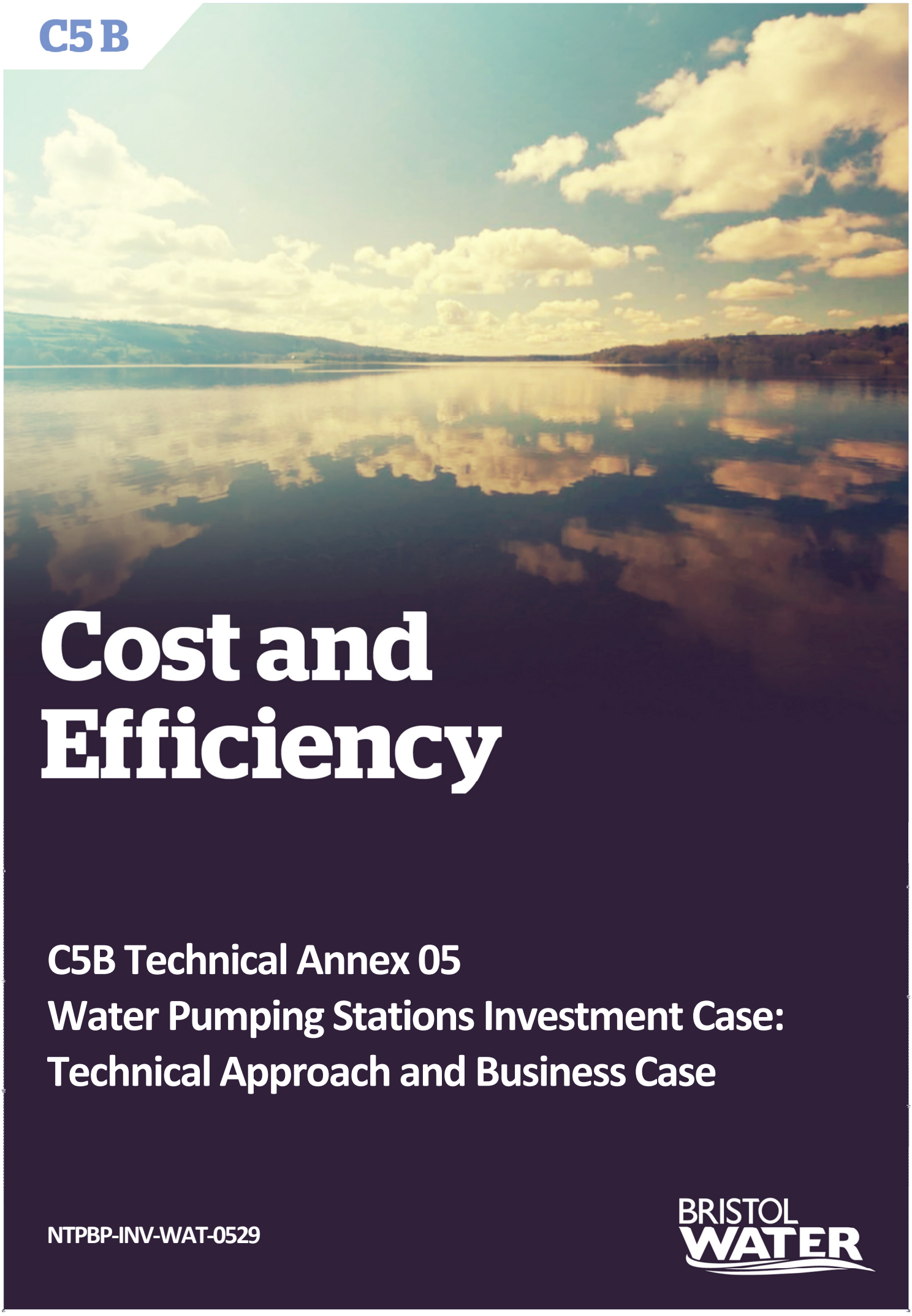
C5 B



Cost and Efficiency

C5B Technical Annex 05
Water Pumping Stations Investment Case: Technical Approach and Business Case

NTPBP-INV-WAT-0529

BRISTOL WATER

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1 Foreword

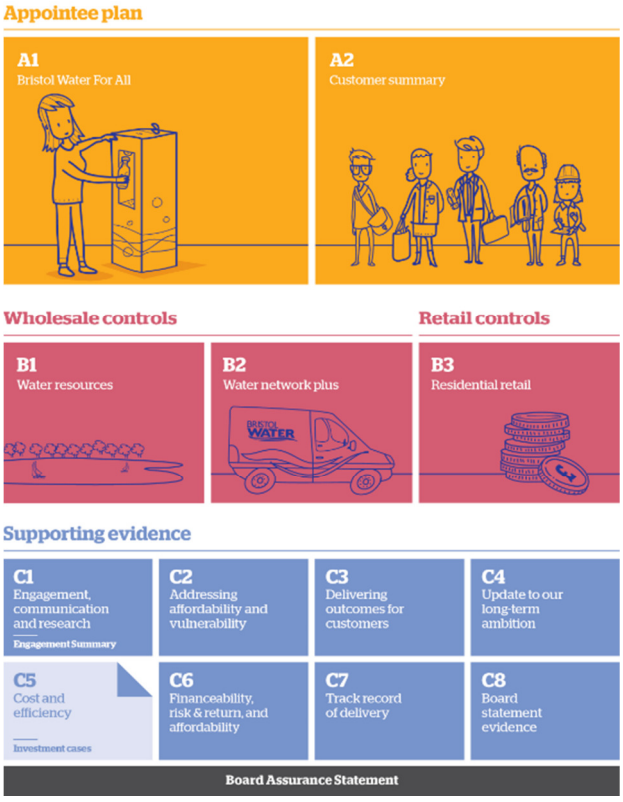
The Water Pumping Stations investment case will address specific site operational and maintenance issues by implementing capital maintenance interventions of obsolescent plant that will contribute to a Safe and Reliable supply to our customers.

We currently have 114 water pumping stations which boost or lift water in the treated water distribution network to the customer.

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

This investment case, one of 21, will summarise the facts, risks and investment requirements for water pumping stations for the next review period for 2020 to 2025. This investment case will also summarise performance for water pumping stations for the current review period from 2015 to 2020 and our methodology for determining and delivering the future water pumping stations 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 customers with a Safe and Reliable water supply, we will focus on maintaining the level of risk posed by our one hundred and fourteen water pumping stations. We will achieve this by using our totex investment approach which includes investment of base maintenance and capital expenditure of £5.285m. We will deliver six interventions that will contribute towards the interruptions to supply and unplanned maintenance – non-infrastructure performance commitments. We will challenge ourselves to deliver more efficiently and apply innovation to the process we adopt to pump water. When considering our efficient and innovative approach we plan to deliver our water pumping stations capital programme for £4.862m.

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 plant.

Water pumping stations is a collective term for all assets associated with boosting or lifting water in the potable, treated water distribution network to the customer. Raw water pumping stations are covered in the Raw Water Pumping Stations Investment Case. At July 2018 we operate and maintain one hundred and fourteen water pumping station sites.

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 water pumping stations measures are the occurrence of unplanned maintenance events (target 3272), properties at risk of receiving low pressure (target 60), and supply interruptions (target 1.8).

As at July 2018 we are achieving our AMP6 target for unplanned maintenance - non-infrastructure and forecast that we will continue to achieve it through the remainder of AMP6. For properties at risk of receiving low pressure, we are forecasting to meet our AMP6 target of sixty nine properties. In terms of supply interruptions, our current measure is unplanned customer minutes lost, for which we are forecasting to miss our AMP6 target of 12.8 by just 0.04%.

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

The investment will cover six schemes with a total capital expenditure of £5.285m. These include £2.124m for a major capital refurbishment at Purton High Lift and £3.161m for the renewal/refurbishment of smaller high lift, transfer, booster and resilience water pumping station and minor works.

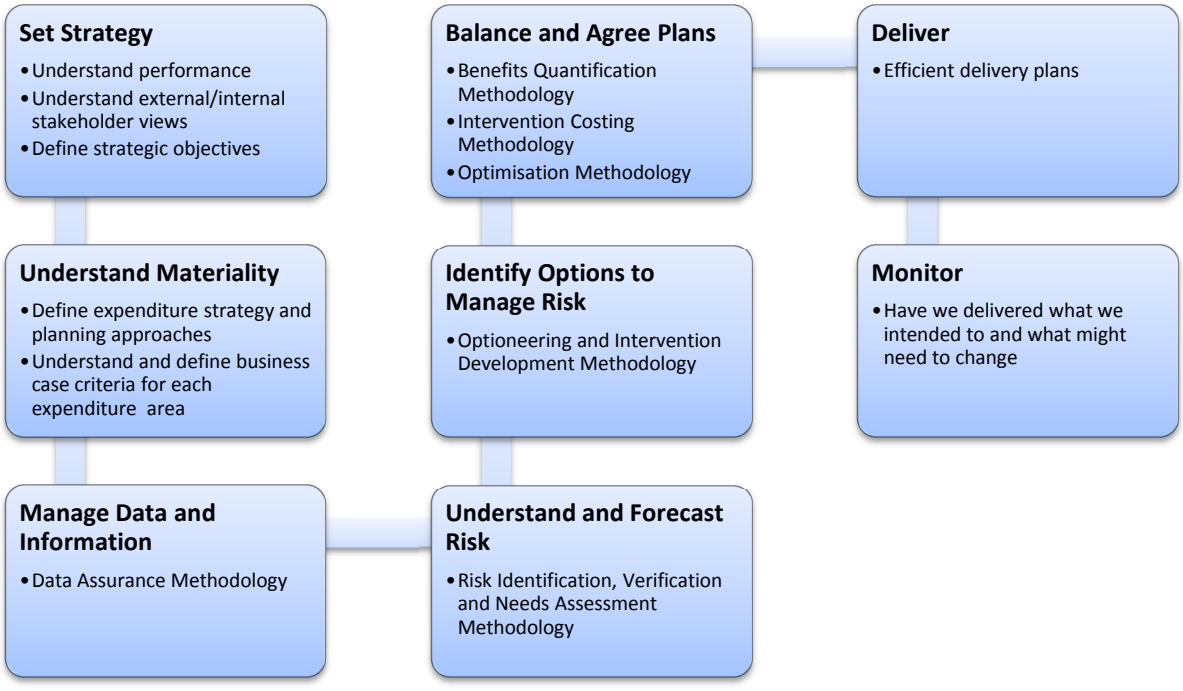
The minor works will cover both full pumping station refurbishment and rolling programmes of investment which would typically include the following treated water distribution assets:

- Suction wells, inlet valves and penstocks, and instrumentation;
- Substructure pump chambers and pits;
- Mechanical, electrical, and instrument, automation and control (MEICA) systems associated with lifting or boosting water;
- External buried flow meters associated with pump control and monitoring; and
- Auxiliary services including lighting, ventilation, fire protection and security systems.

Should we fail to invest in water pumping stations or not achieve the two associated performance commitments mentioned above, there is a risk that our water pumping stations will fail leading to an unreliable supply of water. Consequently we will not provide our customers with the Safe and Reliable Supply that is a key outcome for them.

In order to ensure that we meet customers' priorities and mitigate the risks associated with water pumping stations, 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 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 £5.285m from 2020 to 2025 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 our costs by 8% during AMP7. This will be achieved by delivery of our business transformation programme results in in a post-efficiency investment of £4.862m.

Costs are allocated to the Treated Water Distribution business unit and all investment is related to maintaining the long term capability of non-infrastructure assets.

Table 1: Performance Commitment Targets and Percentage Contribution from Water Pumping Stations

Performance Commitment	Unit	2019/20 Baseline	2024/25 Target	Total targeted performance improvement in AMP7	Water pumping stations % contribution to performance Target
Supply interruptions	Average mins per property	12.20	1.80	10.40	3.28%
Properties at risk of receiving low pressure	Number of properties	69	60	9	78.43%
Unplanned maintenance - non-infrastructure	Number of jobs	3972	3272	704	7.30%

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

This investment case contributes 7.30% towards our AMP7 target for the unplanned maintenance – non-infrastructure performance commitment. 23.24% of our performance improvement for this commitment will be achieved through investment case interventions. We will achieve the remaining performance improvement through our operational maintenance activities.

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 water pumping station assets associated with boosting or lifting water in the treated water distribution network to the customer. These assets are classified into three types of pumping station and comprise of:

- Lift pumping stations allocated at each of our sixteen operational water treatment works; these lift water to the service reservoir or directly into distribution;
- Transfer or resilience pumping stations; and
- Booster pumping stations (forty nine supplying Cap zones which are areas directly supplied by the pumps, as opposed to gravity fed pumps from a raised reservoir. This means customers are reliant on the continuous operation of the pump).

We have one hundred and fourteen water pumping stations that support provision of supply to our customers.

This investment case summarises the investment in AMP7 to meet our customers' expectations for a Safe and Reliable Supply through refurbishment of our water pumping stations. This will reduce the risk of unplanned supply interruptions and unplanned maintenance events due to water pumping station failure.

The primary objective of this investment case is to maintain a stable level of risk at water pumping stations and ensure on-going and sustainable asset lives.

We have assets that will become less reliable as they continue to deteriorate during the asset management period, leading to increased operating costs, as the number of unplanned maintenance events rise, and there is an increase in unplanned supply interruptions due to equipment failures. The profile of our assets' ages is shown in Table 2 below.

Table 2: Age of Water Pumping Station Assets

Age of WPS assets in years		% of total WPS Assets
From	To	
41	50	8%
31	40	13%
21	30	39%
11	20	13%
1	10	28%

We have established minimum levels of expenditure in relation to the base maintenance of water pumping stations, as set out in the Non-Infrastructure Base Maintenance Investment Case. These minimum levels provide investment for routine and reactive maintenance, to ensure the continuation of 'business as usual'. The investment proposed through this Water Pumping Stations investment case will contribute towards these minimum levels, as it represents improvements to the performance of our

water pumping station assets above current levels. Investment for water pumping stations in relation to non-infrastructure base maintenance is described in full in section 5.6.

The following assets are related to, but are excluded from the Water Pumping investment case as they have been included in other investment cases:

- Raw water pumping stations (see Raw Water Pumping Stations)

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

- Trunk Mains; shared target of supply interruptions;
- Distribution Mains; shared target of supply interruptions;
- Network Monitoring; shared targets of supply interruptions and properties at risk of receiving low pressure;
- Raw Water Pumping Stations; shared target of unplanned maintenance - non-infrastructure;
- Treatment Works Strategic Maintenance; shared target of unplanned maintenance - non-infrastructure;
- ICA and Telemetry; shared target of supply interruptions; and
- Resilience; shared target of supply interruptions.

3.2 Strategy

Developing the investment needs for our water pumping stations 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 provides the strategic framework that supports this vision and enables investment in our water pumping stations to clearly focus in delivering against outcomes and performance commitments.

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 our assets are, and remain, 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 is a specific outcome (Safe and Reliable Supply) and specific performance commitments (supply interruptions, properties at risk of receiving low pressure, and unplanned maintenance - non-infrastructure maintenance) that have strategic targets and incentives that will be directly influenced by our investment needs for water pumping stations.

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 for our water pumping stations 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 Water Pumping Stations 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[2]. Detailed 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 95% confidence these centres would not flood

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

[2] A4g: customer online panel March 2018

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 Water Pumping Stations, specific details planned investment as associated performance can be found in section 3.4.

3.4 Asset Health, AMP7 Performance Commitments & Outcome Delivery Incentives

This investment case supports our Safe and Reliable Supply outcome, by investing in our water pumping station assets in order to provide high quality, reliable supplies for present and future generations.

The Safe and Reliable Supply outcome will be measured through a set of associated performance commitments. Our planned investment in water pumping stations will support the achievement of the performance commitments set out in Table 3.

Table 3: Performance Commitments Associated with Water Pumping Stations

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
Properties at risk of receiving low pressure,	Number of properties	69	68	66	64	62	60	9
Unplanned maintenance – non-infrastructure	Number of jobs	3976	3272	3272	3272	3272	3272	704

With regard to asset health performance commitments, our investment in water pumping stations will help ensure our assets are being maintained appropriately for the benefit of current and future generations. We measure this through some specific asset health performance commitments, which for water pumping stations are properties at risk of receiving low pressure and unplanned maintenance – non-infrastructure. These performance commitments enable Ofwat, on behalf of customers, to compare our asset health performance across AMP6 and AMP7, and to compare our asset health performance with that of other water companies.

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

Statutory and compliance obligations have influenced the development of interventions in this investment case and the investment for AMP7. Relevant legislation is detailed below:

We have a statutory obligation under the Environmental Protection Act 1990 to ensure that we prevent the release of pollution into the environment. A further statutory obligation is detailed under the Groundwater Regulations Act 2009, where we are obliged to prevent the discharge of hazardous substances and non-hazardous pollutants into groundwater, unless it is in accordance with permits granted to us by the Environment Agency.

Within this investment case there are specific risks that we are seeking to mitigate in order to ensure our continued compliance with these obligations. These are explained in section 5.

3.6 AMP6 Investment And Performance

Our AMP6 investment in water pumping stations supports our ability to meet our performance commitments for unplanned customer minutes lost and unplanned maintenance - non-infrastructure. Our investment in AMP6 will also underpin our performance commitments for supply interruptions and unplanned maintenance - non-infrastructure in AMP7.

AMP6 investment related to water pumping stations is summarised in Table 4. 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 4: AMP6 capex Investment

Year	Water pumping stations capex (£m)
2015/16 actual	0.028
2016/17 actual	0.009
2017/18 actual	0.002
2018/19 forecast	0.717
2019/20 forecast	0.187
AMP6 forecast	**0.939**

The AMP6 performance commitments that are related to water pumping station investment, and our performance, are given in Table 5.

Table 5: AMP6 Performance Related to Water Pumping Stations

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
Properties at risk of Low pressure						
Bristol Water	Target	69	69	69	69	69
	Company Performance	71	94	65	69	69
Unplanned Maintenance - Non-Infrastructure						
Bristol Water	Target	3976	3976	3976	3976	3976
	Company Performance	3353	2870	3279	3976	3976

Our asset reliability non-infrastructure performance commitment consists of two sub-indicators, which are - turbidity at water treatment works and unplanned maintenance events (non-infrastructure). Our performance against these two sub-indicators is used to assess our capability of delivering customers expected level of service both now and in the future.

As we have met our target for the turbidity sub-indicator and outperformed the unplanned maintenance events sub-indicator, we have met our target for this performance commitment, which has been assessed as 'stable' for the third consecutive year of AMP6 (measures are: improving, stable, marginal, deteriorating).

In AMP7, these two sub-indicators will be reported as separate performance commitments.

Our AMP6 forecast for unplanned maintenance events is set at the target (3976) as the availability and reliability of supporting data at present does not allow a better assessment of performance. We are working to improve our asset data practices to better inform our performance forecasts.

Unplanned customer minutes lost is included as it has been used throughout AMP6 to measure related 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.

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 expenditure (opex) or capital expenditure (capex).

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

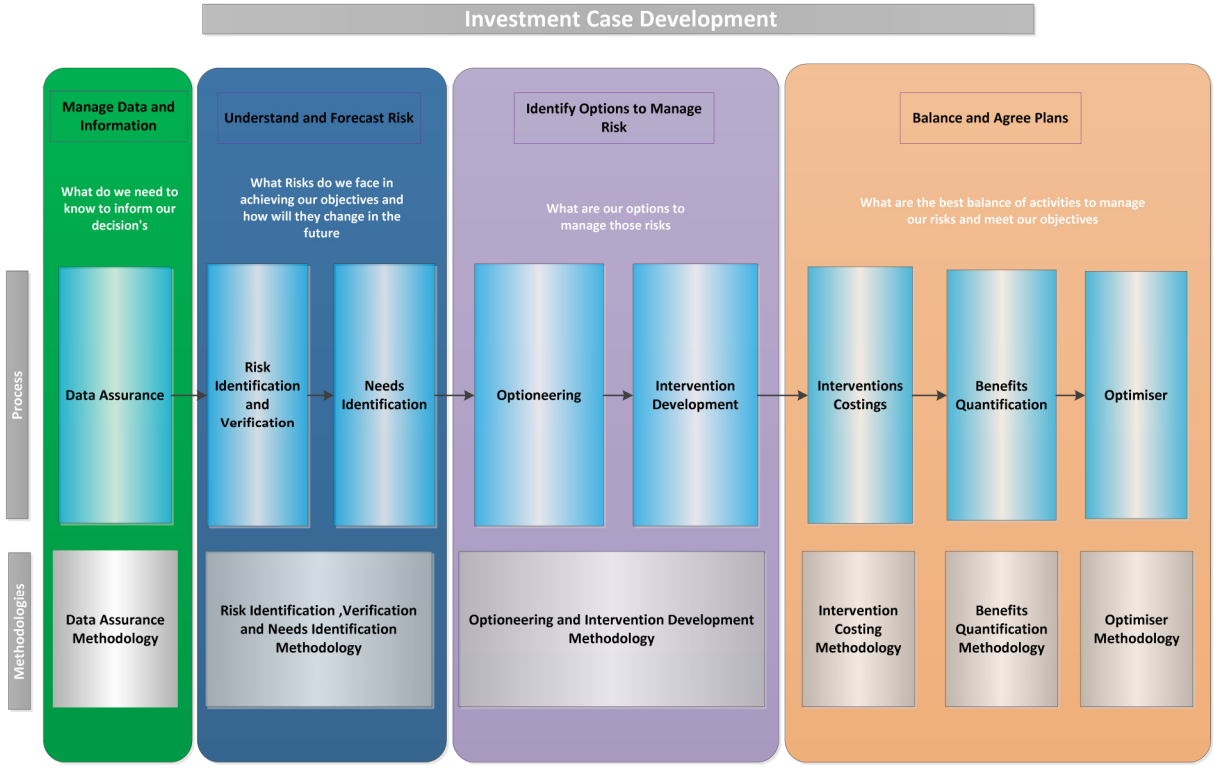
We have created and implemented a process that is supported by a set of six methodologies. When developing the methodologies, we wanted to ensure that they:

- 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[3].

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 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

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

£140m) of the total capital investment plan, and represents two hundred and eight six individual data types. We have evaluated all two hundred and eight six 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.

The following sections detail the results of the data assurance and Annual Performance Report assessments undertaken for this investment case.

Quality Assessments

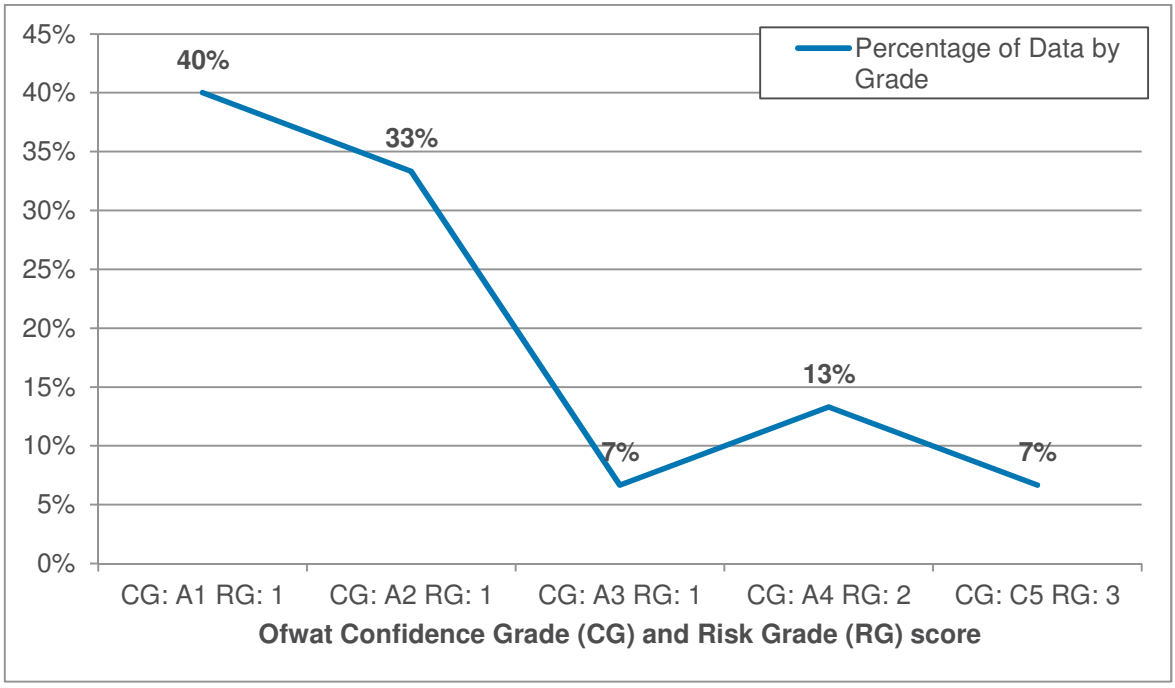
Each data point used in this investment case has been assured for completeness, accuracy, and reliability, and has been given an overall score for quality in terms of a Risk Grade score between 1 and 5 (1 being good quality, 5 being poor quality). The risk grade has subsequently been aligned to the equivalent Ofwat Confidence Grade scores A1-D6 (A1 being highest confidence, D6 being lowest confidence).

A list of data used in this investment case is provided in Appendix B (actual data sets can be provided upon request). A total of fifteen specific data types were identified of which fourteen (93%) have been assessed as having good quality (Confidence Grade A1-B4 and Risk Grade 1-3).

Following a review, it was found that the remaining 7% of data were mainly text or qualitative assessments rather than quantitative assessments. This data will be included for enhancement as part of our business as usual approach to improve the quality of our data, which is outlined in our data and information strategy.

Figure 3 summarises the number of data types scored against Ofwat Confidence Grades and Risk Grades.

Figure 3: Percentage of Data Types by OFWAT Confidence Grade and Risk Grade



Annual Performance Report Assessments

The fifteen data types have also been assessed in their utilisation in the Annual Performance Report. This process is subject to both internal and external assurance and has governed methodologies that are applied in the provision of Annual Performance Report data tables. The assessment of the Annual Performance Report submission, and application of the methodologies, are formally governed and recorded.

Ten data types, 77% of the data used in this investment case, were assessed as already required for Annual Performance Reporting and therefore subject to the assurance requirements as set out in Annual Performance Report methodologies.

4.1.2 Risk Identification, Verification & Needs Assessment Methodology

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

- The risks that we are currently facing are captured in a single risk register;
- 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;
- 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.

Unselected risks 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 was 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 of 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 capex 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, 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 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 capex and opex.

Expected Capital Cost (capex before)

If we deliver the capex 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 estimated 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 opex 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 optimiser model assesses interventions primarily on the overall benefit, which takes account of performance and whole life costs. The investment optimiser calculates the whole life cost as the net present value over forty 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; or
- 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 optimiser 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 C1 (slower Improvement plan, suggested improvement plan and faster improvement plan).

4.2 Applying the investment process to Water Pumping Stations

Each of the following sections describes the specific details associated with the application of the investment case development process for water pumping stations.

4.2.1 Investment Case Risk Identification, Verification & Needs Assessment

There were one hundred and twenty three risks identified in the Strategic Risk Register, associated with this investment case. Every risk went through a process of assessment, scoring, and review, following the Methodology of Risk Identification, Verification and Needs Identification.

Ten risks were selected and developed into need statements, to be taken forward into optioneering and intervention development. The risk descriptions, scoring and associated needs statements are captured in the Strategic Risk Register. Details of the selected risks are provided in Appendix C.1.

One hundred and two risks were not selected and these risks return to being monitored and reviewed under our business as usual risk management process. Details of the non-selected risks are provided in Appendix C.2.

An example of a non-selected risk is given below in Table 6.

Table 6: Example of Unselected Risk

SRR ID	IC No	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	Customers Impacted	Max Impact	Risk Score
SRR29	04	Charterhouse Treatment Works	IF Charterhouse Treatment Works final pump station fails due to age and deterioration THEN potential loss of supply to customers supplied by Mast Reservoir.	2	1	2	1	1	1	2	4

In the example above, it was determined that the pump station was unlikely to fail before AMP8 or 9 and therefore was allocated a likelihood score of two. The impacts of such a failure were assessed to be small primarily because of good resilience in the network which allows Banwell East Pumping Station to supply the reservoir and customers from the Stowey supply zone.

The 'Line of Sight' for the whole process, beginning with the selected risks, the source of the risk, a record of source documents used to verify the risks, and the needs statements, is captured in the Water Pumping Station Investment Case Intervention Register[4].

4.2.2 Optioneering & Intervention Development

As described in section 4.2.1, ten 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 ten needs statements. These options were peer reviewed and all options identified as not viable were discarded. Viable options were converted into intervention. Each intervention had its costs and benefits assessed.

For example, against the selected risk SRR31 regarding Coley Pumping Station, four options were identified and one of these was developed into an intervention, as shown in Table 7.

[4] Bristol Water Water PS IC Intervention Register NTPBP-CAL-WAT-0140

Table 7: Example of Options Selection for SRR31

SRR Description	Need Description	Proposed option Name	Proposed option description	Option Viability	Option to be developed into Intervention	Ref No	Intervention Title	Intervention Description
SRR31 (combined with SRR32, 330, 331 and 689) IF aging assets at Coley pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 5,166 customer connections will be at an increasing risk of low pressure or loss of supply (SRR31 Risk Score = 16)	To provide customers with a Safe and Reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Coley PS with 34 recorded in last 3 years (higher than average, for this type of asset). The assets will be over 40 years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate. These pumps supply 13,000 connections and in the event of pump failure could affect 5166 customer connections including 196 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Coley PS - Replacement	Build a replacement pumping station next door to the existing pumping station. This would include a new suction tank to resolve current suction issues.	This option is viable; however it is the most expensive option.	Yes	04.001.04	Coley PS - Replacement	New pumping station on greenfield site including land procurement, pump basement, new suction well and electrical switchroom, and mechanical, electrical and control systems installation.
		Coley PS - Refurbishment	Refurbish PS - replace switchgear, pumps, motors, drives, surge vessel, valves and above ground pipework. Address issues with Suction conditions of the pumps.	This is a viable option. It will resolve the issues on the site but constructability will be awkward as the site will have to remain in service during the refurbishment	Yes	04.001.03	Coley PS - Refurbishment	Refurbish existing pumping station including extension of the existing suction well, building refurbishment and replacement of mechanical. Electrical and control systems installation.
		Coley PS - Refurbishment Phase A	Address issues with Suction conditions of the pumps by removing suction tank.	Viable option only if Sherborne Treatment Works is taken out of service	N/A	N/A	N/A	
		Do Nothing	Business as usual; Fix on fail and	This will not mitigate the risk of customer losing supply, and will mean the pumping station will deteriorate further. Not a viable option.	No	N/A	N/A	

A total of eleven interventions were identified in this way. These included in some cases, multiple interventions against a single selected risk and these were identified as mutually exclusive during intervention selection.

A summary of all selected risks and their associated options is included in Appendix D. A summary of all non-selected risks is given in Appendix C.2.

Once interventions were developed, costs were prepared which are discussed in section 4.2.3.

4.2.3 Intervention Costing

In this investment case costs for all interventions were calculated in collaboration with ChandlerKBS, based on activity schedules supplied by Bristol Water. Indirect overheads (contractor on-costs including preliminaries, design costs, contract management) and Bristol Water overheads were then applied at intervention level. These overheads were based on Bristol Water data where available, or industry average where Bristol Water data was not available.

As described in section 4.2.2, we have identified a total of eleven interventions (including mutually exclusive options for the same risk) to be taken forward for scope development and cost estimation. For each of the eleven interventions, high level scope documents were developed, including an activity schedule and annotated drawings. ChandlerKBS utilised a water industry unit cost database to complete cost estimation in accordance with their own assured methodology.

The costed activity schedules were returned to Bristol Water for peer review, leading to further refinement in collaboration with ChandlerKBS. Often, we used historical data to cross check through this process. An example of this are the historic costs for AMP5 pumping station refurbishment at Almondsbury and Purton, and the new Pumping station at Lockleaze.

For the high voltage electrical intervention at Purton High Lift Pumping Station, the ChandlerKBS unit cost database did not have an adequate dataset to provide reliable costs for some of the larger assets. This intervention was partially costed by Bristol Water using direct supplier quotations and previous tender costs for similar schemes (the electrical line items in the activity schedules) and partially costed by ChandlerKBS (the remaining line items in the activity schedule, overheads and the total intervention cost).

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

Cost Example - Dry Hill Pumping Station Replacement

Unplanned maintenance events have been increasing year on year at Dry Hill Pumping Station, with nine recorded in last three years. The assets will be over thirty five years old by the end of AMP7 and most will have passed their serviceable life. Unplanned maintenance events are expected to increase together with the risk of interruptions to supply as the assets deteriorate.

We have established a direct cost of undertaking the works of £0.388m. 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 £0.063m 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.

We have therefore used the "patch and repair" cost, calculated as £0.452m. As the risk is current and highly likely to occur within the next 12 months have applied a factor of 1 to account for the likelihood of the risk materialising within the 5 year AMP. We have estimated that this reactive cost to be £0.452m (£0.452m multiplied by 1).

All of the direct costs above gave us an intervention cost of £0.451m to implement the intervention in a planned way (the capex after).

We have established that if we undertook the above intervention in a planned way, there would be a saving in operational expenditure £0.78 (opex after).

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

4.2.4 Benefits Quantification

Eleven water pumping station interventions were assessed for direct and indirect benefits. These are presented in Appendix E.

In terms of indirect benefits, the performance commitments that relate to this investment case are discussed below.

Supply Interruptions

Supply Interruptions were assessed using the new metric of interruptions to supply greater than three hours and is measured as minutes per total number of properties supplied. DG3 data, between 2001 and 2016, was used to develop an annual average for the number of minutes of supply interruptions per property attributable to pumping stations being out of service for greater than three hours. The annual average was then split proportionally against each appropriate risk and associated intervention. The information was recorded in the relevant benefits calculation and the impact was assessed.

Properties at risk of Low Pressure

The proposed increased network monitoring will provide primary benefits against our performance commitments by providing additional pumping capacity (e.g. by fitting booster pumps to raise pressure locally) in order to reduce low pressure complaints. This benefit is linked to that provided by our investment in network monitoring, which will provide the data and information to enable us to better understand our network and the causes of low pressure experienced by customers.

Unplanned Non-Infrastructure Maintenance Events

The Unplanned Non-Infrastructure Maintenance contribution was assessed using operational data from our company financial, operational and asset systems. Accurate data was available for the years 2010–2016 and was used to identify average annual outage per annum. The information was recorded in the relevant benefits calculation and the overall impact on the company output, as a percentage, was assessed.

While a specific intervention would not be expected to fully eradicate unplanned non-infrastructure maintenance events, a reduction of 80% was considered a reasonable assumption. The change in unplanned non-infrastructure maintenance events before and after implementation of the intervention was recorded in the benefits calculation for input to the investment optimiser input form.

5 Outcome

5.1 Selected Interventions

The eleven interventions developed within the Water Pumping Stations investment case were assessed through the investment optimisation process. Of these eleven interventions, six were 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 reducing our costs by 8% during AMP7. This will be achieved by delivery of our business transformation programme.

We see innovation as 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 enable. 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 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
- **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.

The six selected interventions are set out in Table 8, along with details of the associated costs.

Table 8: Selected Interventions, Costs, and % Performance Contribution

ID	Intervention Title	Total Capex (£)	Change in Opex per annum (£)	Supply interruptions	Properties at risk of receiving low pressure	Unplanned maintenance – non-infrastructure
04.001.01	Barrow Backwell Hill - Refurbishment	£814,100	-£404	1.21%	12.08%	0.57%
04.001.02	Beggar Bush Pumping Station - Replacement	£436,230	-£105	0.03%	6.47%	0.68%
04.001.05	Dry Hill Pumping Station - Replacement	£451,300	-£783	0.35%	6.70%	0.23%
04.001.06	Tetbury (Tower and High Lift) Pumping Station - Refurbishment	£449,740	-£1,219	0.13%	6.67%	1.48%
04.001.08	Purton High Lift Pumping Station Resilience	£2,124,156	-	-	-	1.65%
04.002.01	Pumping Station Base Maintenance (Minor Works)	£1,009,357	-£3,102	1.56%	46.50%	2.70%
Water Pumping Stations Selected Interventions Totals		**£5,284,883**	**-£5,613**	**3.28%**	**78.43%**	**7.30%**
Water Pumping Stations Total with 8% Capex Efficiency		**£4,862,092**				

Of these six interventions, four were selected because they are cost-beneficial, helping to offset future bill increases for our customers. Additionally, these four interventions also provide contributions to achieving the unplanned maintenance – non-infrastructure, properties at risk of low pressure, and supply interruption performance commitment targets. The four interventions are:

- Beggar Bush Pumping Station – Replacement
- Dry Hill Pumping Station – Replacement
- Purton High Lift Pumping Station Resilience
- Pumping Station Base Maintenance (Minor Works)

The remaining two interventions, 04.001.01 (Barrow Backwell Hill – Refurbishment) and 04.001.06 (Tetbury (Tower and High Lift) Pumping Station – Refurbishment) are selected specifically for their contributions to achieving the performance commitments above.

The individual interventions are described in the following sections.

Barrow Backwell Hill - Refurbishment

Unplanned maintenance events have been increasing year on year at Barrow HL (Brackley Hill) Pumping Station, with thirteen recorded in last three years. The assets will be over thirty years old by the end of AMP7 and most will have past their serviceable life. Unplanned maintenance events are expected to increase together with the risk of supply interruptions as the asset deteriorates. These pumps supply 20,000 connections and in the event of pump failure could affect 18,800 customer connections, including three hundred and thirty four vulnerable customers.

Refurbishing or replacing the pumps, electrical systems and controls, and the provision of additional booster pumping capacity, will help ensure that a Safe and Reliable Supply is maintained for our customers.

Beggar Bush Pumping Station - Replacement

Unplanned maintenance events have been increasing year on year at Beggar Bush Pumping Station with fifteen recorded in last three years. The assets will be over thirty five years old by the end of AMP7 and most will have passed their serviceable life. Unplanned maintenance events are expected to increase together with the risk of supply interruption as the asset deteriorates. These pumps supply five hundred and nineteen connections and in the event of pump failure, could affect 519 customer connections including twenty eight vulnerable customers.

Refurbishing or replacing the pumps, electrical systems and controls, and the provision of additional booster pumping capacity will help ensure that a Safe and Reliable Supply is maintained for our customers.

Dry Hill Pumping Station - Replacement

Unplanned maintenance events have been increasing year on year at Dry Hill Pumping Station, with nine recorded in last three years. The assets will be over thirty five years old by the end of AMP7 and most will have passed their serviceable life. Unplanned maintenance events are expected to increase, together with the risk of supply interruption as the asset deteriorates.

Refurbishing or replacing the pumps, electrical systems and controls, and the provision of additional booster pumping capacity, will help ensure that a Safe and Reliable Supply is maintained for our customers.

Tetbury (Tower and High Lift) Pumping Station - Refurbishment

Unplanned maintenance events have been increasing year on year at Tetbury Pumping Station, with nine recorded in last three years. The assets will be over thirty five years old by the end of AMP7 and most will have passed their serviceable life. Unplanned maintenance events are expected to increase, together with the risk of supply interruption as the asset deteriorates. These pumps supply 3,141 connections and in the event of pump failure, could affect 2,935 customer connections, including thirty one vulnerable customers.

Refurbishing or replacing the pumps, electrical systems and controls, and the provision of additional booster pumping capacity, will help ensure that a Safe and Reliable Supply is maintained for our customers.

Purton High Lift Pumping Station Resilience

Purton Treatment Works accounts for approximately 30% of our day to day and maximum deployable output. The treatment works output is lifted by the Purton High Lift Pumps to Pucklechurch service reservoir before being distributed to customers. The High Lift pumps and their associated 3.3kV electrical starter systems will be fifty years old by the end of AMP7 and will have passed their serviceable life. Pump repairs can take a considerable amount of time because of the size and age. Electrical systems no longer meet with current standards, have been modified over the intervening years, and consequently pose a risk of catastrophic failure causing unplanned outage from the treatment works and possibly serious injury or death.

Refurbishing or replacing the pumps, electrical systems and controls will help ensure that a Safe and Reliable Supply is maintained for our customers.

Pumping Station Base Maintenance (Minor Works)

Approximately a third of unplanned maintenance events are caused by water treatment pumping assets. Without investment, unplanned maintenance events are expected to increase, together with the risk of interruptions to supply as the assets deteriorate further. The risk assessment has identified twelve pumping stations that need investment to ensure that the level of unplanned maintenance events can be sustained.

Refurbishing or replacing the pumps, electrical systems and controls, and the provision of additional booster pumping capacity, will help ensure that a Safe and Reliable Supply is maintained for our customers.

This Investment Case 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 all related to the maintenance of non-infrastructure assets. Water Service and Business Unit Allocation is summarised in Table 9.

Table 9: Water Service and Business Unit Allocation

Wholesale Control	Water Network Plus	Total
Business Unit Allocation	***04 Treated Water Distribution***	
Water Pumping Stations capital investment (%)	**100%**	**100%**
Water Pumping Stations capital investment	**£5.285m**	**£5.285m**
Maintaining the long term capability of the assets - non-infra	£5.285m (100%)	**£5.285m (100%)**
Water Pumping Stations capital investment with 8% capex efficiency		**£4.862m**

5.2 Contribution to Performance Commitments

Table 10 set outs the percentage contribution to performance commitment improvement provided by the selected water pumping station interventions.

Table 10: Contribution to performance commitment targets from Selected Interventions

Performance Commitment	Unit	2019/20 Baseline	2024/25 Target	Targeted performance commitment Improvement in AMP7	Water Pumping Stations % contribution to performance target
Supply interruptions	Average mins per property	12.20	1.80	10.40	3.28%
Properties at risk of receiving low pressure	Number of properties	69	60	9	78.43%
Unplanned maintenance (non-infrastructure)	Number of jobs	3972	3272	704	7.30%

Asset Health

Our AMP7 investment in treatment works strategic maintenance will help ensure our assets are being maintained appropriately to deliver resilient water services to current and future generations.

Unplanned Maintenance – Non-Infrastructure

This investment case contributes 7.30% towards our unplanned maintenance – non-infrastructure AMP7 target. Approximately a quarter of our performance improvement will be achieved through investment case interventions. We will achieve the remaining performance improvement through our operational maintenance activities

5.3 Non-Selected Interventions

Of the eleven interventions developed within this investment case, five were not selected because they did not provide the most cost beneficial way of meeting performance commitment targets compared to other interventions available.

The risks associated with the five non-selected interventions represent residual risks that will be carried during AMP7. We will continue to monitor these residual risks throughout AMP7, and if the process requires these risks to be mitigated, we will respond with appropriate action. Details of the five non-selected interventions are given in Appendix F. An example is given in Table 11.

Table 11: Example Non-Selected Intervention and Residual Risk

SSR ID	Risk & Need Statement	Non-Selected Intervention & Residual Risk
SRR334	Unplanned Non-Infrastructure Maintenance has been increasing year on year at Page Lane Pumping Stations. The assets will be over 35+ years old by the end of AMP7 and most will have passed their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to supply as the assets deteriorate. These pumps supply 1,069 connections and in the event of pump failure could affect 946 customer connections including 103 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply.	**Non-Selected Intervention:** 04.001.07 West Pennard Page Lane Pumping Stations – Replacement **Residual Risk:** IF aging assets at Page Lane pumping station are not refurbished or replaced to improve pumping stations reliability THEN number of unplanned maintenance events will increase and 946 customer connections will be at an increasing risk of low pressure or loss of supply.

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

We are not planning to change the number of water pumping stations in our network and therefore there will still be one hundred and fourteen as we proceed into AMP8.

We anticipate that the strategic replacement and renewal of our water pumping station assets will follow a similar pattern in AMP8 as proposed for AMP7.

There are a number of risk items that have been developed into interventions which have not been selected for inclusion in the AMP7 business plan (as given in the Appendix F), which will be reappraised for investment in AMP8.

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

To date, no water pumping station failures have impacted on the performance commitment unplanned outage, but there are risks associated with the deteriorating High Lift pumping stations going forward. An unplanned outage is an event which can affect either part or all of the source works which contributes to maximum production capacity, and if we do not invest in these aging assets then there is a risk that the incidence of unplanned outages causing supply interruption will occur.

5.6 Base Maintenance

We have established minimum levels of investment in relation to the base maintenance of water pumping stations, as set out in the Non-Infrastructure Base Maintenance investment case. These minimum levels provide investment for routine and reactive maintenance, to ensure the continuation of 'business as usual'. The minimum value for mechanical and electrical assets within treatment works and pumping stations is £21m. These minimum levels have been determined through a combination of analysis of historical activity and costs, deterioration modelling to establish underlying asset deterioration, and investment planning analysis. Full details are provided in the Non-Infrastructure Base maintenance investment case.

The investment planned through this investment case contributes towards the minimum investment levels, as the selected interventions improve the performance of our water pumping station assets above current levels.

In relation to this investment case, the Non-Infrastructure Base Maintenance investment case defines minimum levels of expenditure for mechanical and electrical assets in treatment works and pumping stations. The minimum investment levels are summarised in Table 12.

Table 12: Contribution to Minimum Non-Infrastructure Base Maintenance Investment

Non-Infrastructure Base Maintenance Asset Group	Minimum AMP7 investment to maintain asset health (£m)	AMP7 investment provided through WPS interventions (£m)[6]	AMP7 investment provided through all interventions (£m)	Additional investment requirement as Base Maintenance (£m)
Treatment Works & Pumping Stations – mechanical and electrical	21.0	5.136	18.233	2.767

[6] Only selected water pumping station interventions are considered in the assessment of contribution to base maintenance minimum spend. This assessment uses 70% of the 'capex before' (reactive cost) of these interventions, to recognise that the typical cost of a proactive intervention is 70% of a reactive intervention. Full details of this assessment methodology are provided in the Non-Infrastructure Base Maintenance investment case.

5.7 Historic & AMP7 Investment Comparison

A summary of historical investment values in water pumping stations are provided in Table 13 along with our AMP7 investment in water pumping station 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 13: Historical & AMP7 Investment

AMP	Values	WPS Investment Capex (£m)
AMP5	AMP5 actual	2.675
AMP6	2015/16 actual	0.028
	2016/17 actual	0.009
	2017/18 actual	0.000
	2018/19 forecast	0.717
	2019/20 forecast	0.187
	AMP6 forecast	**0.940**
AMP7	**AMP7 pre-efficiency**	**5.285**
	AMP7 8% capex efficiency applied	**4.862**

Our AMP7 investment in water pumping stations is greater than in AMP5 and AMP6. In AMP7, we are proposing to increase our investment in targeted improvement schemes to implement cost-beneficial solutions to identified risks and to meet our AMP7 performance commitments.

6 Conclusions

In order to ensure our one hundred and fourteen water pumping and booster stations continue to be resilient and deliver our customers' priorities, we will measure progress via performance commitments for which we have set delivery targets.

In AMP7, the water pumping stations measures are the occurrence of unplanned maintenance events (target 3272), properties at risk of receiving low pressure (target 60), and supply interruptions (target 1.8).

An initial list of one hundred and twelve risks was narrowed down to eleven potential interventions. These interventions have been developed and assessed through our asset management totex focused process and put forward for investment optimisation. Of these a total of six interventions were selected on the basis that they are cost beneficial interventions that meet our customers' priorities and associated performance commitments.

We plan to invest a pre-efficiency total of £5.285m on six capital maintenance interventions. The proposed interventions will reduce operating costs by approximately £5.6k per annum. We have set ourselves a challenging target of reducing our costs by 8% during AMP7. This will be achieved by delivery of our business transformation programme, resulting in a post-efficiency investment of £4.862m.

The interventions proposed are expected to contribute 7.3% of the unplanned maintenance events target (3272), 78.43% of the properties at risk of receiving low pressure target (60) and 3.28% of the interruptions to supply target (1.80) for the end of AMP7.

Our business plan provides assurance to both achieve and monitor the delivery of its outcomes, it will meet relevant statutory requirements and licence obligations imposed by the Drinking Water Inspectorate and the UK Government.

7 Appendices

- Appendix A: Line of Sight
- Appendix B: Datasets
- Appendix C.1: Selected Risks
- Appendix C.2: Non-Selected Risks
- Appendix D: Options Considered
- Appendix E: Interventions Developed
- Appendix F: Non-Selected Interventions

7.1 Appendix A: Line of Sight

Water Pumping Stations Line of Sight

Investment Case
NTPBP-INV-WAT-0529

Customer Priorities

- Top Quality Water Supplies
  - Reliability
- Best Experience
  - Carries Out Work Effectively

Performance Commitments

Optimiser Input Form Reference
NTPBP-CAL-WAT-0348

Slower Plan
Suggested Plan
Faster Plan

Targets based on NTPBP-CAL-LD4-0639

- Supply Interruptions — 4.2 | 1.8 | 1.5
  - Customer High Priority
  - ODI: Common Reward and Penalty
- Unplanned non Infra Maintenance — 3.272 | 3.272 | 3.272
  - Customer High Priority
  - ODI: Bespoke Reward and Penalty
- Other Monetised Benefits

Interventions

04.001.04
04.001.03
04.001.01
04.001.02
04.001.05
04.001.06
04.001.07
04.002.01
04.001.04
04.001.03
04.001.01
04.001.02
04.001.05
04.001.06
04.001.07
04.001.08
04.003.02
04.003.01

OFWAT Initial Assessment Tests

OFWAT Initial Assessment Tests	Test Area
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	Engaging Customers
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	Securing long term resilience
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	
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	Targeted controls , markets and innovation
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	Securing Confidence and Assurance

Board Requirements

Board Requirements	
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	Customer Engagement
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	Resilience
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.	Business Planning
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
- Common New Performance Commitment
- Bespoke Performance Commitment
- Bespoke New Performance Comittment

Document Number: NTPBPP-MET-WAT-0719

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
NTPBP-INT-DG3-UNP-0703 DG3 Report - All Interruptions to Supply - Oct-01 to Dec-16.xlsx	Unplanned customer Minute Lost (DG3) Report	✓	-	-	✓
REQ-0215 2017-18 KPI energy efficiency summary snapshot 270418.xlsx	Energy efficiency summary	✓	-	✓	✓
NTPBP-CAL-PUM-0701 - Pumping station consequence of failure.xlsx	Network modelling to support pumping station risk review	✓	-	-	-
NTPBP-INT-PUM-0697 Pumping station Site Survey - 2017.pdf	Observations from pumping station site surveys conducted in 2017.	✓	-	-	-
NTPBP-CAL-MON-0085 Monthly Failures Report.xlsx	Maintenance Report examples from asset performance. Repeat failure reports. Unscheduled maintenance reports back to 2010. Example of monthly report to OTMs	✓	-	-	-

7.3 Appendix C.1: 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
SRR290	Beggar Bush	IF aging assets at Beggar Bush pumping station are not refurbished or replaced to improve PS reliability and access THEN number of unplanned maintenance events will increase and 519 customer connections will be at an increasing risk of low pressure or loss of supply.	4	3	2	2	2	3	3	12
SRR291	Beggar Bush	Combined with SRR290	4	1	3	2	2	3	3	12
SRR292	Beggar Bush	Combined with SRR290	4	1	3	2	2	3	3	12
SRR293	Beggar Bush	Combined with SRR290	4	1	2	2	2	3	3	12
SRR294	Beggar Bush	Combined with SRR290	4	1	3	2	2	3	3	12
SRR295	Dry Hill PS	Combined with SRR297	3	1	2	2	3	4	4	12
SRR296	Dry Hill PS	Combined with SRR297	3	1	2	2	3	4	4	12
SRR297	Dry Hill PS	IF aging assets at Dry Hill pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and customer connections will be at an increasing risk of low pressure or loss of supply.	3	1	3	2	3	4	4	12
SRR31	Coley PS	IF aging assets at Coley pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 5,166 customer connections will be at an increasing risk of low pressure or loss of supply.	4	1	3	3	2	4	4	16
SRR32	Coley PS	Combined with SRR31	4	1	3	3	4	4	4	16
SRR330	Coley PS	Combined with SRR31	4	1	3	3	2	4	4	16
SRR331	Coley PS	Combined with SRR31	4	1	3	3	2	4	4	16
SRR334	West Pennard Page Lane PS	IF aging assets at Page Lane pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 946 customer connections will be at an increasing risk of low pressure or loss of supply.	3	1	3	2	4	3	4	12
SRR335	West Pennard Page Lane PS	Combined with SRR334	3	4	3	2	2	3	4	12

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR630	Barrow TW	IF aging assets at Barrow (Brackley Hill) HL pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase from and 18,888 customers will be at an increasing risk of low pressure or loss of supply.	4	1	1	2	4	5	5	20
SRR631	Tetbury TW	IF aging assets at Tetbury TW HL and Tetbury Tower pumping stations are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 2,935 customer connections will be at an increasing risk of low pressure or loss of supply.	3	1	2	2	4	3	4	12
SRR632	All Pumping Stations	IF aging assets at small pumping stations are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and customer connections will be at an increasing risk of low pressure or loss of supply.	3	1	3	1	4	4	4	12
SRR633	All Pumping Stations	If Bristol Water improves its condition based monitoring on critical high value assets THEN asset maintenance can be optimised to avoid asset failures and unnecessary maintenance reducing Unplanned Non-infrastructure Maintenance and overall operational costs.	3	1	3	1	4	1	4	12
SRR635	All Pumping Stations	IF an oil spill occurs at a site where facilities do not comply with the least bulk fuel oil storage regulations THEN fines, litigation, environmental and reputational damage will occur.	2	4	4	3	5	1	5	10

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR657	Purton High Lift	IF aging assets at Purton HL pumping station are not refurbished or replaced to improve PS reliability THEN risk of a catastrophic failure of pumping station will increase overtime leading to an Unplanned Outage of the TW and loss of 30% of BW deployable output.	4	1	3	4	4	5	5	20
SRR689	Coley PS	Combined with SRR31	2	1	4	1	1	1	4	8

7.4 Appendix C.2: Non-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
SRR24	Banwell Riverside	**IF** stagnant water from deadlegs caused by removal of water quality instruments at Alderley TW enters supply **THEN** possible customer complaints, taste and odour, and water quality failures.	1	2	1	1	4	2	4	4
SRR25	Cooks Corner PS	UCML if badger set underneath the standby generator at Cooks Corner PS should it be not available when required	1	1	2	2	3	4	4	4
SRR27	Axbridge TW	If final water pumps fail, then reduced output to res (Axbridge-Area 3)	2	1	2	1	1	1	2	4
SRR28	Cheddar TW	If surge vessels structurally fail, then no protection on the main (Cheddar-Area 3)	1	1	3	2	2	5	5	5
SRR29	Charterhouse TW	IF Charterhouse TW final pump station fails due to age and deterioration THEN potential loss of supply to customers supplied by Mast Reservoir.	2	1	2	1	1	1	2	4
SRR30	Almondsbury PS	IF chlorination system fails THEN H&S and loss of supply	2	3	1	5	5	5	5	10
SRR33	Cheddar TW	If draycott pumps fail then reduced output from site (Cheddar-Area 3)	2	1	3	1	1	1	3	6
SRR34	Clevedon TW	If high lift (force) pumps fail, then reduced out put from site (Clevedon-Area 3)	2	1	3	1	1	1	3	6
SRR36	Cheddar TW	IF at Cheddar TW the Draycott drives fail THEN cannot deliver water to the Draycott area OR (post SRS installation) cannot deliver capacity to Brent Knoll	2	1	2	2	2	4	4	8
SRR37	Blagdon PS	If the non return valves on the Blagdon PS pumps fail THEN will be unable to use pump set to supply either Banwell TW or Barrow TW	4	1	1	1	1	1	1	4
SRR286	Keeds Lane	IF access required into Keeds lanes THEN upgrade of access to remove rungs and replace fibreglass lid for confide space	3	3	2	3	2	3	3	9
SRR287	Keeds Lane	IF the pipework at Keeds lane fails (inc valves, NRVs and actuator) leading to significant leakage THEN reduced or total loss to Beggar Bush and onto Failand tower	2	1	2	2	2	3	3	6
SRR288	Keeds Lane	IF the MCC at Keeds lanes fails THEN lose the whole site as no backup generator in place- lose water supply to beggar Bush lane and Failand tower	2	1	3	2	2	3	3	6
SRR289	Keeds Lane	If the pump fails at Keeds Lance THEN reliant on standby pump	2	1	2	2	2	3	3	6
SRR298	Clevedon PS	High Lift PS 30yrs old	2	1	3	2	3	2	3	6
SRR299	Clevedon PS	Main switchboard 50yrs old	4	1	2	2	1	2	2	8
SRR300	Clevedon PS	Obsolete starters	2	1	2	2	3	2	3	6
SRR301	Clevedon PS	PLC 30yrs old	3	1	2	2	3	2	3	9
SRR302	Clevedon PS	Well pumps need to be replaced	2	1	2	2	3	2	3	6
SRR303	Tickenham Hill PS	Controls are old technology	2	1	2	2	2	2	2	4
SRR304	Tickenham Hill PS	Pumps Duty/Assist-don't run that often	2	1	1	2	2	2	2	4

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR305	Tickenham Mill PS	If power failure occurs then possibility of loss of water to High level customers and Cadbury Reservoir	4	1	1	2	2	2	2	8
SRR306	Tickenham Mill PS	IF work carried out on pipework/valves then possibility of exposure to asbestos	2	4	3	2	2	2	4	8
SRR307	Alveston	All equipment on site is over 40 years old	2	1	2	2	2	3	3	6
SRR308	Alveston	Motors have carbon brushes	2	1	2	2	2	3	3	6
SRR309	Alveston	Switchboard complete requires replacement	2	1	3	2	2	3	3	6
SRR310	Alveston	Generator is seized and is not being repaired (Barrow Garage)	3	1	3	2	2	3	3	9
SRR311	Tresham PS	Pump Chamber-Difficult Access	2	2	3	1	2	1	3	6
SRR312	Tresham PS	Pipework Pumps & Valves in poor condition	3	1	3	1	2	1	3	9
SRR313	Tresham PS	Pump Controls need upgrading	3	1	2	1	2	1	2	6
SRR314	Tresham PS	Telemetry equipment & Starters in two separate Iron Pillars	3	1	2	1	2	1	2	6
SRR315	Tresham PS	No Generator	4	1	1	1	2	1	2	8
SRR316	Hawksbury Upton PS	Pumps, Valves and pipework in Poor Condition	3	1	3	2	2	3	3	9
SRR317	Hawksbury Upton PS	Starter Drives (Omron) seem ok	3	1	1	1	1	3	3	9
SRR318	Hawksbury Upton PS	Main Switchboard OK	3	1	1	1	1	3	3	9
SRR319	Wick PS	IF Starters fail due to age then possibility of spares shortage	2	1	2	1	2	2	2	4
SRR320	Wick PS	If general housekeeping of the site not improved potential failure of equipment	2	1	2	1	2	2	2	4
SRR321	Hopewell PS	If pump/motor/valve/pipework fails then potential reduction is supply to Cap Zone	1	1	2	3	2	4	4	4
SRR322	Hopewell PS	If Switchboard/Generator fails then potential loss of supply to Cap Zone	1	1	2	3	2	4	4	4
SRR323	Totterdown PS	If site security not improved potential risk of vandalism acts leading to loss of supply	2	1	2	3	2	3	3	6
SRR324	Highridge PS	If Surge Vessel unavailable due to freezing/vandalism then potential loss of supply to withywood and Dundry	2	1	1	2	2	3	3	6
SRR325	Highridge PS	If Pump starters fail due to age (and spares unavailable) then potential reduced output to withywood and Dundry	2	1	1	2	2	4	4	8
SRR326	Highridge PS	If handrails on Reservoir steps not installed possibility of injury	3	3	2	3	2	1	3	9
SRR327	Withywood PS	If Surge Vessel unavailable due to freezing/vandalism then potential loss of supply to Dundry	3	1	1	2	2	3	3	9
SRR328	Withywood PS	If pump/motor/valve/pipework fails then potential reduction is supply to Dundry	3	1	1	2	2	3	3	9
SRR329	Withywood PS	If site security not improved potential risk of vandalism acts leading to loss of supply to Dundry	3	1	2	2	2	3	3	9
SRR332	Stoney Stratton PS	If pumps/valves fails then potential reduction is supply to Westcombe Res	1	1	1	1	2	2	2	2

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR333	Stoney Stratton PS	If Electrical distribution assets fail (due to it's age) then possibility of loss of supply to Westcombe Res	2	1	1	1	2	2	2	4
SRR336	Edgarley PS	IF pumps fail then risk of reduction of supply to Tor Hill Res	3	1	2	1	2	3	3	9
SRR337	Elderbush PS	If requirement to work inside pump chamber possibility of access issues due to bad design of the chamber	2	3	4	1	1	3	4	8
SRR338	Elderbush PS	If valves/pipework damaged (due to location next to access ladder then possibility of flooding pump chamber	2	1	3	1	1	1	3	6
SRR339	Cinnamon Lane PS	IF pumps/valves fail (due to age) then risk of reduction of supply to Ten Acre Res	4	1	2	1	2	2	2	8
SRR340	Leigholt PS	IF pumps/valves fail (due to age) then risk of reduction of supply to Ivythorn Res	2	1	2	2	2	3	3	6
SRR341	Clutton PS	If overgrowing Ivy not removed from the Wooden Shed potential failure of equipment leading to reduction in supply to top half of Clutton Village (WWM8016)	2	1	1	2	2	3	3	6
SRR342	Penpole Lane PS	If control cabinet damaged due to its location (cars parking against control cabinet) then loss of control over site.	2	1	2	1	2	1	2	4
SRR343	Shirehampton PS	If Starters/ Control panel assets fail (due to it's age) then possibility of loss of supply to high points in the surrounding districts mainly in the Kings Weston and Comber Dingle areas.	4	1	2	2	2	3	3	12
SRR344	Durdham Down PS	If pump/starter/control panel fails (due to age) then loss of supply to …	2	1	1	1	1	1	1	2
SRR345	Stockwood PS	No risks other than the VS Drives are original	1	1	3	1	1	1	3	3
SRR346	Whitchurch Cemetery PS	Station mothballed – pump chamber prone to flooding and pumps prone to seizing due to non use	2	1	3	1	2	1	3	6
SRR347	East Dundry PS	2 pumps but only one VS Drive since 2007 – station doesn't normally run.	2	1	2	1	1	1	2	4
SRR348	Rocks Lane PS	If VS drives fail (due to age) then possibility of loss of supply to cap zone DM3442 to Felton, Lulsgate, Redhill and Butcombe	3	1	2	4	3	3	4	12
SRR349	Rocks Lane PS	If site security not improved potential risk of vandalism acts leading to loss of supply to cap zone DM3442 to Felton, Lulsgate, Redhill and Butcombe	3	1	2	4	3	3	4	12
SRR350	Cleeve PS	If site security not improved potential risk of vandalism acts leading to loss of supply to cap zone DM3442 to Felton, Lulsgate, Redhill and Butcombe	2	1	2	2	2	2	2	4
SRR351	Cleeve PS	1 pump is original and in poor condition	2	1	2	1	2	2	2	4
SRR352	Rhodyate PS	IF pumps fail (due to age) then loss of standby.	2	1	2	1	2	2	2	4

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR353	Rhodyate PS	IF controls (due to age) then loss of ability to Boost supply along Wrington Lane Congresbury including Westhay Rd Ropers Lane and Long Lane at the top end of Wrington village.	2	1	2	1	2	2	2	4
SRR354	Rhodyate PS	If tree growing next to the Pump Building - then possibility of building/equipment destruction leading to loss of supply and or leakage.	2	1	1	1	2	2	2	4
SRR355	Rowberrow PS	Main Incoming Switchboard original and could fail	2	1	3	3	3	4	4	8
SRR357	Winscombe PS	If Winscombe Borehole control fail (due to age) then loss of supply to Banwell TW	2	1	2	1	2	1	2	4
SRR358	Winscombe PS	If Winscombe Hill Reservoir control fail (due to age) then loss of supply to Winscombe Res	2	1	2	1	2	1	2	4
SRR359	Norton Hill PS	If tree growing next to the Pump Building - then possibility of building/equipment destruction leading to loss of supply to Cap Zone and or leakage.	2	1	1	1	2	2	2	4
SRR360	Clandown PS	If pumps/motors/valve fail (due to age) then loss of supply to Peasdown St John	2	1	2	1	2	3	3	6
SRR361	Kilmersdon PS	If overgrowing Ivy not removed from the building then potential equipment failure leading to loss of supply to Terry Hill Res	3	1	1	1	2	1	2	6
SRR362	Terry Hill PS.	If pumpset valves operation required and not possible (due to their condition) then possible reduction/loss of supply to cap zone	2	1	3	2	2	3	3	6
SRR363	Faulklands PS	If UPVC pipework (vulnerable to breakage) fails then poor pressure to six houses that if feeds	2	1	2	1	2	1	2	4
SRR364	Faulklands PS	If overgrowing Ivy not removed from the Wooden Shed potential failure of equipment leading to poor pressure to six houses that if feeds	3	1	1	1	2	1	2	6
SRR365	Notting Hill PS	If Starters/ Control panel assets fail (due to age of 2 of them) then possibility of loss of supply to local area of Badgworth, Alston Sutton, Chapel Allerton	2	1	2	2	2	2	2	4
SRR366	Eastwoodlands PS	If overgrowing Ivy not removed from the Kiosk potential failure of equipment leading to loss of supply to a small capped system of properties in the East Woodlands area	3	1	1	1	2	1	2	6
SRR367	Eastwoodlands PS	If Starters/ Control panel assets fail (due to age) then possibility of event leading to loss of supply to a small capped system of properties in the East Woodlands area	2	1	2	1	2	1	2	4
SRR368	Eastwoodlands PS	If Pumps/ Motors fail (due to age) then possibility of loss of supply to a small capped system of properties in the East Woodlands area	2	1	2	1	2	1	2	4

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR369	Compton Road PS	If Starters, Pumps, Controls, Isolators, Valves (due to their condition) then possibility of loss of supply to a small-capped zone(Maxwell Road, Westway Lane and part of Compton Road)	2	1	3	2	2	3	3	6
SRR370	Compton Road PS	If overgrowing Ivy not removed from the Kiosk potential failure of equipment leading to possibility of loss of supply to a small-capped zone(Maxwell Road, Westway Lane and part of Compton Road)	3	1	1	2	2	3	3	9
SRR371	Church Lane Cap Zone	interruptions and Loss of supply should Church Lane Cap Zone Pumps fail	2	1	1	1	2	2	2	4
SRR372	Dundry Cap Zone	interruptions and Loss of supply should Dundry Cap Zone Pumps fail	2	1	1	1	2	2	2	4
SRR373	East Dundry Cap Zone	interruptions and Loss of supply should East Dundry Cap Zone Pumps fail	2	1	2	1	2	2	2	4
SRR374	Frome Cap Zone	interruptions and Loss of supply should Frome Cap Zone Pumps fail	3	1	2	2	3	4	4	12
SRR375	Hawkesbury Upton Cap Zone	interruptions and Loss of supply should Hawkesbury Upton Cap Zone Pumps fail	4	1	1	1	2	2	2	8
SRR376	Hopewell PS (aka Kingswood) Cap Zone	interruptions and Loss of supply should Hopewell PS (aka Kingswood) Cap Zone Pumps fail	1	1	3	3	4	5	5	5
SRR377	Knowle Cap Zone	interruptions and Loss of supply should Knowle Cap Zone Pumps fail	2	1	2	2	3	5	5	10
SRR378	Marshfield Cap Zone	interruptions and Loss of supply should Marshfield Cap Zone Pumps fail	2	1	1	1	2	3	3	6
SRR379	Norton St. Philip Cap Zone	interruptions and Loss of supply should Norton St. Philip Cap Zone Pumps fail	2	1	1	1	2	3	3	6
SRR380	Peasedown St.John Cap Zone	interruptions and Loss of supply should Peasedown St.John Cap Zone Pumps fail	2	1	1	1	2	3	3	6
SRR381	Rocks Lane Cap Zone	interruptions and Loss of supply should Rocks Lane Cap Zone Pumps fail	2	1	2	4	3	3	4	8
SRR382	Tickenham Mill Cap Zone	interruptions and Loss of supply should Tickenham Mill Cap Zone Pumps fail	2	1	1	1	2	3	3	6
SRR383	Tresham Cap Zone	interruptions and Loss of supply should Tresham Cap Zone Pumps fail	4	1	1	1	2	2	2	8
SRR384	Wick Cap Zone	interruptions and Loss of supply should Wick Cap Zone Pumps fail	2	1	2	1	2	2	2	4
SRR591	Cinnamon Lane PS	Cinnamon Lane PS Building/Structure is in very poor condition, which could lead to loss of supply and Health & Safety Risks	4	1	2	2	2	3	3	12
SRR600	Shirehampton PS	Risk of loss of supply resulting from failure of Shirehampton PS Improvements	4	1	1	3	2	3	3	12
SRR605	Shirehampton PS	Interruptions and disruptions to supply - critical 8" main burst - Sea Mills, Bristol.	3	1	1	3	2	3	3	9

SRR ID	Location/Zone	Revised Risk Description	Likelihood	Human Health / Environment	Ease to Resolve	Publicity & Reputation	Regulatory Impacts	customers Impacted	Max Impact	Risk Score
SRR617	Edgarley PS	Risk of loss of supply resulting from failure of Edgarley Pumping Station pump #1	4	1	2	2	2	3	3	12
SRR619	Whitchurch PS	Whitchurch PS OOS limiting drought contingency options	3	1	3	1	1	1	3	9
SRR697	Rowberrow PS	IF site Transformer fails THEN standby generator used and reduced output from site as reduced power (Rowberrow PS)	1	1	3	1	3	1	3	3

7.5 Appendix D: Options Considered

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
SRR31	IF aging assets at Coley pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 5,166 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN12	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels.	Coley PS - Replacement	Build a replacement pumping station next door to the existing pumping station. This would include a new suction tank to resolve current suction issues.	This option is viable, however it is the most expensive option.	Yes
SRR32							
SRR330			Unplanned Non-Infrastructure Maintenance has been increasing year on year at Coley PS with 34 recorded in last 3 years (higher than average, for this type of asset). The assets will be over 40 years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.	Coley PS - Refurbishment	Refurbish PS - replace switchgear, pumps, motors, drives, surge vessel, valves and above ground pipework. Address issues with Suction conditions of the pumps.	This is a viable option. It will resolve the issues on the site but constructability will be awkward as the site will have to remain in service during the refurbishment	Yes
SRR331				Coley PS - Refurbishment Phase A	Address issues with Suction conditions of the pumps.	This will allow reduction in operational visits to reset pumps due to low pressures.	Yes
SRR689			These pumps supply 13,000 connections and in the event of pump failure could affect 5166 customer connections including 196 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.				
				Do Nothing	Business as usual; Fix on fail ~~and~~	This will not mitigate the risk of customer losing supply, and will mean the pumping station will deteriorate further. Not a viable option.	No
SRR630	IF aging assets at Barrow (Brackley Hill) HL pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase from and 18,888 customers will be at an increasing risk of low pressure or loss of supply.	SRRN14	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels.	Barrow Backwell Hill PS - Refurbishment	Refurbish PS - replace switchgear, pumps, motors, valves and above ground pipework.	This is a viable option. Refurbishment will also be the most cost effective option over building a new station.	Yes
			Unplanned Non-Infrastructure Maintenance has been increasing year on year at Barrow HL (Brackley Hill) PS with 13 recorded in last 3 years. The assets will be over 30 years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.				
			These pumps supply 20,000 connections and in the event of pump failure could affect 18,800 customer connections including 334 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Barrow Backwell Hill PS - Refurbishment	Refurbish PS - replace switchgear, pumps, motors, valves and above ground pipework.	This is a viable option. Refurbishment will also be the most cost effective option over building a new station.	Yes
SRR290	IF aging assets at Beggar Bush pumping station are not refurbished or replaced to improve PS reliability and access THEN number of unplanned maintenance events will increase and 519 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN15	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels.	Beggar Bush PS - Replacement	Replace PS with package booster station. Create CAP zone to abandon Failand Tower	This is a viable option. BW land is available and this proposed solution has the added benefit of removing a confined space risk. Pumping assets will be easier to maintain and will be in a security rated enclosure.	Yes
SRR291							
SRR292			Unplanned Non-Infrastructure Maintenance has been increasing year on year at Beggar Bush PS with 15 recorded in last 3 years. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.				
SRR293							
SRR294			These pumps supply 519 connections and in the event of pump failure could affect 519 customer connections including 28 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Beggar Bush PS - Replacement Phase 1	Replace Pumps and electrics reusing existing structures and plant as far as practical	This is a viable option. Issues with confined spaces will still exist but design modifications could allow easier access to buildings.	Yes

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
SRR297 SRR295 SRR296	IF aging assets at Dry Hill pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN16	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Dry Hill PS with 9 recorded in last 3 years. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.	Dry Hill PS - Replacement	Depending on outcome of network study replace station with a single pumping's station to supply both zones.	Viability will have to be confirmed by network modelling in AMP6. If PS cannot be combined into 1 zone each set of pumps should be refurbished separately.	Yes
			Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs	Do Nothing	Business as usual; Fix on fail	This will not mitigate the risk of customer losing supply, and will mean the pumping station will deteriorate further. Not a viable option.	No
SRR631	IF aging assets at Tetbury TW HL and Tetbury Tower pumping stations are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 2,935 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN17	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Tetbury TW HL and Tetbury Tower PS with 29 recorded in last 3 years. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.	Tetbury (Tower and High Lift) PS - Refurbishment	Refurbish PS - replace pumps, motors, drives and above ground pipework	This is a viable option. Refurbishment will also be the most cost effective option over building a new station.	Yes
			These pumps supply 3,141 connections and in the event of pump failure could affect 2,935 customer connections including 31 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Do Nothing	Business as usual; Fix on fail	This will not mitigate the risk of customer losing supply, and will mean the pumping station will deteriorate further. Not a viable option.	No
SRR334	IF aging assets at Page Lane pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 946 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN18	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Page Lane PS. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.	West Pennard Page Lane PS - Replacement	Replace PS with package booster station.	This is a viable option and most cost effective. BW land is available and the new PS can be installed offline. New PS will allow pumps to be maintained without unacceptably risking supply.	Yes
			These pumps supply 1,069 connections and in the event of pump failure could affect 946 customer connections including 103 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Do Nothing	Business as usual; Fix on fail	This will not mitigate the risk of customer losing supply, and will mean the pumping station will deteriorate further. Not a viable option.	No
SRR657	IF aging assets at Purton HL pumping station are not refurbished or replaced to improve PS reliability THEN risk of a catastrophic failure of pumping station will increase overtime leading to an Unplanned Outage of the TW and loss of 30% of BW deployable output.	SRRN40	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels.	Purton High Lift PS Resilience	Refurbish and extend existing 3.3kV switchboard to replace existing oil circuit breaker with vacuum contactors and provide extension for additional pump feeder; 1 No new 46Ml/d vs. 175m multistage, suspended bowl type pump complete with 1250kW, 3.3kV	This is a viable option - as per solutions report	Yes

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
			Purton TW accounts for approximately 30% of BW's day to day and maximum deployable output. The TW output is lifted by the Purton HL Pumps to Pucklechurch service reservoir before being distributed to customers. The HL pumps and their associated 3.3kV electrical starter systems will be 50 years old by the end of AMP7 and will be past their serviceable life. Pump repairs can take a considerable time period to carry out because of the size and age. Electrical systems no longer meet with current standards, have been modified over the intervening years and consequently pose a risk of catastrophic failure causing Unplanned Outage from the treatment works and possibly serious injury or death. An intervention is required to replace the existing electrical starter systems and refurbish the pumps, pipework and valves at Purton HL to minimize the risk of a catastrophic failure and prevent a significant period of Unplanned Outage.		close coupled motor; Refurbish 2 No existing 46Ml/d vs. 175m multistage, suspended bowl type pump; CFD study and calculation of pumping station discharge manifold and pump sump; Redesign and replacement of 46" steel discharge manifold including non return and actuated isolating valves; Modifications to existing sump to improve pump efficiencies; 2 No, 1250kW, 3.3 kV water cooled low harmonic variable speed drive with sequencing control; 9 No 3.3kV switchboard for pump control; HV and LV electrical installation; 10m3/s vs. 200Pa Starter room enhanced ventilation system including wall penetrations and 20m of steel duct; Minor civil works including plinths and wall penetrations for cables; Modification to existing PLC control systems and software		
SRR632	IF aging assets at small pumping stations are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN19	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Approximately 1/3rd of Unplanned Non-Infrastructure Maintenance is caused by WTP assets. Without investment Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate further. The risk assessment has identified 12 pumping station that need investment to ensure that the level of Unplanned Non-infrastructure Maintenance can be sustained.	PS Minor Works	Carry out "Minor works", asset replacement, on pumping stations that have assets highlighted as having particular age/condition issues.	Bristol Water have had a minor works programme for the last few AMP periods which covers replacement of ageing assets therefore this is not an unusual or complex intervention.	Yes
SRR635	IF an oil spill occurs at a site where facilities do not comply with the least bulk fuel oil storage regulations THEN fines, litigation, environmental and reputational damage will occur.	SRRN22	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Remedial works are required on bulk fuel oil storage installations at Blagdon PS, Victoria PS and Pucklechurch PS as they do not conform to oil storage regulations. There is also a risk of pollution to the environment that needs to be reduced and there is non-compliance with regulations that needs to be addressed to prevent fines	Bulk fuel oil compliance works	Carry out redial works on pumping station sites as detailed in the Black and Veatch Bulk Fuel Oil Deficiencies and Solutions Report	Viable option. Standard engineering interventions to resolve non-compliances	Yes
SRR633	If Bristol Water improves its condition based monitoring on critical high value assets THEN asset maintenance can be optimised to avoid asset failures and unnecessary maintenance reducing Unplanned Non-infrastructure Maintenance and overall operational costs.	SRRN20	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. The failure of high value assets is expensive and means the asset can be out of service for a considerable period of time while repairs are effected. Condition based monitoring is needed to provide early warning of asset failures to reduce Unplanned Non-infrastructure Maintenance and consequently Interruptions of Supply and Unplanned Outages. A medium to long term reduction in operating costs is also expected.	Condition Monitoring	Install condition monitoring on pumping plant rated over 40kW	Asset condition and performance monitoring is an integral part of a predictive maintenance approach to asset management. It can utilise permanently installed or mobile sensors to collect data in order to analyse changes in the performance or condition of asset components while they are in operation. Any deviation in the performance or condition of the asset from its standard parameters can be an indication of the early stages of wear and deterioration and allow action to be taken before customers are affected	Yes

7.6 Appendix E: Interventions Developed

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 (£)	Other Monetised Benefits (£k)	Unplanned non-infa maintence (No.)	Unplanned Maintenance Non Infra
SRR31	IF aging assets at Coley pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 5,166 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN12	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Coley PS with 34 recorded in last 3 years (higher than average, for this type of asset). The assets will be over 40 years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.	Coley PS - Replacement	Build a replacement pumping station next door to the existing pumping station. This would include a new suction tank to resolve current suction issues.	This option is viable,	04.001.04	Coley PS - Replacement	£3,981,571	-£5,950	-	0.099732	11.2
			These pumps supply 13,000 connections and in the event of pump failure could affect 5166 customer connections including 196 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Coley PS - Refurbishment	Refurbish PS - replace switchgear, pumps, motors, drives, surge vessel, valves and above ground pipework. Address issues with Suction conditions of the pumps.	This is a viable option. It will resolve the issues on the site but constructability will be awkward as the site will have to remain in service during the refurbishment	04.001.03	Coley PS - Refurbishment	£2,340,690	-£5,950	-	0.099732	11.2
SRR630	IF aging assets at Barrow (Brackley Hill) HL pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase from and 18,888 customers will be at an increasing risk of low pressure or loss of supply.	SRRN14	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Barrow HL (Brackley Hill) PS with 13 recorded in last 3 years. The assets will be over 30 years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate. These pumps supply 20,000 connections and in the event of pump failure could affect 18,800 customer connections including 334 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Barrow Backwell Hill PS - Refurbishment	Refurbish PS - replace switchgear, pumps, motors, valves and above ground pipework.	This is a viable option. Refurbishment will also be the most cost effective option over building a new station.	04.001.01	Barrow Backwell Hill - Refurbishment	£814,100	-£400	-	0.14888	4
SRR290	IF aging assets at Beggar Bush pumping station are not refurbished or replaced to improve PS reliability and access THEN number of unplanned maintenance events will increase and 519 customer connections will be at an increasing risk of low pressure or	SRRN15	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Beggar Bush PS with 15 recorded in last 3 years. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate.	Beggar Bush PS - Replacement	Replace PS with package booster station. Create CAP zone to abandon Failand Tower	This is a viable option. BW land is available and this proposed solution has the added benefit of removing a confined space risk. Pumping assets will be easier to maintain and will be in a security rated enclosure.	04.001.02	Beggar Bush PS - Replacement	£436,230	-£110	-	0.00395	4.8

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 (£)	Other Monetised Benefits (£k)	Unplanned non-infa maintence (No.)	Unplanned Maintenance Non Infra
	loss of supply.		These pumps supply 519 connections and in the event of pump failure could affect 519 customer connections including 28 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.										
SRR297	IF aging assets at Dry Hill pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN16	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Dry Hill PS with 9 recorded in last 3 years. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs	Dry Hill PS - Replacement	Depending on outcome of network study replace station with a single pumping's station to supply both zones.	Viability will have to be confirmed by network modelling in AMP6. If PS cannot be combined into 1 zone each set of pumps should be refurbished separately.	04.001.05	Dry Hill PS - Replacement	£451,300	-£780	-	0.043538	1.6
SRR631	IF aging assets at Tetbury TW HL and Tetbury Tower pumping stations are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 2,935 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN17	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Tetbury TW HL and Tetbury Tower PS with 29 recorded in last 3 years. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate. These pumps supply 3,141 connections and in the event of pump failure could affect 2,935 customer connections including 31 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	Tetbury (Tower and High Lift) PS - Refurbishment	Refurbish PS - replace pumps, motors, drives and above ground pipework	This is a viable option. Refurbishment will also be the most cost effective option over building a new station.	04.001.06	Tetbury (Tower and High Lift) PS - Refurbishment	£449,740	-£1,220	-	0.015639	10.4
SRR334	IF aging assets at Page Lane pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 946 customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN18	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Unplanned Non-Infrastructure Maintenance has been increasing year on year at Page Lane PS. The assets will be over 35+ years old by the end of AMP7 and most will have past their serviceable life. Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate. These pumps supply 1,069 connections and in the event of pump failure could affect 946 customer connections including 103 vulnerable customers. Unplanned non-infrastructure maintenance needs to be reduced to near zero to reduce the risk of Interruptions to Supply. Better pumps and improved control will also provide reductions in energy consumption and operating costs.	West Pennard Page Lane PS - Replacement	Replace PS with package booster station.	This is a viable option and most cost effective. BW land is available and the new PS can be installed offline. New PS will allow pumps to be maintained without unacceptably risking supply.	04.001.07	West Pennard Page Lane PS - Replacement	£451,030	-£590	-	0.008135	1.6

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 (£)	Other Monetised Benefits (£k)	Unplanned non-infa maintence (No.)	Unplanned Maintenance Non Infra
SRR657	IF aging assets at Purton HL pumping station are not refurbished or replaced to improve PS reliability THEN risk of a catastrophic failure of pumping station will increase overtime leading to an Unplanned Outage of the TW and loss of 30% of BW deployable output.	SRRN40	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Purton TW accounts for approximately 30% of BW's day to day and maximum deployable output. The TW output is lifted by the Purton HL Pumps to Pucklechurch service reservoir before being distributed to customers. The HL pumps and their associated 3.3kV electrical starter systems will be 50 years old by the end of AMP7 and will be past their serviceable life. Pump repairs can take a considerable time period to carry out because of the size and age. Electrical systems no longer meet with current standards, have been modified over the intervening years and consequently pose a risk of catastrophic failure causing Unplanned Outage from the treatment works and possibly serious injury or death. An intervention is required to replace the existing electrical starter systems and refurbish the pumps, pipework and valves at Purton HL to minimize the risk of a catastrophic failure and prevent a significant period of Unplanned Outage.	Purton High Lift PS Resilience	Refurbish pumps and modify systems to improve pump efficiency.	This is a viable option - as per solutions report	04.001.08	Purton High Lift PS Resilience	£2,124,156	£0	-	-	11.6
SRR632	IF aging assets at small pumping stations are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and customer connections will be at an increasing risk of low pressure or loss of supply.	SRRN19	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Approximately 1/3rd of Unplanned Non-Infrastructure Maintenance is caused by WTP assets. Without investment Unplanned Non-infrastructure maintenance is expected to increase together with the risk of Interruptions to Supply as the assets deteriorate further. The risk assessment has identified 12 pumping station that need investment to ensure that the level of Unplanned Non-infrastructure Maintenance can be sustained.	PS Minor Works	Carry out "Minor works", asset replacement, on pumping stations that have assets highlighted as having particular age/condition issues.	Bristol Water have had a minor works programme for the last few AMP periods which covers replacement of ageing assets therefore this is not an unusual or complex intervention.	04.002.01	PS Base Maintenance (Minor Works)	£1,009,356	-£3,100	-	0.190881	19
SRR635	IF an oil spill occurs at a site where facilities do not comply with the least bulk fuel oil storage regulations THEN fines, litigation, environmental and reputational damage will occur.	SRRN22	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. Remedial works are required on bulk fuel oil storage installations at Blagdon PS, Victoria PS and Pucklechurch PS as they do not conform to oil storage regulations. There is also a risk of pollution to the environment that needs to be reduced and there is non-compliance with regulations that needs to be addressed to prevent fines	Bulk fuel oil compliance works	Carry out redial works on pumping station sites as detailed in the Black and Veatch Bulk Fuel Oil Deficiencies and Solutions Report	Viable option. Standard engineering interventions to resolve non-compliances	04.003.01	Bulk Fuel Oil Regulation Compliance - Works	£151,130	£0	£2.70	-	-
SRR633	If Bristol Water improves its condition based monitoring on critical high value assets THEN asset maintenance can be optimised to avoid asset failures and unnecessary maintenance reducing Unplanned	SRRN20	To provide customers with a safe and reliable supply and keep water flowing to the tap there is a need to ensure the reliable transportation of water through the treated water distribution network. With respect to the WPS this entails providing reliable, well maintained, good quality assets that minimise interruptions to supply and unplanned TW outages, and maintain unplanned non-infrastructure maintenance at sustainable levels. The failure of high value assets is expensive and means the asset can be out of service for a considerable period of time while repairs are effected.	Condition Monitoring	Install condition monitoring on pumping plant rated over 40kW	Asset condition and performance monitoring is an integral part of a predictive maintenance approach to asset management. It can utilise permanently installed or mobile sensors to collect data in order to analyse changes in the performance or	04.003.02	Condition Monitoring	£435,132	£16,000	-	-	8.8

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 (£)	Other Monetised Benefits (£k)	Unplanned non-infa maintence (No.)	Unplanned Maintenance Non Infra
	Non-infrastructure Maintenance and overall operational costs.		Condition based monitoring is needed to provide early warning of asset failures to reduce Unplanned Non-infrastructure Maintenance and consequently Interruptions of Supply and Unplanned Outages. A medium to long term reduction in operating costs is also expected.			condition of asset components while they are in operation. Any deviation in the performance or condition of the asset from its standard parameters can be an indication of the early stages of wear and deterioration and allow action to be taken before customers are affected							

7.7 Appendix F: Non-Selected Interventions

Ref. No.	Intervention Title	Expected Capex after (£)	Change in Opex (£)	Residual Risk
04.001.04	Coley PS - Replacement	£3,981,571	-£5,950	IF aging assets at Coley pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 5,166 customer connections will be at an increasing risk of low pressure or loss of supply.
04.001.03	Coley PS - Refurbishment	£2,340,690	-£5,950	IF aging assets at Coley pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 5,166 customer connections will be at an increasing risk of low pressure or loss of supply.
04.001.07	West Pennard Page Lane PS - Replacement	£451,030	-£590	IF aging assets at Page Lane pumping station are not refurbished or replaced to improve PS reliability THEN number of unplanned maintenance events will increase and 946 customer connections will be at an increasing risk of low pressure or loss of supply.
04.003.01	Bulk Fuel Oil Regulation Compliance - Works	£151,130	£0	IF an oil spill occurs at a site where facilities do not comply with the least bulk fuel oil storage regulations THEN fines, litigation, environmental and reputational damage will occur.
04.003.02	Condition Monitoring	£435,132	£16,000	If Bristol Water improves its condition based monitoring on critical high value assets THEN asset maintenance can be optimised to avoid asset failures and unnecessary maintenance reducing Unplanned Non-infrastructure Maintenance and overall operational costs.