C5 B

Cost and Efficiency

C5B Technical Annex 09
Network Monitoring Investment Case: Technical Approach and Business Case

NTPBP-INV-NET-0534

BRISTOL WATER

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1 Foreword

The Network Monitoring investment case will address specific capital interventions to improve the performance of our network. Network monitoring investment will provide data related to condition of our network, which can use to inform our future strategy and decision making.

Network monitoring refers to the monitoring of flow, pressure, noise and vibration within the distribution network in order. This data obtained through this monitoring provides indications of leaks and failures.

Our current proactive network monitoring consists of monitoring pressure and flow using loggers. We currently have pressure loggers in each of our 396 district meter areas and flow loggers in approximately 200 of our waste water meter districts The information retrieved is used for leakage control, as well as providing information to manage customer interruptions.

The purpose of this document is to set out our customer led, outcome focused plan, which will mitigate risks posed by and associated with network monitoring.

The investment case, one of 21, will summarise the facts, risks and investment requirements for network monitoring for the next review period for 2020 to 2025. This investment case will also summarise performance for network monitoring for the current review period from 2015 to 2020, and our methodology for determining and delivering the future network monitoring strategy.

This investment case document is a technical annex to section C5B of our overall business plan submission, as illustrated by the diagram below:

This investment case is aligned to the Water Network Plus Wholesale Control aspect of our business plan. It is recommended that this investment case is read in conjunction with the PR19 Investment Case Summary Document[1] which outlines in detail our methodology for defining investment.

[1] Bristol Water PR19 Investment Cases Summary Document NTPBP-INV-PR1-0635

2 Executive Summary

In order to provide our customers with a Safe and Reliable Supply, we will enhance our network and through improved monitoring and control. We will achieve this by using our totex investment approach which includes investment in base maintenance and capital expenditure of £2.765m. We will deliver two interventions that will contribute towards six performance commitments. We will challenge ourselves to deliver more efficiently and apply innovation to our process for monitoring our Network. We will also focus on trialling new monitoring devices which we may deploy in AMP8. When considering our efficient and innovative approach we plan to deliver our Network Monitoring capital programme for £2.544m.

At Bristol Water we have completed an extensive customer engagement programme which has identified that one of five key priorities for customers is that we keep the water flowing to their tap and one of our four key outcomes is that we provide a Safe and Reliable Supply.

This investment case will address specific site operational and maintenance issues, by utilising a totex approach to determine necessary capital maintenance investment to manage obsolescent assets.

To deliver our customers' priorities and meet our compliance obligations we will measure progress via performance commitments for which we have set delivery targets both for the end of AMP6 and for AMP7. In AMP7, the measures related to Network Monitoring are supply interruptions (target 1.8 minutes per property), leakage (target 36.5 Ml/d), mains bursts (target 133/1000km), customer contacts about water quality – appearance (target 0.43 per 1,000 population), properties at risk of receiving low pressure (target 60 properties), and per capita consumption (target 135 l/h/d).

As at July 2018 we are achieving our AMP6 target for negative water quality contacts and properties at risk of receiving low pressure, and forecast that we will continue to achieve these through the remainder of AMP6. We are currently underperforming against our targets for unplanned customer minutes lost, mains bursts, and per capita consumption, but are forecasting to achieve our end of AMP6 targets. We are currently underperforming against out leakage target, and have implemented an action plan to improve on our leakage performance with the aim of meeting our AMP6 target.

We have set the level of investment for our Network Monitoring so that is sufficient to deliver our performance commitments and takes asset deterioration into account. This will ensure the continued performance of our Networks and enable us to continue to deliver a safe, high quality, and reliable drinking water supply to our customers.

We will achieve this in a number of ways;

- By installing pressure monitoring into every district meter area and flow loggers into every waste water meter district; and
- Utilising new technologies which will provide us with an improved understanding of our network.

During this review period we have been working with two suppliers of innovative new monitoring loggers and their associated data analytical tools in order to prove their benefits in the field. These new technologies also allow noise transmitted through the pipe wall and through the water itself to be

monitored. This aids in the rapid detection and location of leaks and mains bursts. The loggers can be deployed as a suite of 4 or 5 monitors in a network area and when used in this way the data can be continuously monitored to so that when the noise signature of a burst is detected in multiple loggers, the accurate location of the burst can be triangulated based on the position of the monitors.

The improvement in our network monitoring will provide the following benefits:

- **Reducing supply interruptions and mains bursts**, by aiding the rapid location of bursts and detecting leaks before they become bursts;
- **Reducing leakage**, by detecting leaks quicker and thereby reducing the time over which water is lost through a leak;
- **Reducing low pressure complaints**, by providing data and information to enable us to better understand our network and the causes of low pressure experienced by customers;
- **Reducing appearance contacts**, by allowing us to better monitor and understand how water moves around the network, and enabling us to take action to reduce areas where there is little water movement. It is in these areas that sediment can accumulate and this can then generate customer contacts about the appearance of water.

Our Network Monitoring investment case therefore represents a significant part of providing a Safe and Reliable Supply to our customers.

We currently have a good base level of loggers with pressure loggers in each of our 396 District Meter Areas and flow loggers in approximately 200 of our waste water meter district. This base level of monitoring is driven by proactive leakage management through monitoring flow and pressure at district meter area level.

To deliver continued benefits to our customers we need to develop a network configuration that enhances the way we manage our network by creating a smarter network through deployment of additional sensors across. We will achieve this by installing:

- 396 additional pressure loggers in all district meter areas;
- 160 additional transient monitors in our highest risk district meter areas; and
- 1000 additional flow loggers in all remaining waste water meter districts.

This proactive approach will improve our overall response time and reaction to customers as well as highlight any other issues such as low pressure. In addition, installing permanently deployed transient loggers will provide advance warning of harmful transient flow before it causes a burst.

To continue to deliver improved performance we have identified that transferable noise loggers may deliver complimentary benefits. Noise loggers are low cost devices which are mounted on existing washouts, valves and air valves throughout a district meter area, and are typically installed every 150m of distribution main. These devices detect noise within the pipeline and transmit the data for processing centrally. The high number of devices enables leaks to be detected and located quickly. Over the past few years, the technology of noise logging has improved significantly and the cost has reduced.

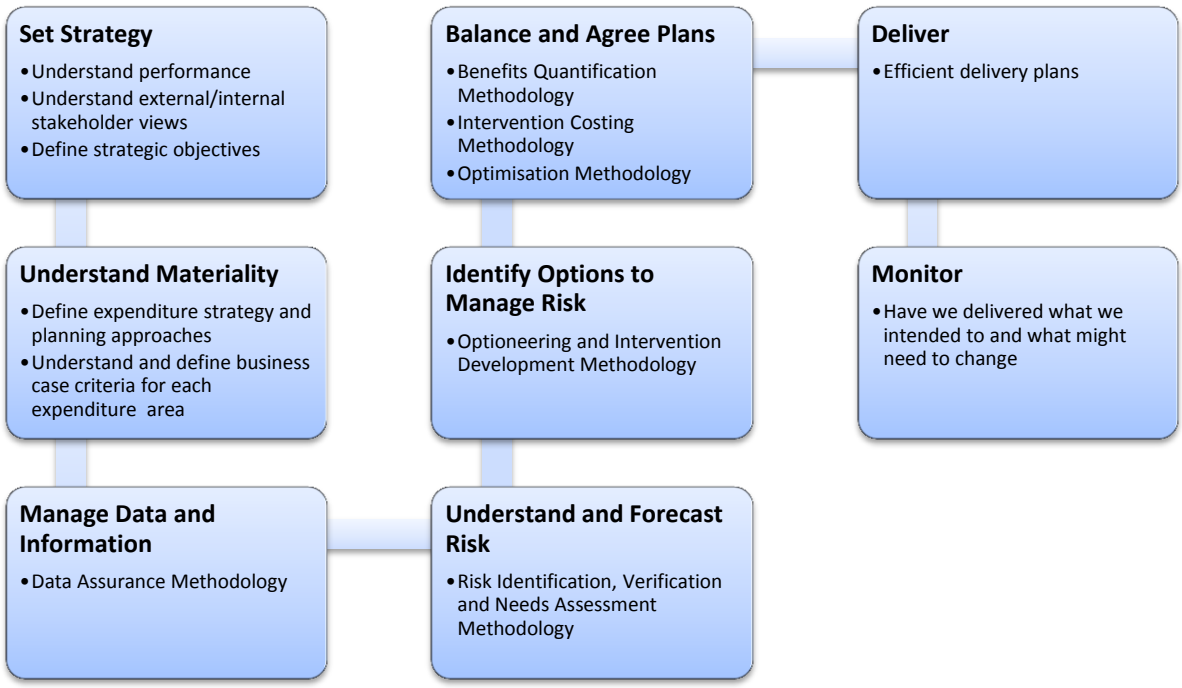
To further understand the benefits provided by noise logging on improving performance, especially to prevent supply interruptions and burst mains we will undertake a trial to test the performance of

transferrable noise logging devices. We will initially install noise loggers in the two worst performing district meter areas, and if the benefits provided are demonstrated to be useful, the loggers can be transferred to other district meter areas within our network to provide further monitoring.

Should we fail to invest in network monitoring, we may fail to deliver water to our customers at the pressure and flow they expect, and we may fail to achieve our stated outcome of a safe and reliable water supply.

In order to ensure that we meet customers' preferences and mitigate the risks associated with water treatment works strategic maintenance we have adopted an asset management totex focused approach as set out in Figure 1.

Figure 1: Approach to meeting customer priorities and Mitigating Risks



This approach enables us to demonstrate a full "line of sight" from customer priorities, through risk review, options analysis and investment optimisation, to outcomes and benefits provided for our customers.

We plan to invest £2.765m from 2020 to 2025 in order to achieve the performance commitments associated with the outcome 'Safe and Reliable Supply', as set out in Table 1.

We have set ourselves a challenging target of reducing costs by 8% during AMP7. This will be achieved by delivery of our business transformation programme and therefore result in a post-efficiency investment of £2.544m.

Costs are allocated to the Treated Water Distribution Business Unit. Investment is all related to Non-Infrastructure assets and is other capital expenditure.

Table 1: Performance commitment targets and percentage contribution from Network Monitoring

Performance Commitment	Unit	2019/20 Baseline	2024/25 Target	Total targeted performance commitment improvement in AMP7	Network Monitoring % contribution to performance commitment target
Supply interruptions	Average mins per property	12.20	1.80	10.40	13.68%
Leakage	Ml/d	43	36.5	6.5	3.13%
Mains bursts	Per 1000km	142	133	9	4.48%
Customer contacts about water quality – appearance	Contacts per 1,000 population	0.93	0.43	0.50	6.35%
Properties at risk of receiving low pressure	Number of Properties	69	60	9	21.57%
Per capita consumption	Litres/ head/ day (l/h/d)	142	135	7	0.29%

Our AMP7 investment in network monitoring will help ensure our assets are being maintained appropriately to deliver resilient water services to current and future generations

For per capita consumption, in total 26.71% of performance improvement is achieved through interventions within investment cases. The remaining performance improvement will be achieved as a result of a wider customer education programme.

Full details of our outcomes, performance commitments, and outcome delivery incentives are provided in Section C3 of our business plan.

3 Background To Our Investment Case

3.1 Context

This investment case covers our entire network is sub-divided into groups of mains, spatially and with common connectivity as follows:

- District meter areas; and
- Waste of water meter districts.

Waste of water meter districts are generally subdivisions of district meter areas, with smaller numbers of customers supplied in each subdivision. We have 396 district meter areas, and approximately 1,200 waste water meter districts.

We currently have pressure loggers in each of our 396 district meter areas and flow loggers in approximately 200 of our waste of water meter districts. This base level of monitoring is driven by proactive leakage management through monitoring flow and pressure at district meter area level.

During this review period we have been working with two suppliers of innovative new monitoring loggers and their associated data analytics tools to prove their benefits in the field.

These loggers have the potential to change the way we manage our network by providing high-resolution data for informed decision making, mitigating risks, extending asset lifetimes and reducing leaks and bursts. When installed across a network, these loggers coupled with powerful analytical tools provide an innovative solution for monitoring anomalous behaviour, network stresses, bursts, pressure transients, and negative spikes, most of which are often invisible at lower resolution with basic logging devices.

The loggers include high resolution pressure loggers which measure, record and transmit high resolution data to cloud based data analytical tools. The high resolution of the data enables damaging pressure transients[2] to be monitored and tracked through the network and from this changes can made to operational practices and processes to reduce transients. The ability to monitor transients also allows the analysis of Cumulative Pressure Induced Stress (CPIS™). This is an innovative metric developed by one of our suppliers Inflowmatix, which measures the stress on pipework caused by small and large pressure transients. These would be missed with basic logging devices but can be found and understood easily using the supplier's analytical tools.

The other supplier we worked with is Syrinix. Syrinix produce a similar high speed data logger to Inflomatix, but use their analysis software to interpret the data for slightly different reasons. We ran a project with Syrinix[3], which involved a number of field trials on distribution and trunk mains deploying Pipeminder-S high speed pressure data loggers, and simulating bursts and leaks on our network at a range of flow rates / durations. This work allows us to develop the ability both detect and triangulate the source of pressure transient activity to identify burst/leak location. This triangulation allows a narrowing

[2] Pressure transients are sharp spikes in water pressure which travel through distribution networks following sudden changes in flow, typically caused by operational changes, such as pump stops or valve closure.
[3] Syrinix, 2018, Bristol Water Project Report Executive Summary, BRI-EN19-003.

of the search area for a burst or leak within a District Meter Area or Waste Water Meter District, allowing for a faster repair, thus reducing run time and therefore leakage and also minimising potential customer impact. The trial sought to test and prove the theory of detecting and triangulating transients based on wave propagation modelling and extended into developing tools for strategic logger deployment to capture events and refinement and automation of data analysis / alarming functionality with the Syrinix RADAR software.

These new technologies also allow noise transmitted through the pipe wall and through the water itself to be monitored. This aids in the rapid detection and location of leaks and mains bursts. The loggers can be deployed as a suite of 4 or 5 monitors in a single district meter area and when used in this way the data can be continuously monitored to so that when the noise signature of a burst is detected in multiple loggers, the accurate location of the burst can be triangulated based on the position of the monitors.

The proposed increased network monitoring will therefore provide benefits by:

- Reducing supply interruptions and mains bursts by aiding the rapid location of bursts and detecting leaks before they become bursts;
- Reducing leakage by detecting leaks quicker and thereby reducing the time over which water is lost through a leak;
- Reducing low pressure complaints by providing data and information to enable us to better understand our network and the causes of low pressure experienced by customers;
- Reducing appearance contacts by enabling us to better monitor and understand how water moves around the network. This will then enable us to take action to reduce areas where there is little water movement. It is in these areas that sediment can accumulate and this can then generate customer contacts about the appearance of water.

The following assets are related to, but are excluded from, the treatment works strategic maintenance investment case as they have been included in other investment cases:

- Distribution Mains;
- Trunk Mains; and
- Pumping Stations.

This investment case is also interdependent with the following investment cases as they share the same performance commitment targets -

- Trunk Mains; shared targets of Supply Interruptions, Leakage, Mains Bursts, and Customer Contacts About Quality – Appearance.
- Distribution Mains; shared targets of Supply Interruptions, Leakage, Mains Bursts, and Customer Contacts About Quality – Appearance.
- Water Pumping Stations – shared target of Supply Interruptions and Properties at Risk of Receiving Low Pressure.
- Bulk Meters and PRVs – shared target of Leakage.

- Customer Meters – shared target of Per Capital Consumption.
- Network Ancillaries – shared target of Leakage.
- Leakage – shared target of Leakage.
- ICA and Telemetry – shared target of Supply Interruptions.
- Resilience – shared target of Supply Interruptions.

3.2 Strategy

Developing the investment needs for network monitoring is underpinned by our long term corporate strategy which has the vision “Trust beyond water-we provide excellent experiences”. Our Outcomes Delivery Framework together with our Strategic Asset Management Plan provide the strategic framework that supports this vision and enables investment in our distribution mains to clearly focus in delivering against outcomes and performance commitment.

Our long term strategy, as set out in the Outcome Delivery Framework (Section C3 of our Business Plan), has a focus on resilience and a growing need to ensure that our assets are, and remain, fit , well maintained and effective in meeting our performance requirements. There are three strategic drivers identified that together, ensure we meet our current and future needs for customers and stakeholders. These are:

- **Operational Resilience** - which have performance commitments to reflect reliability, resilience and quality of water
- **Customer Focused** - performance commitments to reflect customer service and affordability
- **A Sustainable Business** - performance commitments to reflect the environment representing our community and sustainable resources.

Within this strategy there are specific outcomes (Safe and Reliable Supply, and local community and environmental resilience) and specific performance commitments (Supply Interruptions, Leakage, Per Capita Consumption, Mains Bursts, Appearance and Low Pressure) that have strategic targets and incentives that will be directly influenced by our investment needs for network monitoring.

Our Asset Management Strategy has objectives developed in alignment with the long term strategy and delivery of corporate objectives and outcomes. These objectives cover both our short-term needs and longer-term aims, and drive the capability development plan and asset planning activities. Delivery of the investment in network monitoring will be driven through the Asset Management Framework, which is designed to enable the efficient and effective planning and delivery of all our asset related activities, to successfully deliver our business and customer outcomes. The framework aligns to, and interacts with, our corporate drivers, which in turn are there to deliver the external expectations and requirements placed upon us by our stakeholders.

We need to ensure that planned investment is sufficient for the continuation of business as usual activities and routine and reactive maintenance, and the continued provision of high quality water to our customers.

This investment case articulates the bottom-up asset interventions that are required in AMP7 to achieve the outcomes that customers, regulators and other stakeholders have told us they expect.

3.3 Customer Priorities

Customer priorities relating to Bristol Water's outcomes and performance commitments have been determined through our extensive programme of customer engagement and research. During the development of our business plan we have engaged with over 37,000 customers and conducted over 50 pieces of research. By delivering customer engagement, we have ensured that we can build on the customer insights that we have gained, producing a business plan influenced by our engagement events. This ensures that at Bristol Water we have engaged effectively with our customers on longer-term issues, and have taken into account the needs and requirements of different customers including those in vulnerable circumstances and also our future customers.

Through this process our customers have told us that their top priorities have remained largely unchanged from PR14 and have been identified as follows:

- You can get a bill you can afford
- Keeping the water flowing to your tap
- Help to improve your community
- Save water before developing new supplies
- You get the best possible experience every time you need us

Our engagement with our customers has resulted in the development of four specific outcomes for PR19, which capture what our customers and stakeholders have said; these are as follows:

- Excellent Customer Experiences
- Safe and Reliable Supply
- Local Community and Environmental Resilience
- Corporate Financial Resilience

In order to deliver our customers' priorities and outcomes we will measure progress via twenty six performance commitments for which we have set delivery targets.

There is a clear relationship between our investment in network monitoring and one of our outcomes – Safe and Reliable Supply.

We undertook more detailed discussions at phase 2 of our engagement process; gathering evidence (see section **C1 – Customer engagement, communication and research** appendix to our business plan) which gave us a wealth of information about how our customers' view Bristol Water, our services, and long term plans. We also explored short and long-term trade-offs in decision making and asked customers to tell us how we should approach long term issues of resilience and how we could best respond to service interruptions. When discussing the Safe and Reliable Supply outcome with our customers, we found that they are understanding of one-off events and often focus more on how we can improve our response to them. We asked them about investment in water quality and reliability and we asked what areas they felt most comfortable investing in. In our March 2018 customer panel, our customers prioritised reliability above local environment, resilience and customer experience[4]. Detailed

[4] A4g: customer online panel March 2018

analysis of customers' views on this area can be found in **section C3 – Delivering Outcomes for Customers.**

We consulted in three potential scenarios in relation to our Safe and Reliable Supply outcome:

			2024/25 target		
Service	**Performance Commitment**	**2020 target**	**Slower improvement plan**	**Suggested improvement plan**	**Faster improvement plan**
Water quality	Compliance risk A lower score reflects a lower risk of water quality problems	1.22	0.7	0	0
Interruptions to supply	Supply interruptions greater than 3 hours (average minutes per property)	12.2	4.2 66% improvement	1.8 85% improvement	1.5 88% improvement
Water that doesn't look clear	Number of customer contacts about the appearance of tap water (contacts per 10,000 customers)	9.3	9.3	4.3 54% improvement	3.2 66% improvement
Water that doesn't taste or smell right	Number of customer contacts about the taste and smell of tap water (contacts per 10,000 customers)	3.0	3.0	2.5 17% improvement	1.4 53% improvement
Protection against a major water supply event	Risk of a major event - population centre size protected against critical asset failure	Centres over 25,000 people*	Centres over 25,000 people	Centres over 10,000 people (10 year programme)	Centres over 10,000 people (5 year programme)
Forecast increase to the average bill from additional investment			**£5**	**£14**	**£18**

* With 90% customers in these centres remaining at risk

Results show affordability concerns have driven some customers to choose the slower plan, whereas customers also value the service improvements in the suggested plan. In summary, we consider that a plan with a lower bill level with the suggested improvement plan is more likely to be acceptable to more customers (particularly low-income groups). You can see more about how the feedback from our draft business plan consultation influenced each of our performance commitments in section C3.

The level of support for our plan expressed by our customers, both those we have engaged with over a period of time and those we met for the first time, gives us confidence that our final business plan strikes the right balance of delivering service improvements that customers value at a price that is acceptable to the majority.

This investment case describes how we will achieve the suggested improvement plan and associated level of performance through our investment in network monitoring. Specific details on our planned investment and associated performance can be found in Section 3.4.

3.4 Asset Health Performance Commitments, AMP7 Performance Commitments & Outcome Delivery Incentives

The health of our assets is a key element in delivering resilient water services to our customers. Our investment in Network Monitoring will help ensure our assets are being maintained appropriately for the benefit of current and future generations. We measure our asset health through some specific performance commitments, which for Network Monitoring are customer contacts about water quality – appearance. These performance commitments enable us to evaluate our long-term asset health performance.

Additionally, our investment in Network Monitoring will support the outcomes 'Safe and Reliable Supply' and 'Local Community and Environmental Resilience', by investing in Network Monitoring in order to provide high quality, reliable supplies for present and future generations, and to make our services robust to what the future may hold. The Safe and Reliable Supply and Local Community and Environmental Resilience Outcomes will be measured through a set of associated performance commitments.

Our planned investment in Network Monitoring will support the achievement of the performance commitments set out in Table 2.

Table 2: Associated performance commitments

Performance Commitment	Unit	2019/20 Baseline	2020/21	2021/22	2022/23	2023/24	2024/25	Performance Improvement Required in AMP7
Supply interruptions	Average mins per property	12.20	4.2	3.6	3.0	2.4	1.8	10.40
Leakage (annual)	Ml/d	43	42	41	39.5	38	36.5	6.5
Mains bursts	Per 1000km	142	133	133	133	133	133	9
Customer contacts about water quality – appearance	Contacts per 1,000 population	0.93	0.83	0.73	0.63	0.53	0.43	0.50
Properties at risk of receiving low pressure	Number of Properties	69	68	66	64	62	60	9
Per capita consumption (annual)	Litres/ head/ day (l/h/d)	142	140.6	139.2	137.8	136.4	135	7

Per capita consumption is the average amount of water used by each person each day. It measures how much water we use every year. This is also part of our long term strategy to meet the changing demand for water as described above. Our intention is to encourage behaviours to reduce the amount of water we use, thereby helping customers save money for the future and further adapt to the challenges of climate change.

Full details of our outcomes, performance commitments, and outcome delivery incentives are provided in Section C3 of our business plan

A detailed diagram illustrating the full line of sight between customers, outcomes, performance commitments, and outcome delivery incentives related to this investment case is included in Appendix A.

3.5 Compliance Obligations

There are no statutory or compliance obligations that are influencing the development of interventions in this investment case and the investment for AMP7.

3.6 AMP6 Investment and Performance

Our AMP6 investment in network monitoring supports our ability to meet our performance commitments for unplanned customer minutes lost, leakage, mains bursts, negative water quality contacts, properties at risk of receiving low pressure, and per capita consumption. Our investment in AMP6 will also underpin performance commitments in AMP7.

We have re-categorised data used in line with the scope of our investment cases. For historic data we have used the 2016/17 wholesale cost assessment data (data tables 1 and 2). Forecast data has been derived from PR19 data (data tables WS1 and WS2).

Table 3: AMP6 Network Monitoring Investment

Year	Network Monitoring Investment Capex (£m)
2015/16 (Actual)	£0.000
2016/17 (Actual)	£0.000
2017/18 (Actual)	£0.227
2018/19 (Forecast)	£0.000
2019/20 (Forecast)	£0.000
AMP6 Total (Forecast)	**£0.227**

Our AMP6 investment delivers specific monitoring improvements to our strategic mains. Additional AMP6 investment related to network monitoring (e.g. for loggers etc.) is included within our AMP6 investment for leakage control and improvement, and hence is not included within the investment values stated above.

The AMP6 performance commitments that are related to network monitoring investment, and our performance, are given in Table 4.

Table 4: Historic AMP6 Performance related to Network Monitoring

Performance Commitment		2015/16	2016/17	2017/18	2018/19 (Forecast)	2019/20 (Forecast)
Unplanned Customer Minutes Lost						
Bristol Water	Target	13.4	13.1	12.8	12.5	12.2
	Company Performance	15.5	13.1	73.7	12.5	12.2
Leakage (Current Leakage) (Ml/d) (annual)						
Bristol Water	Target	48.0	47.0	45.0	44.0	43.0
	Company Performance	44.2	46.4	46.6	44.0	43.0
Mains Bursts						
Bristol Water	Target	142	142	142	142	142
	Company Performance	113	153	179	142	142
Negative water quality contacts						
Bristol Water	Target	2422	2409	2322	2275	2221
	Company Performance	2329	2162	1711	2275	2221
Properties at risk of receiving low pressure						
Bristol Water	Target	69	69	69	69	69
	Company Performance	71	94	65	69	69
Per Capita Consumption						
Bristol Water	Target	145.2	144.4	143.6	142.8	142.0
	Company Performance	141.1	144.1	144.5	142.8	142.0

Unplanned customer minutes lost is included as it has been used throughout AMP6 to measure and report on performance related to supply interruptions. It will be replaced by Supply Interruptions in AMP7. The unplanned customer minutes lost performance commitment was not met for 2017/18. The average amount of minutes lost per property per year (at 73.7 minutes) was significantly affected by an exceptional burst event at Willsbridge in July 2017, which we explained in a detailed case study in our 2017/18 mid-year performance report.

With regard to leakage, at PR14, we set ourselves challenging leakage targets; to reduce leakage by 12% between 2015 and 2020. Our 2017/18 performance was below target due to a number of factors primarily the exceptional weather at the beginning of 2018. We underperformed against our target for 2017/18 due to the exceptional weather in 2017/18. Excluding our estimate of a 1.7Ml/day impact of the cold weather in March 2018, our actual current leakage performance after technical data adjustments improves from 46.6Ml/day to 44.9Ml/day. This would have been in line with our target of 45Ml/day. Towards the end of 2017/18 we began to see benefits from our deployment of additional resource and the impact of improving the effectiveness of our leakage response. We have implemented an action plan to improve on our Leakage performance to ensure we meet our AMP6 target. We are currently forecasting to achieve the final year AMP6 target of 43Ml/d. Our investment in AMP6 will also underpin our performance commitment for Leakage in AMP7. Full commentary on our Leakage performance is provided in our 2017/18 Annual Performance Report.

Negative water quality contacts is included as it has been used throughout AMP6 to measure and report on performance related to customer contacts about water appearance and taste/odour. It will be replaced by two performance commitments in AMP7: customer contacts about water quality – appearance, and customer contacts about water quality – taste/odour.

We have worked with Ofwat and the rest of the industry to align the reporting definition to help customers understand comparative performance in AMP6. See Section C3 of our Business Plan for full details.

4 Developing Our Investment Plan

As we have discussed earlier, the starting point for investment case development is to understand our customers' priorities and determine associated performance commitments. We have adopted totex principles to determine how we should invest in order to deliver these priorities and associated commitments. The totex approach we have adopted considers which the best solution is because it is the lowest cost over the whole life of the asset, regardless of whether it is operational or capital expenditure.

Whilst we do not currently have health and risk indices across our asset groups, we do have a wealth of data. In some cases, analytical models such as the mains deterioration model, provides us with a view of how our assets are performing, as well as a view on their deterioration. The following section describes the process we have created and followed in order to develop our investment cases.

4.1 Investment Case Development Process

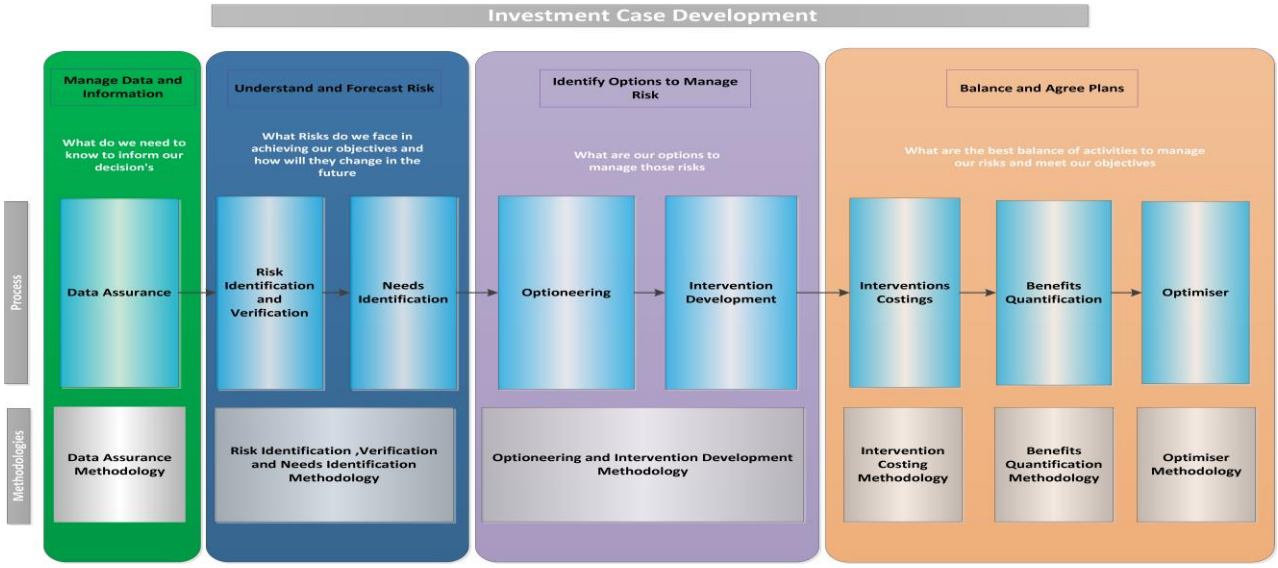
We have created and implemented a process that is supported by a set of six methodologies. When developing the methodologies, we wanted to ensure that they:

- Deliver what the customers have asked for;
- Satisfy our business needs; and
- Deliver a high quality business plan in accordance with Ofwat's company monitoring framework.

The collective application of these methodologies has enabled us to develop investment proposals that are well evidenced through a line of sight approach, ensuring our investment plan achieves the required targets at the optimal cost.

Figure 2 illustrates, at a high level, the process required to identify risks that require addressing in AMP7, and the subsequent development of appropriate interventions.

Figure 2: Investment case process overview - level 1 diagram



An overview of each of the key stages is described below and all of the methodologies are provided in the PR19 Investment Cases Summary Document.

4.1.1 Data & Data Assurance

The development of our investment cases is dependent on having consistent, accurate and assured data. We therefore recognise that we must be able to demonstrate the quality of the data and information used in the development of our investment cases.

Wherever possible, we have utilised data from our core company systems in order to undertake our analysis and we have sense checked the quality of the data as we have used it.

However, in addition, we have applied a data assurance methodology. We have assessed data quality in terms of completeness, accuracy and reliability. In addition, the methodology also assesses whether data is used as part of the Annual Performance Report to Ofwat, and hence already subject to existing Annual Performance Report assurance mechanisms.

In total we have developed twenty one investment cases. The values of these investment cases range from less than £1m to over £37m. Our overall capital investment plan totals circa £212m.

We have selected a sample of nine investment cases, and have applied detailed data assurance based on their value and complexity. The total value of these nine investment cases represents 66% (circa £140m) of the total capital investment plan, and represents 286 individual data types. We have evaluated all 286 data types and we have evaluated them for quality and their use in the Annual Performance Report process. The overall data quality assessment identified 93% of the data as being good quality, and 55% as having been used and assured through the Annual Performance Report process.

This investment case was not included as part of the sample of nine investment cases. We will continue to focus on improving the quality of our data and the associated assurance processes.

4.1.2 Risk Identification, Verification & Needs Assessment Methodology

The purpose of our risk identification, verification and need assessment is to ensure that:

- The risks that we are currently facing are captured in a single risk register; and
- Each risk is assessed and verified to determine details about the nature and magnitude of the risk and whether any mitigation is currently planned in this AMP period; and
- Each risk is scored on a common basis to allow risks to be compared; and
- The most significant risks are identified, and that for each a clear and uniquely referenced statement of need is produced to define the problem as clearly as possible, and to identify what benefits or performance commitments mitigation of this risk will achieve.

The risk score is the product of the likelihood and consequence, each is scored 1 to 5 and then multiplied together to provide a potential maximum risk score of 25.

Risks scoring 15 to 25 are the most significant strategic risks, and these were developed into needs statements.

Those scoring 10 or 12 were subject to a further round of review. Where the risk was confirmed, it was developed into a needs statement. Where the risk was not confirmed (for example it is currently being addressed in AMP6 or the risk was assessed to be not as significant as initially scored), it was not considered further as part of the PR19 investment planning process.

The risks scoring 1 to 9 were considered to be risks of a lower priority and were therefore not considered further as part of the PR19 investment planning process.

The risks not considered further as part of the PR19 investment planning will continue to be monitored and assessed as part of the live business and on-going business as usual risk management process. Where there is a need to mitigate these risks within the AMP, we will respond with appropriate action, such as increased base maintenance.

Further development of our business as usual risk management process is on-going and we are looking to innovate by developing smarter systems to optimise this process.

We developed need statements for all selected risks.

4.1.3 Optioneering & Intervention Development Methodology

The next stage in our process is to develop options of how we could meet the needs of the selected risks.

To generate the options, data was gathered from a number of sources (see Appendix B). This included meetings with stakeholders and historical records, including reviews following operational events, previous scheme proposal reports and previous options assessment reports.

We then progressed to data assimilation, analysis and consultation with key stakeholders. Multiple options were developed and recorded. These options were reviewed and all options identified as not viable were discarded.

All viable options were identified as proposed interventions with a unique reference number and were taken forward for further scope development, benefits calculation and costing.

4.1.4 Intervention Costing Methodology

In order to provide assurance of our investment costs and to ensure standardisation, we engaged ChandlerKBS as our costing partner. They were selected in part due to their ability to provide us with industry comparable cost data, often at intervention level. They supported us in several ways:

- In some instances development and analysis of intervention costs, and
- Support to build our cost database

Indirect overheads, such as contractor costs, design costs, contract management, and our overheads have been applied at intervention level. Wherever possible we used our data or if unavailable, we used industry average costs.

Therefore we have to assess the expected capital cost of each intervention.

Expected Capital Cost (capex after)

If we deliver the capital expenditure intervention in a planned way, we have labelled it as 'capex after'. This is the expected capital cost of the intervention.

Cost estimates were usually based on high level scopes, which contained activity schedules provided by ourselves, and were developed using the cost model we developed with ChandlerKBS.

4.1.5 Benefits Quantification Methodology

The benefits for each intervention are those which are considered to affect company performance during subsequent AMP periods.

Benefits can be assessed as either being:

- Direct – savings in reactive capex or savings in operational expenditure-opex; or
- Indirect – improvement in performance commitments or other resultant effects on the company's performance.

Both direct and indirect benefits are considered and quantified.

Direct Benefits

We have a totex approach which considers both capital and operational expenditure.

Expected Capital Cost (capex before)

If we deliver the capital expenditure intervention in an unplanned way, we have labelled it as 'capex before'. This is the reactive cost that would potentially arise if we had to deliver the intervention in an unplanned way.

We could respond to this scenario in one of two ways:

- 'Patch and Repair' or
- Implementation of the intervention in an un-programmed accelerated manner.

The capex before was determined for each intervention. For most interventions the estimate is site specific. A risk factor, taken from the likelihood score recorded in the risk register, was applied to the initial capex value to produce the final capex before value.

Where a 'patch & repair' solution would not be appropriate, should the risk materialise, this would lead to the immediate implementation of the intervention. The cost of the intervention in this scenario is the expected capital cost of the intervention (capex after), with the application of a suitable uplift to cover the costs associated with fast-tracking the intervention, for example, the cost of labour at premium rates.

The expected capex before effectively formed the 'Do Nothing' option.

Expected Opex Before & Opex After

In most cases we have made an estimate of the operational expenditure levels either with investment - opex after or without investment - opex before. Opex includes power, chemicals, materials, contract hire and in house labour.

Opex before represents the opex expenditure associated with not mitigating a risk through capital investment, for example, increased maintenance visits or replacement of components.

Opex after represents the additional opex cost to the business after the implementation of an intervention. These could include negative values associated with predicted savings associated with increased plant efficiency or performance, or positive values where there is an operational cost increase, for example greater inspection levels.

Indirect Benefits

To measure our performance against our customers' priorities and the associated performance enhancements associated with interventions; we measure the impact that each intervention had on the performance commitment measure.

Other Benefits

In addition to the performance commitments described above, other indirect benefits which do not relate to performance commitments were calculated and recorded in the benefits calculations where appropriate. This includes avoidance of health and safety penalties, customer compensation payments, and environmental penalties. These benefits have been monetised.

Once the benefits were prepared, the interventions were put forward for investment optimisation.

4.1.6 Investment Optimisation & Intervention Selection

The investment optimisation process determines which interventions are selected to provide the optimal AMP7 investment plan, by delivering the targeted performance commitment improvements, at the lowest cost. We have utilised a water industry standard system (Servelec 'Pioneer') to optimise our AMP7 investment plan. Pioneer provides the functionality for us to assess all interventions developed across all of the investment cases. It will assess the interventions both individually and in comparison to other interventions. It is a decision support tool that produces an optimal investment plan to meet the targeted performance commitment improvements required in AMP7.

The Pioneer investment optimisation model assesses interventions primarily on the overall benefit, which takes account of performance and whole life costs. The investment optimisation calculates the whole life cost as the net present value (NPV) over 40 years. This determines if an intervention is cost beneficial.

We will select interventions for one or more of the following reasons:

- The intervention is mandated (i.e. Drinking Water Inspectorate - water quality requirement).
- The intervention is cost-beneficial
- The intervention is required to achieve the performance commitment targets.

Any performance commitment improvement obtained from mandated or cost-beneficial interventions will contribute to overall performance improvement.

A series of business reviews and sense checks of the investment optimisation results have been undertaken prior to finalising the AMP 7 investment plan.

We can of course model any number of scenarios, and during the process of engaging our customers we ran three scenarios as described in Appendix C.1 (slower Improvement plan, suggested improvement plan and faster improvement plan).

4.2 Applying the investment process to Network Monitoring

Each of the following sections describes the specific details associated with the application of the investment case development process for network monitoring.

4.2.1 Risk Identification, Verification & Needs Assessment

There were 2 risks identified in the Strategic Risk Register associated with this investment case. Both risks went through a process of assessment, scoring, and review .

The two risk identified risks were selected and developed into need statements. Details of the selected risks are provided in Appendix C.1.

Two risks were selected (as given in Table 5) and developed into need statements and there were no non-selected risks.

Table 5: Selected risks

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	Customers Impacted	Max Impact	Risk Score
SRR39	Non Site Specific	IF the latest tools and equipment for detecting and monitoring leakage are not employed then Bristol Water will fail to meet its AMP7 leakage target.	3	2	4	3	4	3	4	12
SRR625	All supply area	Risk of Customer Minutes Lost (Supply Interruptions)	3	2	4	3	5	3	5	15

4.2.2 Optioneering and Intervention Development

This specific data for this investment case came from, Geographical Information Systems (GIS) data, results from field trials which we conducted in conjunction with suppliers of high resolution network monitoring loggers, output from leakage studies which we commissioned, and historic performance data on supply interruptions, mains bursts and per capita consumption.

Two risks were selected and developed into needs statements. Further investigation of these needs included data assimilation, analysis and consultation with key stakeholders. Multiple options were developed and recorded for each of the two needs statements. These options were peer reviewed and any options identified as not viable were discarded.

For example, against the selected risk regarding the failure to meet our supply interruptions target, four options were identified and three of these were developed into interventions, as shown in Table 6.

Table 6: Example of Options Selection

Strategic Risk Register	Need Description	Proposed Option Name	Proposed Option Description	Option Viability?	Ref No	Intervention Title	Intervention Description
IF increased interventions are not taken during AMP7 THEN we will fail to meet its performance commitment against Supply Interruptions. (Risk Score: 15)	We are currently performing in the lower quartile on Supply Interruptions. Part o the cause of this is the inability to detect the location of bursts and leaks quickly to reduce customer supply interruptions. Investment is needed to turn this position around and to achieve the AMP7 performance commitments on Supply Interruptions.	Business As Usual	This option involves continuing to operate the network with low levels of network monitoring.	This is not an acceptable option because we are likely to fail to meet their Performance commitments for supply interruptions and for leakage.	N/A		
		Install increased network monitoring over AMP7	Install during AMP7 (a) 396 Pressure Loggers in all district meter areas; (b) 160 Transient Monitoring in Highest Risk district meter areas; and (c) 1000 Flow Loggers in all remaining waste water meter districts.	Viable option	9.001.01	Install increased network monitoring over AMP7	Install during AMP7 (a) 396 Pressure Loggers in all district meter areas; (b) 160 Transient Monitoring in Highest Risk district meter areas; and (c) 1000 Flow Loggers in all remaining waste water meter districts.
		Install the same increased network monitoring but spread over AMP7 and 8	Install during AMP 7 and 8 (a) 396 Pressure Loggers in all district meter areas; (b) 160 Transient Monitoring in Highest Risk district meter areas; and (c) 1000 Flow Loggers in all remaining waste water meter districts.	Viable option	9.001.02	Install the same increased network monitoring but spread over AMP7 and 8	Install during AMP 7 and 8 (a) 396 Pressure Loggers in all district meter areas; (b) 160 Transient Monitoring in Highest Risk district meter areas; and (c) 1000 Flow Loggers in all remaining waste water meter districts.
		Install pilot trial of 240 transferable noise loggers over 30km of distribution main	Install pilot trial to test innovation of noise logging devices. Test on 2 worst performing district meter areas. If benefits proven these can be removed and transferred to other district meter areas.	Viable option	9.001.03	Install pilot trial of 240 transferable noise loggers over 30km of distribution main	Install pilot trial to test innovation of noise logging devices. Test on 2 worst performing district meter areas. If benefits proven these can be removed and transferred to other district meter areas.

All viable options were identified as proposed interventions with a unique reference number and were taken forward for further scope development, benefits calculation and costing. A total of 3 interventions were identified in this way. These included in one case, two interventions against a single selected risk and these were identified as mutually exclusive during intervention selection.

A summary of the selected risks and their associated options is included in Appendix D.

4.2.3 Intervention Costing

We have identified a total of 3 interventions (including mutually exclusive options for the same risk) to be taken forward for scope development and cost estimation. For the intervention to install increased network monitoring over AMP7, a high level scope document was developed including an activity schedule and quotes from suppliers of loggers. ChandlerKBS utilised a water industry unit cost data base to complete estimation in accordance with their own assured methodology.

AMP7 costs for installing the same increased network monitoring over AMP7 and 8 were taken as half the cost of installing in AMP7 alone.

The costed activity schedules were returned to us for peer review, leading to further refinement in collaboration with ChandlerKBS.

The cost for installing a trial of 240 transferable noise loggers over 30km of distribution main was based on a figure estimated by RPS Environmental Ltd as part of their leakage studies which we commissioned. Their estimate covered the installation of transferable noise loggers over 300km of distribution main. Therefore, assuming the same density of loggers, 10% of the RPS estimate was taken to account for installation over 30km of main.

The cost for each developed is presented in Appendix E. An example of how those costs have been developed is outlined below:

Cost Example: Increased Network Monitoring over AMP7

We are currently performing in the lower quartile on Supply Interruptions. Part of the cause of this is the inability to detect the location of bursts and leaks quickly to reduce customer supply interruptions. Investment is needed to achieve our AMP7 performance commitments on Supply Interruptions.

We have established a cost of undertaking the works of £2.033m; this includes labour and materials as well as contractual costs. The latter includes items such as (but not limited to) contractor accommodation, contractor management, contractor overhead and profit, and design. We have then applied Bristol Water's overhead of £0.452 for internal activities associated with the intervention, such as project management, land & compensation, legal, environmental costs, commissioning/handover, contract management, operations & system support, consultants and administration.

All of the direct costs above gave us an intervention cost of £2.485m to implement the intervention in a planned way (the capex after).

If however, we did not undertake the work to install monitoring proactively, then we would continue to respond reactively to customer supply interruptions. Should we have to undertake this work reactively it would be completed as a 'patch and repair' (i.e. targeted mains replacement), calculated as £0.470m.

We have established that if undertook the above intervention would provide an operational expenditure increase of £0.320m (Opex After).

Once interventions were costed, benefits could be calculated which are discussed in Section 4.2.4.

4.2.4 Benefits Quantification

Two Network Monitoring interventions were assessed for Direct and Indirect benefits. The proposed increased network monitoring will provide primary benefits against our performance commitments by:

- Reducing supply interruptions and mains bursts by aiding the rapid location of bursts and detecting leaks before they become bursts;
- Reducing leakage by detecting leaks quicker and thereby reducing the time over which water is lost through a leak;
- Reducing low pressure complaints by providing data and information to enable us to better understand our network and the causes of low pressure experienced by customers;
- Reducing appearance contacts by enabling us to better monitor and understand how water moves around the network. This will then enable us to take action to reduce areas where there is little water movement. It is in these areas that sediment can accumulate and this can then generate customer contacts about the appearance of water.

Furthermore, increased network monitoring will provide a range of secondary benefits as described below:

- Data from increased network monitoring will inform changes to operational practices and processes allowing, for example changes to valve isolation practises to ensure that the network remains calm (that is, free of transient pressures) and thereby reducing mains bursts;
- Increased network monitoring will assist in the identification of customer side plumbing losses to some degree and there will be a corresponding benefit in the per capita consumption figure which includes customer side plumbing losses.
- Data collected from increased network monitoring will lead to a better and more accurate burst model. The improved accuracy will help to avoid spending money on replacing the wrong length of pipe in subsequent AMP periods.
- Data from increased network monitoring will be used to target future spend into ways to calm the network instead of spending much greater sums on pipe replacement.
- The energy efficiency of pumps can be improved by introducing additional control loops using network data to detect deterioration in performance.

The third intervention to install pilot trial of 240 transferable noise loggers over 30km of distribution main is intended to test the benefits of this technology within the particular case of the Bristol Water network. Experience from the industry tells us that noise logging provides benefits in larger and more open networks where little existing monitoring exists. We have a well sub-divided, but relatively small network with a system of flow and pressure monitoring already in place. We therefore need to understand what further benefits noise logging can give to our customers and we are proposing to trial noise loggers within our environment of increased logging across the network. This trial will allow us to gain an improved understanding of the benefits of transferable noise loggers and the data they can provide. However, no quantified benefits have been assigned to this trial in terms of expected contribution to performance improvement.

5 Outcome

5.1 Selected Interventions

The three interventions developed within the Network Monitoring investment case were assessed through the Optimisation process. Of these three interventions, two have been selected.

When it comes to delivering our programme of works we know that we must continue to be innovative and efficient. We have set ourselves a challenging target of improving our cost efficiency by 8% during AMP7. This will be achieved by delivery of our business transformation programme.

We see innovation as an integral to our everyday working at Bristol Water: We have deliberately embedded it within the business-as-usual processes of our asset management teams by embracing the full flexibility that totex and outcomes enables. We will look to be innovative in the following ways:

- **Open Innovation:** We have defined our strategic innovation challenges and run events such as our “Innovation Exchange” that invite suppliers to present their innovative solutions to predefined challenges that we set;
- **Market Scanning:** We conduct market scanning through for cutting edge technology against our strategic innovation challenges and feed this into our optioneering process. In particular we subscribe to the Technology Approval Group which regularly scans and meets with water companies to unearth the most promising innovations for the sector; and
- **Partnering:** we undertake leading research into areas that we provide effective solutions for the future.

We will specifically look for process innovations that mean we can contribute to our 8% efficiency challenge and keep our customers’ bills low into the future.

An example of such innovation employed in the development of this investment case is pressure transient monitors. These monitors employ sector leading technology to enable pressure in the pipeline to be measure many times per second. This enables the identification of instantaneous pressure changes in the water or by changes in the background noise transmitted in the pipe wall or transmitted in the water. Data from the monitors is transmitted back to centralised software which marshals and analyses the received data to match the measured noise and pressure signatures to typical noise and pressure signatures created by leaks. Close matches indicate a potential leak in the main and an automated message is sent to operatives enabling them to investigate further at the location. When multiple monitors are employed within the same network zone the signals can be triangulated to provide a precise location of the burst or leak.

The two selected interventions are set out in Table 7, along with details of the associated costs and contribution to performance improvement

Table 7: Selected interventions, costs, and % performance contribution

ID	Intervention Title	Total Capex (£)	Change in Opex per annum (£)	Supply interruptions	Leakage	Mains bursts	Customer contacts about water quality – appearance	Properties at risk of receiving low pressure	Per capita consumption
09.001.01	Install increased network monitoring over AMP7	£2,485,064	£319,880	13.68%	3.13%	4.48%	6.35%	21.57%	0.29%
09.001.03	Install pilot trial of 240 transferable noise loggers over 30km of distribution main	£280,000	£13,823	-	-	-	-	-	-
Network Monitoring capital investment (pre-efficiency)		**£2,765,064**	**£333,703**	**13.68%**	**3.13%**	**4.48%**	**6.35%**	**21.57%**	**0.29%**
Network Monitoring capital investment with 8% capex efficiency		**£2,543,859**							

Installation of transferable noise loggers was selected because it is a business requirement to determine the benefits that these loggers will bring to our specific network, which is characterised as a relatively small, well sub-divided network with a system of flow and pressure monitoring already in place. This intervention includes the installation of a pilot trial to test innovative transferrable noise logging devices. These will be initially installed in the two worst performing district meter areas. If benefits are proven these can be removed and transferred to other district meter areas.

Installation of increased network monitoring over AMP7, was selected because it is cost beneficial, helping to offset future bill increases for our customers. This intervention includes installation during AMP7 of 396 pressure loggers in all district meter areas; 160 transient monitoring in highest risk district meter areas; and 1000 flow loggers in all remaining waste water meter districts.

The total Network Monitoring investment is aligned to the Water Network Plus Wholesale Control category of our Business Plan. Costs are allocated to the Treated Water Distribution business unit. Investment is related to maintaining the long term capability of our non-infrastructure assets. Water Service and Business Unit Allocation for customer Meters summarised in Table 8

Table 8: Water Service and Business Unit Allocation

Wholesale Control	**Water Network Plus**	**Total Capex**
Business Unit Allocation	***04 Treated Water Distribution***	
Network Monitoring capital investment (%)	**100.0%**	**100%**
Network Monitoring capital investment	**£2.765m**	**£2.765m**
Maintaining the long term capability of the assets - non-infra	£2.765m (100%)	**£2.765m (100%)**
Network Monitoring capital investment with 8% capex efficiency		**£2.544m**

5.2 Contribution to Performance Commitments

Table 9 set outs the percentage contribution to performance commitment improvement provided by the selected Network Monitoring interventions.

Table 9: Contribution to performance commitment targets from selected interventions

Performance commitment	Unit	2019/20 Baseline	2020/21	2021/22	2022/23	2023/24	2024/25	Total performance improvement required in AMP7	Network Monitoring contribution to performance improvement
Supply interruptions	Average mins per property	12.20	4.2	3.6	3.0	2.4	1.8	10.40	13.68%
Leakage (annual)	Ml/d	43	42	41	39.5	38	36.5	6.5	3.13%
Mains bursts	Per 1000km	142	133	133	133	133	133	9	4.48%
Customer contacts about water quality – appearance	Contacts per 1,000 population	0.93	0.83	0.73	0.63	0.53	0.43	0.50	6.35%
Properties at risk of receiving low pressure	Number of Properties	69	68	66	64	62	60	9	21.57%
Per capita consumption (annual)	Litres/ head/ day (l/h/d)	142	140.6	139.2	137.8	136.4	135	7	0.29%

For per capita consumption; in total 26.71% of performance improvement is achieved through interventions within Investment Cases. The remaining of performance improvement will be achieved as a result of a wider customer education programme.

5.3 Non-Selected Interventions

Of the three interventions developed within this investment case, one was not selected. This is because this non-selected intervention 09.001.02 ‘Install the same increased network monitoring but spread over AMP7 and 8’ was set as mutually-exclusive with intervention 09.001.01 ‘Install increased network monitoring over AMP7’, whereby only one of these two interventions may be selected by the investment optimisation. As the scope of the non-selected intervention delivered less in AMP7 than the selected intervention, there is no associated residual risk that will be carried during AMP7. Details of the non-selected intervention are given in Appendix F.

5.4 Assumptions

There are a number of general assumptions that have been made in the development of our investment cases. These are discussed in detail in section 11 of the PR19 Investment Cases Summary Document[5]. There are no additional specific assumptions related to this investment case.

5.5 AMP 8

In AMP8 we propose to continue the growth in network monitoring within our network and continue to optimise the use of technology to increase the benefits that these assets can bring to our customers.

5.6 Base Maintenance

This investment case covers all activities related to network monitoring performance improvement and therefore no assessment of base maintenance investment is required.

5.7 Historic & AMP7 Investment Comparison

A summary of historical investment in Network Monitoring are provided in Table 10 along with the planned AMP7 investment in Network Monitoring interventions. We have re-categorised data used in line with the scope of our investment cases. For historic data we have used the 2016/17 wholesale cost assessment data (data tables 1 and 2). Forecast data has been derived from PR19 data (data tables WS1 and WS2).

Table 10: Historical & AMP7 Investment

AMP	Capital investment values	Investment (£m)
AMP5	AMP5 actual	0.000
AMP6	2015/16 actual	0.000
	2016/17 actual	0.000
	2017/18 actual	0.227
	2018/19 forecast	0.000
	2019/20 forecast	0.000
	AMP6 forecast	**0.227**
AMP7	AMP7 pre-efficiency	**2.765**
	AMP7 8% capex efficiency applied	**2.544**

Our levels of Network Monitoring investment have increased since AMP5 and AMP6; however other additional AMP6 investment related to network monitoring (e.g. for loggers etc.) is included within our AMP6 investment for leakage control and improvement, and hence is not included within the investment values stated above. In AMP7, we are proposing increased investment to implement cost-beneficial solutions to identified risks, and to undertake trail of technologies that will improve our understanding of our network, for the benefit of our customers.

[5] Bristol Water, 2018, PR19 Investment Cases Summary Document, NTPBP-INV-PR1-0635

6 Conclusions

To ensure our Network Monitoring assets continue to deliver our customers' priorities, we will measure progress via performance commitments for which we have set delivery targets.

In AMP7, the Network Monitoring measures are supply interruptions (target 1.8 minutes per property), leakage (target 36.5 Ml/d), mains bursts (target 133/1000km), customer contacts about water quality – appearance (target 0.43 per 1,000 population), properties at risk of receiving low pressure (target 60 properties), and per capita consumption (target 135 l/h/d (annual).

An initial list of two risks was used to generate a total of three interventions. These interventions have been developed and assessed through our asset management totex focused processes and put forward for optimisation. Of these three interventions, one were selected on the basis that they meet our customer priorities and associated performance commitments, and the other on the basis that it is required to improve our understanding of our network and to obtain information that will be used to improve our performance.

We plan to invest a pre-efficiency total of £2.765m on Network Monitoring. The interventions are expected to create an additional opex of £334k. We have set ourselves a challenging target of reducing our costs by 8% during AMP7. This will be achieved through delivery of our business transformation programme, resulting in a post-efficiency investment of £2.544m.

The selected interventions contribute to ensuring our assets are maintained appropriately for the benefit of current and future generations. The interventions also contribute to meeting six of these performance commitments. The most significant contributions are to supply interruptions (13.68%), mains bursts (4.48%), customer contacts about water quality – appearance (6.35%) and properties at risk of receiving low pressure (21.57%).

Additionally, the use of innovative pressure transient monitors will further help us to continue providing a high quality of service to the customer by improving our ability to pinpoint and rectify any potential faults in the pipelines using industry sector leading technology.

As at July 2018 we are achieving our AMP6 target for negative water quality contacts and properties at risk of receiving low pressure, and forecast that we will continue to achieve these through the remainder of AMP6. We are currently underperforming against our targets for unplanned customer minutes lost, mains bursts, and per capita consumption, but are forecasting to achieve our end of AMP6 targets.

If we fail to invest in our Network Monitoring assets, we will not meet our customers' priority for a Safe and Reliable Supply and for saving water before developing new supplies, and our asset health will ultimately continue to deteriorate to unacceptable levels

Our business plan provide assurance that it will deliver and monitor delivery of its outcomes, meet relevant statutory requirements and licence obligations and takes into account any UK Government strategic policy statements.

7 Appendices

Appendix A: Line of Sight
Appendix B: Datasets
Appendix C1: Selected Risks
Appendix C2: Non-Selected Risks
Appendix D: Options Considered
Appendix E: Interventions Developed
Appendix F: Non-Selected Interventions

7.1 Appendix A: Line of Sight

Network Monitoring- Line of Sight

Investment Case
NTPBP-INV-NET-0534

Customer Priorities

- Top Quality Water Supplies
- Saving Water

Performance Commitments

Optimiser Input Form Reference

NTPBP-CAL-DIS-0353

Slower Plan
Suggested Plan
Faster Plan

Based on Lockdown 5

Safe and Reliable Supply of Water

Reliability → **Supply Interruptions** (4.2 / 1.8 / 1.5)

Customer High Priority
ODI — Common Reward and Penalty

Reliability → **Mains Bursts** (137 / 137 / 137)

Customer Medium Priority
ODI — Common Reward and Penalty

Quality → **Discolouration Contacts** (9.3 / 4.3 / 3.2)

Customer High Priority
ODI — Bespoke Reward and Penalty

Quality → **Risk of Low Pressure** (60 / 60 / 60)

Customer High Priority
ODI — Bespoke Reward and Penalty

Local Community Resilience

Leakage → **Leakage** (41 / 36.5 / 36)

Customer High Priority
ODI — Common Reward and Penalty

Leakage → **Per Capita Consumption** (138 / 135 / 129)

Customer High Priority
ODI — Common Reward and Penalty

Interventions

09.001.01
09.001.02

OFWAT Initial Assessment Tests

Test Area	OFWAT Initial Assessment Tests
Engaging Customers	What is the quality of the Company's customer engagement and participation and how is it incorporated into the companies business plan and ongoing operations
Securing long term resilience	How well has the company used the best available evidence to objectively assess and prioritise the diverse range of risks and consequences of disruptions to its systems and services and engaged effectively with customers on its assessment of the risks and consequences
	How well has the company objectively assessed the full range of mitigating options and selected the solutions that represent the best value for money over the long term and support from customers
Targeted controls , markets and innovation	To what extent has the company clearly demonstrated that it has considered whether all relevant projects are technically suitable for direct procurement for customers. Where it has one or more such projects, to what extent has the Company provided a well reasoned and well evidenced value for money assessment
Securing Confidence and Assurance	To what extent does the company have a good track record of producing high quality data, taking into account the company's data submission, assurance process and statement of high quality , and our 2018 assessment of the company under the Company Monitoring Framework
Board Requirements	
Customer Engagement	Assurance that the company's business plan has been informed by customer engagement and feedback from the company's CCG about the quality of its customer engagement and how this has been incorporated into the plan
Resilience	Assurance that the company's business plan has been informed by a robust and systematic assessment of the resilience of the company's systems and services; customer views on managing resilience and a comprehensive and objective assessment of interventions to manage resilience in customers long term interests
Business Planning	How has it challenged an satisfied itself that the overall strategy for data assurance and governance processes delivers a high quality data
	How has it challenged and satisfied itself that the business plan will enable the company to meet its statutory and licence obligations , now and in the future and take account of the UK and Welsh governments strategic policy statements.
	How has it challenged and satisfied itself that its plan will deliver operational financial and corporate resilience over the next control period and the long term through its governance and assurance processes, taking into account of its track record of performance

Performance Commitment Key

- Common Performance Commitment
- Bespoke Performance Commitment
- Common New Performance Commitment
- Bespoke New Performance Comittment

Document Number: NTPBP-

7.2 Appendix B: Datasets

This appendix lists the datasets used in this investment case and where they have been utilised.

Dataset File Name	Data Summary	Process In Which Data Has Been Used			
		Risk Identification, Verification and Needs Assessment	Optioneering	Intervention Costing	Benefits Quantification
BRW0504-007-02 LRF Summary (linkless).xlsx	Leakage - Natural Rate of Rise and Leakage Flow Rate information calculated by RPS	-	-	-	✓
Bristol Water Energy Bill FY 16-17.XLSX	Bristol Water total energy bill for FY 16-17 to determine average Cost £ per kWh of electricity	-	-	✓	✓
REQ-0210 Copy of interruptions_extract_analysis.xlsx	Data showing what proportions of supply interruptions are caused by trunk mains	-	-	-	✓
Meeting - Network monitoring 03-11-17 - Typ costs.docx	Meeting notes detailing costs for installation and running costs of network monitoring devices	-	-	✓	-
Logical Boundary Table (lbt_26-05-17).xlsx	Logical Boundary Table, giving all of Bristol Water's DMAs & WWMDs.	-	-	✓	-

7.3 Appendix C1: Selected Risks

This appendix shows the 2 selected risks of the 2 relevant risks.

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR39	Non Site Specific	IF the latest tools and equipment for detecting and monitoring leakage are not employed THEN BW will fail to meet its AMP7 leakage target.	3	2	4	3	4	3	4	12
SRR625	All supply area	Risk of Customer Minuets Lost (Supply Interruptions)	3	2	4	3	5	3	5	15

7.4 Appendix C2: Non-Selected Risks

Not applicable - all relevant risks were chosen for this investment case..

7.5 Appendix D: Options Considered

This appendix shows the 8 options considered from the 2 selected risks

Strategic Risk Register (SRR) Reference	SRR Revised Risk Description	Risk Need		Identification & Viability of Options			
		SRR Need ID	Need Description (from SRR)	Proposed Option Name	Proposed Option Description	Option Viability?	Option to be Developed into an Intervention?
SRR39	IF increased interventions are not taken during AMP7 THEN BW will fail to meet its performance commitment against Supply Interruptions.	SRRN46	BW are currently performing in the lower quartile on Supply Interruptions. Part o fthe cause of this is the inability to detect the location of bursts and leaks quickly to reduce customer supply interruptions. Investment is needed to turn this position around and to achieve the AMP7 performance commitments on Supply Interruptions.	Business As Usual	This option involves continueing to operate the network with low levels of network monitoring.	This is not an acceptable option because BW are likely to fail to meet their Performance commitments for supply interruptions and for leakage.	N
				Install increased network monitoring over AMP7	Install during AMP 7 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	Y
				Install the same increased network monitoring but spread over AMP7 and 8	Install during AMP 7 and 8 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	Y
SRR625	Risk of Customer Minuets Lost (Supply Interruptions)	SRRN47	Bristol Water currently has a leakage target of 43 Ml/d by the end of AMP6 and OFWAT have suggested a further reduction of 15% by the end of AMP7. To achieve such an ambitious reduction will require investment into network monitoring technologies so that leaks can quickly be detected and located.	Install pilot trial of 240 transferable noise loggers over 30km of distribution main	Install pilot trial to test innovation of noise logging devices. Test on 2 worst performing DMAs. If benefits proven these can be removed and transferred to other DMAs.	Viable option	Y
				Business As Usual	This option involves continueing to operate the network with low levels of network monitoring.	This is not an acceptable option because BW are likely to fail to meet their Performance commitments for supply interruptions and for leakage.	N
				Install increased network monitoring over AMP7	Install during AMP 7 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	Y
				Install the same increased network monitoring but spread over AMP7 and 8	Install during AMP 7 and 8 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	Y
				Install pilot trial of 240 transferable noise loggers over 30km of distribution main	Install pilot trial to test innovation of noise logging devices. Test on 2 worst performing DMAs. If benefits proven these can be removed and transferred to other DMAs.	Viable option	Y

7.6 Appendix E: Interventions Developed

This appendix shows the 6 interventions developed from the 8 options.

Strategic Risk Register (SRR) Reference	SRR Revised Risk Description	Risk Need		Identification & Viability of Options			Proposed Interventions		Costs	Benefits					
		SRR Need ID	Need Description (from SRR)	Proposed Option Name	Proposed Option Description	Option Viability?	Ref. No.	Intervention Title	Capex After (£)	Change in Opex (£)	Supply Interruptions (mins/prop/year)	Leakage (Ml/day)	Discoloured Contacts (Contacts per 10,000)	Low Pressure (props per 10,000 connections)	Per Capita Consumption (l/head/day)
SRR39	IF increased interventions are not taken during AMP7 THEN BW will fail to meet its performance commitment against Supply Interruptions.	SRRN46	BW are currently performing in the lower quartile on Supply Interruptions. Part o fthe cause of this is the inability to detect the location of bursts and leaks quickly to reduce customer supply interruptions. Investment is needed to turn this position around and to achieve the AMP7 performance commitments on Supply Interruptions.	Install increased network monitoring over AMP7	Install during AMP 7 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	9.001.01	Install increased network monitoring over AMP7	£2,485,063	£319,880	1.677	0.24	0.4	1.942	0.02
				Install the same increased network monitoring but spread over AMP7 and 8	Install during AMP 7 and 8 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	9.001.02	Install the same increased network monitoring but spread over AMP7 and 8	£1,242,532	£159,940	0.839	0.12	0.2	0.971	0.1

Strategic Risk Register (SRR) Reference	SRR Revised Risk Description	Risk Need		Identification & Viability of Options			Proposed Interventions		Costs	Benefits					
		SRR Need ID	Need Description (from SRR)	Proposed Option Name	Proposed Option Description	Option Viability?	Ref. No.	Intervention Title	Capex After (£)	Change in Opex (£)	Supply Interruptions (mins/prop/year)	Leakage (Ml/day)	Discoloured Contacts (Contacts per 10,000)	Low Pressure (props per 10,000 connections)	Per Capita Consumption (l/head/day)
SRR625	Risk of Customer Minuets Lost (Supply Interruptions)	SRRN47	Bristol Water currently has a leakage target of 43 Ml/d by the end of AMP6 and OFWAT have suggested a further reduction of 15% by the end of AMP7. To achieve such an ambitious reduction will require investment into network monitoring technologies so that leaks can quickly be detected and located.	Install pilot trial of 240 transferable noise loggers over 30km of distribution main	Install pilot trial to test innovation of noise logging devices. Test on 2 worst performing DMAs. If benefits proven these can be removed and transferred to other DMAs.	Viable option	9.001.03	Install pilot trial of 240 transferable noise loggers over 30km of distribution main	£280,000	£13,823	-	-	-	-	-
				Install increased network monitoring over AMP7	Install during AMP 7 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	9.001.01	Install increased network monitoring over AMP7	£2,485,063	£319,880	1.677	0.24	0.4	1.942	
				Install the same increased network monitoring but spread over AMP7 and 8	Install during AMP 7 and 8 (a) 396 Pressure Loggers in all DMAs; (b) 160 Transient Monitoring in Highest Risk DMAs; and (c) 1000 Flow Loggers in all remaining Waste Water Meter Districts.	Viable option	9.001.02	Install the same increased network monitoring but spread over AMP7 and 8	£1,242,532	£159,940	0.839	0.12	0.2	0.971	
				Install pilot trial of 240 transferable noise loggers over 30km of distribution main	Install pilot trial to test innovation of noise logging devices. Test on 2 worst performing DMAs. If benefits proven these can be removed and transferred to other DMAs.	Viable option	9.001.03	Install pilot trial of 240 transferable noise loggers over 30km of distribution main	£280,000	£13,823	-	-	-	-	

7.7 Appendix F: Non-Selected Interventions

Of the three interventions developed within this investment case, one was not selected. This is because this non-selected intervention 09.001.02 ‘Install the same increased network monitoring but spread over AMP7 and 8’ was set as mutually-exclusive with intervention 09.001.01 ‘Install increased network monitoring over AMP7’, whereby only one of these two interventions may be selected by the investment optimisation. As the scope of the non-selected intervention delivered less in AMP7 than the selected intervention, there is no associated residual risk that will be carried during AMP7.

This appendix shows the non-selected intervention. See appendix D for costs or performance commitments.

ID	Intervention Title	Expected Capex after (£k)	Change in Opex (£k)	Residual Risk
09.001.02	Install the same increased network monitoring but spread over AMP7 and 8	£1.243	£160	IF increased interventions are not taken during AMP7 THEN BW will fail to meet its performance commitment against Supply Interruptions.
				IF the latest tools and equipment for detecting and monitoring leakage are not employed THEN BW will fail to meet its AMP7 leakage target and this will be a very difficult position to recover from.