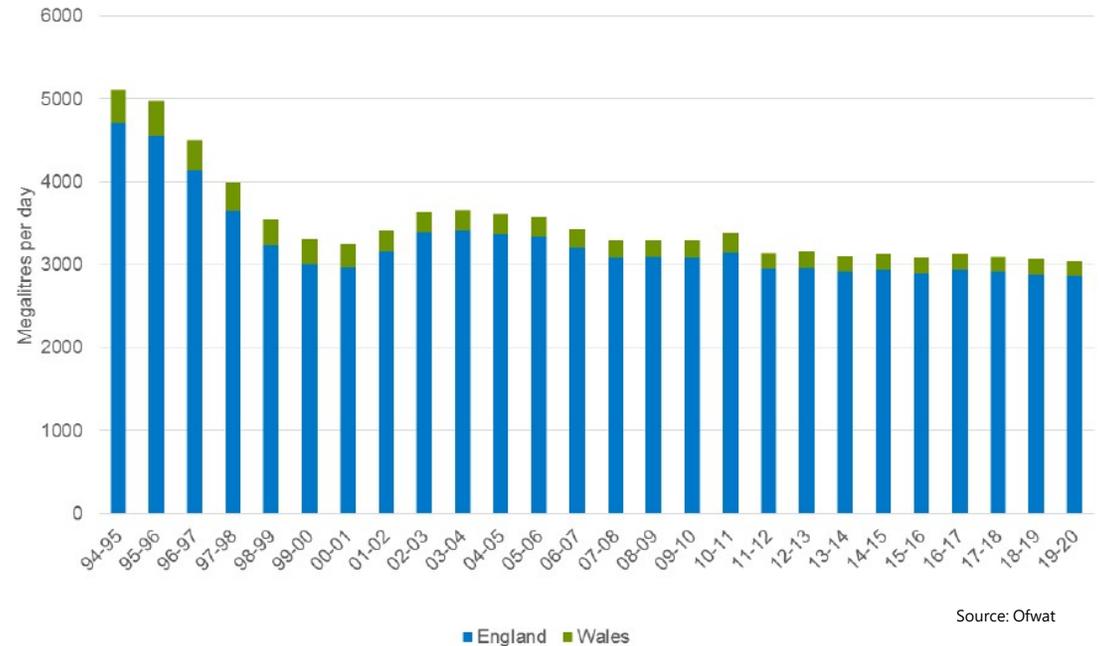
OFWAT PR19 APPROACH TO LEAKAGE

The Ofwat AMP 7 consultation process concluded:

'Historically, leakage targets and performance commitment levels were informed by the sustainable-economic level of leakage (SELL), which in theory delivers the most benefit to customers. We are concerned that this approach has not driven sufficient efficiency improvements or innovation in leakage reduction'

Ofwat also concluded that:

- *'SELL tends to maintain the status quo. This is the result of SELL being based on data that relates to the current knowledge of leakage components and leakage management costs.'*
- *'SELL does not incentivise efficiency or innovation. If companies' current active leakage control is inefficient, it will lead to a higher SELL and a less stretching target. This does not incentivise inefficient companies to become more efficient. It also does not drive innovation.'*
- *'Companies are risk averse. They found that due to companies' risk averse nature in relation to water resource planning, companies are reluctant to plan for lower levels of leakage for the long-term.'*



Source: Ofwat

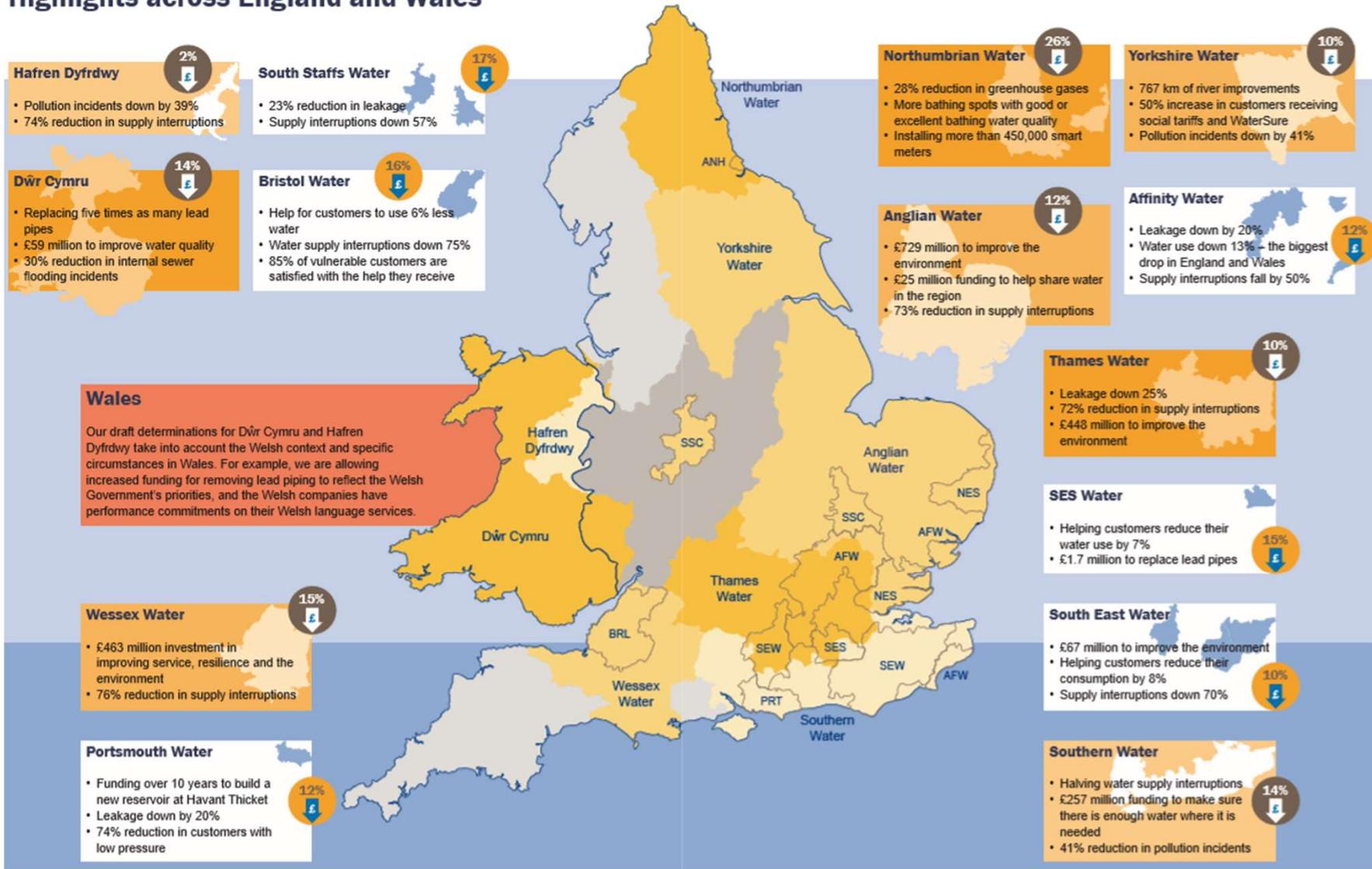
Ofwat now expects companies to propose stretching performance commitment levels to:

- *'achieve forecast upper quartile performance (in relation to leakage per property, per day and leakage per kilometre of main per day) where this is not being achieved – or justify why this is not appropriate;*
- *achieve at least a 15% reduction in leakage (one percentage point more than the largest reduction commitment at PR14) – or justify why this is not appropriate; and*
- *achieve the largest actual percentage reduction achieved by the company since PR14 – or justify why this is not appropriate.'*

SIGNIFICANT COMMITMENTS MADE BY UK WATER COMPANIES FOR PR19

Highlights across England and Wales

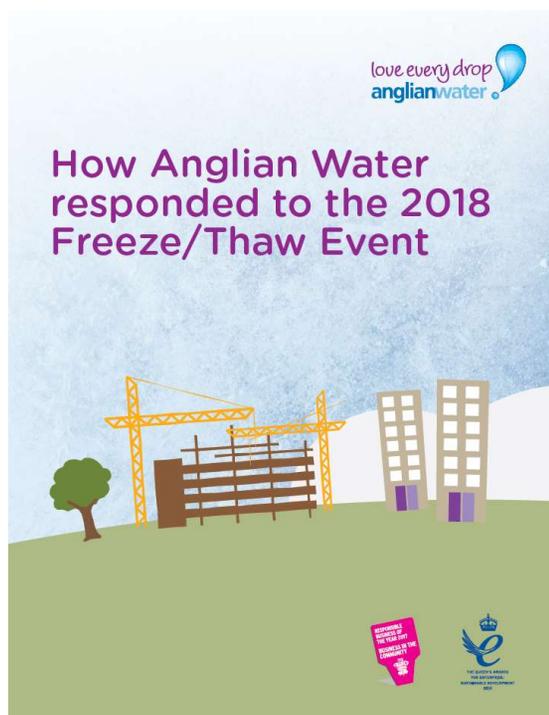
The percentage figure shows reduction in bills before inflation between 2020 and 2025



Source: "Final Determination 18 July 2019", Ofwat

LEADING PRACTICE CASE STUDY – ANGLIAN WATER

The 2018 Freeze-Thaw event in the UK (Beast from the East) put significant strain on infrastructure across the UK. In the water sector the rapidity of the thaw following an extended freeze caused unavoidable problems with burst mains and leaks from customer pipes and company networks. The combination of freeze and rapid thaw caused substantial ground movements and resultant mains bursts. Anglian Water's actions ensured that customer impacts were minimised. Almost no business customers were significantly affected (so cross-infrastructure effects were eliminated), and only 163 homes were off water for more than 12 hours. Over 99.6% of our customers experienced no impact from this event. Where problems did occur they were quickly rectified. Other business priorities continued to be progressed during the event.



The key factors leading to a good outcome for customers included:

- **Putting innovation at the heart:** The Insight and Data Science team drove the operational response to ensure resources were targeted to address areas of greatest need. This was enabled by previous investments in the Integrated Remote Intelligence Service (IRIS) system, including the Integrated Pressure and Leakage Management System (ILPM) and enhanced telemetry, condition monitoring and information systems.
- **Industry-leading position on leakage.** This means less network water losses putting the business in a better place to cope with spikes in demand that flow from an event like this.
- **Resilience approach, based on ISO22301.** This had been used to test the resilience of the company and its partnerships prior to the event.
- **Customer-centric approach of 'restore, repair, recharge'.** to focus first on meeting customer needs (including redeploying water recycling assets) rather than fault repairs.
- **The collaborative approach have pioneered with the supply chain.** The alliancing model allowed the business to quickly deploy 119 gangs and over 400 people to address problems.
- **The quality of customer and stakeholder communications,** both proactive and reactive, across all channels to try to reach the widest range possible.
- **Investment in resilience schemes.** This has reduced the numbers of customers dependent on a single source of supply which gave more options to minimise customer impacts in this event. The resilience planning systems were executed before and during the incident.

Source: "How Anglian Water responded to the 2018 Freeze/Thaw Event", Anglian Water, 2018

SECTION 5

CONCLUSIONS & RECOMMENDATIONS



CONCLUSIONS

- SA Water compares favourably on both the rate of water main breaks and the amount of leakage when compared to Australian and international peers, being in the best performing quartile for both measures.
- Even though SA Water met 5 of its 6 ESCOSA targets last year for attendance and restoration of main breaks, its performance on 'Average Duration of an Unplanned Interruption', not an ESCOSA target, does not compare favourably with peers and has been getting worse for several years.
- Of the 24 capability areas examined, 7 were found to be leading, 15 were found to be typical and there were only 2 areas where SA Water's approach did not compare favourably with peers. SA Water's capabilities to prevent and predict water main breaks, and to minimise the impact of these breaks once they have occurred, are similar to peers in Australia, UK and Europe in many areas and leading in others.
- The area (support to customers post water main breaks) where SA Water was most criticised after the Paradise event, is now considered a strength, which is a significant turnaround over the last few years.
- SA Water's use of modelling tools to link total investment needs with failure rates, technology deployed on the CBD smart water network to identify main breaks before they occur, and the management of asset information are also considered to be leading practice.
- A shift away (for small diameter reticulation mains) from a traditional renewal approach, where the oldest assets are replaced, towards renewal of those water mains that have the greatest repeat interruption on customers is positive.
- The two areas where SA Water's capabilities compare less favourably with its peers are resource management (where a more strategic approach to management of resources is required) and investment optimisation (which examines the business case and justification of investments). Opportunities to improve in both these areas will require a more integrated organisational approach.
- A draft (not yet finalised or submitted to ESCOSA) business case to reduce the number of customers with repeat interruptions (substantiated by a customer willingness to pay study) was examined in detail. The business case was found to include multiple disconnects between the customer willingness to pay study (shown in itself to be a leading practice) and the resulting proposal for more investment.
- SA Water's focus has been primarily on achieving ESCOSA targets which is a statutory obligation it must meet. However, these are aligned to customer response times and less so on driving investment to reduce total community impact including total customer minutes off supply and impact on road users.
- Experience in the UK and other Australian States has shown that more demanding measures focused on total community impact will deliver better outcomes to stakeholders.

KEY RECOMMENDATIONS

The strategic recommendations from this review are:

- Develop a more demanding objectives and incentive regime aligned more closely to total community impact, including total customer minutes off supply and impact on road users, similar to that used in the UK and Victoria.
- Develop an end-to-end value chain (including supply chain) to minimise the disconnects in the business and to ensure the 'line of sight' from all activities back to customer needs is visible and effective.
- Engender a more demanding culture that provides internal challenge and ongoing assurance throughout the value chain.
- Continue to develop innovative ways of reducing the total community impact of main breaks (e.g. total customer minutes off supply and road users) through improved processes, work practices and further deployment of SA Water's smart water network.

A number of more detailed potential improvement opportunities have been identified in the body of this report.

It is acknowledged that SA Water is already addressing many of these but it is recommended that all potential opportunities are reviewed and prioritised in light of this review.

ACKNOWLEDGEMENTS

AMCL would like to extend its thanks to all SA Water personnel for their constructive and enthusiastic contribution to this review.

Throughout the review, SA Water personnel have exhibited a strong desire to continue to learn and improve SA Water's practices in relation to the management of water mains.

APPENDIX A

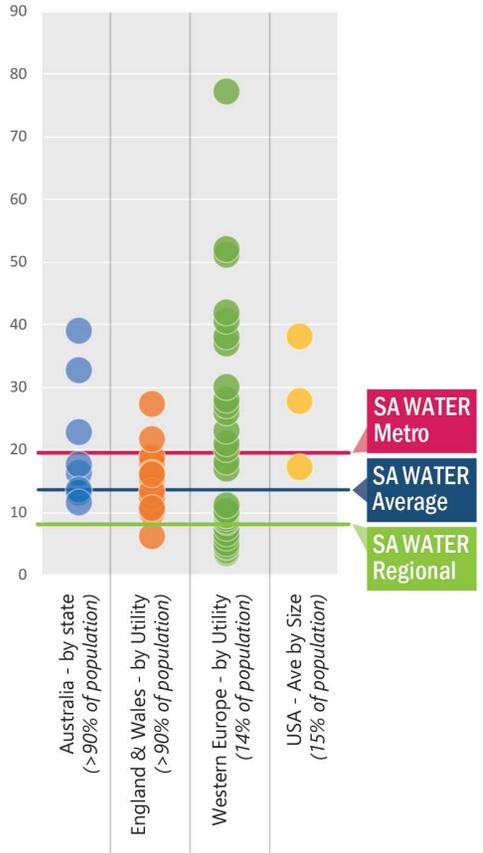
Detailed Analysis of Performance

Refer Section 2 for Summary Assessment



WATER MAIN BREAKS

**Water Main Breaks
(Number/Year/ 100km)**



Sources:
 1. "National performance report 2017-18: urban water utilities, Bureau of Meteorology"
 2. "Service Delivery Report 17/18", Water Services Regulation Authority (Ofwat)
 3. "Learning from International Best Practices - 2018 Water & Wastewater Benchmark", European Benchmarking Co-operation
 4. "Water Main Break Rates In the USA and Canada: A Comprehensive Study", March 2018, Utah State University

What are Water Main Breaks?

A water main break is classified as where the pipe barrel has either leaked (through a hole or crack caused by corrosion or ground movement) or where the pipe barrel has ruptured. Water main break rates (no. / 100km / year) is a common globally used metric to track the state of a water network. A greater rate can indicate a network that has more issues or is not being managed in an effective way.

How is SA Water Performing v Global Benchmarks?

SA Water (rate of 13.6 water main breaks / year / 100km) compares favourably to other utilities around the world. Water main break rates can provide an indication of how well a utility understands its network, prioritises and funds its investments, however, it does not provide a complete answer. There are many underlying factors that can influence the rate of water main breaks either positively or negatively, for example, method of installation (poor bedding exposes pipe to greater external forces), network age (older pipes generally fail more), pipe material types (certain types fail more dramatically, topography (can result in increased water pressure), soil types (dictates corrosion rates and soil expansiveness), and weather conditions (impacts wetting / drying) of soils. SA Water generally has expansive soils and a large proportion of the worst performing material types (cast iron and asbestos cement), and moderate network pressures. This can lead to higher failure rates. A significant proportion of SA Water's regional water mains are major pipelines (as a percentage of length) compared to Adelaide Metro. Major pipelines have lower levels of main breaks due to their management approach, which reduces the overall water main break rate of the regional area compared to Adelaide Metro. There are various definitions of what constitutes a water main break used around the world. The data presented here uses a similar definition of a water main break and so provides a reasonable comparison. Water main break rates are considered to be lagging indicators, where investment now (or lack of it) can take several years to show in long term performance.

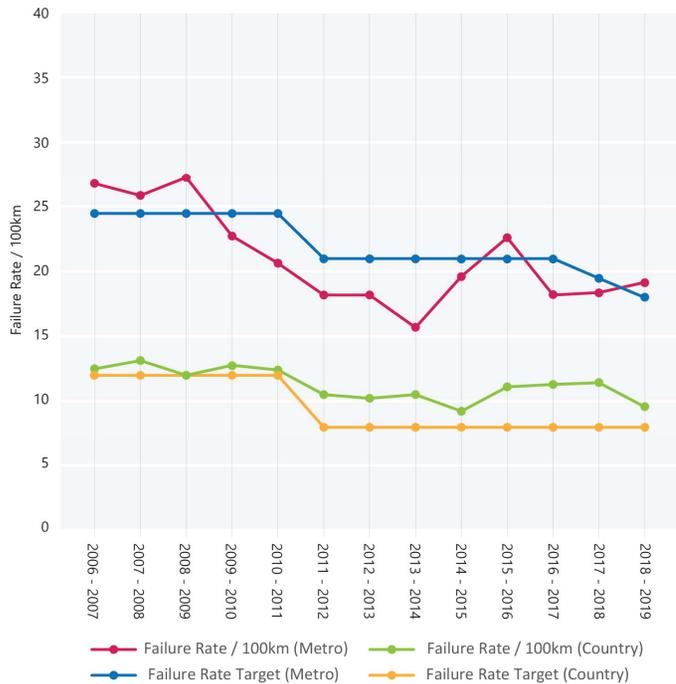
SA Water Approach

SA Water splits its water mains into three main categories to manage. Reticulation mains (smaller pipes providing water directly to the customers), trunk mains (mid sized mains transferring water to the smaller pipes) and major pipelines (those transferring water between regional areas over long distances). SA Water has a comprehensive knowledge of its pipe network, including age, location, material and contractor. This along with failure history and condition assessments are used to prioritise investments. A summary of the approach used is shown below.

	Maintenance Activities	Management Approach	Renewal
Reticulation Mains	<ul style="list-style-type: none"> Monitor for leaks, repair when break 	<ul style="list-style-type: none"> Track main break history Condition assessments of a sample of failed pipes 	<ul style="list-style-type: none"> Replace based on number of breaks that occur
Trunk Mains / Major Pipelines	<ul style="list-style-type: none"> Flush mains, monitor for leaks, repair when break 	<ul style="list-style-type: none"> Detailed condition assessments for full mains 	<ul style="list-style-type: none"> Replace based on condition, failure history and consequences of failure

WATER MAIN BREAKS – HISTORICAL PERFORMANCE

Annual Number of Failures in the Network (Metro vs. Regional)



Source: SA Water

How is SA Water Performing?

SA Water has been tracking and targeting the reduction of water main breaks for many years. It tracks and monitors water main breaks for the Adelaide metro and regional areas, as well as the trunk mains and major pipelines.

SA Water has no ESCOSA service standard for water main breaks. SA Water has a self imposed target of <16.7 main breaks / 100km / year for Adelaide Metro and <8 main breaks / 100km / year for the regional area, which was set to maintain the current level of performance. The regional target includes the major pipelines which effects this metric.

SA Water has reduced its target over the last 25 years which it is using to drive new approaches to reduce the number of breaks. SA Water is currently failing to meet its self imposed metrics.

Adelaide Metro: The number of main breaks over the last 25 years has reduced substantially for the Adelaide Metro network, now approximately two thirds of the number from the 1990's. Annual fluctuations are mainly due to weather changes.

SA Water Approach

SA Water has undertaken several initiatives over the last few years to reduce the number of water main breaks. The SA Water smart water network has included a network of over 300 sensors designed to identify pipe leaks before they result in an uncontrolled break, which has not reduced the number of total breaks, but has reduced significantly the number of uncontrolled breaks, thus reducing impacts on the community. Active pressure network management and reduction of network pressure fluctuations has also reduced mains breaks in some areas.

SA Water has recently undertaken research in life extension practices for Cast Iron, Asbestos Cement and High Density Polyethylene pipe materials. This research has identified leading practices from other utilities adopted in Australia and Europe. The outcomes of this research has the potential to extend the life of these materials and enable much improved life prediction (and water main break rates). SA Water plans to undertake research into tracking soil moisture through embedded sensors. These practices are yet to be adopted.

Potential Opportunities

- Separate metric between controlled leaks and uncontrolled breaks, to demonstrate benefits of SA Water's smart water network.
- Improve forecasting of pipe lives / water main breaks by adopting the SA Water research. Adopt some of innovation approaches to life extension that SA Water has already identified.
- Link water main rate predictions to resourcing levels – SA Water can predict a few months in advance the likely increase in main break rates through weather patterns, but information not currently used.
- Further extend SA Water's CBD smart water network with increased use of hydrophone sensors, especially along trunk mains in high traffic areas to assist in identifying potential main failures before they occur.
- Consider customer smart meters (beyond auto meter reading), which have deep penetration in Europe and increasing in Australia. Can assist leak detection, main break identification, pressure calming, response times. SA Water has had a minimal rollout of smart meters and is considering extending it further. The SA Water business case has primary focused on customer side benefits with minimal quantification of network benefits.

TRUNK WATER MAINS – WATER MAIN BREAKS

Trunk Mains – What are they?

SA Water has 1,304km of trunk water mains that are fed by service reservoirs, with the majority located within urban areas (especially Adelaide). Depending on the network design (level of localised redundancy) a failure of a trunk water main may impact customer supply. As many of the trunk water mains are located along major roads, a failure can lead to significant traffic disruption and due to the pressure and volume of water can lead to significant property damage. Many of the trunk mains have redundancy and therefore can often be repaired with minimal impact of customer supply, but due to the number of customers they supply if there is no redundancy they can impact the supply to many customers. Trunk mains are expensive to build, maintain and repair. The best practice approach to managing these pipelines is to avoid failure and renew/repair before they break.

Trunk water mains failures have led to many of the high profile water main failures that SA Water has experienced in the last five years, including the Paradise Main and those along South Road.

How is SA Water Performing?

SA Water has no ESCOSA service standard. SA Water has a self imposed target of <10 main breaks / 100km / year, which was set to maintain the current level of performance.

SA Water until recently was just meeting the target, but a review of historical data has recategorised many of the historical main breaks, so this target is now easily being met.

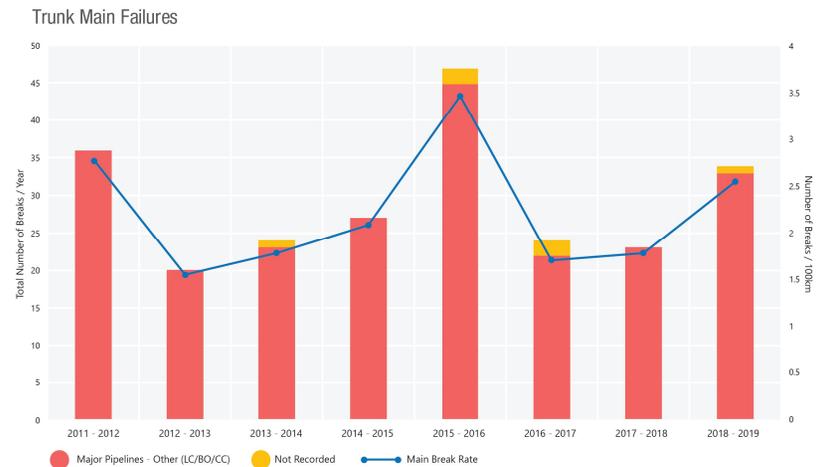
Trunk mains are typically included within the total number of main breaks published by water utilities so no direct benchmarks are available, however, the rates are similar to data available from other water utilities. The number of main breaks over the last 8 years has remained fairly stable with an increased focus on these mains occurred post the Paradise Main incident.

SA Water Approach

SA Water has a comprehensive condition monitoring program for trunk mains, which enables the majority of pipeline issues to be identified and fixed before they occur. SA Water uses a risk based prioritisation approach to target investments, though the current approach is considered to be not as mature as other utilities and industries. SA Water is currently improving this approach, which will more closely align it to leading practice. There has been increased investment in trunk mains in the last few years, though this investment has been prioritised based on condition and failure history, and not necessarily on total community impact (e.g. total customer minutes off supply and road users).

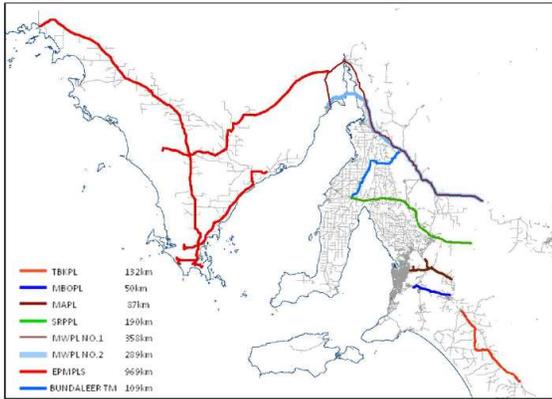
Potential Opportunities

- Demonstrate linkage between major pipelines breaks and impact on customers. Forecast the likely future impact on customers.
- Reconsider the target – the current target conflicts with the objective of avoiding failure of trunk mains and is potentially too high.
- Risk prioritisation approach – continue to evolve to enable a greater connection between failure and the total community impact (e.g. total customer minutes off supply and road users), considering the time to repair, redundancy and emergency management plans. Approach to move beyond a simple multiple criteria analysis to quantifying real impacts.



Source: SA Water

MAJOR PIPELINES – WATER MAIN BREAKS



Major Pipelines – What are they?

SA Water has 2,175km of major pipelines that are fed by several major pump stations and dams, which transport water across long distances with the majority outside of urban areas. Typically (though can be influenced by a number of factors) a failure of a major pipeline has minimal impact (if they are repaired quickly) on supplying customers (due to storage within the network) or impact on the community (as they are mostly in rural areas). Most of these pipelines have no redundancy and therefore need to be repaired quickly to prevent customers from losing supply.

Major pipe lines are expensive to build, maintain and repair. The best practice approach to managing these pipelines is to avoid failure and repair before they break. Many of these major pipelines are categorised as 'State Critical Infrastructure'.

How is SA Water Performing?

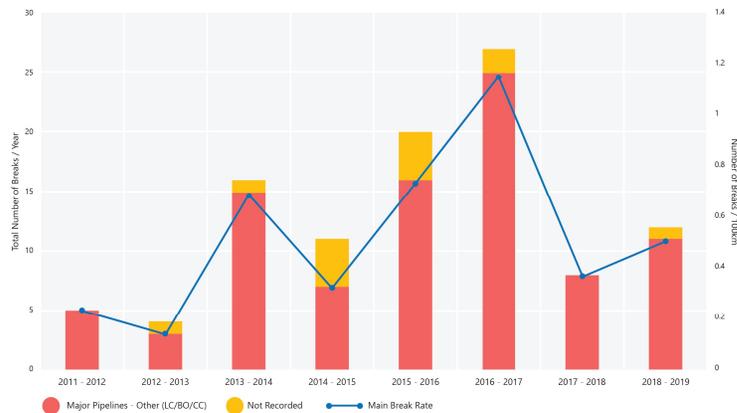
ESCOSA has not set SA Water a service standard. SA Water has a self imposed target of <4 main breaks / 100km / year, which was set to maintain the current level of performance and not adversely impact customers.

SA Water was until recently just meeting its target, but a review of historical data has reduced the number of real (not weeps) mains breaks that have occurred, so this target is easily being met.

Major pipelines are each unique assets and very few other utilities have a network as extensive as SA Water's so benchmarking is not considered to be meaningful.

The number of main breaks over the last 8 years has been generally increasing as the major pipelines have aged. There has been a downward trend over the last two years, however, though this is very positive it is difficult to determine if this is sustainable due to the relatively few breaks that do occur and the historical volatility of the number of breaks. SA Water has not forecasted into the future the likely number of breaks.

Major Pipeline Failures



SA Water Approach

SA Water has a comprehensive condition monitoring program for major pipelines, which enables pipeline issues to be identified and fixed before they occur.

SA Water uses a risk based prioritisation approach to target investments, though the current approach is considered to be not as mature as other utilities and industries. SA Water is currently improving this approach, which will more closely align it to leading practice.

Several of the current regulatory period proposed capital projects are intended to reduce the likelihood of major pipeline breaks, however, it is not clear what the impact will be on the future water main break rates and customers.

Potential Opportunities

- Demonstrate linkage between major pipelines breaks and impact on customers. Forecast the likely future impact on customers.
- Reconsider the target – the current target conflicts with the leading practice objective of avoiding failure of major pipelines (especially state critical assets) and is potentially too high, especially as the data has been recategorised.
- Risk prioritisation approach – continue to evolve to enable a greater connection between failure and the total community impact (e.g. total customer minutes off supply and road users), considering the time to repair, redundancy and emergency management plans. Approach to move beyond a simple multiple criteria analysis to quantifying real impacts.

Source: SA Water

NON REVENUE WATER (INCLUDING LEAKAGE)

Infrastructure Leakage Index



Sources:
 1. SA Water
 2. www.leakssuite.com
 3. "National performance report 2017-18: urban water utilities, Bureau of Meteorology"

SA Water Approach

SA Water has (like all mature water utilities) a comprehensive understanding of non revenue water, well established programs to improve both apparent (metering errors) and real loses. This includes pressure control, active leak detective, pipe replacement, improving data, reducing unauthorised consumption, and improving the accuracy of both it bulk meters and customer meters.

The current approach appears to target maintaining the current level of non revenue water, though this is not stated or aligned to an Economic Leakage Level (as adopted in the UK and some Australian utilities (eg Sydney Water). A number of improvement actions have been outlined, though the economic or environment benefit each will deliver is not clear.

Non Revenue Water – What is it?

All water supply networks have unaccounted for water, which is water that is not billed to customers. It includes real leakage (through joints and breaks), network flushing (water quality maintenance) and metering errors. The objective of all water utilities is to be able to accurately measure the flow of water through the network and reduce real leakage through economic decision making to a point where it is costs more to reduce the leaks than to source, treat and transport the water.

How is SA Water Performing?

Measuring non revenue water is not straight forward and various metrics have been developed to enable comparisons and support investment decision making. The Infrastructure Leakage Index is one method that is used by many utilities around the world and attempts to give an indication of real leakage against operating needs and metering errors. The ideal value is 1, but some utilities operate below this level.

SA Water had a value of 0.8 (1.2 in Adelaide / 0.7 in regional SA) in 2017/18, which is at the low end compared to many other utilities around Australia and internationally.

SA Water does not have an ESCOSA service standard for non revenue water. An internal target of 2.06 kL/km/day (approx. equivalent of ILI of 1) has recently been set.

SA Water customer willingness to pay analysis indicates that customers do not want to pay more to reduce leakage.

Potential Opportunities

- Calculate Economic Leakage Level (ELL) and use it for justification of setting performance targets. It must be clear that if the desire is to move beyond the ELL then it is for customer satisfaction or environmental reasons.
- Set target to incentivise reductions, similar to the UK, where continued reductions must be achieved through innovation thereby driving down the ELL, which is similar to the approach adopted by IPART.
- SA Water has plans to calculate non revenue water for smaller distribution areas to enable a more targeted approach. This approach aligns to leading practice.
- Rollout of a larger smart water network to enable greater pressure management and leak detection in real time.

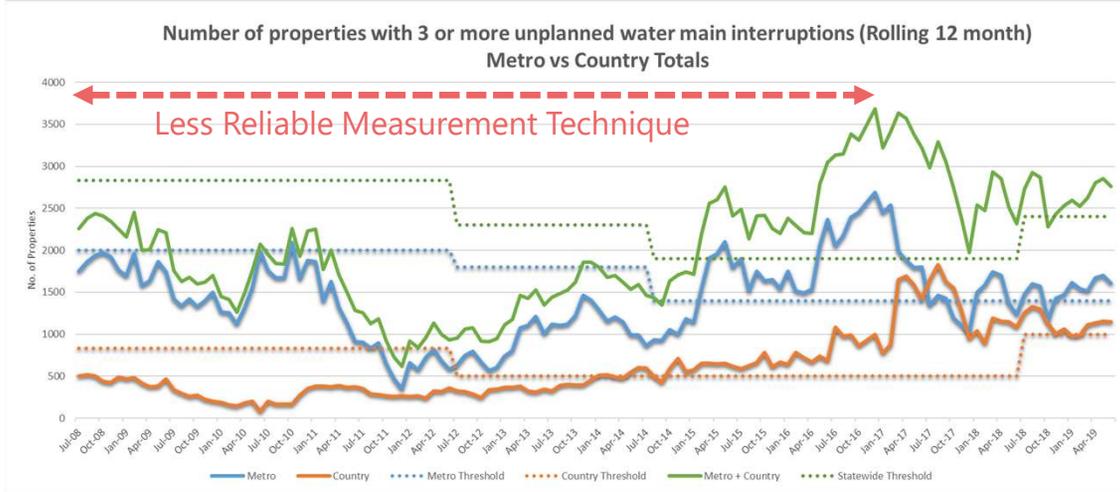
PROPERTIES WITH 3+ UNPLANNED INTERRUPTIONS PER YEAR

Unplanned Interruptions – What are they?

The number of unplanned interruptions represents the number of times within a year that a customer has lost supply (for an hour or more – as defined by some utilities – SA Water has no time limit) without being notified. Customer 'outrage' increases exponentially with each additional unplanned interruption, so many water utilities track this measure and aim to minimise the number of customers who experience repeat unplanned outages within a 12 month period. This measure is used extensively within Australia by regulators (eg IPART and ESC) to track utility performance, however, is not used widely outside of Australia by regulators.

How is SA Water Performing?

ESCOSA has not set SA Water a service standard. SA Water has self imposed targets for the number of customers experiencing 3 or more outages for both its Adelaide Metro and Country areas. SA Water is currently failing to meet both these metrics. SA Water's performance against this metric and its targets have deteriorated considerably over the last 10 years, however, SA Water in 2017 enhanced its method to collect the number of customers impacted by each water main break. SA Water has stated that data pre 2017 should not be relied upon. Over the last two years the performance has remained fairly constant and due to several contributing factors no trend should be relied upon for this period. SA Water recently increased (relaxed) its target as it was considered that the metric was not achievable during the period. Due to different measurement techniques and metrics it is not possible to benchmark this metric against other utilities.



Source: SA Water

SA Water Approach

SA Water tracks the number of unplanned interruptions for every customer and has recently enhanced this algorithm. An analysis model is used to prioritise water main replacements and target mains that have had multiple failures, caused 3 or more interruptions to customers, poor pipe condition based on assessments of a sample of failed pipes and the length of time of the interruptions.

The approach is focused on the reticulation (small diameter mains) as the majority of trunk mains and major pipelines have considerable redundancy.

The approach adopted by SA Water to manage this metric is considered to align with leading practices used by other water utilities both within Australia and internationally.

Potential Opportunities

- Review targets – the target of 3 or more interruptions is not used in the UK and is becoming less widely used in Australia, where some utilities have moved towards 6 or more, or the total number of minutes off supply.
- Review method for setting targets – targets should be costed and understood before being set.
- Number of unplanned interruptions is considered a customer centric measure, however, other water utilities use it with a combination of other metrics to minimise the level of customer 'outrage', including:
 - Notification of unplanned outages through email / SMS.
 - Interruptions during peak periods.
 - Rebates provided through Guaranteed Service Levels (GSL's) as used in the UK and other Australian States (for breaking service standards, for example, the number of unplanned water supply interruptions or not notifying customer of planned or unplanned outages).

AVERAGE DURATION OF AN UNPLANNED INTERRUPTION

Average Duration of Unplanned Interruption (Minutes)



Source: Derived from National performance report 2017-18: urban water utilities, Bureau of Meteorology data. Calculated based on a weighted average by water main length.

Average Duration of an Unplanned Interruption – What is it?

The average duration of an unplanned interruption is the average time a customer is without water supply due to an unforeseen interruption that requires attention by the utility. (Source: National Performance Report, Bureau of Meteorology).

This is not an ESCOSA target. Instead SA Water is set targets by ESCOSA as restoring supply for three priority classes of water main breaks within set time periods (Priority 1 = 5 hours; Priority 2 = 8 hours; Priority 3 = 12 hours).

Average Duration of an Unplanned Interruption is calculated by SA Water for inclusion within the National Performance Report, but is not used as an internal performance benchmark. Other water utilities use the average duration of an unplanned interruption (minutes) (common in Australia) as well as the total number of minutes of interruption / per customer (UK utilities). Others use total customer minutes off supply including both planned and unplanned outages.

How is SA Water Performing?

ESCOSA has set SA Water a service standard of restoring supply for 99% of cases. SA Water has met 5 out of 6 targets for Water in the last year and has been steadily improving its performance over time.

However, SA Water has over the last 8 years has had a steady increase in the average duration of an unplanned interruptions, even though it has continued to meet its ESCOSA targets. South Australia benchmarks as the worst state in Australia for the average duration of an unplanned interruption.

In the last few years, two practices as SA Water (Allwater) has changed, as a result of safety issues, that has contributed to a decline of its performance. SA Water (Allwater) in the Adelaide metro has chosen not to excavate 'live' cast iron water mains and not work on mains that are within 10m of a connected live main where thrust protection does not exist or is unknown. This has resulted in an increase of time to repair mains as larger sections of the network must be isolated and more customers have lost supply. These practices have not been applied in the regional areas. A requirement to transport spoil over a greater distance due to a central site closure in the Adelaide metro area has also contributed to declining performance.

SA Water Approach

SA Water tracks its performance against its ESCOSA targets closely (included within multiple SA Water's managers KPI's and a key Allwater KPI) and makes management / resource decisions to achieve these targets. Some practices are being implemented to reduce the average duration of an unplanned interruption, however, SA Water (Allwater) was not able to present a rigorous approach to reduce times. Best in class water utility in Australia (SE Water) has had long term approach to reducing average duration of an unplanned interruption. Rigorous incentives in the UK have driven water utilities to substantial reduce times over several years, including new innovative ways to complete work of water mains.

Potential Opportunities

- Add additional metrics (and set targets) including tracking total customer interruption minutes (for both planned and unplanned) similar to the UK water utilities, and electricity utilities / metro rail business around the world).
- Adopt a proactive approach to reducing time to restore supply (including identified innovation methods adopted in the UK including use of line stops) – no detailed (currently at a high level) assessment has been undertaken of the time breakdown to restore from dispatch, network operations & field work. Allwater has commenced 'ride alongs' to start this detailed analysis as well as identified other potential improvements, including expanding capability (valve operation for <150mm mains) of field teams, and optimising field crew resource positioning.
- Undertake rigorous risk assessment of implemented practices – and potential identify other risk mitigation approaches. Review approach to approve and adopt practices across the entire business.

ESCOSA Targets – Metro

	2014/15	2015/16	2016/17	2017/18	2018/19	Target
Water Event Attendance	99%	99%	99%	98%	99%	99%
Water Quality Response	97%	98%	97%	97%	97%	96%
Water Service Restoration	98%	97%	98%	99%	99%	99%

ESCOSA Targets – Regional

	2014/15	2015/16	2016/17	2017/18	2018/19	Target
Water Event Attendance	99%	99%	99%	99%	99%	99%
Water Quality Response	100%	100%	99%	100%	99%	96%
Water Service Restoration	98%	99%	99%	99%	98%	99%

Source: SA Water

APPENDIX B

Detailed Analysis of SA Water Capabilities

Refer Section 3 for Summary Assessment



FINDINGS: STAKEHOLDER REQUIREMENTS

How is SA Water Performing?

- Changes in SA Water to be more customer focused is positive and evident in the culture of the business.
- Significant efforts have been made to understand customer requirements and needs in the event of a water main break.
- Customer willingness to pay has been considered in decision making but we are not confident in the reliability of the willingness to pay conclusions around setting budgets for delivering these outcomes. This conclusion is based on the one draft business case that was reviewed during this assessment. Other business cases were not tested, so the applicability of this finding to other business cases is not known.
- Insufficient consideration of road users - DPTI has proposed dollar values for interruptions to road users, however, this has not yet been incorporated into decision making and reporting.
- SA Water Board has been engaged in recent conversations around setting organisational KPIs through workshops. This has included discussions on risk appetite and trade-off's between various objectives, including their achievability.

Evidence / Good Practice

- *Ofwat - Delivering Water 2020 – Our Final Methodology for the 2019 Price Review* place a very heavy emphasis on understanding customer requirements and ensuring these are embedded in the Water Companies' approach including significant financial rewards and penalties.
- *UK Water Public Interest Commitments, April 2019* – UK Water (on behalf of all UK Water Companies) has set five key goals for the industry for 2030; 1) triple the rate of sector-wide leakage reduction, 2) end water poverty, 3) achieve carbon net zero carbon emissions, 4) eliminate equivalent of 4 billion plastic bottles and 5) achieve 100% commitment to social mobility pledge.
- Frontier Economics report *Performance Commitments and ODI incentives at PR19* on the effectiveness of willingness to pay.

Potential Opportunities

- Continue to develop the customer willingness to pay analysis but widen the scope to include all stakeholders including road users. Scenario's being tested could be more tangible and a sensitivity analysis being undertaken.
- Further develop the transparency with which the outcomes from customer willingness to pay analysis are incorporated into decision-making.
- Ensure stakeholder requirements are fed into the process of determining objectives and measures for SA Water, including Water Security, Resilience & Climate Change.
- Engage further with the SA Water Board to ensure KPIs (and incentives) reflect the desired total community impact (e.g. total customer minutes off supply and road users) and aligns with leading practices for regulated water (and non-water) utilities.

FINDINGS: OBJECTIVES

2

Objective
Setting

3

Objective
Monitoring

How is SA Water Performing? - Objective Setting

- SA Water objective framework demonstrates alignment between business strategy, corporate objectives and asset class objectives. However, these objectives are primarily focused on ESCOSA targets (which are a statutory obligation) and not sufficiently on total community impact (e.g. total customer minutes off supply and road users).
- ESCOSA targets are less mature when compared to more mature regulatory environments (eg ESC (Victoria) and Ofwat (England and Wales), some are not very demanding on SA Water and do not align with total community impact (e.g. total customer minutes off supply and road users).
- Confusing use of language between AM objectives and Level of Service statements and inconsistencies in objectives across different documents.
- Unclear in certain documentation whether objectives are annual, over the regulatory period, or relate to 2028.

How is SA Water Performing? - Objective Monitoring

- SA Water tracks and monitors KPI's in across the business. KPI's are monitored at several layers in the business and used to drive business improvements.
- SA Water and Allwater KPIs are aligned with internal and ESCOSA objectives (even though these objectives are not reflective of all customer and other stakeholder needs).
- Many KPIs are rated as 'green' but not necessarily an indicator of satisfied customers and stakeholders, as the KPIs are not measuring the full customer impact of supply interruption for planned & unplanned interruptions and not reflecting impact on traffic / community disruption.

Evidence / Good Practice

- Ofwat Outcome Delivery Incentives.
- SAIDI / CAIDI in the electricity industry.
- Weighted customer minutes delay used by London Underground.
- Portugal performance management system – aimed at middle management to get alignment of decisions to corporate objectives.

Potential Opportunities

- Review the organisational and AM objectives in light of customer & stakeholder expectations and international leading practice.
- Consider introducing more demanding / customer focused objectives and incentive regime aligned more closely to total community impact (e.g. total customer minutes off supply and road users).
- Improve the consistency of objectives in all SA Water documents and ensure it is clear what timeframe these objectives relate to.
- Align the Performance Management Framework that tracks achievement of these objectives throughout the value chain.
- Establish more tangible risk appetite statements linked to objectives to assist the business in their application and decision making.

How is SA Water Performing?

- There has been an increased focus on Customer Service over the last few years
- SA Water has significantly improved its capabilities and approach to dealing with customers in the event of a water main break, which has included a new Customer Delivery Group with Customer Liaison Officers dedicated to dealing with customers.
- SA Water is also proactive in using the media to try to create positive messaging with customers and road users about planned and ongoing work.
- Regular Customer engagement surveys are undertaken.
- Communication with customers via text messages to inform of planned and unplanned work that will impact them.
- Regular engagement with the wider water sector through industry bodies and peer to peer contact.

Evidence / Good Practice Example

- Anglian Water – Summary of response to 2018 Freeze-Thaw event.
- Anglian Water created Tactical Operations Team keep customers informed of our plans and prioritise workloads – this has become the driving force of restore teams and uses telemetry to rezone / re-valve to minimise impact on customer. Also responsible for scheduling the repair teams with clock monitoring against the 3 hour measure.
- Engaging in the circular economy – case study of city of Copenhagen.

Potential Opportunities

- Opportunity to better integrate customer service group and operations control in order to reduce the number of interface points in the event of a water main breaks. At present, though these groups are located in close proximity, they are managed through different areas of SA Water, and considering how these groups interface on a daily basis could enable improved network and customer outcomes.

FINDINGS: CORE PROCESSES (1)

How is SA Water Performing?

- SA Water has several processes for assessing risks and using them in decision making. These are aligned to its corporate risk framework.
- SA Water uses a risk model to rank and prioritise investments for the reticulation, trunk mains and major pipelines. These models use historical failure history for assessing likelihood of failure, and a multi criteria analysis for estimating consequences of failure.
- Risk is not quantified in dollars.
- SA Water has recently developed a water main management bowtie diagram to assess the maturity of the controls in the management of water mains. This bowtie assessment is still draft has not yet been used to support assurance activities.
- Criticality is inconsistently used across the business.
- Risk relating to traffic interruption is not included in risk models, though this is being considered for the new prioritisation models being developed.
- Assessment of overland flow paths is not included in the risk models.

Evidence / Good Practice Example

- Many electricity rail and rail businesses have developed fully quantified risk models for assessing investments. Ofgem (UK) has developed a guideline for UK distribution and transmission businesses. AER has developed a guideline for Australia electricity distribution and transmission businesses. Western Power is a leading electricity in Australia in the quantification of risk.
- WSAA has developed a guideline for undertaking risk assessments of water networks.
- SE Water is an example of a mature risk assessment methodology for water mains, including the estimation of traffic impacts.
- *Australian National Guidelines for Transport System Management* provides methodology for valuing interruptions to road users.
- Anglian Water WISPA model – 2018 Freeze-Thaw review for details – analysed and increased resilience of the network if critical assets were lost.

Potential Opportunities

- Risk to be quantified in dollars and used in decision making and risk models (including impact on road users).
- Draft bowtie for water main breaks to be finalised and used for risk assessments, mitigation strategies or assurance controls.
- Develop a consistent approach to criticality and use this in AM decision-making and embed in GIS / Maximo.
- Continue to implement a new method / tool to enable risks to be assessed from all threats.
- Utilise insurance pay-outs for property damage to help quantify the risk to property.
- Consider developing the assessment of overland flow paths not included in the risk models.

FINDINGS: CORE PROCESSES (2)

Asset Class
Strategies

Asset
Standards

How is SA Water Performing? - Asset Class Strategies

- Separate strategies exist for each of the main components of the water supply system. Key strategies exist for the reticulation network, trunk / major pipelines, non-revenue water, metering, and the smart water network. Strategies present the approach to manage the asset class, along with how it will be managed to align with the objectives and investment plans aligned to condition and outcome requirements.
- Some of the AMS documents (SAMP, LAMP, Life Cycle Approaches, Asset Management Plans) are somewhat repetitive.
- Work undertaken to understand deterioration modes of pipe types (cast iron, asbestos cement, HDPE) to extend life has been based on global research and assisted through the relationships possible through Allwater shareholders. This has included assessing changing water quality parameters (eg pH) and water pressure to potentially extend asset life.
- Trenchless v Open Trenching – SA Water for the majority of cases replace mains based on open trenching. SA Water has trialled trenchless technologies in the past (without achieving the full desired outcomes) and based on these learnings are working with WSAA to develop an Australian Standard before attempting a greater roll-out.
- Innovation program within the business and processes / assessment tool being developed. CEO led recent 'ripple effect' workshops.

How is SA Water Performing? - Asset Standards

- Standards / types have evolved over time and are updated in response to asset issues / root cause analysis investigations.
- Good example is where the pipe material standard (PVC PN 20) has been introduced to assist in network pressure calming.

Evidence / Good Practice Example

- Anglian Water has moved from ~90% trenched to ~90% trenchless with ~50% carbon reduction over a number of years.
- Anglian Water Innovation shop window.
- Research into material and fittings for certain environmental / geotechnical conditions.

Potential Opportunities

- Undertake a review of trenchless renewals vs open trenching and consider the full economic, social and environmental impacts of both approaches approach. SA Water is currently working with WSAA to develop an Australian standard for trenchless technologies to enable greater consistency of approach from contractors as previous trials have not had all the expected outcomes.
- SA Water trunk mains / major pipelines life cycle approach document does not reflect updated approach. SA Water is currently redeveloping this approach document.
- Simplify / align description of alignment of objectives through the SAMP, LAMP, Life Cycle Strategies / AMP's and reduce duplication.

FINDINGS: CORE PROCESSES (3)

Investment
Forecasting

Intervention
Optimisation

How is SA Water Performing? - Investment Forecasting

- SA Water uses the PARMS model to forecast future investment needs based on testing various scenarios against the current service objectives.
- SA Water forecasts future investment needs 25 years in advance based on current objectives.
- Need to further develop these models to forecast future investment needs to reflect total community impact (e.g. total customer minutes off supply and road users).

How is SA Water Performing? – Intervention Optimisation

- SA Water uses a combination of risk and service levels to prioritise investments. This includes an assessment of the risk before and after the investment and the likely impact of service levels. Capital projects are linked to service outcomes within the asset management plan.
- SA Water has not historically linked investment to willingness to pay assessments, however, for the planned upcoming regulatory submission to ESCOSA, service outcomes priority and investment levels have been influenced by a willingness to pay analysis. A planned increase in investment is linked to the willingness to pay, which will potentially assist in reducing the number of customers experiencing three or more service interruptions within a year.
- As an outcome of the questioning through this review, SA Water has identified significant assumptions and some errors that were made in the development of this draft business case. This draft business case had been through some level of internal SA Water review though had not been through a final independent review or submitted to ESCOSA.
- Other draft business cases have not been tested through the AMCL review and the findings applicability to other business cases is not known. As an outcome of finding these errors, SA Water is reviewing the drivers for water main investment and will reset any future business case on those drivers. An overview of issues found are outlined on the next page.
- 'Negative' willingness to pay (where customers are asked about a lower level of service) are not considered for reducing existing business plans.

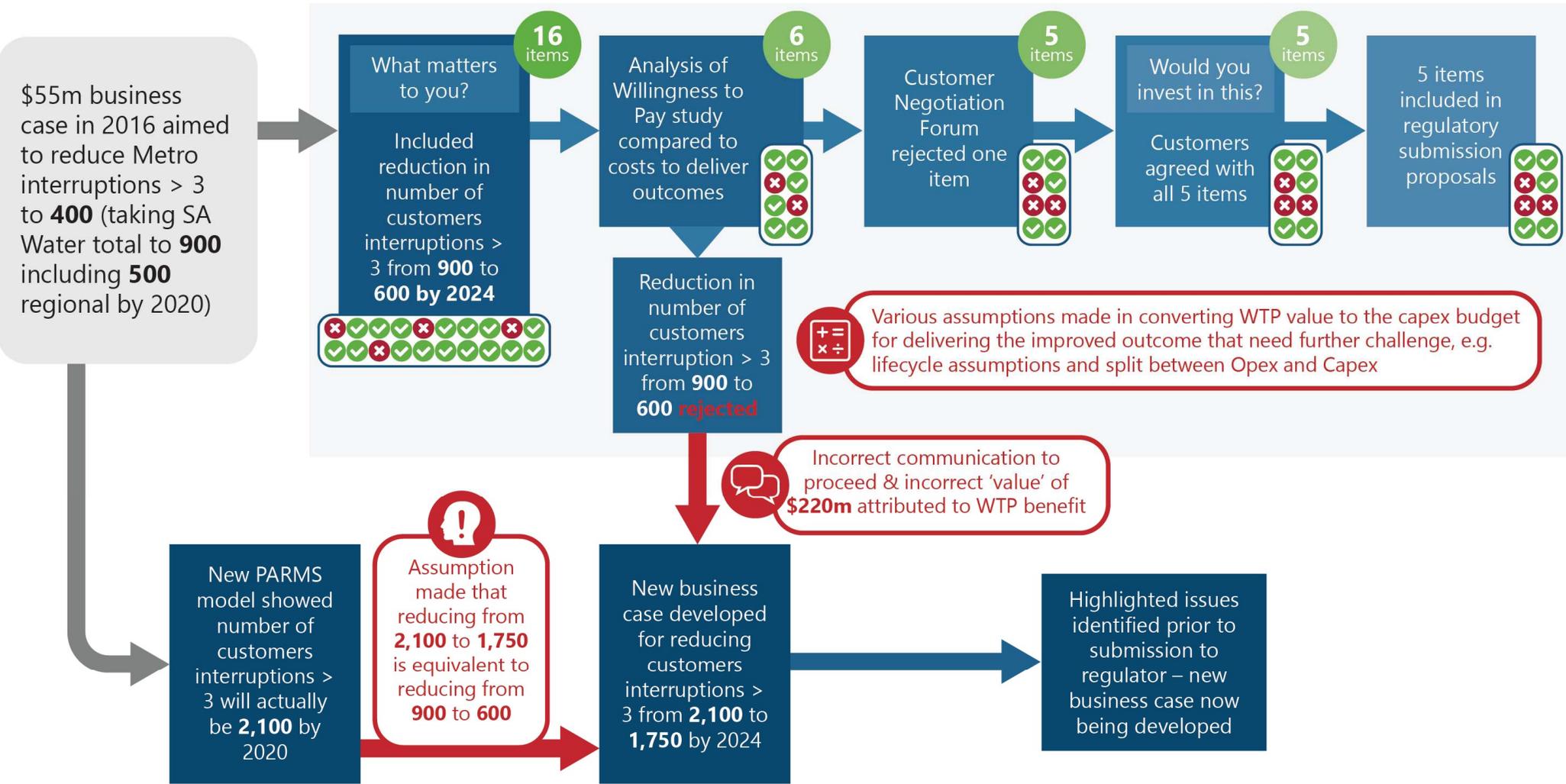
Evidence / Good Practice Example

- AMCL Market study into Asset Investment Planning solutions contains a range of good practice examples of tools and case studies.
- Frontier Economics report *Performance Commitments and ODI incentives at PR19* on the effectiveness of willingness to pay.

Potential Opportunities

- Business case process needs more robust challenge and assurance to ensure 'line of sight' is maintained with stakeholder requirements.
- Include full value of total community impact (e.g. total customer minutes off supply and road users) cost in business cases.
- Current deterioration models are quite well developed, however, they are backward looking (i.e. based on historical data only). Based on current R&D at SA Water there is the potential to move these models from backward looking to forward looking and significantly improve the forecasting of future asset lives and main break predictions.
- Current approach being adopted by Ofwat is not to solely rely upon willingness to pay for justifying business cases, and that it is only one of several inputs that should be considered.

ISSUES IN BUSINESS CASE FOR REDUCING CUSTOMERS IMPACTED > 3 TIMES



FINDINGS: CORE PROCESSES (4)

Identify &
Prioritise Pipes

Predict &
Identify Breaks

How is SA Water Performing? – Identify & Prioritise Pipes

- Good deterioration models and understanding of future failure rates.
- Reticulation pipes: SA Water tracks the number of unplanned interruptions for every customer. An analysis model is used to prioritise water main replacements and target mains that have had multiple failures, caused 3 or more interruptions to customers, poor pipe condition based on assessments of a sample of failed pipes and the length of time of the interruptions.
- Trunk main & major pipelines: Current approach is based on a combination of condition and a multi criteria approach to estimate consequences of failure. Current approach is currently being redeveloped by SA Water.

How is SA Water Performing? – Predict and Identify Leaks

- Long term prediction – within risk / investment prioritisation models.
- Short-term (real-time) - Smart water network (leak prediction) rolled out in the Adelaide CBD only and has been quite successful – enabled potential uncontrolled breaks to be identified before they occur.

Evidence / Good Practice Example

- Anglian WISPA Model –linking asset performance data / weather history and soil type – drives burst predictions and therefore resource needs – calibrated number of predicted main breaks to actual numbers, accuracy of which is measured and reported by Ofwat.
- Anglian Water Tactical Operations Centre providing greater focus for real-time monitoring of network / alarms.
- TransGrid (NSW) and NYPA (USA) have implemented asset –centric control rooms to monitor SCADA / sensors. AI used to predict faults.
- Smartball solution used by Scottish Water (although SA Water has previously trialled its use with limited benefits).

Potential Opportunities

- Continue to evolve risk prioritisation approach to enable a greater connection between failure and the total community impact (e.g. total customer minutes off supply and road users). Approach to move beyond a simple multiple criteria analysis to quantifying real impacts.
- Based on current R&D at SA Water there is the potential to move these models from backward looking to forward looking and significantly improve the forecasting of future asset lives and main break predictions.
- Increased level of pressure modulation to further calm the network – maybe able to assist in Allwater excavation on 'live' cast iron mains.
- Further rollout of smart meters to be identify network transients and main breaks in real time.
- Introduce enhanced network control room used for monitoring and analysing assets in real-time – this can also potentially be used to assist the field staff in real-time make decisions on how the main break should be repaired, carry out further testing, manage local pressures etc.

FINDINGS: CORE PROCESSES (5)

Maintenance Regimes

Work Practices

Maintenance Effectiveness

How is SA Water Performing? – Maintenance Regimes

- No proactive planned maintenance regimes specific for valves.
- Condition assessments are specified and regularly undertaken for trunk mains and major pipelines.

How is SA Water Performing? - Work Practices

- Rule based approach to work practices has been adopted by Allwater in some instances which has resulted in longer average duration of an unplanned interruption, e.g. 10m rule and excavating on 'live' cast iron mains.
- Line stops are not commonly used to minimise impact on customer interruption, though overlancers and temporary supplies are regularly used in regional areas where there is opportunity and need (critical customers etc).
- SA Water approach is not to extensively use a trenchless approach to pipe renewals due to historical issues with consistency of contractors and cost. SA Water is actively pursuing an approach to enable a greater use of trenchless technologies.

How is SA Water Performing? – Maintenance Effectiveness

- Maintenance execution (where specified) appears to be undertaken to plan, including condition assessments, water main flushing, leak detection.
- Valves maintenance is reactive and not proactive. SA Water looking at program of valve maintenance / exercising.
- Alliance meetings are regularly held where maintenance delivery / effectiveness is reviewed.

Evidence / Good Practice Example

- Anglian Water has adopted 'Restore' teams who focus on restoring service to customers using Line Stops and other innovative work practices.
- Typical UK approach for working on live mains would be to undertake a risk assessment for each location based on set of criteria.
- Use of line stops is common place in the UK to more quickly restore service to customers.
- Iota (SE Water) trialling the use of smart key for valves – tracks the number of turns to open and then close the valves – looking at embedding within the configuration management system.

Potential Opportunities

- Develop proactive maintenance regimes for valves. Undertake valve reliability centred maintenance (RCM) analysis.
- Consider adoption (has been trialled) of line stops to reduce number of customer interruptions and reduce restore times in some cases.
- Though some grouping of work orders is undertaken by dispatch through 'Click', further grouping of similar work orders (to minimise travel time) requires improvement for both planned and reactive work.
- Need to identify location / facility for dumping spoil – existing facility has been closed and is causing extended period to restore service to customers – on the urgent list for Allwater, but requires a collaborative approach with SA Water to rectify.

FINDINGS: CORE PROCESSES (6)

Spares & Materials

Accessible Information

How is SA Water Performing? – Spares & Materials

- Historical issues of non-catalogued spares – project underway to bring these spares under inventory - >50% now complete.
- Inventory managed through Ellipse for Regional but Maximo for Allwater – some interfaces with Maximo for tracking spares against jobs.
- Work in progress to identify critical assets and to justify spares holding according to the risk associated these critical assets.
- Part of the business continuity plans and managed through key depots / warehousing.

How is SA Water Performing? – Available Information

- Onsite teams appear to have sufficient, up to date information from tablets using Aquamap.
- Ability to update valve status information robust.
- Examples of silo thinking relating to information systems – Click / Maximo / Website leading to potential insufficiencies of information provision for onsite teams.
- Effective user community for the 'work order app' and other systems to ensure feedback is obtained from users and considered for future versions.

Evidence / Good Practice Example

- Network Rail in the UK has contracted VS Supply Chain Solutions for the supply of materials and consumables as part of an initiative to transform its material & logistics supply chain covering a wide range of general consumables, commodities and rail specific spare, consolidating the supply from over 300 suppliers.

Potential Opportunities

- Need to improve access for Allwater staff to SA Water systems – issue with being able to be able to stay logged on for long periods – inhibits the ability productively use the system. Currently underway.
- Identify critical assets and develop business cases for critical spares holding to reflect the risk associated with critical assets.
- Complete task to bring all spares holdings under formal inventory management.

FINDINGS: CORE PROCESSES (7)

Resource
Management

Contract
Management

How is SA Water Performing? – Resource Management

- Resource management not managed strategically - no alignment of resource numbers to forecast work volumes.
- Poor planning of work leads to inefficient use of resources – Allwater aware and working with SA Water on this.
- Dispatch making decisions on resources but not accountable for budget (most relevant for Allwater) – primary driver is meeting ESCOSA targets and not delivering efficiently.
- Allwater resource 'slates' not accurate causing planning difficulties.
- Utilisation of Allwater field crews and contractors is currently measured using simple metrics and not provided to SA Water.
- SA Water (Allwater) has split the work day into two shifts to better align workforce availability with workload. Due to industrial relations constraints these shifts are staffed by unionised and non-unionised employees which has resulted in training / competencies variations.

How is SA Water Performing? – Contract Management

- Allwater is an Alliance – alliance meetings are regularly held and evidence of good relationships. However, some practices do not necessarily lead to the optimal outcome for customers, for example, though there was engagement with SA Water relating to changing work practices (10m rule and excavation on 'live' cast iron mains), the decisions have resulted in increased average duration of an unplanned interruption.
- Limited incentive to minimise total community impact (e.g. total customer minutes off supply and road users) for both Allwater and regional areas – primary focus is on ESCOSA requirements (which are a statutory obligation), though other measures are used.

Evidence / Good Practice Example

- Anglian Water's @ One Alliance has resulted in a collaborative approach with its supply chain, including:
 - Forecasting work volumes (The alliance and its resource needs are aligned to a view of the network condition and potential impacts over a 10+year period.)
- Joint measurement of outcomes.
- Switch teams to planned activities before weather events / switch teams to unplanned during events.
- Teams are flexible to be switched between planned / unplanned work / across boundaries.

Potential Opportunities

- Review forms of metro Adelaide contracts to improve its collaborative approach and outcomes. Include incentive to minimise impact to customer. This review has already began as a result of SA Water previously recognising these issues.
- Review accountabilities for making decisions on resources and budget.
- Improve alignment of resource numbers to forecast work volumes.
- Potential for better planning of work to minimise waste and to ensure work is delivered more efficiently.
- Develop measures of productivity and utilisation for regional (work in progress) and Allwater (undertaken but improvements are planned for greater insight and granularity) and share with SA Water to identify improvement opportunities.

FINDINGS: CORE PROCESSES (8)

Logistics
Management

Customer
Management

How is SA Water Performing? - Logistics Management

- Improvements to dispatch since bringing in in-house but still challenges in optimising the dispatch of crews.
- SA Water has implemented 'Click' to assist in streamlining the dispatching of work crews. Implementation of 'Click' has not delivered the automation benefits expected.
- Click rollout had no defined measures of success – was expecting 90% automation but so far had only achieved ~10% originally but now up to 20% for Metro and 30% for Regional.

How is SA Water Performing? – Customer Management

- This is an area of strength with the an increased customer focus over the last few years.
- New single point of contact improving communications and Customer Liaison Teams providing on-site support to customer affected by breaks.
- New CRM has been introduced to manage the customer experience / history.

Evidence / Good Practice Example

- Other UK water utilities have had significant benefits from Click but are now replacing it with a next generation tool.
- Anglian Water – Summary of response to 2018 Freeze-Thaw event
 - Creation of Repair v Restore Teams – Restore teams focused purely on restoring supply ASAP.
 - Prioritised vulnerable customers for water drops.
- Capability to triple the size of the call centre staff for major incidents by switching staff from other roles.
- Anglian Water created Tactical Operations team – monitoring & modelling in real-time – support incidents in real-time (analyse current customer to identify potentially vulnerable customers / identify high risk areas using geospatial tools that account for topography / .keep customers informed of our plans and prioritise workloads)

Potential Opportunities

- Active work orders in Click are not tracked in real-time through a 'display screen' as is the practice with the CRM KPIs.
- Develop plans to further optimise the scheduling / automation of dispatch (current work in progress).
- Better integration of newly developed Escalation Process with existing business processes and SA Water Corporate Risk Framework / Appetite.
- Opportunity to better integrate Operations Control & Customer Teams to reduce number of interface points.
- Deploy CRM to manage case history for the Single Point of Contact (SPOC) or the (Community Service Field Officers (CSFO) – being done through river / SharePoint.

FINDINGS: ORGANISATIONAL CAPABILITY

6

Organisational
Capability

How is SA Water Performing?

- SA Water has competent workforce that is continuously evolving to meet the changing needs of the business. SA Water interviewed during the review were passionate about doing their best to meet the needs of the community and their customers.
- SA Water has developed a competence development approach for its staff. The application of this framework is at the discretion of managers. Anecdotal evidence suggests that this framework has not been consistently applied. 'Click' training was initially on-the-job without formal / continued training for SA Water dispatchers, though SA Water is now developing more formalised training for users.
- Change Management issues were identified in a few examples, including 'Click' implementation, approvals / implementation for changes to work practices (eg Allwater 10m rule / 'live' cast iron main excavation).
- No end-to-end process has been defined that describes the overall value chain for SA Water and how the organisation (and supply chain) align to this and how key interfaces and handover points are managed.
- SA Water has developed a robust approach for managing resilience and business continuity.

Evidence / Good Practice Example

- @ One Alliance – key to success is the grind to make it work – alignment of objectives and incentives – long term 5 + 5 + 5 years.
- Global economic forum publication on successful Alliancing by BCC (capital focus).
- ElectraNet end to end value chain used as blue-print for organisational capability improvement.
- ISO 22301 – International Standard on societal resilience – business continuity management.

Potential Opportunities

- Review change management capability within the business (organisational change and technical change).
- Develop an end-to-end value chain that enables the full capability of the water main management to be reviewed and streamlined.
- Review the organisation structure, key interfaces and handover requirements against this end-to-end process.
- Review approach to developing capability within each SA Water function.
- Implementation of process improvement capabilities focused on core processes targeting efficiency, consistency, and outcomes, for example, Lean techniques.

How is SA Water Performing?

- Recently developed a strategy for 'smart' technologies rollout within SA Water. This is considered to align with leading practice.
- Smart water network implemented in CBD and main breaks detected through transient pressure are considered leading practice.
- SA Water states that the CBD smart water network has had good outcomes in regards to proactive management of leaks (over 50% identified and fixed before they became uncontrolled breaks) but these benefits have not yet been quantified.
- Customer Smart Meters – SA Water has developed a business case (approved by the SLT) for a limited staged rollout. The approach to smart customer meters is outlined within the SA Water smart strategy.
- Investment has been made in the capability to analyse data more fully and develop algorithms for predicting breaks (Patent applied for).
- Piloting hydrophone technology on trunk mains.

Evidence / Good Practice Example

- Anglian shop window for innovation – all technologies trialled on 20,000 person town (Newmarket) to test the benefits of the technology resulting in 8% reduction in water usage through changing customer behaviour and proactive identification of 500 leaks.
- Israel – sensors with micro-turbines for use in remote areas.
- Group Intelligence – Tekever - satellite scanning.
- Southern Water has biggest network of smart meters – main benefits benefit have been to offer a service to help customers identify leaking appliances rather than changing behaviours.
- Smartball solution used by Scottish Water (although SA Water has previously trialled its use with limited benefits).
- Anglian Water - the largest telemetry system in western Europe, with over 750,000 separate points monitored, sophisticated modelling, mapping and analytical tools. Integrated Remote Intelligence Service (IRIS) system, and Integrated Pressure and Leakage Management System (ILPM) provides high quality information which data scientists can then use to target our actions to minimise customer impacts.

Potential Opportunities

- Further roll-out of the SA Water smart water network using hydrophone sensors, especially on the trunk mains in high traffic areas.
- Quantification of the benefits of the SA Water smart water network in terms of improved total community impact (e.g. total customer minutes off supply and road users).
- Consider further rollout of smart meters (beyond auto meter reading). Can assist with leak detection, main break identification, pressure calming, response times.

FINDINGS: ASSET INFORMATION

8

Information
Availability

How is SA Water Performing?

- Approach to asset information management is key area of strength - core asset information (spatial location, work history etc. / data quality is very good and continuously being improved.
- History of the network / corporate knowledge of the network – documentation, collection and maintenance of water mains history approach is considered leading practice.
- Number of improvement initiatives to improve data have been implemented and are underway (eg configuration management tools, AquaNet, customers interrupted by water mains breaks.

Evidence / Good Practice Example

- UK leading in the development of collaborative approach to BIM / 3D data - Cambridge Centre for Digital Built Britain is leading this work as part of the UK National Digital Twin initiative.
- BaseForm solutions using AI / machine learning to identify patterns in data and help predict breaks.

Potential Opportunities

- Opportunity to improve failure cause hierarchy / codes as existing structure mixes faults, causes, remedies.
- Dynamic valve status synchronisation with the GIS – will greatly assist with configuration management of valves within the network (SA Water would need to upgrade elements of the GIS to enable) – no valve baseline.
- Damaged (non-operable) valves are not currently identified in the GIS – a future upgrade may enable these to be tracked.
- Stored GPS location at time of work order change is not being used to automate / validate work order status changes.
- Critical assets are not captured (tagged) in the GIS, though they are documented within SA Water documents.
- No vision for BIM / 3D data.
- Exception completion reports are used to verify work orders but no verification of data accuracy is undertaken.
- Photos for all water main breaks are not taken.
- Traffic disruption impact is not collected against work orders.
- Continue to develop data quality reporting metrics.

FINDINGS: CONTINUOUS IMPROVEMENT

9

Continuous Improvement

How is SA Water Performing?

- SA Water has a formal, well used and well documented approach for significant incident investigations. A root cause analysis approach is used.
- Response to Paradise has been comprehensive and identified 4 clear improvements which have all been taken forward - 1) Increase Investment in Renewals, 2) Smart Technologies, 3) Communications with Customers & 4) Support with Customers post incidents.
- Though there are assurance activities undertaken within SA Water, no assurance framework covering the full scope of asset management activities was presented by SA Water. Internal audit function is established under the Boards' Governance, Finance and Risk Committee - examines AM processes where these are identified as having the potential for high risk outcomes.
- Level 1 / 2 lines of defence are informal – several significant issues relating to the business case on willingness to pay for the number of customers experiencing three or more service interruptions within a year were not picked up. A planned independent review of all business cases prior to submission to ESCOSA has not yet started (planned to start soon), which may have picked up these similar issues.

Evidence / Good Practice Example

- Most UK companies do this well – driver is best practice Board governance.
- Ofwat web site – leadership and governance best practice – April / Oct 2018.
- Portugal performance assessment system for linking decisions to corporate objectives.
- Anglian Water – Response to the 2018 Freeze-Thaw event.

Potential Opportunities

- Develop / implement an assurance framework that covers the 3 lines of defence and the scope of asset management activities. Develop risk-based assurance activities for L1 and L2 lines of defence in line with this framework.
- Key lessons from investigations that may be able to applied broadly across the business are not always leveraged and opportunities have been potentially missed.
- Further investigations could be undertaken to analyse and record root causes of an increased number of water mains failures – very few are undertaken and root cause is often assumed based on failure type. SA Water is considering this in part for AC pipes.
- Trigger to initiate investigations is informal / ad-hoc, though has been used for recent major events.

POTENTIAL IMPROVEMENT OPPORTUNITIES

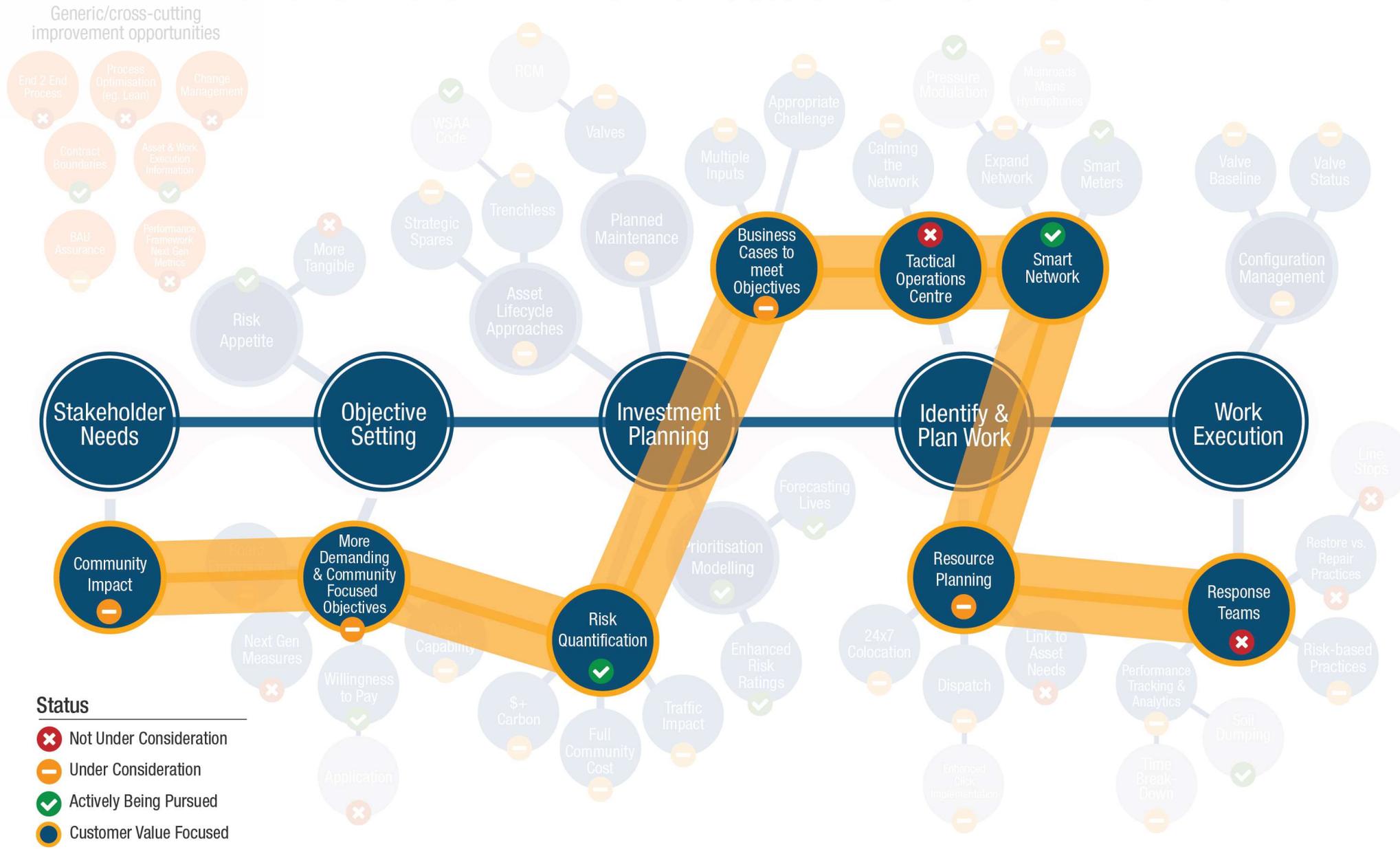
The previous pages have presented a number of potential improvement opportunities for SA Water to consider. These will all need to be assessed against SA Water's regulatory and financial context in order to determine which should be progressed and in what order.

The following slides summarise these opportunities and also provide some structure to the interrelationship between the improvements. There are two diagrams summarising included to provide this:

- Diagram one: shows the main value drivers that, in our opinion, will provide the greater value to stakeholders if implemented.
- Diagram two: shows the supporting improvement opportunities that will enable these key value drivers to be fully realised.

Each improvement opportunity is shown as a heading and cross references have been provided to link back to the detailed findings in Appendix A and B.

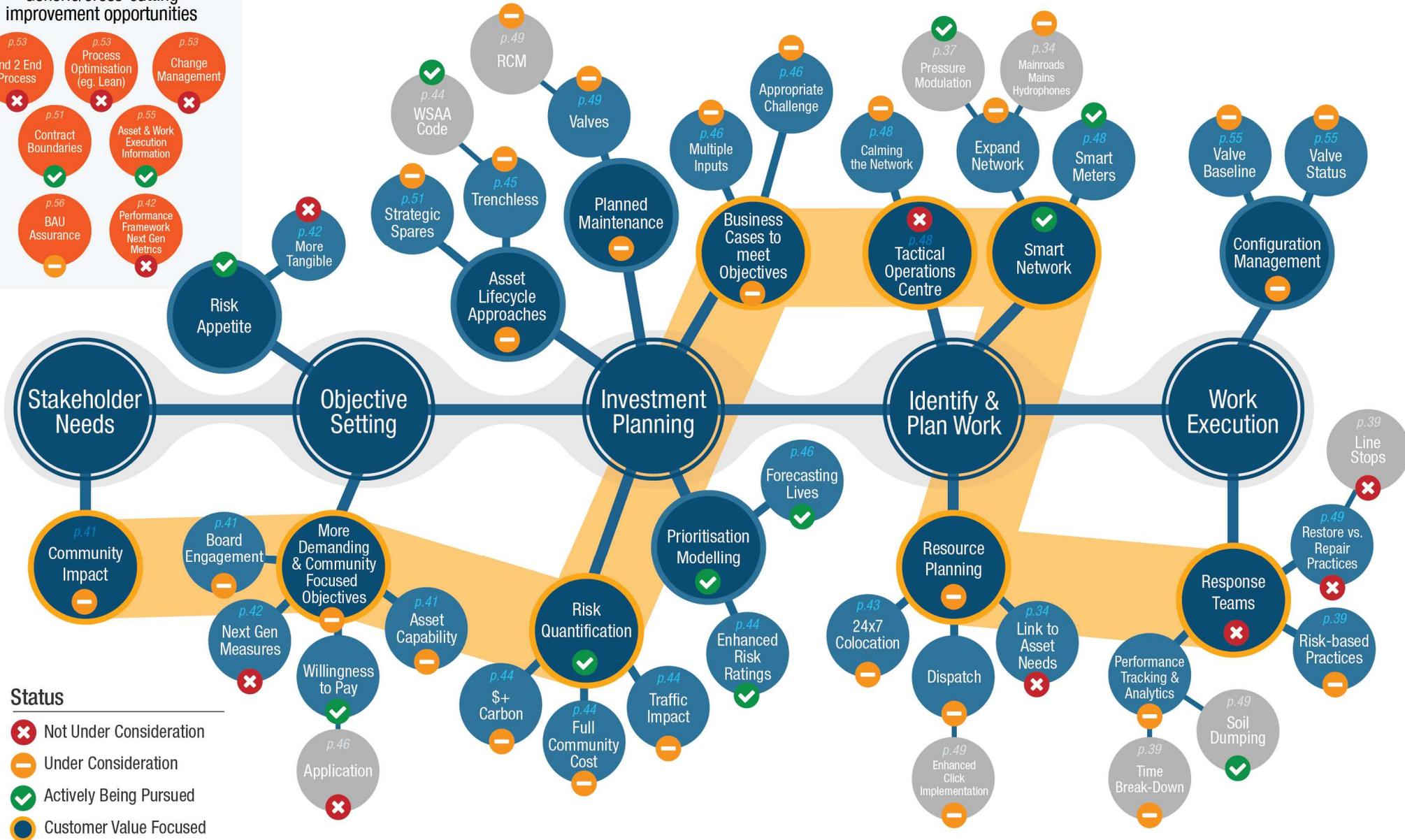
MAIN OPPORTUNITIES FOR DELIVERING VALUE TO CUSTOMERS AND OTHER STAKEHOLDERS



- Status**
- ✘ Not Under Consideration
 - ⊖ Under Consideration
 - ✔ Actively Being Pursued
 - 🔵 Customer Value Focused

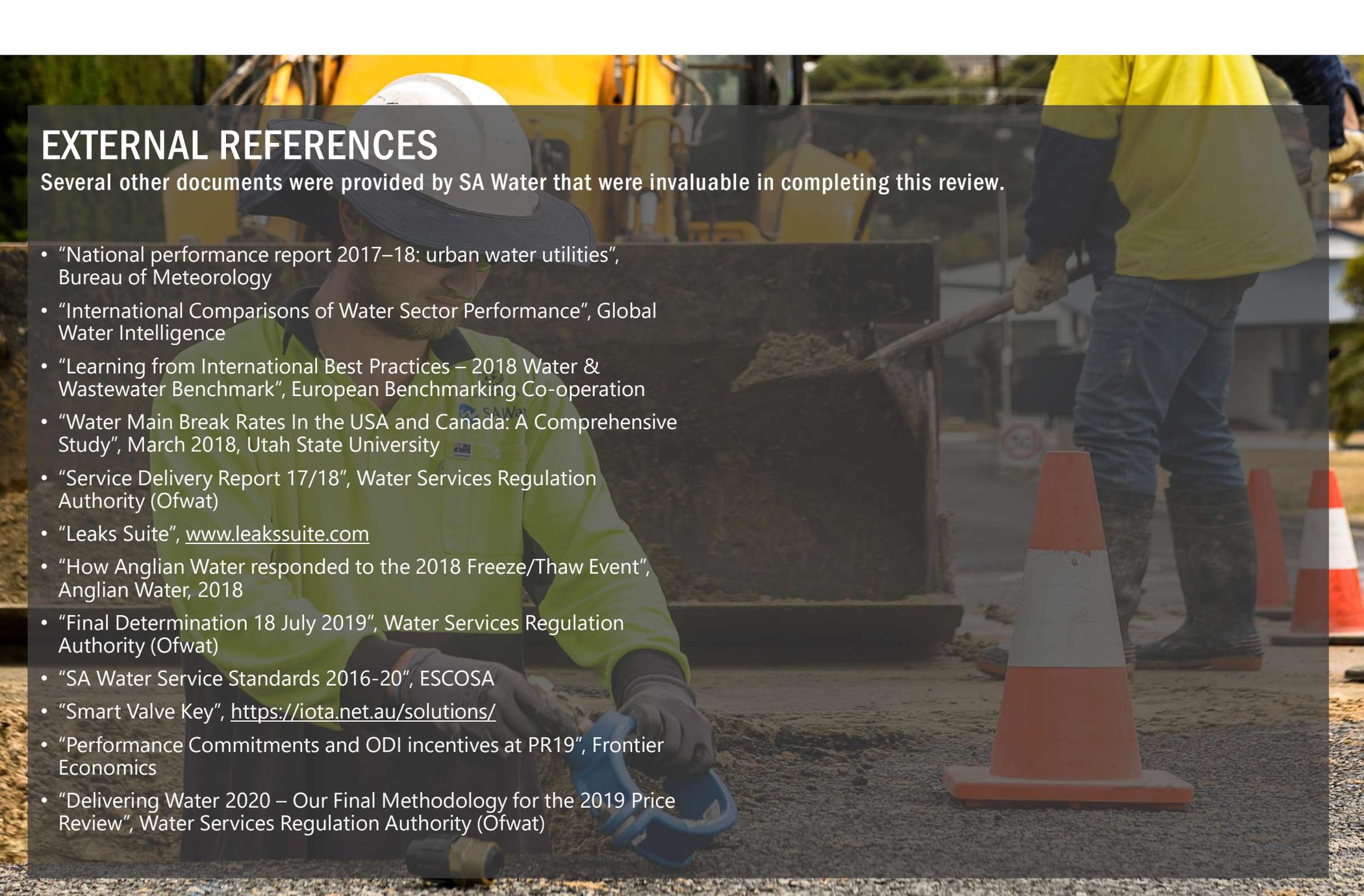
SUPPORTED BY A RANGE OF OTHER IMPROVEMENT OPPORTUNITIES

Generic/cross-cutting improvement opportunities



Status

- ✘ Not Under Consideration
- Under Consideration
- ✔ Actively Being Pursued
- Customer Value Focused



EXTERNAL REFERENCES

Several other documents were provided by SA Water that were invaluable in completing this review.

- “National performance report 2017–18: urban water utilities”, Bureau of Meteorology
- “International Comparisons of Water Sector Performance”, Global Water Intelligence
- “Learning from International Best Practices – 2018 Water & Wastewater Benchmark”, European Benchmarking Co-operation
- “Water Main Break Rates In the USA and Canada: A Comprehensive Study”, March 2018, Utah State University
- “Service Delivery Report 17/18”, Water Services Regulation Authority (Ofwat)
- “Leaks Suite”, www.leakssuite.com
- “How Anglian Water responded to the 2018 Freeze/Thaw Event”, Anglian Water, 2018
- “Final Determination 18 July 2019”, Water Services Regulation Authority (Ofwat)
- “SA Water Service Standards 2016-20”, ESCOSA
- “Smart Valve Key”, <https://iota.net.au/solutions/>
- “Performance Commitments and ODI incentives at PR19”, Frontier Economics
- “Delivering Water 2020 – Our Final Methodology for the 2019 Price Review”, Water Services Regulation Authority (Ofwat)