TA 12.WW04 Sewers and Rising Mains
Business Case

September 2018
Version 1.0

Contents

1. Executive Summary

Name of business case	WW04 Sewers and Rising Mains		
Context	We have 39,541km of sewers including 1,503km of rising mains. This is expected to grow through new developments and the adoption of rising mains associated with private pumping stations, not adopted in AMP6. The number of pollution incidents from sewers reduced by 50% and from rising mains by 30% since 2013. Similarly, we have reduced internal flooding by 30% over the same period, but we need to go further to meet the expectations of our customers and regulators. Reducing groundwater infiltration of sewers in low-lying coastal regions and chalk downs is the most affordable, cost effective way to support growth, protect the environment and reduce energy use.		
Customer and stakeholder views	Customers are concerned with the high level of development in the region and the potential consequences on our infrastructure. Prevention of sewer flooding, now and in the future, is a high priority for customers. Customers value environmental protection and expect services to be delivered in an environmentally-friendly way. Avoiding pollution incidents is important, overall it is a medium priority for improvement.		
Our aim	We aim to deliver Quartile 1 performance for internal flooding and pollution incidents We aim to improve to average for external flooding from Quartile 3 We will carry out groundwater infiltration reduction and surface water management where these flows are increasing flood risks, restricting growth, increasing resilience to extreme weather		
Scope of this business case	All capital maintenance and base opex investment relating to sewers and rising mains.		
	Botex	Enhancement	Total
Totex (£'m)	£329.7m	£16m	£345.7m
Opex (£'m)	£204.0m	£5.7m	£209.7m
Capex (£'m)	£125.7m	£10.3m	£136.0m
Residual, post-AMP7 capex (£'m)	-	-	-
20 year Whole life totex (£m)[35]	£14,520	£56,682	-
20-year cost benefit (£m)	£32,468	-£63	-
Materiality (% 5 year Totex of Wastewater Networks Plus)	-	-	14.6%
Relevant business plan table lines	WWS1 5 and WWS1 12	WWS2 30, WWS2 77	

Botex – Base maintenance of sewers and rising mains				
Overview of AMP7 proposals	We will maintain the health of our underground assets by rehabilitating circa 73km of sewers (£25.4m) and 13km of our highest risk rising mains (£20.1m). We will reduce groundwater infiltration into our sewerage system through 20 infiltration reduction schemes (£17.3m), including the first phase of a 10-year plan to reduce infiltration issues in Chichester. We will enable a step change in flooding and pollution through a technology led strategy, as we move to a 'smart'[1] network. Our strategy and assessment of options is set out in TA.12.WW07 Flooding and Pollution Strategies, with £16.0m of the overall £26.7m enhancement expenditure associated with our sewers and rising mains. We will continue to improve the effectiveness and efficiency of our operations through our Operational Excellence programme.			
Why are the proposals the best programme- level option for customers	We have assessed five options for the planned replacement of sewers and five options for rising mains based on whole life costs and performance. Our preferred options have the lowest whole life cost for both sewers and rising mains. Deterioration models indicate a risk of deterioration in performance, we remain confident this can be managed through improved investment targeting and our Operational Excellence[2] programme. We have discounted options that would be unaffordable for our customers and options that would lead to an unacceptable performance. By selecting a lower cost rehabilitation approach, we are able to increase infiltration work whilst keeping overall costs in line with AMP6 forecast expenditure. We will improve reduce flooding through a technology led flooding reduction strategy, our most cost beneficial option.			
What we would like to highlight	We will increase efficiency through the use of new technology to survey sewers for infiltration and rising mains for defects that could lead to a burst. We will reduce the risks from fats, oils and greases through data analytics, education and natural fat busting microbes.			
Performance Commitments supported by this business case				
PC	How relevant is this business case?	Comment		
Internal flooding incidents	High	73% of internal flooding incidents were due to sewer blockages, 1% due to sewer collapse (2013-14 to 2016-17)		
External flooding incidents	High			
Pollution incidents	High	33% of pollution incidents were due to sewers in 2016		
Schemes and scheme-level options				
Schemes over £20m	Options			
	Description		Cost	Selected option and rationale
None	-		-	-

[1] An automated sewerage network that can detect and respond to changes in flow to reduce risk of flooding and pollution

[2] Explained in Chapter 7. Transforming our Business and Resilience

2. Scope of Technical Annex

This technical annex covers the investment relating to sewers and rising mains which equates to £345.7m in Totex for the AMP7 period. Figure 1 shows this investment in context with our entire PR19 Wholesale Plan where £345.7m represents 14.6% of the Wholesale Wastewater Networks + Plan of £2,374m.

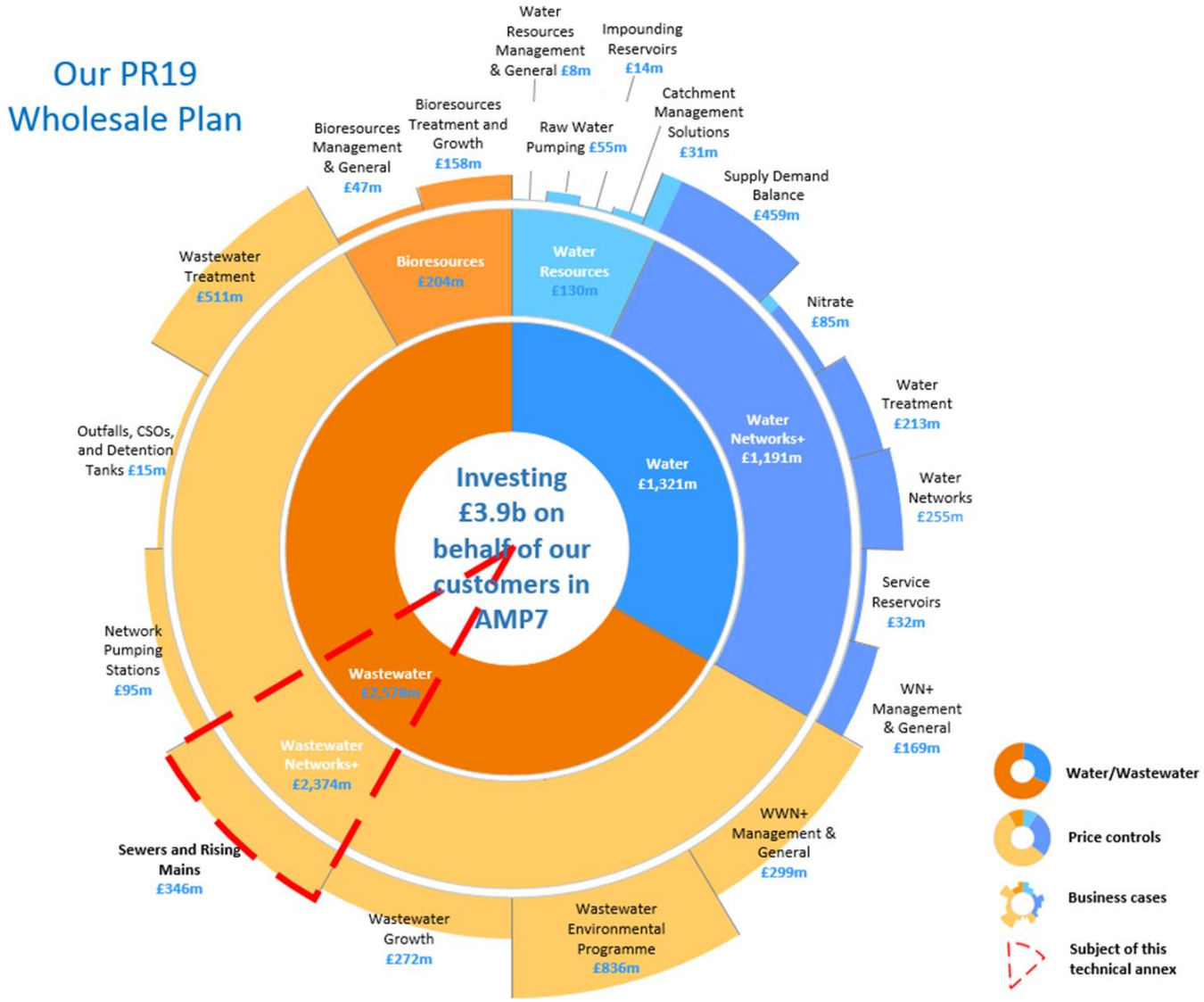

Figure 1: Our PR19 Wholesale Plan[3]

This technical annex covers the maintenance relating to the following asset classes:

20,574 km of legacy public sewers (excluding rising mains) [4]
17,464 km of former private sewers (S105A) adopted in 2011[4]
1503 km of legacy public rising mains[5]
An estimated 62 km of rising mains associated with former private pumping stations adopted in 2016[6] is currently unmapped.

[3] Business case investment data (Gold Lockdown 4, SW, 2018)
[4] Length of public and former private sewers (2016-17 Information Request and 2017-18 APR for Ofwat, SW, 2017 and 2018)
[5] Length of rising mains (2016-17 Information Request and 2017-18 APR for Ofwat, SW, 2017 and 2018)
[6] See calculation in Section 3.1

Pipe bridges
Network monitoring
Flooding mitigation measures

Other assets on the sewer network are detailed in TA.12.WW02 Network Pumping Stations and TA.12.WW03 Outfalls, CSOs and Detention Tanks.

3. AMP6 Strategy

3.1 Investment Strategy

We halved the number of Category 3 pollution incidents between 2014 and 2017[7], meeting and beating our promise to customers[8]. We are protecting customers' homes and businesses, having reduced internal sewer flooding incidents by 30% in AMP6.[8]

The main sewer investment programmes in AMP5/6 are outlined below:

Between 2011-12 and 2016-17, we rehabilitated 115 km of sewers.[9]
In AMP6, we are replacing 17 km of high risk rising mains.[10]

In 2016, we adopted approximately 62 km of rising mains associated with the formerly private pumping stations, increasing our rising main total length by more than 4%.[6]

Groundwater infiltration, exacerbated by the wettest winter[11] on record in 2013-14, caused flooding and restricted toilet use for our customers. In AMP5 we invested £13m on infiltration in more than 20 locations[12], with an additional £6.2m forecast by the end of AMP6. This has significantly reduced the risk of flooding and the need to over-pump diluted wastewater, reducing environmental impact.

Table 1 summarises our AMP6 forecast expenditure on sewers and rising mains.

[7] Historical and forecast performance (Wastewater PC Predictions v15, SW, 2018)
[8] AMP6 commitments (Wholesale Monitoring Plan 2015-20 v7.8, SW, 2018)
[9] Length of sewers rehabilitated (2016-17 Information Request for Ofwat, SW, 2017)
[10] AMP6 rising main progress (SW SME, 2018)
[11] Wettest winter for England and Wales (Met Office, 2014)
[12] AMP5 expenditure on infiltration reduction (Management accounts, SW, 2015)

Table 1: AMP6 Expenditure (£m) on Sewers and Rising Mains (2017-18 Prices)[3]

	AMP6 Actual					
	2015/16	2016/17	2017/18	2018/19	2019/20	AMP6 Total
TOTEX	**65.378**	**73.481**	**68.219**	**74.977**	**53.716**	**335.771**
CAPEX	**21.199**	**24.459**	**18.630**	**28.662**	**9.126**	**102.076**
Sewer Rehabilitation (Inc. partnerships and allocation from growth to base infra)	4.626	5.188	5.123	3.815	0	18.751
Other Sewer Maintenance	6.754	8.280	8.164	6.146	3.959	33.303
Surface water management in Eastbourne	0.249	0.365	0.738	5.061	1.246	7.659
Rising mains	4.514	7.441	3.746	8.227	2.141	26.069
Flow Reduction (Infiltration and Surface water)	3.958	2.274	0	0	0	6.232
Internal Flooding mitigation	1.064	0.906	0.813	3.689	0.890	7.362
External Flooding Enhancements	0.035	0.006	0.046	1.724	0.890	2.700
OPEX	**44.178**	**49.022**	**49.589**	**46.315**	**44.590**	**233.695**
Sewer Jetting	6.128	6.789	5.862	5.448	5.448	29.675
Sewer Network Opex	35.197	39.274	40.953	38.077	36.352	189.853
CCTV	2.501	2.665	2.546	2.487	2.487	12.686
Flooding Enhancement Opex (SLM, Predictive Modelling, FOG)	0.353	0.293	0.228	0.303	0.303	1.480

Note. AMP6 Actual comprises actual expenditure to the end of 2017-18 and current forecast expenditure in 2018-19 and 2019-20

Table 2 shows that we successfully reduced sewer collapses and maintained stability of the number of burst rising mains. We are on track to meet our internal flooding and pollution incidents performance commitments[8]. Rather than just sewer rehabilitation and rising main replacement, we invested in awareness campaigns, sewer jetting and surveys. We also benefited from average rainfall in AMP6 to date which reduces the risk of sewer collapse.

Table 2: AMP6 Sewer and Rising Main Replacement Compared to Performance

	Forecast delivery in AMP6	2013-14 performance[7]	2017-18 performance[7]
Planned sewer rehabilitation	53.7 km[13]	262 sewer collapses	143 sewer collapses
Planned rising main replacement	17 km[10]	92 rising main bursts	91 rising main bursts
Total	**70.7 km**	**354 collapses and bursts**	**234 collapses and bursts**

[13] AMP6 forecast sewer rehabilitation (SW SME, 2018)

Our AMP6 successes have informed our AMP7 investment strategy for planned sewer rehabilitation and rising main replacement, as described in Section 5.1.

Adoption of Private Pumping Stations

Defra introduced 'The Water Industry (Schemes for Adoption of Private Sewers 2011) Regulations which required water and sewerage companies to adopt private pumping stations by 1 October 2016 based on various criteria [14].

We have adopted 773 pumping stations with 34 awaiting survey to determine eligibility for adoption under the existing regulations. There is also the potential for a future change which could result in a further 90+ 'supplementary' (built post June 2011) pumping stations being transferred to us by 2025.[14]

We estimate the adoption of private pumping stations and their associated rising mains has increased our rising main asset base by 62km – a 4% increase. This is based on determining the distance between pumping stations and their nearest public sewer, which is similar to the rest of the industry. Based on this, the estimated average length of an adopted rising main is 80m.[15] Multiplying this by the number of pumping stations adopted (773) equals approximately 62km of additional mains.

As the rising mains have only recently been adopted, it is not yet possible to comment on their material, condition or age in comparison to our existing asset stock of rising mains.

3.2 Customer Benefits and Resilience

Our investment has delivered stable serviceability and delivered positive outcomes for customers under the following sewer network performance commitments:

- We have **maintained / improved the health of our sewerage network,** the combined number of sewer collapses and rising main failures has reduced from 354 in 2013-14 to 234 in 2017-18. Placing us in the upper quartile of the industry.[7]
- We **reduced sewer blockages** from 22,411 in 2013-14 to 19,478 in 2017-18, placing us just below industry median[7]
- We **reduced internal flooding incidents** (excluding severe weather) from 581 in 2013-14 to 401 in 2017-18 – placing us above industry median in 2016-17[7]
- In comparison to other water and sewerage companies, our performance on **external flooding incidents** was below the median in 2016-17[7]
- We **reduced Category 1 to 3 pollution incidents** by 62% from 324 in 2013 to 123 in 2017 – a 62% reduction, though average performance in 2017[7]

Our investment in sewer rehabilitation and infiltration reduction delivered positive outcomes for customers and the environment by reducing pollution and flooding incidents.

3.2.1 Pollution Incidents

Reducing sewer collapses, rising main failures and blockages correlates with a reduced number of pollution incidents impacting the environment. Figure 2 shows a decrease in Category 1, 2 and 3 pollution incidents attributed to foul sewers in AMP5 and AMP6. We delivered significant reductions in the first two years of the AMP and achieved our target of halving the number of Category 3 incidents by the end of 2017[8].

[14] See TA.12.WW02 Network Wastewater Pumping Stations
[15] Adopted rising main length (SW E-mail to other Water and Sewerage Companies, 2017)

Reducing pollution incidents improved our environment and delivered positive outcomes for the many customers who enjoy using our region's rivers and bathing waters.

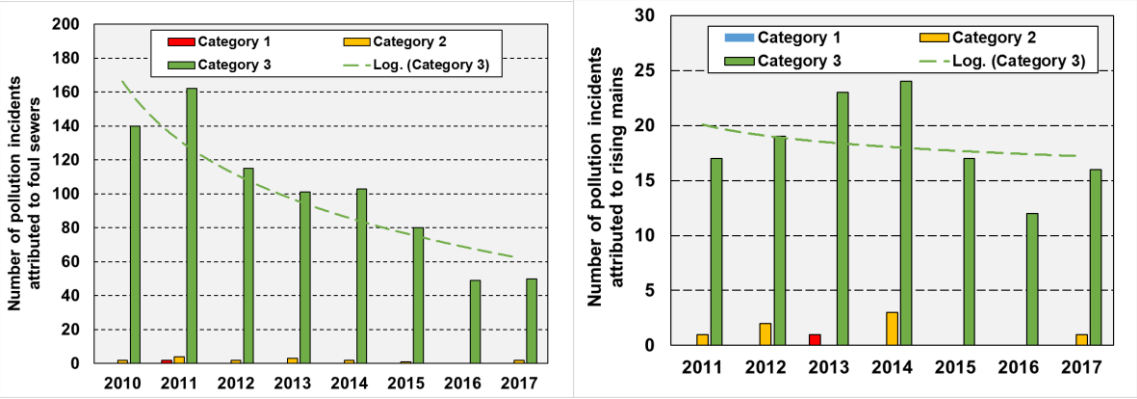

Figure 2: Pollution Incidents Attributed to Foul Sewers and Rising Mains in AMP5 and AMP6[16]

3.2.2 Internal and External Flooding Incidents

Sewer collapses can also result in flooding of customers' homes. However, Figure 3 shows 73% of internal flooding incidents are caused by blockages. This highlights the importance of continued investment in FOG (Fats, Oil and Grease) and unflushable material awareness and education, in addition to delivering more efficiently than in AMP6.

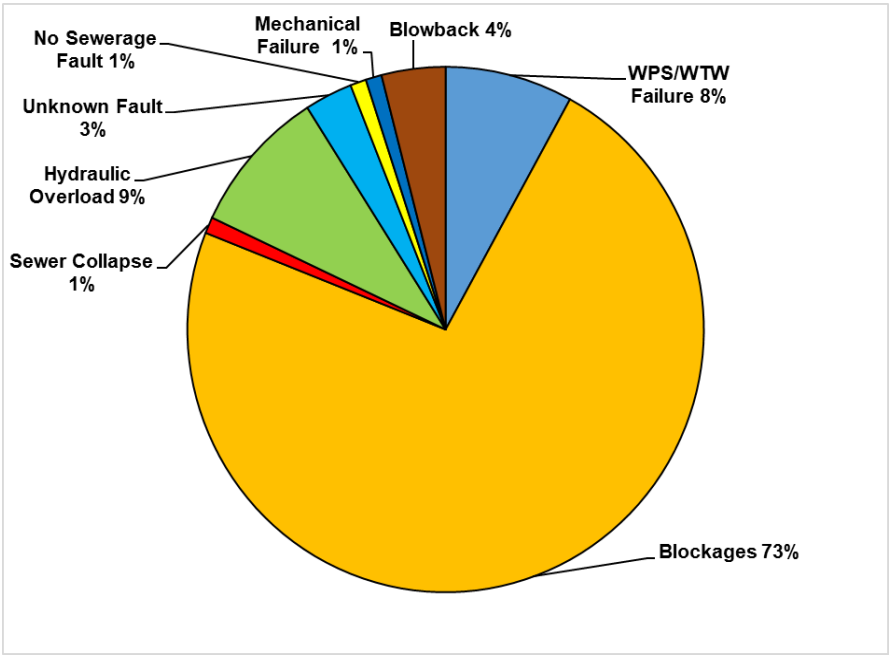

Figure 3: Root Causes of Internal Flooding (Average of 2013-14 to 2016-17)[17]

Figure 4 shows our performance for internal flooding incidents improved from Quartile 3 in 2013-14 to median level in 2015-16 and 2016-17 when comparative data was last available.

[16] Pollution incidents attributed to sewers and rising mains (SW report to EA, 2010 to 2017)
[17] Root causes of internal flooding (SIRF data, SW, 2017)

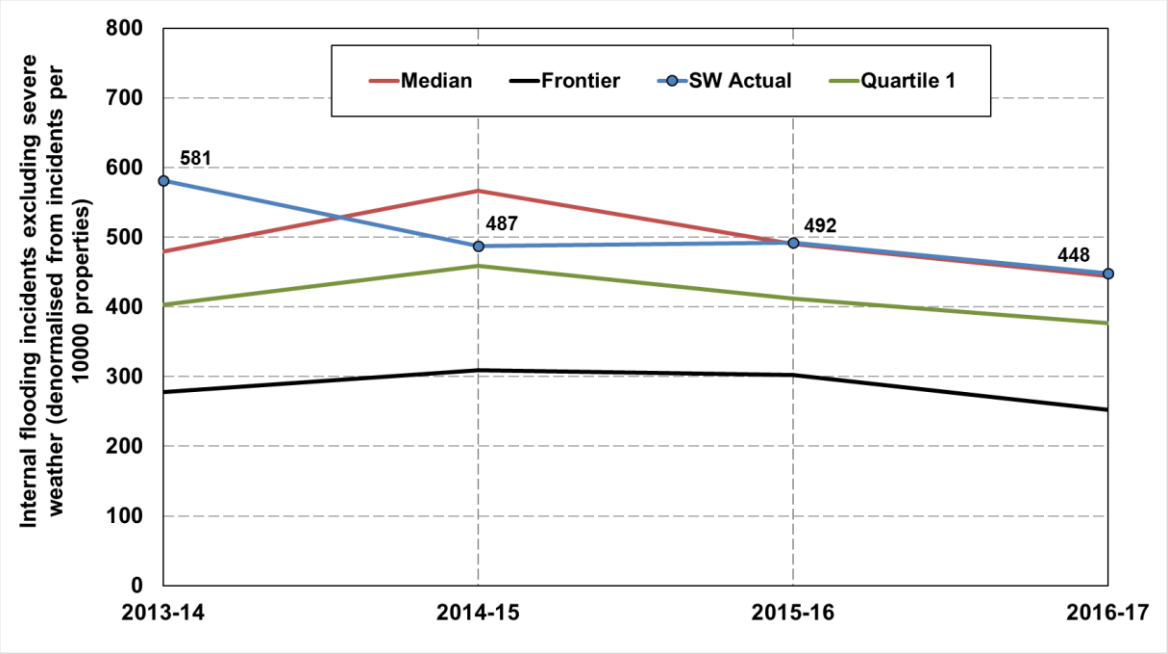

Figure 4: Historical Internal Flooding Incidents Excluding Severe Weather[7]

Figure 5 shows our performance for external flooding incidents per 10,000 properties was in Quartile 3 when comparative data was last available in 2016-17.

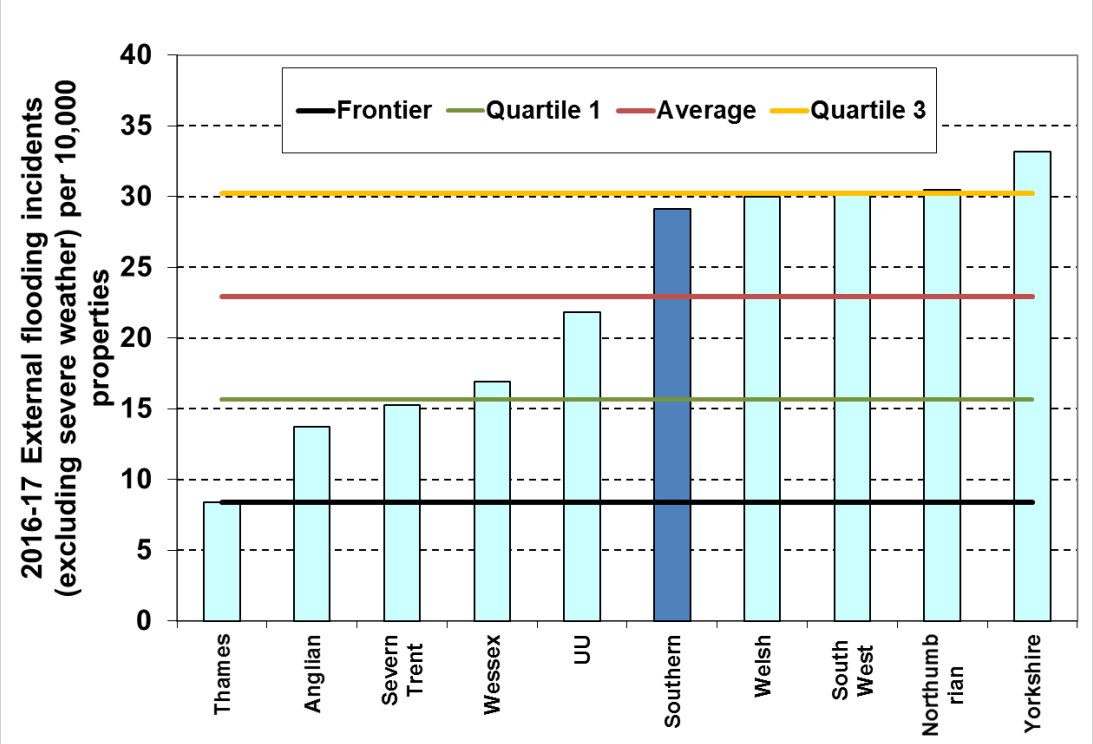

Figure 5: External Flooding Incidents Excluding Severe Weather in 2016-17[7]

3.2.3 Infiltration Reduction

Infiltration of sewers poses a challenge in a number of catchments across our region – this was most notable during the winter of 2013-14, the wettest on record[11] when groundwater levels rose above the sewer level in many villages located on the North and South Downs chalk or in coastal areas with high groundwater tables.

To prevent flooding, we tankered excess flows or over-pumped screened, diluted flows into watercourses. These short-term measures are inefficient, and more importantly, disruptive to local customers and the environment. The medium to long-term solution is to identify where infiltration is taking place and seal the sewers.

The EA's regulatory position statement concerning discharges from groundwater surcharged sewers[18] requires companies to prepare Infiltration Reduction Plans (IRP) and implement the agreed actions before permitting discharges into watercourses in exceptional circumstances. An essential part of the IRP is identifying and implementing engineering works to reduce infiltration into sewerage systems.

Between 2010 and 2020 we will have invested £19.2m[3,12], to tackle infiltration, which significantly reduced the risk of flooding and restricted toilet use for customers in affected areas and minimised the need for over-pumping to watercourses. By securing additional capacity, we increased the resistance of our network to groundwater and overall resilience. To further improve this resistance, we will increase our investment in infiltration reduction in AMP7.

3.2.4 Resilience

Our focus on the 4Rs of resilience (see Figure 6) allowed us to achieve these improvements.

<u>We addressed each of the 4Rs during AMP6</u>

- Reliability – by targeting the jetting program in 'zero flood zones' which have a high percentage of internal flooding incidents due to blockages
- Response or recovery – alarms and monitors
- Redundancy –removing Buchan traps
- Resistance – infiltration reduction and planned replacement of sewers and rising mains

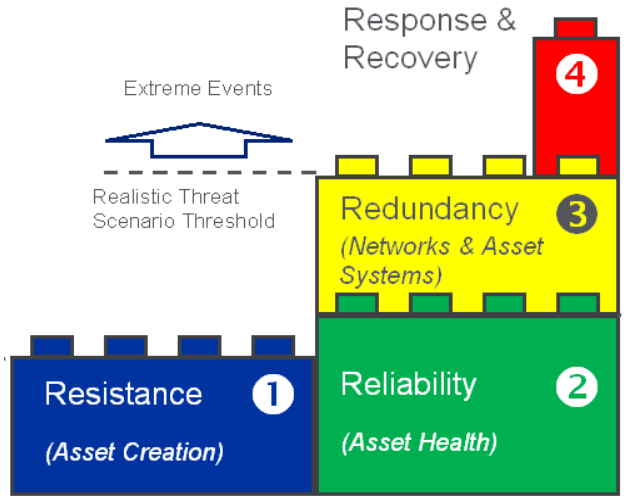

Figure 6: The 4 Rs Concept of Resilience

To determine the level of investment required to maintain stable service for sewer collapses we used a forward-looking risk-based analysis. We used deterioration models, calibrated using historical performance data, and incorporating willingness to pay data and social, consequential and environmental costs into cost-benefit analysis to identify optimal investment for future AMPs.

[18] RPS Discharges made from groundwater surcharged sewers (EA, 2014)

4. Drivers for Change

4.1 Customer and Stakeholder Views

As outlined in Chapter 4: Customer and Stakeholder Engagement and Participation, we used insight from our extensive programme of customer and stakeholder engagement to develop a deep understanding of their views and priorities. From an environmental perspective, we have also drawn on the views of a diverse range of non bill-paying customers who utilise water across our region through stakeholder panels, workshops and audits, including the Environment Agency, Natural England and local authorities. All insight gathered from our customer and stakeholder engagement programme can be found in Chapter 4.

Prevention of internal sewer flooding is a high priority for customers, with external flooding being a medium priority. Customers empathise with those that have experienced flooding and believe that it is a terrible event. Our performance was average for internal flooding but below average for external flooding. Despite improvements in performance in recent years there is a high desire to see us improve our network to prevent sewage flooding.

Our customers believe we have a duty to protect and enhance the environment. 'Doing no harm to the environment' has been outlined as a minimum requirement for customers, whilst protecting and enhancing the natural environment is the level of service that customers expect. Customers want water and wastewater services to be delivered in an environmentally friendly way now and in the future.

Maintaining the health of our water and wastewater assets is a high priority for customers. They expect us to ensure we can deliver the same level of services in an environmentally friendly manner for future generations. Avoiding pollution incidents is a medium priority for customers. Similarly, our stakeholders expect us to improve how we measure our environmental impact and to heavily reduce our impact on the environment. Environmental groups, some local authorities and regulators want to see significant improvements on pollution. Blueprint for Water has echoed these sentiments and want us to aim for zero pollution incidents, 100% monitoring of CSOs and 100% self-reporting of incidents. The Environment agency are pushing for a 40% improvement in performance from 2016 figure by 2025 as part of WISER. Regulators and the Blueprint believe companies should not be rewarded through ODIs for complying with the statutory minimum.

Stakeholders also want to see strategic plans for wastewater which deliver long-term resilience. Reports by the Cabinet Office and the Environment, Food and Rural Affairs Committee called for clearer, easier to understand communication around flood risk. Government's 25 Year Environment Plan commits to reducing the risk from flooding, including through greater use of natural flood management solutions.

Customers and stakeholders see protecting the environment from pollution as a partnership. They expect us to 'do the basics brilliantly' and maintain and operate our pumping stations (and other equipment) to protect the environment from pollution. Our customers also understand that reducing blockages caused by customers placing fats, oils, grease and wet wipes into the network will help protect the environment and reduce pollution. Customers indicated that they would like us to help increase education on what they should and should not be disposing of down the drain and explore in-home innovations to limit this behaviour. Our stakeholders also express strong support for education/community engagement on FOG.

The focus of our customers of the future is on protecting and enhancing the environment in the short and long term. They relate treatment works compliance to protecting the environment, and as such, generally rank this measure higher other customer groups. Figure 7 outlines customers' views on the level of priority for the performance commitment categories. The view was developed by triangulating the evidence from our customer engagement and our historic performance data for each performance commitment. The performance commitments were then grouped into categories based on similarity. The full results and approach can be found in TA.4.3 Triangulation of Customer Priorities.

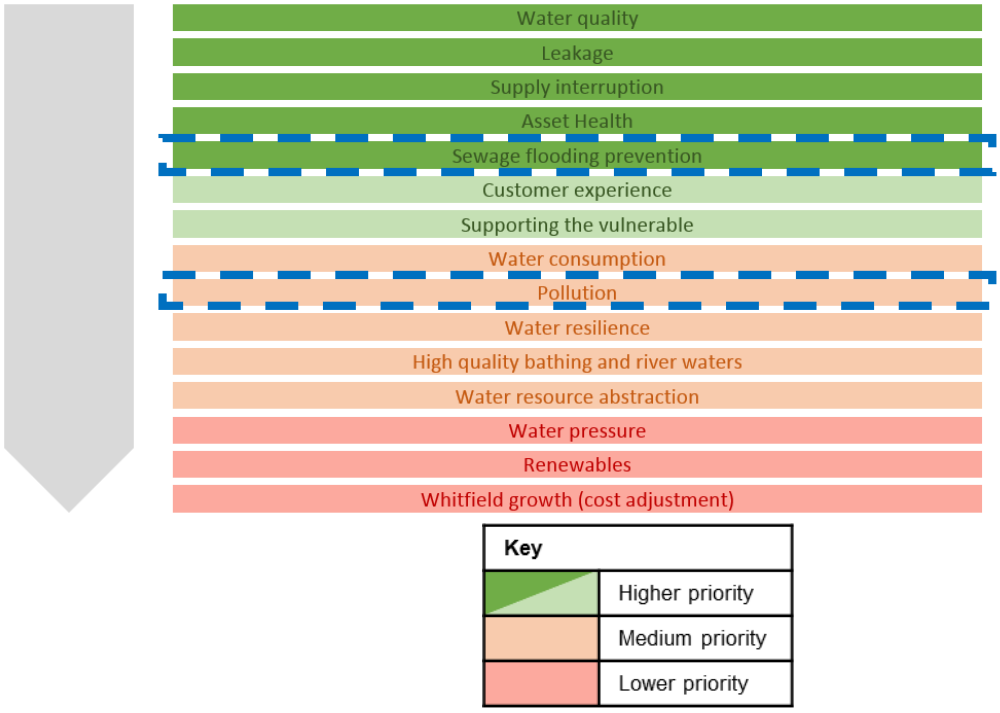

Figure 7: Relative Priority of Services According to Our Customers

We have used this understanding of our customers' priorities to define a set of performance commitments and investment proposals, and validated and refined these over the course of our programme of customer engagement. Our success at delivering on these priorities for our customers will be measured by the performance commitments outlined in this technical annex. Customers, stakeholders and regulators expect us to reduce flooding in AMP7. Achieving this reduction is the key driver which has shaped our investment strategy. Our long-term aim is to eliminate internal flooding by 2040.

4.2 Future Trends and Pressures

There are a number of future trends and pressures on the sewer network broadly grouped into industry-wide and regional and company-specific issues:

- Significant changes in regulatory expectations require an improvement to Quartile 1 performance for pollution and internal flooding.[19]
- Changing weather patterns with more extreme storms[20] will put additional pressure on sewer networks with a predicted increase in flows of surface water in our pumping stations and rising mains.

[19] AMP7 performance commitments (Chapter 6: Outcomes, Performance Commitments and ODIs, SW, 2018)
[20] Increase in extreme storms (UK Climate Projections, Defra, 2009)

- Regulatory requirement to quantify and improve the long-term health of sewerage assets and resilience to future pressures.
- Customers' behaviour may vary with respect to the disposal of FOG, wet wipes and other unflushable material in sewers.

Regional and Company specific issues

- The population in the South East is predicted to grow by 15% to 2040.[21] There will be an estimated 400,000 connections[21], increasing wastewater flows and reducing existing capacity
- Our sewers and rising mains increased by 1.4%[4] and 1%[5] respectively between 2011-12 and 2016-17 due to new developments. In AMP7 our sewerage network is likely to increase by at least the same rate.
- Our region has over 700 miles of coastline[22] and a high proportion of our sewerage network is located in coastal towns and cities which makes them vulnerable to:
    - Sea levels rises which are predicted to be 21-68cm for London between 1990 and 2095[23]
    - Infiltration due to groundwater level rises linked to sea level rises
    - Faster deterioration of below ground assets due to saline groundwater
    - Tidal locking of outfalls due to sea level rises will increase the risk of flooding in the catchment[24]
    - Groundwater infiltration into sewers is a significant proportion of dry-weather flow in many catchments. This reduces the headroom for population growth in those catchments and creates risks that dry weather flow permits will be breached.

5. AMP7 Strategy

5.1 Investment Strategy

Our AMP7 strategy builds on our AMP6 approach. Table 3 shows our proposed AMP7 totex on sewers is £345.7m, a £9.9m increase on our forecast AMP6 expenditure. This is due to additional activities to improve flooding performance and schemes to reduce infiltration in catchments where this is restricting growth or potentially impacting the environment. This investment will improve our services to customers whilst keeping bills affordable.

Our strategy will deliver for customers and ensure bills remain affordable by becoming 'brilliant at the basics' and improving resilience in reliability, redundancy and response and recovery.

We considered five options for planned sewer rehabilitation and rising main replacement and our preferred option is to invest £25.4m and £20.1m respectively. Modelling indicates that this level of expenditure risks increased sewer collapses and rising main failures, however we will mitigate this risk through improved prioritisation of rehabilitation of high

[21] Population growth (Let's Talk Water, SW, 2017)
[22] Coastline length (Let's Talk Water, SW, 2017)
[23] Sea level rise (UK Climate Projections, Defra, 2009)
[24] See TA.12.WW03 Outfalls, CSOs and Detention Tanks

risk sewers and replacement of air valves and rising mains. Note that Table 3 values include both planned and reactive expenditure.

By selecting lower cost options for sewer and rising main rehabilitation, we can increase expenditure on infiltration whilst keeping bills affordable. We plan to invest £17.3m to improve network resistance by reducing groundwater infiltration.

With our customers' support, £16m of enhanced additional expenditure on sewers would enable us to move towards Quartile 1 performance for internal flooding and improve to average performance for external flooding. This is cost beneficial and will lead to an enhanced customer experience through AMP7 and beyond.

Table 3: AMP7 Expenditure (£m) on Sewers and Rising Mains (2017-18 Prices)[3]

	AMP7			
	Price Control	**QBEG**	**Ofwat Table**	**AMP7 Total**
TOTEX				**345.735**
CAPEX				**135.991**
Sewer Planned and Reactive Rehabilitation (Including allocation from growth to base infra)	Wastewater networks +	Base Main - Infra	WWS1 12	45.956
Other Sewer Maintenance	Wastewater networks +	Base Main - Infra	WWS1 12	31.476
SUDS partnership in Eastbourne	Wastewater networks +	Enhancement	WWS2 30	1.695
Partnerships Seaford Groyne	Wastewater networks +	Base Main - Infra	WWS1 12	1.440
Rising mains	Wastewater networks +	Base Main - Infra	WWS1 12	29.572
Flow Reduction (Infiltration and Surface water)	Wastewater networks +	Base Main - Infra	WWS1 12	17.263
Internal Flooding mitigation	Wastewater networks +	Enhancement	WWS2 30	2.774
External Flooding Enhancements	Wastewater networks +	Enhancement	WWS2 30	5.815
OPEX				**209.744**
Sewer Jetting	Wastewater networks +	Base Main - Infra	WWS1 5	29.676
Sewer Network Opex	Wastewater networks +	Base Main - Infra	WWS1 5	166.434
CCTV	Wastewater networks +	Base Main - Infra	WWS1 5	12.686
AMP6 Enhancement Opex Adjustment	Wastewater networks +	Base Main - Infra	WWS1 5	-4.700
Flooding Enhancement Opex (SLM, Predictive Modelling, FOG)	Wastewater networks +	Enhancement	WWS2 71	5.648

5.1.1 Sewer Rehabilitation Planned and Reactive Expenditure (Capex)

After considering five options, outlined below, our preferred option is to invest a total of £32.3m on planned sewer rehabilitation (£25.4m) and reactive sewer repairs (£6.9m based on AMP6 spend).

The options we considered are:

SR1 – Modelled unconstrained investment to maintain stable service
SR2 – Invest £25.4m on planned sewer rehabilitation
SR3 – SR2 with 10% decrease in cost-beneficial interventions
SR4 – SR2 with 10% increase in cost-beneficial interventions
SR5 – Investment constrained at SR2 level from AMP7 to AMP10 then unconstrained investment to AMP16

At this level of expenditure, our deterioration modelling forecasts an increased risk of sewer collapses (2 to 3% increase) and associated polluting and flooding incidents as detailed in Section 5.2. These risks will be mitigated through prioritising the rehabilitation of high risk sewers and the additional activities described in TA.12.WW07 Flooding and Pollution Strategies.

A list of high-risk sewers has been identified through the Prioritised Asset Deficiency List for Sewerage' (PADLS) database, which has been in use since 2000. PADLS contains details of sewers with known defects based on blockage or collapse incidents, defect reports and planned CCTV surveys. This information is used to develop prioritised planned schemes for current and future years and AMPs.

The final selection process of sewers for planned rehabilitation is based upon risk, recent failure history, cost benefit analysis and available budget. Details of the work completed is recorded in PADLS and used for monthly and annual reporting. The £25.4m investment will enable us to replace approximately 73km of sewers depending on the accessibility (urban/rural) of the sewers that are the highest priority for replacement in AMP7.

Our sewer rehabilitation budget of £46m includes £1.3m of work on a sewer as our contribution to the Brighton to Newhaven coastal protection partnership scheme.

In TA.12.WW05 Wastewater Growth we describe investment required to accommodate the forecast growth in new developments in our region. A proportion of this investment is allocated to base capital maintenance of sewers and rising mains as a result of allocations from Growth and Quality expenditure allocations, in line with Regulatory Accounting Guidelines. This allocation of over £12m is also included in our total sewer rehabilitation budget of £46m.

5.1.2 Rising Main Planned and Reactive Expenditure (Capex)

After considering five options, outlined below and detailed in Section 5.2, our preferred option is to invest a total of £28.5m on planned rising main replacement (£20.1m) and reactive rising main repairs (£8.4m based on AMP6 spend). The £20.1m investment will enable us to replace approximately 13km of rising mains depending on the accessibility (urban/rural) of the rising mains that are the highest priority for replacement in AMP7.

The options for planned rising main replacement that we considered are:

RM1 – Unconstrained investment to maintain stable service
RM2 – Invest £20.1m on planned rising main replacement
RM3 – RM2 with 10% decrease in cost-beneficial interventions
RM4 – RM2 with 10% increase in cost-beneficial interventions
RM5 – Investment constrained at RM2 level from AMP7 to AMP10 then unconstrained investment to AMP16

We have included an additional £1.1m to increase base resilience of the rising main at Chestnut Avenue, Chickenhall[25]. This is a failing, critical terminal rising main which transfers wastewater flows from 20,000 properties in Eastleigh, Hampshire and passes below major railway lines and Southampton Airport. Failure of the rising main could lead to major disruption to transportation links in the area. Four options to replace or reline the rising main have been costed and assessed.[25]

At this level of expenditure, deterioration modelling forecasts a risk of increased rising mains bursts (up to 23%) as detailed in Section 5.2. We are confident we can mitigate these risks through improved monitoring of rising mains and innovative surveying techniques, and repair or replace them before they burst[30]. Some of these techniques are described in our innovation Section 5.3.

The final selection process for rising main replacement schemes is based on risk, cost-benefit analysis, recent failure history and the available budget.

Our AMP7 investment of £29.6m is a £3.5m increase on our AMP6 forecast, allowing for increased rising main length, improving performance on bursts, and will continue to improve the resilience of our ageing rising mains by increasing their resistance to failure.

5.1.3 Infiltration Reduction (Capex)

Between 2010 and 2020 we will have invested £19.2m (£13m in AMP5[12] and £6.2m forecast for AMP6[3]) on infiltration reduction in more than 20 villages and towns across our region to reduce the risk of flooding to customers' properties and the need to over-pump into watercourses. Additionally, groundwater infiltration into sewers is a significant proportion of dry-weather flows in many catchments, reducing the headroom for population growth in catchments and creates risks that dry weather flow permits will be breached.

In AMP7 we will invest £11.2m in infiltration reduction across 20 catchments where high infiltration is increasing flood risks and leading to high dry weather flows at the wastewater treatment works. Table 12 in Appendix 2 shows that the infiltration reduction schemes have a lower AMP7 Totex and 20 year whole life cost than the alternative of process solutions at the wastewater treatment works. Table 4 lists the location of infiltration reduction schemes in AMP7 which will be carried out using a proposed budget of £11.2m.

Table 4: Potential Location of Infiltration Reduction Schemes in AMP7[26]

Hampshire	Sussex	Kent	Surrey	Isle of Wight
Barton Stacey	Alfriston	Grain	Oxted	Chale
Boldre	Cooksbridge	Newnham Valley Preston		Shorwell
Liss	Lidsey	Rolvenden Layne		St Helens
Milford Road, Pennington	Loxwood	Paddock Wood		
Stockbridge				
Thornham				

[25] Chestnut Ave. Rising Main (SW Assets+2 Presentation, 2018)
[26] AMP7 Infiltration reduction schemes to reduce DWF (Schemebuilder, SW, 2018)

Additionally, in line with the Infiltration Reduction Plan agreed with the EA, we are committed to reducing infiltration in the Chichester catchment. This will reduce the risk of untreated discharges into Chichester harbour which would adversely affect shellfish beds and recreational use of the harbour.

Chichester catchment suffers from high flows in the sewer network during periods of prolonged wet weather, contributing to the continuous operation of the storm overflow at Chichester WTW. Untreated discharges from the storm tank at Chichester WTW can have an adverse environmental impact on Chichester Harbour.

We considered nine potential solutions, and our preferred long term solution is to carry out infiltration reduction in the catchment across 2 AMPs, with AMP7 costs of £6.1m.

5.1.4 Sewer Jetting Planned and Reactive (Opex)

Figure 3 shows the vast majority (73%) of internal flooding incidents are caused by blockages in the network – which can also cause pollution incidents. Our planned, targeted sewer jetting programme reduces the risk of blockages by breaking down fats, oils, grease, wipes and grit in sewers.

By analysing historic data we are able to identify locations most at risk and determine the optimum jetting frequency, based on the likelihood that blockages will lead to flooding and pollution incidents. Locations include key trunk mains near wastewater pumping stations or treatment works where it is essential high flows are unimpeded.

We plan to spend £29.7m on planned (£11.8m) and reactive (£17.9m) sewer jetting in AMP7 – equal to our forecast AMP6 spend. Combined with our engagement programme and developing data analytics capability, a more efficient sewer jetting process will enable us to deliver additional activity for this money. This enables us to reduce blockages further and support our aim to achieve upper quartile performance for internal flooding and pollution incidents.

5.1.5 CCTV Planned and Reactive (Opex)

CCTV surveys provide information on the condition of our sewers and their operational performance. Planned CCTV surveys are targeted at high risk sewers where the sewer risk score is based on:

- Historical blockage and collapse incidents
- Analysis of previous CCTV surveys
- Deterioration modelling
- Planned or completed sewer rehabilitation
- Proximity to critical infrastructure (e.g. major road/railway, hospital etc.)
- Proximity to watercourses
- Rolling ball analysis of the impact of sewer flooding.

Priority for planned CCTV is given to sewers that have not been surveyed at all or not surveyed for 15 years or more. In recent years, our planned CCTV has been focused on sewers beneath railways, concrete and masonry sewers and critical, large diameter trunk sewers.

Reactive CCTV follows a sewer collapse or blockage to establish the root cause and confirm the sewer is operating effectively following the clearance of a blockage or a sewer repair.

We plan a total investment of £12.7m on planned (£4.1m) and reactive (£8.6m) CCTV surveys – equal to our forecast AMP6 spend. We will target our CCTV inspections more efficiently to increase the benefits we receive from this activity.

This will support our drive towards upper quartile performance for internal flooding and pollution incidents.

5.1.6 Internal and External Flooding Mitigation (Capex)

Flood mitigation remains a core part of our strategy to further reduce flooding. Internal flood mitigation has been successful during AMP6 but opportunities are becoming more limited, we will invest £2.8m on our internal flooding mitigation programme at properties with existing flooding issues. For AMP7 we will increase our focus on external flooding. Our external flooding strategy is based on £5.8m of external flooding mitigation as described in TA.12.WW07 Flooding and Pollution Strategies. Table 5 shows our proposed AMP7 capex on internal and external flooding mitigation compared to AMP6 forecast expenditure.

Table 5: Investment in Flooding Mitigation in AMP7 Compared to AMP6[3]

	AMP6 Forecast	AMP7 Total	Difference (AMP7 – AMP6)	Technical annex for investment
Internal flooding mitigation (existing issues)	£7.4m	£2.8m	-£4.6m	TA.12.WW04 Sewers and Rising Mains
Internal flooding mitigation (new additions due to growth)	£11m	£11.3m	+£0.3m	TA.12.WW05 Wastewater Growth
Internal flooding mitigation (sub-total)	£18.4m	£14.1m	-£4.3m	
External flooding mitigation	£2.7m	£5.8m	+£3.1m	TA.12.WW04 Sewers and Rising Mains
Total flooding mitigation	**£21.1m**	**£19.9m**	**-£1.2m**	

Table 5 shows that our total (existing issues and new additions) investment on internal flooding mitigation will reduce by £4.3m in AMP7 in comparison to AMP6. This is due to the significant improvement in internal flooding in AMP6. The reduction in internal flooding mitigation will partially be offset by an increase of £3.1m on external flooding mitigation to improve our performance from Quartile 3 to average in AMP7.

Our flood mitigation options are also being extended through Sustainable Drainage 2030. For example, we are piloting options to remove surface water from the sewers through water butts (smart and standard) and soakaways.

5.1.7 Enhanced Flooding Reduction (Capex and Opex)

Our performance for internal flooding incidents improved from Quartile 3 in 2013-14 to average in 2015-16 and 2016-17 when comparative data was last available. Our performance for external flooding incidents was in Quartile 3 in 2016-17.

In AMP7 our strategy is to deliver industry Quartile 1 performance for internal flooding[19] and deliver average industry performance for external flooding through the following base activities:

- Sewer rehabilitation and rising main replacement
- Proactive CCTV and sewer jetting to locate and remove blockages

- Infiltration reduction which will reduce flows and therefore reduce the risk of flooding by increasing capacity
- An increase in the planned maintenance of outfalls to reduce blockage by shingle which can cause flooding
- Removal of Buchan traps
- Improvements in IT and GIS systems to add unmapped sewers, updated incident data etc. to improve response to incidents
- Movement of micro pumping stations from inside a property to the garden to prevent internal flooding in the event of pump failure
- Improvement in existing hydraulic models and create new models to improve knowledge of flooding risk and solutions including understanding the impact of 50 year return period storms

Overall our base plans and the additional investment on internal flooding mitigation would only provide a reduction of 9 incidents per year, which would fall short of our customer targets. In TA.12.WW07 Flooding and Pollution Strategies, we have assessed five options for our internal flooding strategy and four options for our external flooding strategy. Some options were discarded based on cost or lower confidence in forecast benefits. To deliver our preferred option (see Table 6), target Quartile 1 performance and meet our regulators' and customers' expectations, we plan to invest £10.2m to reduce internal flooding incidents.

Table 6: Enhanced Internal Flooding Reduction Activities in AMP7

Activity	Description	AMP7 Total[3]
Internal Flood mitigation	Installation of non-return valves, flood barriers and other flood mitigation activities to prevent internal flooding	£2.8m
Sewer misuse campaigns	FOG and unflushables education continued from AMP6. Use bio-chemicals to digest FOG.	£1.7m
Sewer level monitors	Linked sewer level monitors installed in key parts of the network with telemetry to supply real-time information on flows and levels to provide warning of potential flooding.	£1.3m
Predictive modelling	Predictive modelling software in conjunction with real-time information to predict potential flooding to enable mitigation to be implemented and/or improve the response to incidents.	£2.7m
SuDS and partnership schemes	We will contribute £1.7m (enhancement) on an Eastbourne SuDS scheme	£1.7m
	Total	**£10.2m**

Further information on our internal and external flooding strategies can be found in TA.12.WW07 Flooding and Pollution Strategies.

5.1.8 Sewer Network (Opex)

Sewer network opex will be £166.4m in AMP7, a reduction of £23.5m in comparison to our forecast AMP6 forecast expenditure due to greater efficiency.

5.1.9 Other Activities (Capex and Opex)

Table 7 summarises our AMP7 investment strategy for other activities related to the sewerage network.

Table 7: Other Activities Related to Sewers and Rising Mains3

Activity	AMP7 Totex[3]	Comment
Manhole repairs	£10.0m	Business as usual activity to replace or repair manholes
Drainage models	£8.7m	Business as usual activity to produce Drainage Area Plans, Surface Water Hydraulic Models (contributions to Surface Water Management Plans) and Drainage and Wastewater Management Plans.
Pipe bridges	£2.6m	Mitigate the risk to the public from pipe bridge structures located in the public domain
Sewer diversions	£10.2m (gross) (£1m (net))	Business as usual activity to divert sewers with approximately 90% contribution from developers.
Total	**£31.5m**	

5.1.10 Strategic Initiatives

In addition to our flooding strategy summarised in Section 5.1.7, we will achieve the required improvement in sewer network performance through two other key strategic initiatives which allows us to adapt for the future.

Pollution Strategy

To aim for industry Quartile 1 status for Category 1 to 3 pollution incidents.[19] In addition we would aim for at least stable performance for Category 4 pollution incidents. This would be achieved by carrying out the following activities:

- Focus maintenance on critical sites where pollution is a high risk consequence of asset failure
- Replace poorly performing pumps at critical pumping stations.
- Improve telemetry and the response to alarms
- Focus CCTV and sewer jetting in blockage hotspot and high risk areas
- Increase surveys of critical rising mains including air valves.
- Rising main replacement
- Improve the deployment of temporary pumps and generators
- Sewer rehabilitation and infiltration reduction
- Expand the team working on the data collection and analysis related to pollution.

Our pollution strategy is discussed in more detail in TA.12.WW07 Flooding and Pollution Strategies.

Sustainable Drainage 2030

Our Sustainable Drainage 2030 transformational programme will enable us to achieve better utilisation of our existing sewer network capacity by:

- Removing surface water
- Creating smart networks to manage peak flows
- Raising customer awareness.

This will enable us to achieve the following outcomes:

Increase the resilience of our sewer network to long term pressures caused by population growth, climate change and asset deterioration
Provide an affordable approach to improving flooding and pollution performance.
Enable economic growth in our region
Improved service to our customers.

5.2 Plan Options

Options for enhanced performance in sewer flooding are described in TA.12.WW07 Flooding and Pollution Strategies.

We considered five options for investment in planned sewer rehabilitation and planned rising main replacement in AMP7 and in the long term to AMP16. The options include unconstrained expenditure to maintain stable service with regards to sewer collapses, blockages, flooding and pollution incidents. We also considered several options at a lower level of expenditure although these are likely to result in a deterioration in service to our customers and discarded options with an unacceptable impact on customers' bills or serviceability performance.

5.2.1 Plan Options for Sewer Rehabilitation

Our preferred option for planned sewer rehabilitation is to invest £25.4m in AMP7. This option has an increased risk of sewer collapses (up to 2 to 3%), blockages and consequential pollution and flooding incidents in AMP7. The forecast increase in risk should be mitigated through enhancing our targeting of investment. Table 8 lists the five options we considered for planned sewer rehabilitation and the impact of these on the service we provide for customers.

Table 8: Assessment of Options for Planned Sewer Rehabilitation in AMP7[27]

No.	Description	AMP7 Totex (£k)	Full Whole Life Cost (20 years) NPV (£k)[35]	Willingness to pay support	Ofwat Priority	Other regulator priority	Customer priority	Business strategic alignment	Is this option recommended ?
SR1	Unconstrained expenditure to maintain stable service	£105,000	Base	🔴	🟢	🟢	🟢	🟢	**No** – Stable service but very high impact on customers' bills in AMP7 and future AMPs.
SR2	Top 30% cost beneficial schemes	£25,404	£32,467	🟢	🟢	🟢	🟢	🟢	**Yes** - Slight increase on customers' bills and the 2.6% deterioration in service can be managed. Will increase long-term resilience of the network for least whole life cost.
SR3	Top 20% cost beneficial schemes	£16,900	£35,235	🟢	🔴	🔴	🟡	🟡	**No** - Slight reduction in customers' bills but a 3.1% increase in service deterioration and risk
SR4	Top 40% cost beneficial schemes	£33,700	£33,920	🔴	🟢	🟢	🟢	🟢	**No** – There would be a large increase in customers' bills in AMP7 (2.2% increase in incidents in AMP7)
SR5	Top 30% cost beneficial schemes constrained to AMP10 then unconstrained to maintain stable service	£25,404 (£360,000 in AMP11 to maintain stable service)	£128,296	🔴	🟡	🟡	🟡	🟡	**No** – The significant increase in expenditure in AMP11 could not be funded through customers' bills (2.3% increase in incidents in AMP7)

[27] Plan options for sewers and rising mains (WW_AG_BG_Pioneer v3_Networks_v6, SW, 2018)

Figure 8 illustrates the change in serviceability performance between AMP7 and AMP16 for each of the options compared to option SR1 which would maintain stable service for unconstrained expenditure. By AMP16, options SR2, SR3 and SR4 would result in a deterioration in service of between 13% to 18% in comparison with SR1. If this deterioration in service could not be mitigated through other activities, then option SR5 shows stable service could be regained through very high expenditure in future.

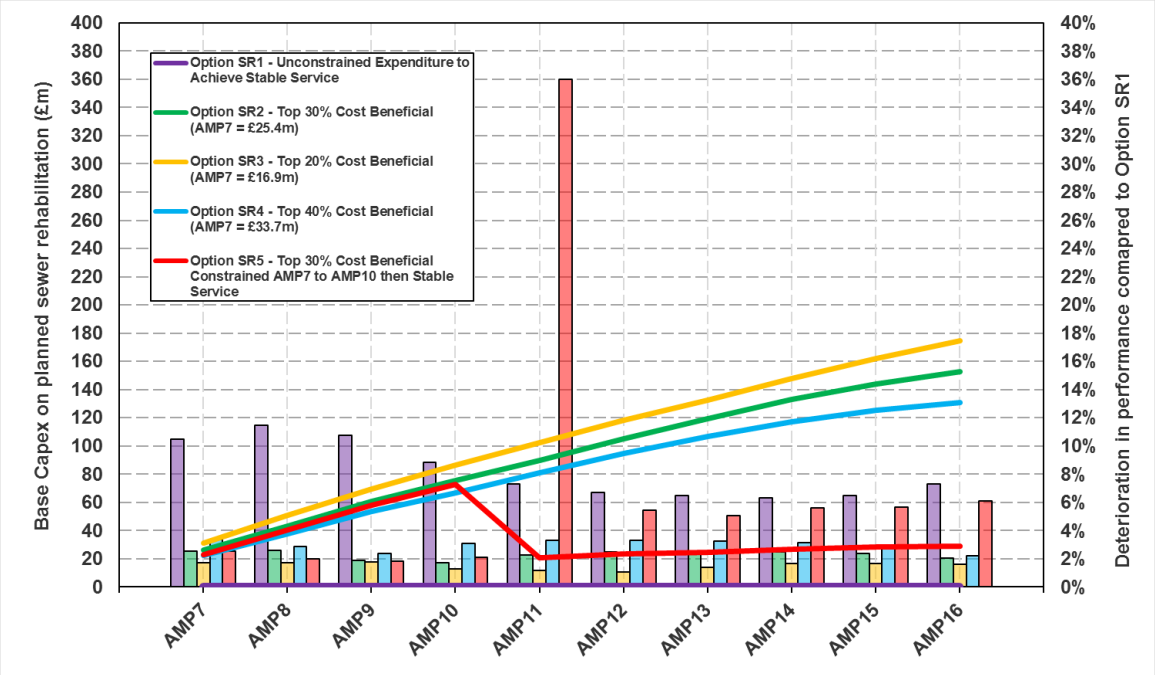

Figure 8: Impact of Options for Sewer Rehabilitation on Serviceability to AMP16[27]

In addition to our preferred option for planned sewer rehabilitation, we have added a further £6.9m for reactive sewer repairs which is based on AMP6 expenditure with an efficiency of 11% applied.

5.2.2 Plan Options for Rising Main Replacement

Our preferred option for planned rising main replacement is to invest £20.1m in AMP7. For our preferred option, our modelling shows a risk of increased rising mains bursts (up to 23%). To mitigate this increased risk and improve investment targeting, we will make greater use of rising main monitoring to identify changes in performance or condition. This includes the more innovative survey approaches referred to in the innovation Section 5.3.

Table 9 lists the five options we considered for planned rising main replacement and the impact of these options on the service we provide to our customers.

Table 9: Assessment of Options for Planned Rising Main Replacement in AMP7[27]

No.	Description	AMP7 Totex (£k)	Full Whole Life (20 years) Cost NPV[35]	Willingness to pay support	Ofwat Priority	Other regulator priority	Customer priority	Business strategic alignment	Is this option recommended?
RM1	Unconstrained expenditure to maintain stable service	£107,000	Base	🔴	🟢	🟢	🟢	🟢	**No** – Stable service but very high impact on customers' bills in AMP7 and future AMPs.
RM2	Top 40% cost beneficial schemes	£20,106	£27,359	🟢	🟢	🟢	🟢	🟢	**Yes** - A slight decrease in customers' bills and the 23% deterioration in service can be managed. This option has the lowest whole life cost.
RM3	Top 30% cost beneficial schemes	£15,200	£27,998	🟢	🔴	🔴	🟡	🟡	**No** - A reduction in customers' bills but an unacceptable 28% increase in service deterioration and risk
RM4	Top 50% cost beneficial schemes	£25,800	£27,634	🔴	🟢	🟢	🟢	🟢	**No** – An increase in customers' bills in AMP7 (19% increase in bursts and pollution incidents in AMP7)
RM5	Top 40% cost beneficial schemes constrained to AMP10 then unconstrained spend to maintain stable service	£20,106 (£219,000 in AMP11 to maintain stable service)	£84,515	🔴	🟡	🟡	🟡	🟡	**No** – The significant increase in expenditure in AMP11 could not be funded through customers' bills (23% increase in incidents in AMP7)

Figure 9 illustrates the change in serviceability performance between AMP7 and AMP16 for each of the options in comparison to option RM1, which would maintain stable service for unconstrained expenditure. By AMP16, options RM2, RM3 and RM4 would result in a deterioration in service of 51% to 110% in comparison with option RM1. If this deterioration in service could not be mitigated through other activities, then option RM5 shows that stable service could be regained through very high expenditure in future. In addition, we added a further £8.4m on reactive rising main repairs based on AMP6 expenditure.

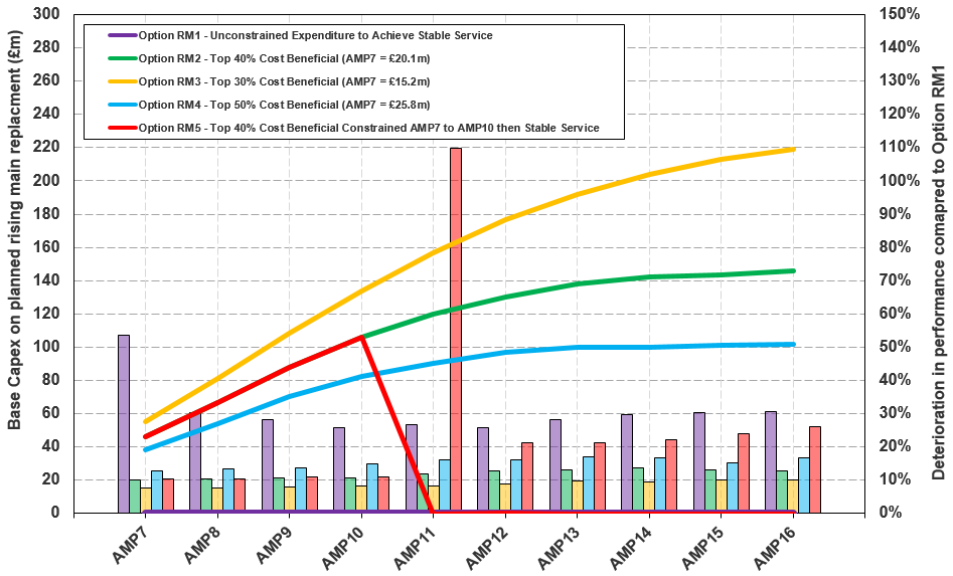

Figure 9: Impact of Options for Planned Rising Main Replacement on Serviceability in AMP7 to AMP16[27]

5.3 Innovation

We will build on the innovative approaches used during AMP6 by implementing a number of new approaches through our AMP7 flooding and pollution strategies, shown in Figure 10. Developing and implementing innovative techniques will ensure we deliver for customers, stakeholders and the environment in an efficient, affordable way.

Detection of groundwater infiltration

Traditional CCTV surveys of infiltration are limited to a small time frame when specific conditions are met, making it possible to see groundwater entering sewers through cracks and joints.

Through AMP5 and AMP6 we trialled new technology to detect sources of groundwater infiltration. This includes the Electro Scan system[28] which locates defects by measuring changes in the electrical resistance of the pipe wall in non-conductive pipe such as clay, plastic and concrete. These materials are electrical insulators and have a high resistance to electric current. Electro Scan can identify the locations of defects in the pipe that can leak water as these defects also leak an electrical current, whether infiltration is occurring at the time.

In the remainder of AMP6 and in AMP7, we will continue to support the trial, development and use of equipment that can locate groundwater infiltration more efficiently. This will enable us to carry out repairs in areas where this will provide the greatest benefit in reducing infiltration in the network and consequential flooding, discharges to watercourses and potential breaches of dry weather flow permits.

[28] Electro Scan description (Electro Scan, 2013)

Figure 10: Flooding and Pollution Innovation – Now and in the Future

Rising Main Surveys

We are using new technology to inform and optimise our rising main replacement programme. We will survey our strategic mains which require a proactive replacement strategy and carry the greatest risk due to the disruption, impact, logistics and cost of repairs. There are three in-pipe rising main survey methods available which are:

1. Sahara[29] – a tethered probe providing acoustic leak detection and gross metal loss assessment in rising mains up to 2 km from an insertion point.
2. SmartBall[30] – provides similar data to the Sahara but is used in larger rising mains with a diameter of greater than 375mm. The SmartBall is free swimming and is able to survey many kilometres of rising main from one deployment. In December 2017, we completed a successful trial of SmartBall on a 2.1 km rising main in Romsey, Hampshire.[31]
3. Pipe Diver[32] – specialises in providing information on corrosion in ferrous rising mains. Surveys over long distances can be carried out from one deployment in large diameter (> 400mm) pipelines.

We will continue using and refining innovative survey techniques on rising mains to ensure we only replace sections of rising mains which contain defects and maximise the benefits to customers from our investment.

Intelligent sewers

We are developing smart sewer networks where intelligent systems will eventually automatically control flows to protect customers' and the environment from flooding and pollution. Throughout AMP5 and AMP6 we have been installing level and flow meters in our sewers and pumping stations. In AMP6, we are also installing event duration monitors at 489 overflows.[8]

We will install further sewer and pumping station monitors to measure levels and flow in the network, enabling us to detect and locate hydraulic overloading, blockages, collapses and pumping station failures.

We will use predictive modelling to predict the location of potential flooding to enable mitigation to be implemented and/or improve the response to incidents.

Our plan to improve monitoring of the sewer network will be spread over 15+ years, and in AMP7 we will lay the foundations for intelligent sewers.

Innovative FOG Education

Around two thirds of blockages are caused by customers trying to dispose of fat, oil and grease (FOG), wipes and other sanitary materials through the wastewater network. We are raising awareness of the link between flushing and flooding, cost-effectively cutting sewer spills - and taking advantage of a brilliant opportunity to talk with and hear from thousands of customers. We are industry leading in this field and won the Gold Award in the Chartered Institute of Public Relations (CIPR) for the best "public engagement campaign that seeks to raise the issue internal domestic flooding. The campaign used a humorous activation to convey its message; awareness of unflushable items increased by five per cent year on year as a result."

[29] Sahara Leak Detection System (WRc, 2018)
[30] SmartBall Leak Detection (WRc, 2018)
[31] SmartBall survey of rising main in Hampshire (SW, 2017)
[32] PipeDiver condition assessment (Pure Technologies, 2018)

To engage younger audiences with our FOG and Unflushables messages, Figure 11 shows an ‘Augmented Reality Experience’ being developed as a smart phone game to teach participants on the correct disposal of different objects. Initially this game will be used at our public events and in the next phase it will be made available for all smart devices from mobile stores.

Figure 11: Augmented Reality Experience and FOG Education

To enable us to reach every single school in our region and as many future customers as possible, we developed downloadable school assembly material with teachers` notes to share our FOG and Unflushables message. This is cost effective as teachers become part of our education resource to help increase awareness. This material can be used with or without a member of our community team being present.

Figure 12: Multi-Premises Food Businesses We Are Working With

We have an estimated 28,000 food businesses across our region and in order to reach as many of them as possible we are engaging at senior level with multi-premises businesses and large chains. We explain the effect of FOG in sewers, on customers and the environment and outline current legislation, regulations and responsibility for grease management. Food businesses can then implement their own management procedures across their sites.

Our dedicated FOG and Unflushables team is carrying out a continuous education campaign built around the animated film “The Unflushables” jointly-produced with the Consumer Council for Water. The supporting social and

traditional media activity achieved almost 1.4 million views in one year. We will expand these activities to reach as many customers as possible to help protect the environment and keep bills affordable.

We continue looking for new ways to educate customers and businesses in areas where FOG and unflushable materials are repeatedly blocking the sewers.

Wastewater Resilience Metric (1 in 50 year storm)

To inform our wastewater resilience performance commitment, we used Water UKs methodology to quantify the percentage of population at high risk of sewer flooding from a 1 in 50 year storm. We utilised hydraulic models of large and medium wastewater catchments which cover 90% of the customers in our region. Using hydraulic modelling, we determined the number and percentage of properties at risk of flooding from a 1 in 50 year storm as shown in the example in Figure 13.

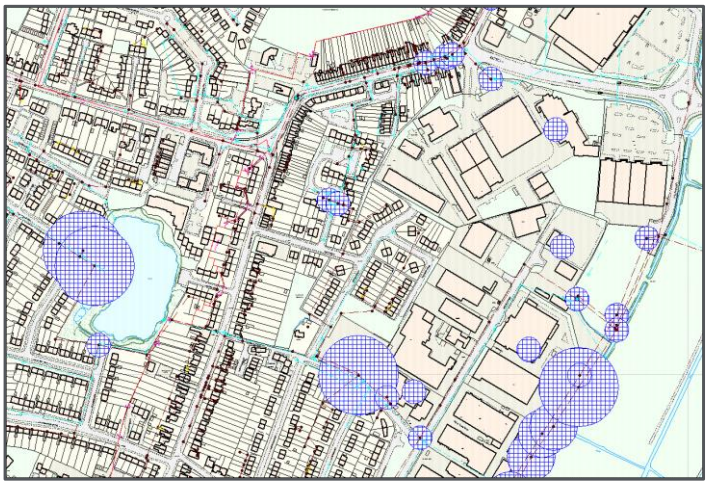

Figure 13: Modelled Properties at Risk of Flooding from a 1 in 50 Year Storm in Ashford

The flooding risk for the remaining 10% of customers was calculated through a manual assessment of the vulnerability of the catchment based on a range of characteristics as defined in the Water UK and Atkins guidelines shown in Figure 14.

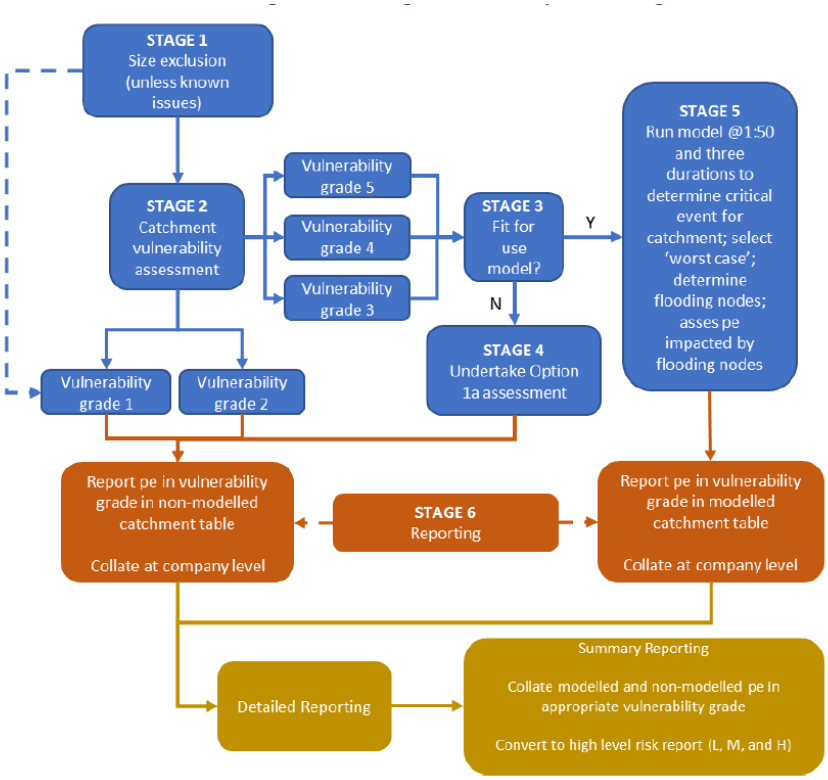

Figure 14: High Level Metric Process to Determine Vulnerability to Flooding[33]

After combining the results, we calculate 7.6% of customers are at risk if a region-wide, 1 in 50 year storm occurred. We aim to reduce the percentage of properties at risk with the range of innovative measures to increase resilience described above. In addition, we will improve the hydraulic models and data analysis to increase confidence in the percentage and location of customers at risk.

Use of market mechanisms

We will investigate new technology and approaches to create a modern, resilient and integrated sewer network. The use of market mechanisms will help reduce our costs and keep customers' bills affordable now and in the future. Mechanisms include:

- Collaborative working with third parties such as local authorities, regulators, highway authorities, Internal Drainage Boards, National Parks and developers on
  - Drainage and Wastewater Management Plans
  - Surface Water Management Plans
  - Reducing sewer misconnections through joint-inspections, monitoring and awareness raising
- Collaborative working with other water and sewerage companies in towns and areas close to the border of our region
- We will contribute to SuDS and partnership schemes to remove surface water from the network
- We will consider additional incentives for customers to reduce surface water flows in the network

[33] Developing and Trialling Wastewater Resilience Metrics (Atkins, 2018)

Our Integrated Water Cycle Management approach recognises the interconnected, complex nature of issues which can impact water. We have been piloting this approach throughout AMP6 in two catchments with a combined area of over 3,200km², 106 wastewater treatment works and over 130 water bodies.

Our experience, as well as learning from international best practice, has informed our Catchment First transformational programme. Through this, we will consider additional market mechanisms such as payments to landowners to change land management practices to reduce flooding or protect water quality.

5.4 Customer Benefits and Resilience

Our sewer network maintenance programme will support improvement on AMP6 performance as shown in Figure 15. The red line represents 2017-18 performance and the blue line represents our performance commitment targets in 2024-25. We have assumed upper quartile performance will gradually improve during AMP7 with poor performing companies improving more than companies who already reach upper quartile.

Figure 15: Summary of Projected Sewer Network Performance for AMP7[7]

Our AMP7 performance commitments are discussed in more detail in Chapter 6: Outcomes, Performance Commitments and ODIs.

5.4.1 Sewer Collapses and Rising Main Failures

Our £25.4m and £20.1m investment in planned sewer rehabilitation and rising main replacement respectively will have most impact on our performance commitment for the combined measure of sewer collapses and rising main failures. At this level of expenditure, deterioration modelling has forecast a 2 to 3% increase in sewer collapses and a 23% increase in rising main bursts as discussed in Section 5.2. We will mitigate through improved identification of high risk sewers and rising mains for replacement. Innovative surveying techniques[30] will enable us to locate leaks in rising mains so we maximise the benefit from our replacement programme.

5.4.2 Internal and External Flooding Incidents

Figure 16 shows our forecast improvement towards Quartile 1 performance for internal flooding incidents. We assumed that Quartile 1 performance will gradually improve during AMP7 with poor performing companies improving more than companies who are already at upper quartile level.

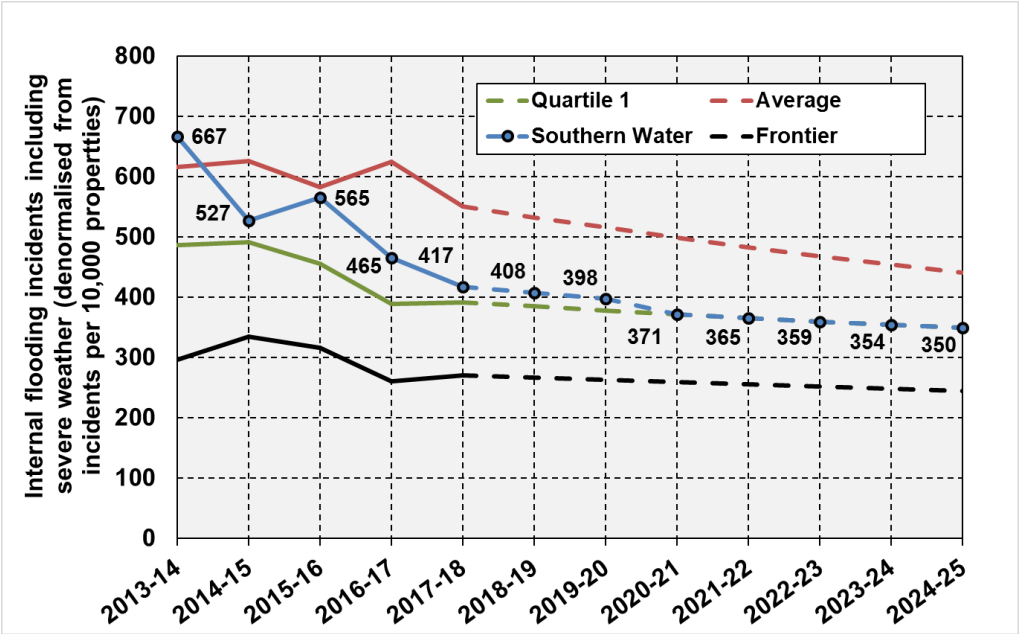

Figure 16: Forecast AMP7 Performance for Internal Flooding Incidents Including Severe Weather[7]

Figure 17 shows our forecast improvement towards average performance for external flooding incidents.

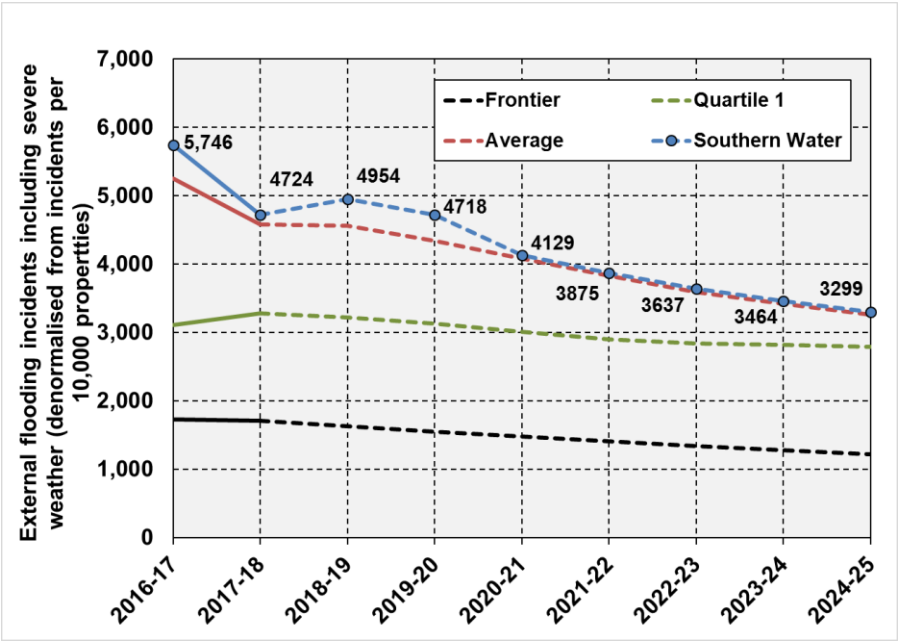

Figure 17: Forecast AMP7 Performance for External Flooding Incidents Including Severe Weather, Curtilage Only[7]

5.4.3 Pollution Incidents

Figure 18 shows our forecast improvement towards Quartile 1 performance for pollution incidents as discussed in TA.12.WW07 Flooding and Pollution Strategies.

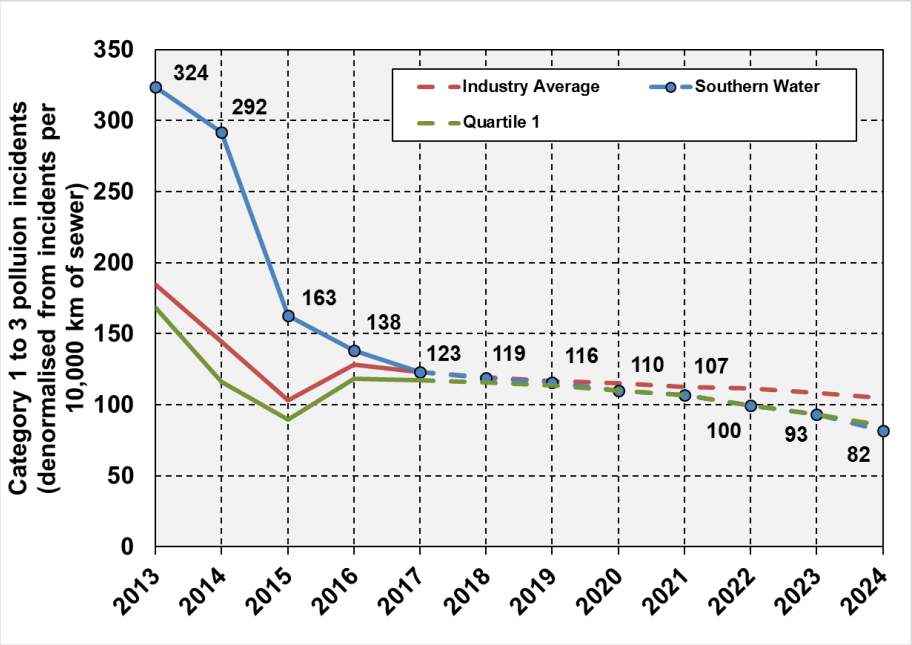

Figure 18: Forecast AMP7 Performance for Category 1 to 3 Pollution Incidents[7]

5.4.4 Resilience

Our customers and resilience are at the heart of our plan and we will improve performance whilst keeping bills affordable as illustrated in Figure 19.

Figure 19 shows the resistance of our sewers to FOG will be improved through targeted FOG education. The reliability of our sewerage network will be improved through a review of our maintenance strategy and achieving operational excellence. We will unlock capacity in sewers through surface water separation and the use of SuDS, rainwater gardens and smart water butts to manage stormwater. Increased sewer flow monitoring will support our intelligent sewers network.

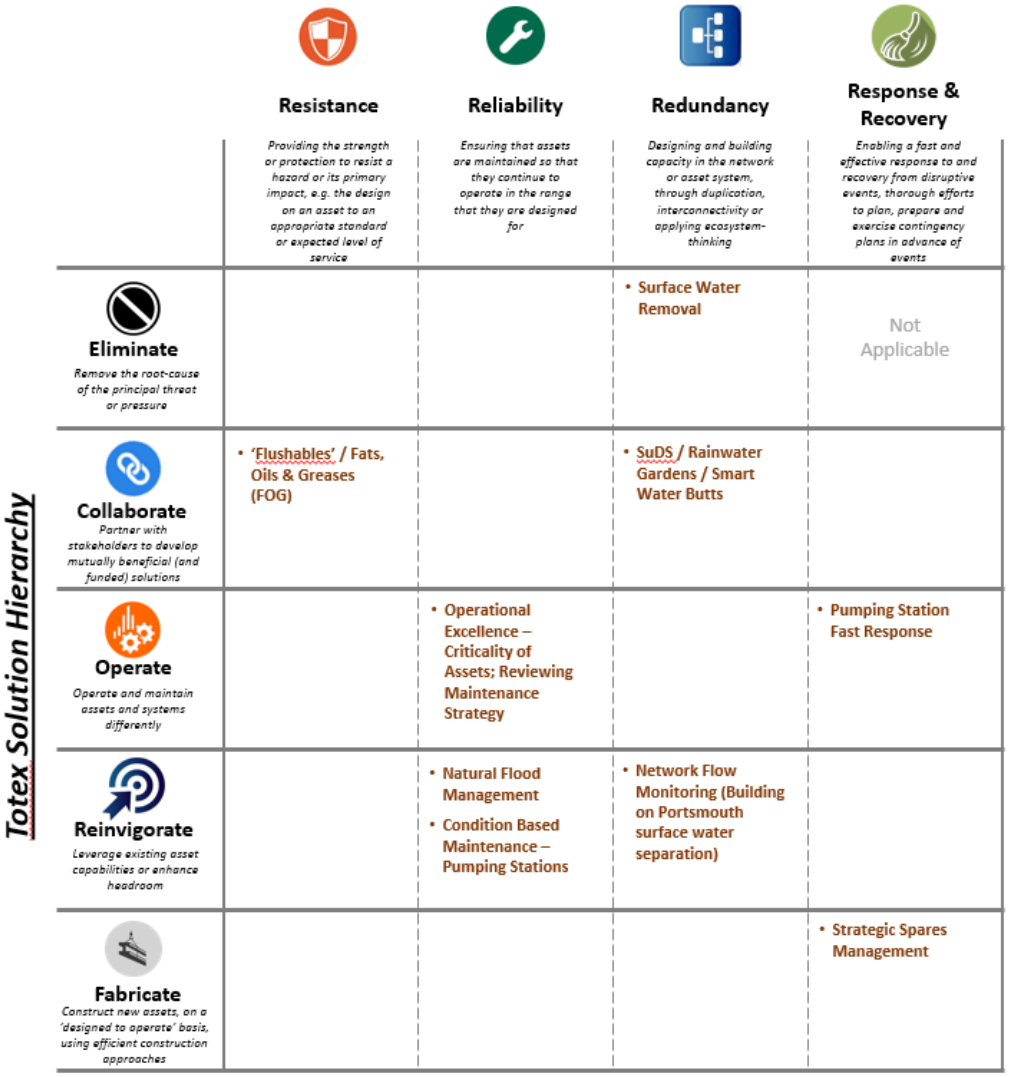

Figure 19: The 4 Rs of Resilience

5.5 Value for Customers

The customer performance commitments that are impacted by investment in sewers and mains are consistently shown to be high priorities for customers.

Our triangulation of the relative priority of our proposed PCs highlighted internal sewer flooding as the highest priority for customers and stakeholders. External sewer flooding is also a high priority for customers, and reported as a medium priority for our stakeholders. The number of pollution incidents are reported as medium priorities for our customers and a high priority for stakeholders.

Customers are highly averse to accepting reductions in service in exchange for lower bills, and in general are willing to pay for improvements in service levels for our proposed wastewater measures:

- the total amount that SW customers would be willing to pay for a reduction of 1 in the number of cases of '**Sewer flooding inside customers' properties'** was **£100,207** per year.
- the total amount that SW customers would be willing to pay for a reduction of 1 in the number of cases of '**Sewer flooding outside customers' properties'** was **£6,899** per year.

Our additional ODI research into willingness to pay for service level improvements indicated that our customers demand and are willing to invest in significant improvements to internal sewer flooding. Customers reported willingness to pay for moderate improvements to external sewer flooding. Full detail on our customer engagement findings can be found in Chapter 4: Customer and Stakeholder Engagement and Participation.

Table 10: Willingness to Pay for Wastewater Measures

Service Attribute	Unit	WTP [£/Unit/Year]		
		Central	Low	High
Sewer flooding inside customers' properties	Case/prop	£100,207	£75,641	£124,773
Sewer flooding outside customers' properties	Case/prop	£6,899	£5,237	£8,562

Based on our customers' willingness to pay information provided in Table 10 we have determined the whole life costs[34] over 20 years[35] for five investment options for planned sewer rehabilitation and five investment options for rising main replacement. Further details of the plan options are provided in Section 5.2.

6. Costing Strategy

Figure 20 shows how we optimised and balanced our proposed expenditure in AMP7 against a range of historical and future issues affecting sewer network maintenance.

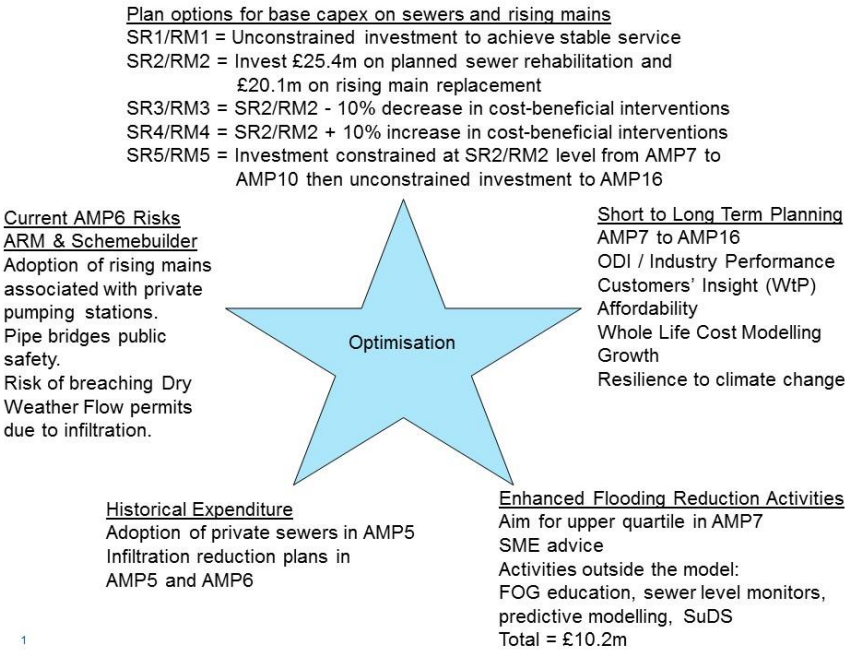

Figure 20: Costing Strategy

[34] Whole life cost model v8.9 for sewers and rising mains (SW, 2018)
[35] Our whole life costs and cost benefit figures have been calculated by extracting a 20 year portion of costs/benefits from a 60 year model. Further details are included in TA.14.5 PR19 Approach to Optioneering

The costs in our plan have been derived using one of the following methods:

Historic spend projection. These costs are mainly for Opex investment where future costs are a continuation of historical expenditure. We assessed whether future costs will be different to historical costs due to improved efficiency, a change in planned work or a required improvement in performance.

Pioneer deterioration model/ triangulated view. The cost for planned sewer rehabilitation and rising main replacement has been based on deterioration modelling as discussed in the plan options in Section 5.2. Our preferred option is based on maintaining serviceability in the short and long term whilst keeping bills affordable for our customers.

Function or detailed cost. We used Schemebuilder or detailed costing using cost curves where there is a high level of information on the scope of the scheme.

Simple scheme cost based on a high level estimate. These costs are for new work programmes where there is limited knowledge on the likely cost. We have based costs on advice from subject matter experts and estimated costs in studies we commissioned on intelligent sewers

7. Key Risks and Opportunities

7.1 Risks

- There is a risk that in AMP7 the industry upper quartile performance for flooding and pollution incidents may improve at a higher rate than we have forecast. This will mean we will have to invest at levels significantly above those presumed to deliver these levels of service to our customers.
- There is a risk that our proposals, which protect customers from excessive costs in AMP7, lead to high costs for customers in future AMP periods. This is because in AMP7 and the immediate future our sewer rehabilitation and rising main repair rates (and those of the rest of the industry) remains very low. (Typically only one thousandth of our sewage network is refurbished/repaired in any 5 year regulatory period).

7.2 Opportunities

- There is an opportunity that the novel and innovative surveying and inspection techniques we are trailing in AMP6 and propose to deploy in AMP7 could improve the identification of defects in sewers and rising mains more effectively than we have assumed. This could allow us to target repairs and refurbishment work more precisely and reduce infiltration, collapses and bursts and subsequent pollution more cost effectively than we assume.
- There is an opportunity that improvements in telemetry, automation and control as part of our 'intelligent sewers' strategy will prove to be more effective than we have assumed. As a consequence improved incident management would reduce the impact to flooding and pollution incidents on our customers.
- There is an opportunity for better joint collaboration between local authorities, the EA, landowners, the water industry and academics. By sharing ideas, information and resources better this would allow us to provide better services to our customers.

Appendix 1: List of Named Schemes

Table 11: Major Schemes in AMP7[3]

Scheme Name	AMP7 Totex	AMP8 Capex
ALFRISTON WTW (Infiltration)	0.089	0
BOLDRE WTW (Infiltration)	0.165	0
BOLDRE WTW (Infiltration)	0.016	0
CHALE WTW (Infiltration)	0.127	0
CHALE WTW (Infiltration)	0.066	0
COOKSBRIDGE WTW (Infiltration)	0.133	0
GRAIN WTW (Infiltration)	0.630	0
LISS WTW (Infiltration)	0.584	0
LOXWOOD WTW (Infiltration)	0.352	0
MILFORD ROAD PENNINGTON WTW (Infiltration)	1.257	0
NEWNHAM VALLEY PRESTON WTW (Infiltration)	0.615	0
OXTED WTW (Infiltration)	0.906	0
PADDOCK WOOD WTW (Infiltration)	1.219	0
ROLVENDEN LAYNE WTW (Infiltration)	0.322	0
SHORWELL WTW (Infiltration)	0.497	0
ST HELENS WTW (Infiltration)	0.815	0
STOCKBRIDGE WTW (Infiltration)	0.036	0
Barton Stacey WTW (Infiltration)	0.141	0
THORNHAM WTW (Infiltration)	2.017	0
Lidsey WTW(Infiltration)	0.699	0
WILLOW WOOD ST LAWRENCE WTW (Infiltration)	0.521	0
Chichester Infiltration Scheme EA driver - new line	6.057	0
(Sewer Misuse) Fats, oils grease campaign (Education)	1.648	11.555
External Flooding (Enhancement)	5.815	
Internal Flooding mitigation (Enhancement)	2.774	
SUDS (Partnership Enhancement Eastbourne)	1.695	
Chestnut Ave Chickenhall Rising Main (Resilience)	1.124	0

Appendix 2: Further Information

In AMP7 we looked at a numerous catchments that had both flow issues and a risk of sewer flooding. After considering a range of solutions it was identified that Infiltration reduction was the lowest whole life cost. Table 12 shows that infiltration reduction schemes offers the lowest AMP7 Totex and 20 year whole life cost solution compared with other process solutions.

Table 12: Comparison of AMP7 Totex and 20 Year WLC for Infiltration Reduction and Process Solutions[26]

Driver	Scheme	SB	Iteration	Description	TOTEX £k	WLC 20yr	Carried Forward	Reason selected
Infiltration Reduction	Alfriston WTW - Growth	3527	1	Process solution	1,017	1185	No	
		3464	2	Sewer infiltration reduction	97	57	Yes	Lowest Totex
	Barton Stacey WTW Process Capacity	3886	1	Process solution	5,877	7017	No	
		3612	2	Sewer infiltration reduction	154	63	Yes	Lowest Totex
	Biddenden WTW Infiltration reduction	3472	2	Sewer infiltration reduction	183	N/A	No	Rejected
	Boldre WTW Process Capacity	4031	1	Process solution	211	257	No	
		3477	2.1	Sewer infiltration reduction	180	63	Yes	Lowest Totex
		3478	2.2	Sewer infiltration reduction	18	6	Yes	Lowest Totex
	Chale WTW Process Capacity	3617	1	Process solution	349	425	No	
		3553	2.1	Sewer infiltration reduction	139	49	Yes	Lowest Totex
		3554	2.2	Sewer infiltration reduction	72	25	Yes	Lowest Totex
	Cooksbridge WTW Infiltration reduction	3550	1	Sewer infiltration reduction	145	51	Yes	Low Totex - No process solution
	Grain WTW Infiltration reduction	4358	1	Sewer infiltration reduction	688	797	Yes	Low Totex - No process solution
	Lidsey WTW Process Capacity	3817	1	Process solution	10,804	14189	No	
		3571	2	Sewer infiltration reduction	763	652	Yes	Lowest Totex
		3949	2	Process solution	10,652	12310	No	
	Liss WTW Infiltration reduction	3663	1	Sewer infiltration reduction	638	426	Yes	Low Totex - No process solution
	Loxwood WTW Process Capacity	3650	1	Process solution	2,592	3773	No	
		3572	2	Sewer infiltration reduction	384	136	Yes	Lowest Totex
	Milford Road Pennington WTW Process Capacity	3489	1	Process solution	12,856	16603	No	
		3586	2	Sewer infiltration reduction	1,373	1386	Yes	Lowest Totex
	Newnham Valley Preston WTW Process Capacity	3976	1	Process solution	5,059	5803	No	
		3573	2	Sewer infiltration reduction	672	292	Yes	Lowest Totex
	Oxted WTW Process Capacity	3776	1	Process solution	8,076	9339	No	
		3575	2	Sewer infiltration reduction	990	693	Yes	Lowest Totex
	Paddock Wood WTW Infiltration reduction	4363	1	Sewer infiltration reduction	1,331	1530	Yes	Infiltration reduction is most effective solution
	Rolvenden Layne WTW Infiltration reduction	4362	1	Sewer infiltration reduction	351	207	Yes	Low Totex - No process solution
	Shorwell WTW Infiltration reduction	4359	1	Sewer infiltration reduction	543	321	Yes	Low Totex - No process solution
	St Helens WTW Process Capacity	3888	1	Process solution	2,278	2647	No	
		3682	2	Sewer infiltration reduction	890	525	Yes	Lowest Totex
	Stockbridge WTW Infiltration reduction	3683	1	Sewer infiltration reduction	40	23	Yes	Low Totex - No process solution
	Thornham WTW Infiltration reduction	4364	1	Sewer infiltration reduction	2,204	2532	Yes	Infiltration reduction is most effective solution