TA.12.WW02 Network Pumping Stations

Business Case

Version 1.0
September 2018

1. Executive Summary

Name of business case	WW02 Network Pumping Stations
Context	Growth from new developments and adopting former private pumping stations is forecast to increase the number of wastewater pumping stations (WPS) from 3,321 in 2018 to over 3,600 by 2025. We had the highest number of pumping stations per km of sewer in 2015-16. We also have a high number of coastal pumping stations where predicted sea level rises are increasing the risk of flooding of our assets. Our targeted investment on improved ways of working for wastewater pumping stations has been a significant factor in the total number of Category 1 to 3 pollution incidents (sewerage only) falling from 324 incidents in 2013 to 123 incidents in 2017.
Customer and stakeholder views	Customers and stakeholders expect us to 'do the basics brilliantly' and maintain and operate our pumping stations to protect the environment from pollution and protect their properties from flooding.
Our aim	a) We aim to deliver Quartile 1 performance for pollution incidents and internal flooding incidents b) We aim to improve to average for external flooding from Quartile 3 c) We will increase the resilience of pumping stations to coastal flooding due to climate change d) Combining improved analytics with intelligent flow meters and monitors to create a smart network will enable us to detect, respond to and resolve potential pollution and flooding incidents before they impact on the environment
Scope of this business case	All capital maintenance and base Opex investment relating to wastewater pumping stations

	Botex	**Enhancement**	**Total**
Totex (£'m)	£83.2m	£12m	£95.2m
Opex (£'m)	£3.7m	£1.7m	£5.4m
Capex (£'m)	£79.5m	£10.3m	£89.8m
Residual, post-AMP7 Capex (£'m)	-	-	-
20-year Whole life Totex (£m)	£78,983	£113,659	-
20-year cost benefit[32]	£126,439	-£40,236	-
Materiality (% 5 year Totex of Wastewater Networks Plus)	-	-	4.0%
Relevant business plan table lines	WWS1 6 and WWS1 12	WWS2 33 and WWS2 80	

Botex – Base maintenance of wastewater pumping stations	
Overview of AMP7 proposals	• We are investing £84.6m over AMP7 to improve the resilience and performance of our network pumping stations. We will invest £74.4m on the base maintenance of pumping stations of up to 3600 WPS including over 770 former private pumping stations adopted to date. We will reduce high-impact, low-likelihood (HILL) risks at WPS where pump failure could lead to severe pollution. • In addition, we will invest £5.1m to improve the coastal flood resilience of Portobello wastewater pumping station which transfers wastewater flows from over 280,000 people in the Brighton area. • A further £5.1m will be spent on routine wet well cleaning. • 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 £10.7m of enhancement expenditure associated with our wastewater pumping stations
Why are the proposals the best programme- level option for customers	We have assessed four options for the maintenance of wastewater pumping stations based on whole life costs and performance. Our preferred option would be affordable to customers in AMP7 and has the least whole life cost. It includes resilience schemes that were not included in other options. Modelling of our preferred option indicates a deterioration in performance but we remain confident that this can be managed through our flooding and pollution strategies. We have discounted options that would be unaffordable for our customers and options that would lead to an unacceptable performance.
What we would like to highlight	We will increase efficiency through the use of key innovations in AMP7 which include reducing the risks of pump blockage from fats, oils and greases through data analytics, education and natural fat busting microbes. We will reduce costs through more energy efficient pumps and we will use quieter pumps to reduce the nuisance to customers.

Performance Commitments supported by this business case		
PC	**How relevant is this business case?**	**Comment**
Pollution incidents	High	34% of pollution incidents were attributable to WPS in 2016
Internal flooding incidents	Low	8% of internal flooding incidents were due to failures at WPS and Wastewater Treatment Works (2013-14 to 2016-17)
External flooding incidents	Low	

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

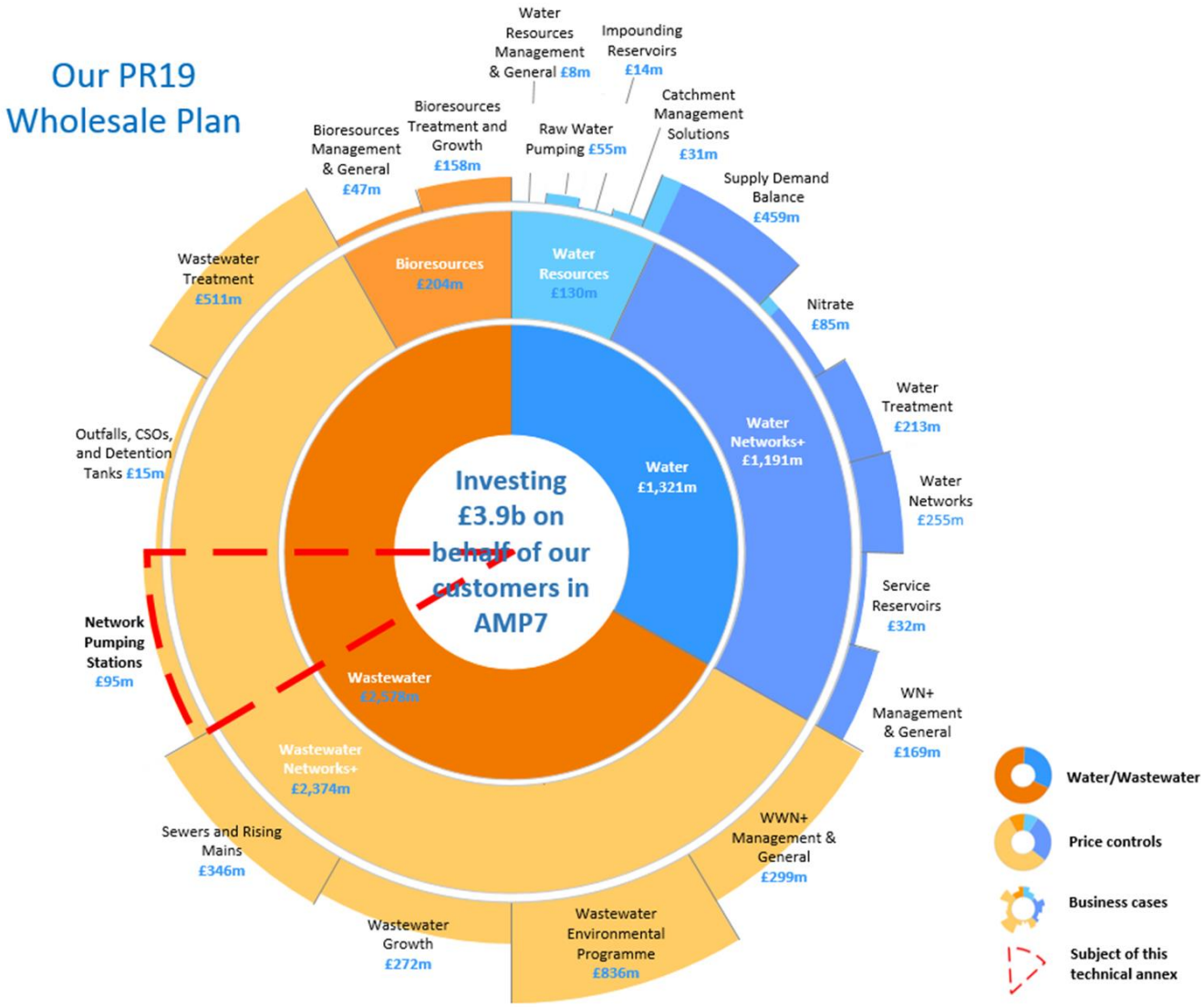
Schemes and scheme-level options			
Schemes over £20m	Options		
	Description	Cost	Selected option and rationale
None			

Contents

2. Scope of Technical Annex

This technical annex describes our proposed £95.2m (Totex equivalent) network pumping stations and pollution prevention maintenance plan for AMP7. This represents 4.0% of the Wholesale Wastewater Networks + Plan of £2,374m.

Figure 1: Our PR19 Wholesale Plan[2]



[2] Business case investment data (Gold Lockdown 4, SW, 2018)

The following assets are within the scope of this plan:

- 3321 wastewater pumping stations[3] including over 770 former private pumping stations[4] adopted since October 2016.
- The number of pumping stations is forecast to increase to circa 3600 by 2025 due to the growth in new housing or business use developments and potential further adoptions of PPS.[5]
- Pumping station monitoring (flow meters, alarms, innovation etc.)

Other assets on the sewer network are detailed in TA.12.WW03 Outfalls, CSOs and Detention Tanks and TA.12.WW04 Sewers and Rising Mains.

3. AMP6 Strategy

3.1. Investment Strategy

In AMP5, we focused capital maintenance investment on high risk pumping stations with the most cost-beneficial solutions. This has allowed us to concentrate on reducing the number of Category 3 pollution incidents in AMP6, with a goal to cut these by at least half by 2017, alongside reducing the number of internal sewer flooding incidents by 25% by 2020.[6]

We have also worked to comply with new transfer regulations, adopting over 770 private pumping stations by the government's October 2016 requirement.[4]

Table 1: AMP6 Expenditure (£m) on Network Pumping Stations (2017-18 Prices) [2]

	AMP6 Actual					
	2015/16	2016/17	2017/18	2018/19	2019/20	AMP6 Total
TOTEX	11.460	20.835	26.478	21.459	11.128	91.360
CAPEX	10.474	19.931	25.505	20.473	10.142	86.525
WPS Planned and Reactive Maintenance	10.474	19.931	25.505	20.473	10.142	86.525
Opex	0.986	0.904	0.973	0.986	0.986	4.835
Wet Well maintenance	0.986	0.904	0.973	0.986	0.986	4.835

Note: operational costs in this technical annex only refer to wet well maintenance costs, all other Opex is included within TA.12.WW04 Sewers and Rising Mains. AMP6 Actual comprises actual expenditure to the end of 2017-18 and current forecast expenditure in 2018-19 and 2019-20.

We are on track to achieve our Category 3 pollution and internal flooding reduction performance commitments[6,7]. We have improved pumping station maintenance, enhanced

[3] Number of WPS (2017-18 APR)
[4] See Section 3.1
[5] See calculation in Section 4.2
[6] AMP6 commitments (Wholesale Monitoring Plan 2015-20 v7.8, SW, 2018)
[7] Historical and forecast performance (Wastewater PC Predictions v15, SW, 2018)

incident response and increased the robustness of our incident verification and evidence capture process, supporting our analysis of root cause. This has allowed us to optimise investment and improve asset performance.

Adoption of Private Pumping Stations

The government introduced new legislation[8] in 2011 to require water and sewerage companies to adopt eligible private pumping stations (PPS) before or on 1st October 2016. A possible future legislative requirement may also require pumping stations built after June 2011 (supplementary) to be transferred.[8]

Our PR14 final determination provided for the adoption of 642 PPS in AMP6 (See Table 2). This includes 552 PPS adopted in October 2016 and an additional 90 'supplementary' PPS adopted in anticipation of a change in the law. [9] Our investment in this area addressed three main areas:

- Ensuring the PPS meets our high health and safety standards.
- Preventing third parties from accessing the pump and its controls.
- The adoption of telemetry and alarms to improve our incident response and address legacy performance issues.

Table 2: AMP6 Adoption of Private Pumping Stations

	No. of PPS eligible for adoption in October 2016	No. of PPS awaiting confirmation of eligibility for adoption	No. of 'Supplementary' PPS for potential early adoptions	Total number of PPS included in expenditure
PR14 Final Determination	552		90	642[9]
AMP6 Forecast	773	34	88 (not included in total)	807[10]

As of the end of 2017, we have adopted 773 pumping stations while considering further adoptions.[10] At least 131 adopted pumping stations are therefore not provided for in our PR14 final determination.

In line with much of the rest of the sector, we do not propose to adopt the 88 identified 'supplementary' PPS[10]. We await guidance on future legislation regarding these facilities.

The adoption of additional private pumping stations in AMP6 has increased the requirement for planned and reactive maintenance whilst increasing the risk of pollution and flooding incidents.

[8] The Water Industry (Schemes for Adoption of Private Sewers) Regulations (Defra, 2011)
[9] Adoption of PPS in AMP6 (PR14 Business Plan Removing Wastewater Effectively, SW, 2013)
[10] Private pumping station adoption numbers (SW, 2018)

3.2. Customer Benefits and Resilience

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

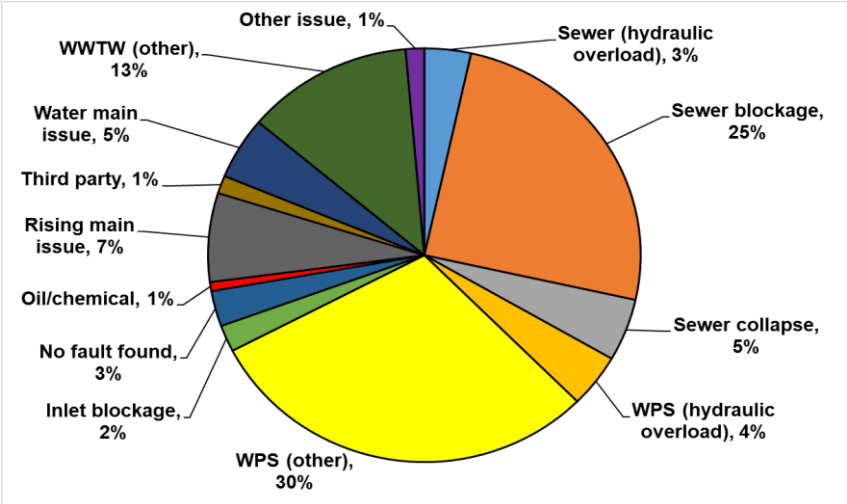
- We **reduced Category 1 to 3 pollution incidents** from 324 in 2013 to 123 in 2017 – a 62% reduction, although our performance in 2017[7] only achieved industry average performance
- We **reduced internal flooding incidents** (excluding severe weather) from 581 in 2013-14 to 401 in 2017-18 – placing 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]

Our investment in wastewater pumping stations delivered positive outcomes for customers and the environment by reducing pollution and flooding incidents.

3.2.1. Pollution Incidents

At PR14, we committed to cut the number of Category 3 incidents by half to 158 by 2017 and to reduce Category 1 and 2 incidents to zero by the end of AMP6[6]. At 34%, wastewater pumping station failure was the biggest cause of incidents (See Figure 2).

Figure 2: Root Cause of Category 3 Pollution Incidents in 2016[11]



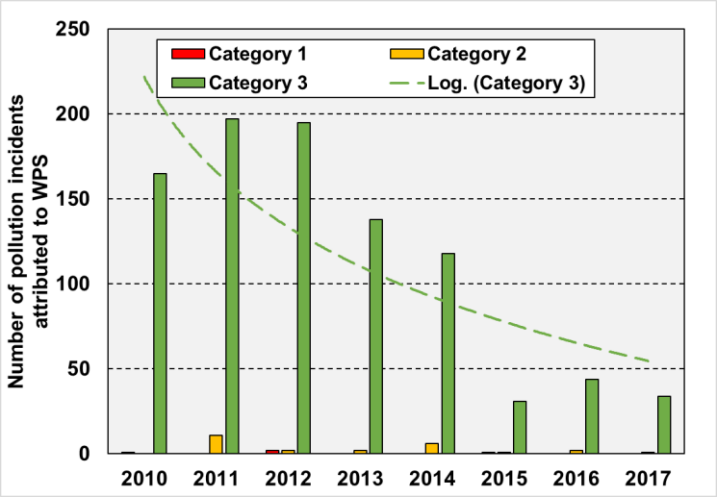
Our AMP6 strategy to reduce pollution incidents focused on the highest risk pumping stations where the identified solutions gave the greatest benefit for least cost. Our strategy has been achieved through improved ways of working to reduce risk using the following approach:

[11] Root causes of pollution incidents (Incident data, SW, 2016)

1. Assign a risk score to the pumping station based on leading indicators such as historical incidents, reactive work and high priority alarms. These are static and dynamic risk scores which build a monthly view of performance improvement or deterioration to enable targeted investment.
2. Survey the top 100 high risk pumping stations to determine the refurbishment requirements.
3. Replace critical plant out of action at high risk sites.
4. Refurbish sites recorded in the Asset Risk Management (ARM) database, part of our risk management framework.
5. Ensure that pumping stations have optimal duty, standby and assist pumps to improve the resilience of the stations to high flows and reduce the risk of failure causing flooding or pollution.
6. Create new multi-skilled maintenance teams which enables a greater number of first time fixes for issues at pumping stations.

Our strategy was successful as the number of Category 1 to 3 pollution incidents attributed to wastewater pumping stations reduced from 124 in 2014 to 35 in 2017 as shown in Figure 3.[12]

Figure 3: Pollution Incidents Attributed to Wastewater Pumping Stations[12]

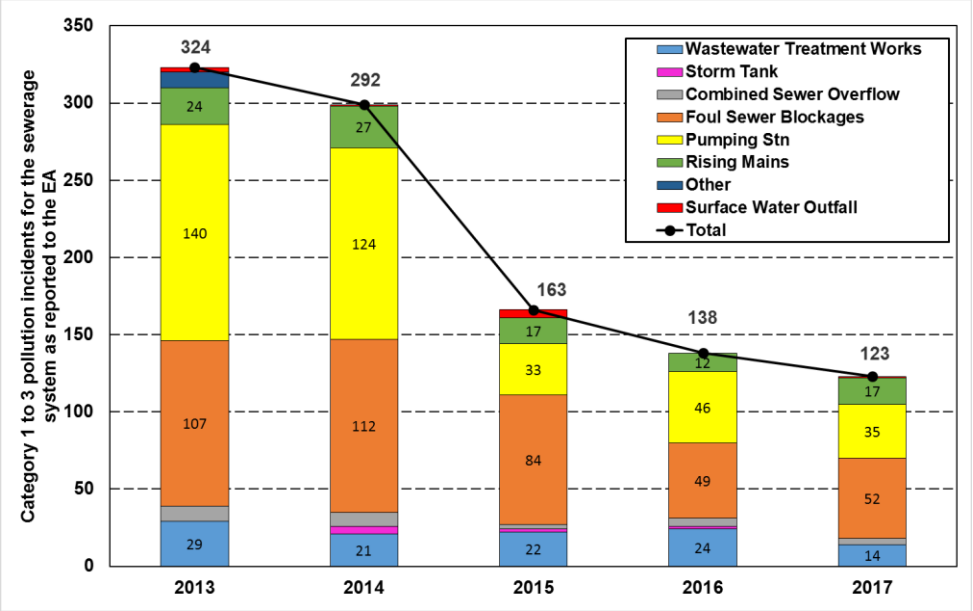


We have met and beaten our promise to customers to reduce pollution incidents by 50% by 2017.[6] Reducing pollution incidents has improved our environment and delivered positive outcomes for the many customers who enjoy using our region's rivers and bathing waters.

Figure 4 shows that our targeted investment on improved ways of working for wastewater pumping stations has been a significant factor in the total number of Category 1 to 3 pollution incidents (sewerage only) falling from 324 incidents in 2013 to 123 incidents in 2017.[7]

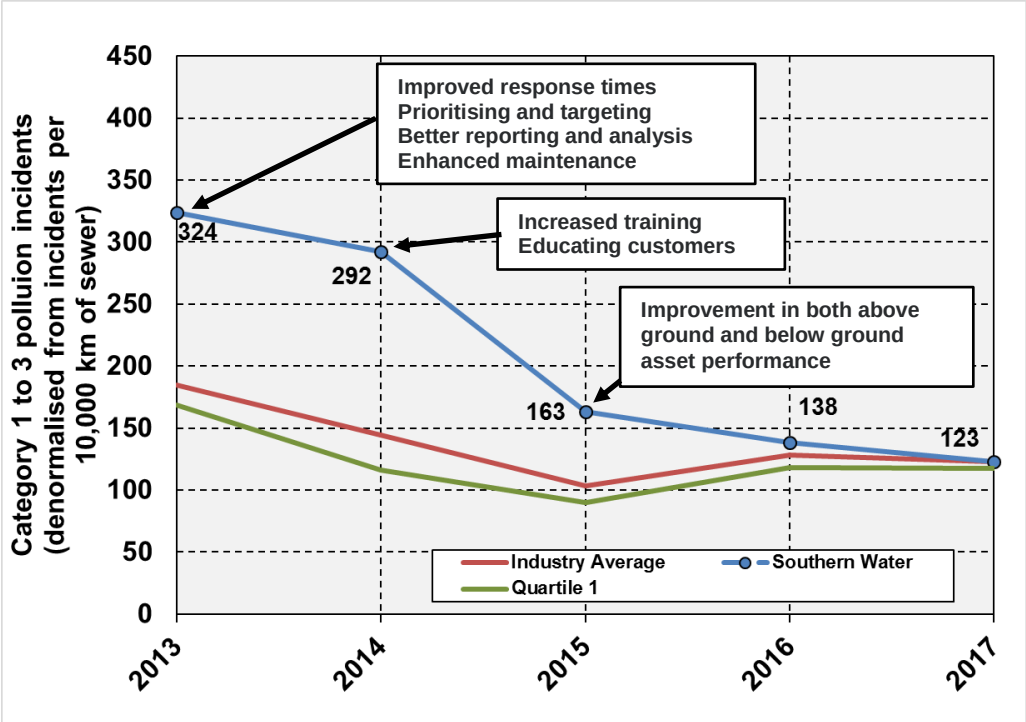
[12] Pollution incidents attributed to WPS (SW report to the EA, 2010 to 2017)

Figure 4: Historical Category 1 to 3 Pollution Incidents (by Asset Type)[13]



Our performance improved from Quartile 4 in 2013 to average in 2017.[7] (See Figure 5)

Figure 5: Comparative Performance for Pollution Incidents[7]



[13] Pollution Stack Strategy Summary (SW, 2018)

3.2.2. Internal Flooding Incidents

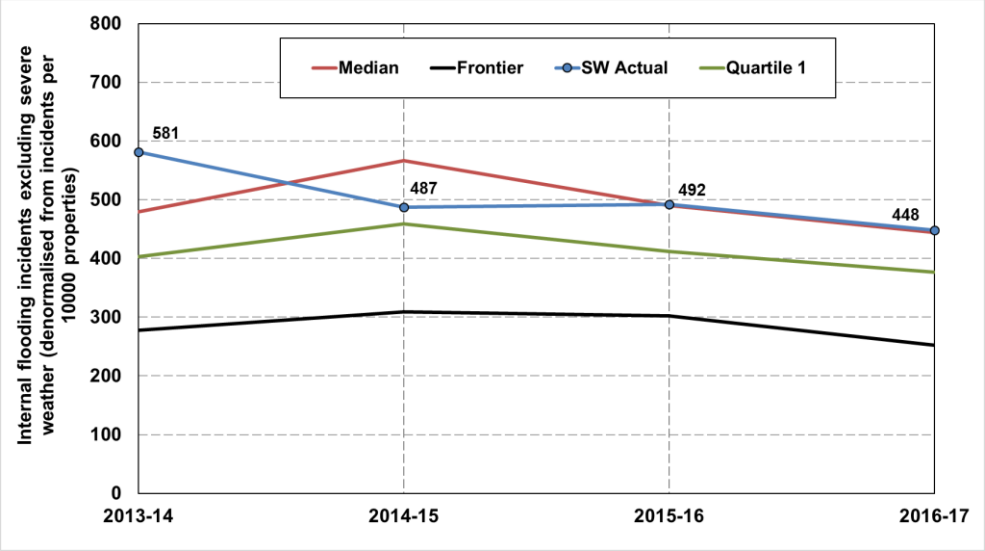
Our strategy of targeting investment on high risk pumping stations also helped us cut the incidence of flooding. The number of internal and external flooding incidents attributable to wastewater pumping stations fell by more than 50% between 2014 and 2016 (See Table 3) while total internal flooding incidents fell from 581 in 2013/14 to 401 in 2017/18.[7] We are therefore on track to meet our AMP6 25% reduction target.[6]

Table 3: Flooding Incidents Caused by a Wastewater Pumping Station Issue[14]

Incident caused by a WPS issue	2012	2013	2014	2015	2016	Total 2012 to 2016
Internal flooding incidents	265	125	177	118	76	**761**
External flooding incidents	1950	1516	2509	1071	1030	**8076**

Figure 6 shows that our performance improved from Quartile 3 in 2013-14 to the median level in 2015-16 and 2016-17.[7] (Comparative data not available for 2017-18).

Figure 6: Historical Internal Flooding Incidents Excluding Severe Weather[7]



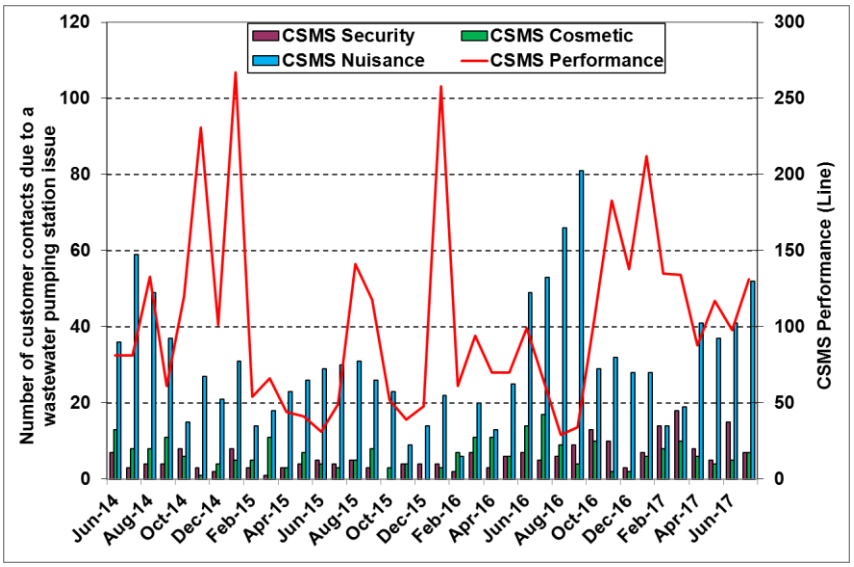
3.2.3. Customer Contacts

By cutting the incidence of pollution and flooding, our AMP6 wastewater pumping station investment has benefited both customers and the natural environment. Private pumping

[14] WPS performance data (2017-07 WPS Performance Report v1, SW, 2017)

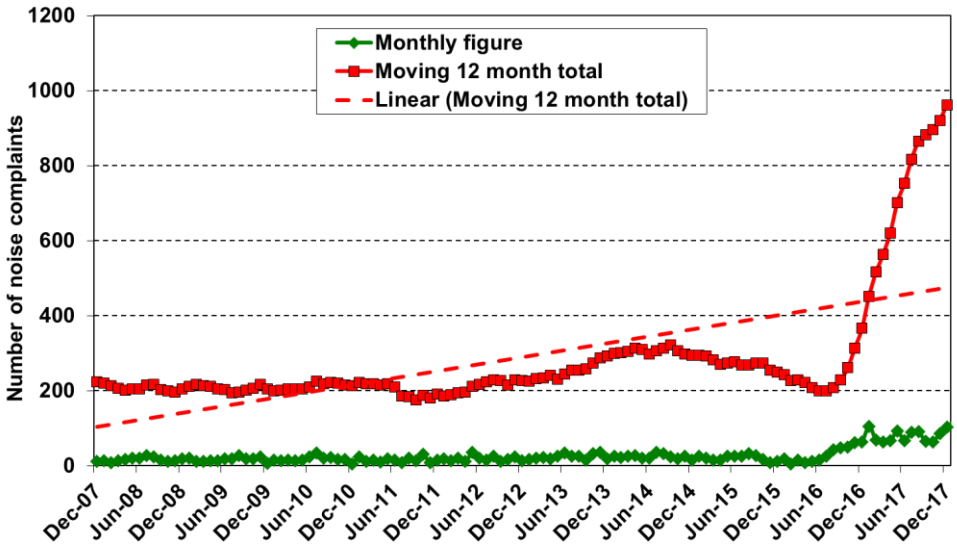
station adoptions have also benefited customers as Southern Water now bears all risk, maintenance and upgrade costs. Despite this, the number of customer contacts has increased since those adoptions. (See Figure 7).

Figure 7: Customer Contact Due to an Issue at a WPS[14]



Noise and odour complaints have also increased post-adoptions, with 85 of 119 noise complaints in January 2018 attributable to adopted private pumping stations[15]. (See Figure 8).

Figure 8: Long Term Noise Complaint Trend[15]



Complaints about adopted private pumping stations are often caused by problems in accessing private property to turn off alarms and carry out planned maintenance

[15] Noise complaints (Air Quality Report, SW, 2017)

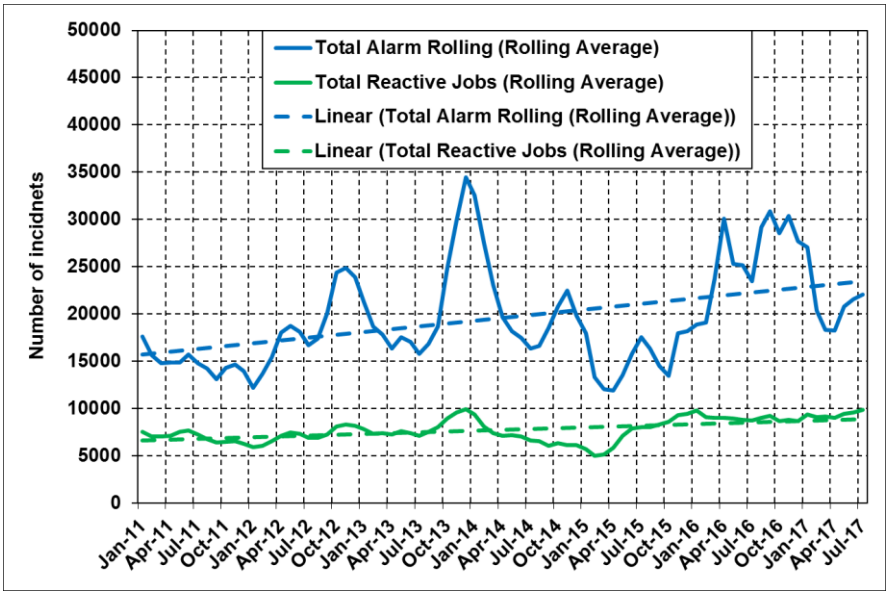
and emergency repairs. In addition, many such stations were adopted with existing unaddressed issues.

We are working hard to bring the adopted private pumping stations up to our health and safety, alarms and telemetry standards. Due to the large number of adoptions, our AMP7 aim of achieving Quartile 1 performance is more challenging. Our investment for AMP7 will need to include the following performance improvements:

- Provision of conditional alarms at WPS that do not have an alarm.
- Replacement of pumps where required.
- Installation of flow meters at small WPS that do not currently have a flow or level meter.

Despite this strong progress, there has been an increase in the background level of risk at wastewater pumping stations. Figure 9 shows a steady increase in the number of high priority alarms and reactive jobs between 2011 and 2017. This is limiting any opportunities to reduce investment on pumping stations. The peak in alarms in 2012 and 2013 was due to above average winter rainfall while the winter 2016 peak is likely to be a result of the adoption of private pumping stations (See above).

Figure 9: Alarms and Reactive Jobs at Wastewater Pumping Stations[14]



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 the views and priorities of our customers. From an environmental perspective, we have also drawn on the views of a diverse range of non bill-paying customers who utilise water across Hampshire, the Isle of Wight, Sussex and Kent 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 medium priority. Customers empathise with those that have experienced flooding and believe that it is a terrible event. Despite us only just falling short of the national average in performance, there is a high desire to see us improve our network to prevent sewage flooding.

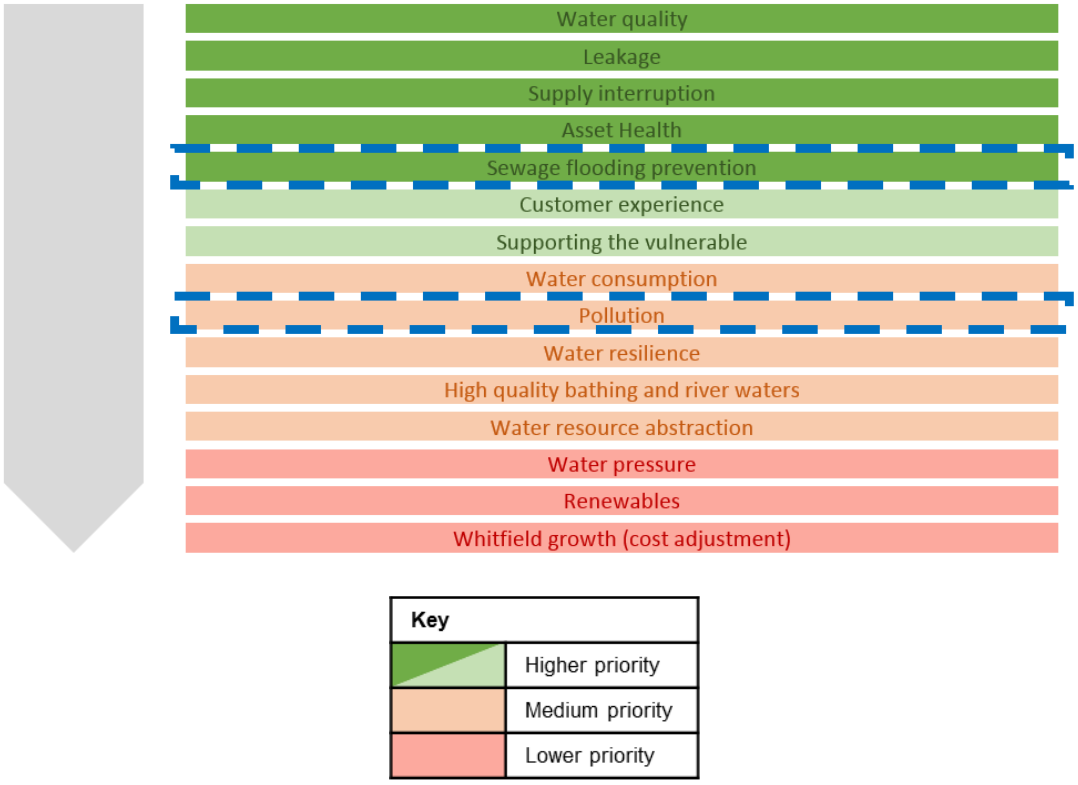
Our customers believe we have a duty to protect and enhance the environment. Doing no harm to the environment has been outlined as a minimum requirement for customers, whilst protecting and enhancing the natural environment is the level of service that customers expect. Customers want water and wastewater 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. Regulators and the Blueprint believe companies should not be rewarded through ODIs for complying with the statutory minimum.

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 than other customer groups. Figure 10 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 10: 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. Both our customers and our regulators expect a reduction in pollution in AMP7, and our longer term strategic aspiration is to eliminate pollution by 2040. Based on this insight we have made pollution the key driver which has shaped our AMP7 investment strategy for network pumping stations.

4.2. Future Trends and Pressures

The following trends and pressures are likely to have a material bearing on the resilience of our sewer network:

1. **Industry wide resilience issues**
    - Regulatory expectation of an improvement to Quartile 1 performance for pollution and internal flooding[16].
    - A requirement to quantify and improve the long-term health of sewerage assets and their resilience to future pressures[17,18]
    - Potential increases in FOG, wet wipes and other unflushable materials. Population growth may drive this trend.
    - More extreme weather events[19], increasing surface water flows in pumping stations and rising mains.

2. **Regional and Company resilience issues**
    - An estimated 8.1% increase in wastewater flows by 2024 due to population growth in the South East.[20] By 2045, the regional population is predicted to grow by 20%, with 500,000 new homes expected.[20]
    - A related increase in the number of WPS from new developments (See Table 5)
    - Coastal pumping station vulnerability. Our region has over 700 miles of coastline[21] with a high proportion of our pumping stations located in coastal towns and cities. Particular vulnerabilities include:
        - A rise in the sea level by a predicted 21-68cm for London between 1990 and 2095. [22]
        - Accelerated deterioration of assets in the harsh marine environment[23].
    - The highest proportion of wastewater pumping stations per 1000 km of sewer of any water and sewerage company[7] (See Table 4 for a comparison of 2015-16 data, i.e. prior to the 2016 adoption of private pumping stations.)

Table 4: Number of WPS per 1000 km of Sewer (Public + S105A) in 2015-16[7]

Anglian	Welsh	North-umbrian	Severn Trent	South West	Southern	Thames	United Utilities	Wessex	Yorkshire
62	60	24	40	59	63	44	26	48	38

[16] AMP7 performance commitments (Chapter 6: Outcomes, Performance Commitments and ODIs, SW, 2018)
[17] Long Term Investment in Infrastructure (UKWIR, 2017)
[18] Wastewater resilience metric (Water UK, 2017)
[19] Increase in extreme storms (UK Climate Projections, Defra, 2009)
[20] Population growth (Let's Talk Water, SW, 2017)
[21] Coastline length (Let's Talk Water, SW, 2013)
[22] Sea level rise (UK Climate Projections, Defra, 2009)
[23] Practical guidance on determining asset deterioration (EA, 2013)

- An increase in the number of private pumping stations eligible for adoption under current legislation. Adoption is still being sought in a number of cases nearly two years after the October 2016 adoption date.
- Potential new legislation providing for the adoption of 'supplementary' private pumping stations. In this region at least 90 private pumping stations may fall within scope during AMP7 (See Section 3.1)
- A forecast increase in the number of wastewater pumping stations from 2544 at the beginning of AMP6 to between 3600 and 3700 by the end of 2025 (See Table 5). This represents a 42% to 45% increase in growth of WPS between 2015 and 2025**.** Between 2020 and 2025 we forecast an increase in WPS of 7% to 10%.

Table 5: Historical and Forecast Number of Wastewater Pumping Stations

Date	Total	Additions	Source
01/06/11	**2334**		'Key Facts 2011' doc (based on Catalogue data) [24]
30/11/13	**2385**		PR14 Business Plan [25]
01/08/15	**2544**		Catalogue data [26]
01/10/16 to 31/12/17		773	Adoption of PPS to meet current legislation[10]
09/11/17	**3271**		Catalogue [27] (not including all PPS adoptions)
March 2018	**3321**		2017-18 APR [3]
Future		34	Potential adoption of further PPS from legislation[10]
2020	**3355 approx.**		**Forecast at the start of AMP7**
By 2025		262	Between 2011 and 2015, the growth in the number of WPS was (2544 - 2334)/4 = 52.5 WPS per year due to new development. This equates to 262 new WPS in a five year AMP period.
By 2025		88-90	Potential adoption of 'supplementary' PPS under future legislation[10]
2025	**3600 to 3700**		**Forecast at the end of AMP7**

- Significant maintenance to bring approximately 800 to 900 of the 1150 WPS additions up to our standards. Despite a preponderance of small former private pumping stations, many of the adopted facilities require work to meet our health and safety, alarms and telemetry standards, as well as work to resolve legacy issues.
- A concomitant increase in AMP7 investment to protect homes, business and the environment from potential flooding and pollution.

These factors have shaped our AMP7 investment plan and will do so for future AMPs periods.

[24] Number of WPS (Catalogue, SW, 2011)
[25] Number of WPS (PR14 Business Plan Removing Wastewater Effectively, SW, 2013)
[26] Number of WPS (Catalogue, SW, 2015)
[27] Number of WPS (Catalogue, SW, 2017)

5. AMP7 Strategy

5.1. Investment Strategy

By developing a clear understanding of the key future trends and pressures described above we have arrived at a proposed AMP7 Totex for base maintenance of wastewater pumping stations of £95.2m, a £3.8m increase on our forecast AMP6 expenditure. This is due to the predicted growth in WPS, as well as provision to move towards Quartile 1 performance in pollution and the provision of coastal flood protection (£5.1m) to improve resilience. Table 6 itemises this.

Table 6: AMP7 Expenditure (£m) for Network Pumping Stations (2017-18 Prices)[2]

	AMP7			
	Price Control	QBEG	Ofwat Table	AMP7 Total
TOTEX				**95.252**
CAPEX				**89.809**
Waste water pumping stations and Portobello WPS Coastal Flood Resilience	Wastewater networks +	Base Main - Non Infra	WWS1 Line 12	79.484
Pollution Enhancement to Upper Quartile	Wastewater networks +	Enhancement	WWS2 Line 33	10.325
Opex				**5.443**
Wet Well maintenance	Wastewater networks +	Base Main - Non Infra	WWS1 Line 6	5.090
WPS FOG	Wastewater networks +	Enhancement	WWS2 Line 80	0.353
AMP6 Base Opex Adjustment	Wastewater networks +	Base Main - Non Infra	WWS1	-1.300
AMP6 Enhancement Opex Adjustment	Wastewater networks +	Enhancement	WWS2	+1.300

5.1.1. WPS Planned and Reactive Maintenance (Capex)

Our AMP7 investment for planned and reactive maintenance on wastewater pumping stations is based on a detailed analysis of four options (See Section 5.2). Our preferred option is to invest £74.4m in base Capex on the maintenance of WPS including the adopted former private pumping stations.

For our preferred option, deterioration modelling shows a risk of an increase in flooding and pollution incidents in AMP7 (up to 17%) as discussed in Section 5.2. We will mitigate this risk

through better targeting of maintenance (part of our Operational Excellence programme[28]) and our flooding and pollution strategies.

HILL risks (High Impact Low Likelihood) at wastewater pumping stations are entered into our asset risk management database (See below) and provide a dynamic list of potential schemes to resolve issues. This investment will be spread out over several AMP periods to keep customers' bills affordable.

Asset Risk Management

The asset risk management system (ARM) was introduced in early 2012 to manage asset risks on a business-as-usual basis. The maintenance risks identified through ARM are generally atypical and tend not to result in like-for-like replacement. Risks are typically identified at asset or site level and recorded on a web based system available to Operational Managers, Asset Managers and Technical Staff. Risks are linked to assets and the risk is quantified by using three factors:

- Probability of failure
- Consequence of failure
- Likelihood of consequence materialising

Risk scores generated through ARM necessarily entail some subjectivity, which we mitigate through regular "challenge" scrutiny sessions. Regular 'Asset+' meetings are attended by subject matter experts to evaluate ARM risks and to ensure that they are scored robustly and based on data, where available.

5.1.2. Portobello WPS Coastal Flood Resilience (Capex)

Our WPS maintenance budget of £79.5m includes £5.1m to repair the coastal flood defences of Portobello wastewater pumping station which is located on the seafront to the east of Brighton. The pumping station serves over 280,000 people and transfers flows from the Brighton area to a major wastewater treatment works at Peacehaven.

The sea defence wall has deteriorated and it now has an estimated five years of remaining life.[29] A storm could breach the sea defences, flood the pumping station, damage assets and pollute the sea. The promenade is in poor condition and the spalling of concrete from the sea wall has deposited a large amount of debris on the beach creating a health and safety hazard.

Repairing the sea wall, concrete groynes, cliff outfall and promenade would make the site resilient to flooding from predicted sea level rises[22] and reduce the risk of a serious pollution incident at the pumping station.

[28] See Chapter 7: Transforming our Business and Resilience
[29] Portobello WPS Resilience (ETS Input Sheet, SW, 2018)

5.1.3. Enhanced Pollution Reduction (Capex and Opex)

Our performance for pollution incidents improved from improved from Quartile 4 in 2013 to average in 2017.[7]

We are aiming for industry Quartile 1 status for Category 1 to 3 pollution incidents[16] as well as stable performance (or better) for Category 4 pollution incidents through base maintenance activities:

- Focusing maintenance on critical sites where pollution is a high-risk consequence of asset failure.
- Replacing poorly performing pumps at critical pumping stations.
- Concentrating CCTV and sewer jetting in blockage hotspot and high-risk areas.
- Improving telemetry and alarm response.
- Increasing surveys of critical rising mains including air valves.
- Rising main replacement.
- Improving the deployment of temporary pumps and generators.
- Reducing infiltration and increasing sewer rehabilitation.
- Enhancing pollution data collection and analysis.

In TA.12.WW07 Flooding and Pollution Strategies, we assess five options for enhanced pollution reduction activities. We have rejected some options based on cost or lower confidence in forecast benefits. To deliver our preferred option (See Table 7), target Quartile 1 performance and meet our regulators' and customers' expectations, we plan to invest £10.7m to reduce pollution incidents.

Table 7: Enhanced Pollution Reduction Activities in AMP7

Activity	Description	AMP7 Total[2]
WPS FOG (Opex)	FOG education campaign in sub-catchments where WPS are regularly blocked by FOG and have a history of pollution incidents	**£0.4m**
Flow management (Capex)	Monitoring and telemetry at WPS to detect issues early and prevent pollution. Install flow meters at WPS that currently have no flow or level meters.	**£2.9m**
Pumping resilience (Capex)	Increase pumping resilience at higher risk sites. 'Smart pump' activities to improve resilience and reduce power consumption. Investigate use of 3D printing to reduce lead times for replacement parts.	**£4.1m**
Conditional alarms (Capex)	Install alarms at WPS and use criticality based maintenance to reduce the risk of pollution.	**£3.3m**
Total		**£10.7m**

5.1.4. Wet Well Maintenance (Opex)

Our pro-active wet well maintenance and cleaning programme reduces the likelihood of pollution, flooding and WPS equipment failure due to the accumulation of FOG and unflushable material in the wet well.

We inspect and clean (where required) sites annually according to the following criteria:

- Potential impact on bathing waters
- Terminal wastewater pumping stations
- Complexity of cleaning
- Recent history of pollution-causing failure
- Period since last clean (these sites require an inspection to review the requirement to clean.)

Our proposed AMP7 budget for wet well maintenance is £5.1m, an increase of £0.3m on our forecast AMP6 expenditure.[2] The additional expenditure reflects the increase in the number of WPS due to the growth in new developments and the adoption of private pumping stations.

5.2. Plan Options

Options for enhancing performance for pollution and flooding are outlined in a separate technical annex TA.12.WW07 Flooding and Pollution Strategies. Costs for the preferred option are included within annex TA.12.WW02 Network Pumping Stations but also within TA.12.WW04 Sewers and Rising Mains.

This section outlines the baseline options assessed for maintaining our pumping stations. We have considered four options for investment in the capital maintenance of wastewater pumping stations in AMP7 and in the long term to AMP16:

- The options include unconstrained investment to maintain stable service with regards to internal flooding, external flooding and pollution incidents.
- We have also considered several options at a lower level of expenditure although these are likely to result in a deterioration in service to our customers.
- Our preferred option is to invest £74.4m in AMP7. This strikes a balance between constraining customers' bills while delivering an acceptable level of service and environmental protection.
- Our modelling indicates a potential 17% increase in flooding and pollution incidents in AMP7 which we propose to mitigate through our Operational Excellence performance improvement programme.

Table 8 lists the four options we have considered for the capital maintenance of wastewater pumping stations and the impact of these options on the service we provide to our customers.

Table 8: Assessment of Options for the Capital Maintenance of WPS in AMP7[30]

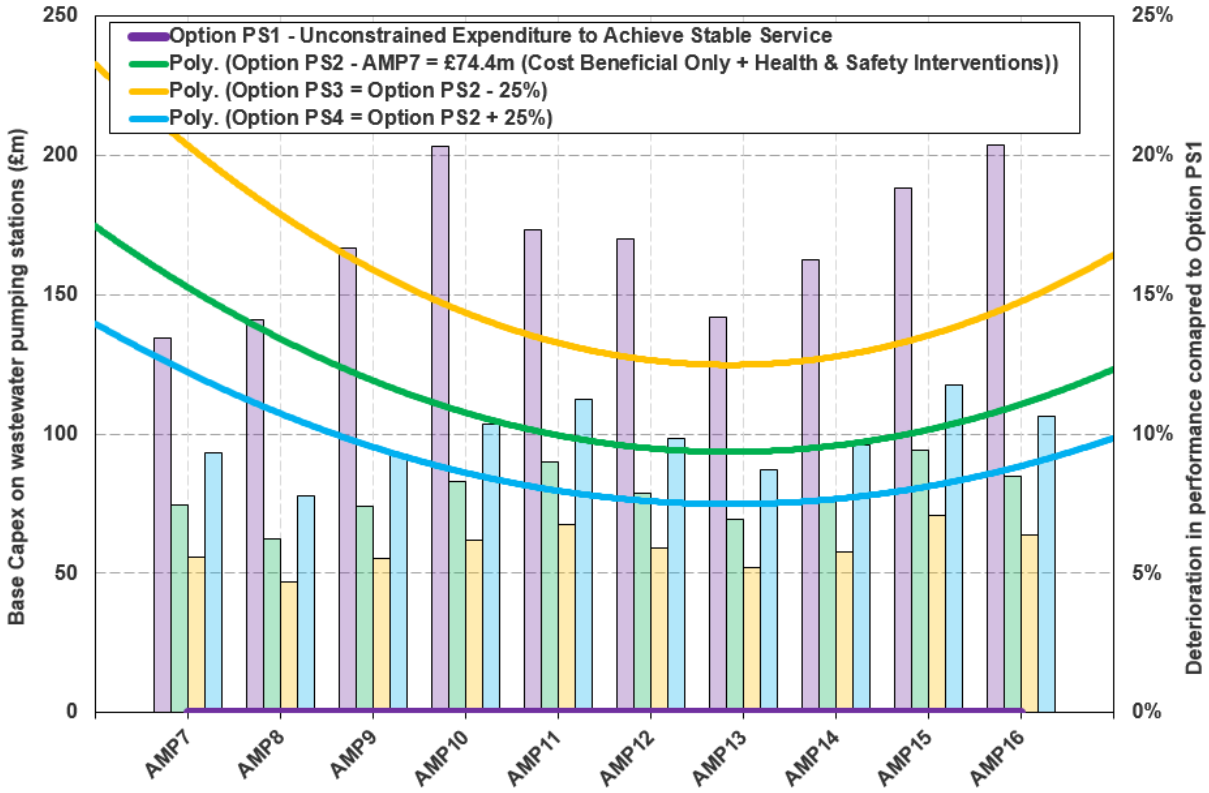
No.	Description For Planned works	AMP7 Totex (£k)	Full Whole Life[31] (20 years[32]) Cost NPV (£k)	Willingness to pay support	Ofwat Priority	Other regulator priority	Customer priority	Business strategic alignment	Is this option recommended?
PS1	Unconstrained expenditure to maintain stable service	£134,000	Base	🔴	🟢	🟢	🟢	🟢	**No** – Very high impact on customers' bills in AMP7 and in future AMP periods.
PS2	Cost-beneficial schemes and fixed health and safety interventions	£74,417	£126,439	🟢	🟢	🟢	🟢	🟢	**Yes** – A reduction in customers' bills and the 17.8% deterioration in service can be managed. Best whole life cost option.
PS3	Option 2 – 25% investment	£56,000	£130,300	🟢	🔴	🔴	🟡	🟡	**No** – A further reduction in customers' bills but an unacceptable 24% increase in service deterioration and risk
PS4	Option 2 + 25% investment	£93,400	£128,648	🔴	🟢	🟢	🟢	🟢	**No** – There would be a higher impact on customers' bills in AMP7 (14% deterioration in service)

Options PS1 and PS4 were dismissed due to what we consider would be an unacceptable increase in customer bills. Option PS2 is the lowest whole life cost option and we believe we can mitigate performance risks therefore we have selected this as our preferred option.

Figure 11 illustrates the change in serviceability performance between AMP7 and AMP16 for each of the options in comparison to Option PS1 (stable service via unconstrained expenditure). As the forecast serviceability performance fluctuates in future AMP periods, polynomial trendlines are provided to enable a comparison between the different options. These suggest that deterioration in performance could be mitigated through the activities described in our pollution and flooding strategies or through higher expenditure in future AMP periods.

[30] Plan options for WPS in AMP7 (Pioneer deterioration model, SW, 2018)

Figure 11: Impact of Plan Options on Serviceability in AMP7 to AMP16[30]



Although all these options show various levels of deterioration, option PS2 does so while meeting customers' expectations about bills with base level performance managed through enhanced pollution activities (See Table 7). We will continue to assess the balance of keeping customers' bills affordable against the risk of deferring asset renewal.

5.3. Innovation

We pursued a number of innovative approaches in AMP6 which can now serve as a good foundation to take forward more extensive innovations as part of our AMP7 pollution and flooding strategies (See Figure 12).

We will innovate to:

- Tackle the root causes of pollution and reach our long-term aspiration of zero pollutions.
- Enhance the environment in line with customers' expectations.
- Seek new and affordable ways to improve performance.
- Improve resilience now and in the long-term, boosting our capacity to cope with climate change and pollution growth.

Figure 12: Pollution and Flooding Innovation – Now and in the Future

The development and use of innovative techniques will ensure we obtain the maximum benefit for our customers from our AMP7 investment on wastewater pumping stations.

Intelligent sewers

We are developing smart networks, a new system capable of controlling flows automatically in the sewers. In AMP5 and AMP6 we have installed level and flow meters in the sewers and pumping stations.

For the remainder of AMP6 and throughout AMP7 we will install further sewer and pumping station monitors to measure levels and flow in the network. This will enable us to detect and locate hydraulic overloading, blockages, collapses and pumping station failures.

We will use weather forecasts in combination with intelligent systems to ensure that our pumping stations are prepared in advance to manage storm water. Intelligent systems would control the operation of pumping stations and their associated rising mains, so that they efficiently transfer storm water around the network to make best use of the available network capacity.

There would be an increase in coverage of telemetry on pumping stations and an improvement in the quality of data to reduce false alarms. We will use condition based monitoring on all sites with telemetry to enable early intervention where needed. Pumping stations level meters together with network flow monitoring will enable us to target response better.

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

Energy optimisation

Our wastewater pumping stations consume a significant quantity of energy. In AMP5 and AMP6 we looked at ways to optimise our energy use and reduce the cost of pumping. In AMP7, we will trial new innovative and quiet energy efficient pumps and equipment.

In AMP7, we will also investigate the innovative use of energy recovery and heat transfer at large pumping stations. The energy could be stored and used as a back-up power supply in case of power failure in the National Grid.

The reduction in energy costs and potential energy recovery will reduce Opex.

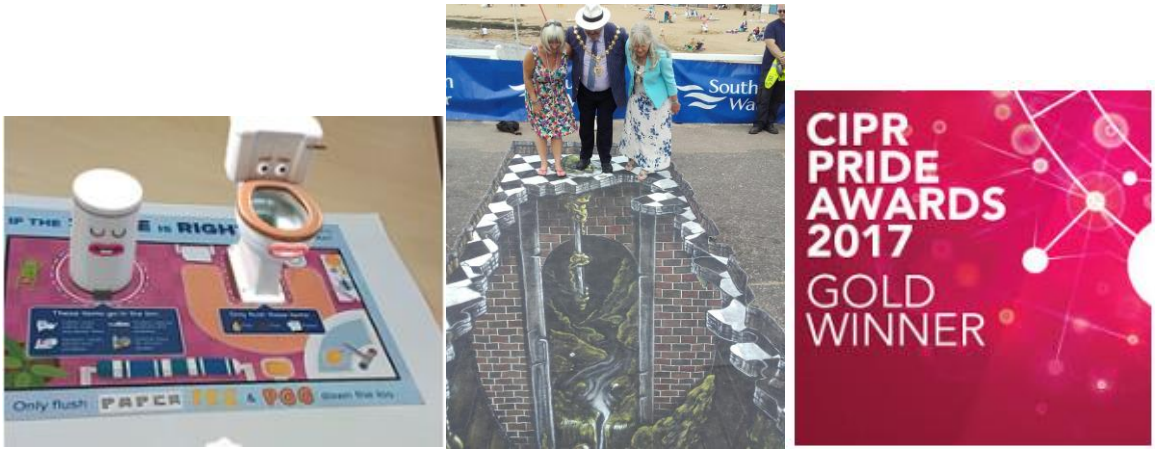
WPS risk assessment

In AMP7, we will use ‘big data’ better to predict where fat, oil, grease, and other unflushables accumulate so we can limit failures at the highest risk pumping stations.

Innovative FOG Education

We are engaging younger audiences on FOG and Unflushables. Figure 13 shows an 'Augmented Reality Experience' being developed as an educational smart phone game. Initially we will use this at public events, before publishing it in all major mobile app stores. 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 of 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."

Figure 13: Augmented Reality Experience



We have also developed downloadable school assembly material with teachers' notes to spread the FOG and Unflushables message. This material can be rolled out to schools with or without a member of our community team being present.

With an estimated 28,000 food businesses in our region, we need to develop new ways to engage to cost-effectively spread the FOG/ Unflushable message. In AMP6, we engaged multi-premises food businesses and large chains to explain the effects of FOG as well as current regulations on grease management.

Figure 14: Multi-Premises Food Businesses we are working with in our region

Our dedicated FOG and Unflushables team is carrying out a continuous education campaign built around the animated film “The Unflushables” produced in co-operation with the Consumer Council for Water. The supporting social media and traditional media activity has reached almost 1.4 million views in one year. We aim to expand these innovative activities to reach as many customers as possible.

In the remainder of AMP6 and throughout AMP7, we will continue to look for new ways to educate customers and business owners in areas where FOG and unflushable materials are repeatedly blocking the sewers and pumping stations.

5.4. Customer Benefits and Resilience

Our programme of maintenance on our wastewater pumping stations will contribute to the improvement on AMP6 performance for pollution incidents and internal flooding incidents. The red line in Figure 15 represents 2017-18 performance while the blue line represents our performance commitment targets in 2024-25. We have assumed that upper quartile performance will gradually improve during AMP7 with poor performing companies improving more than those companies who are already at upper quartile level.

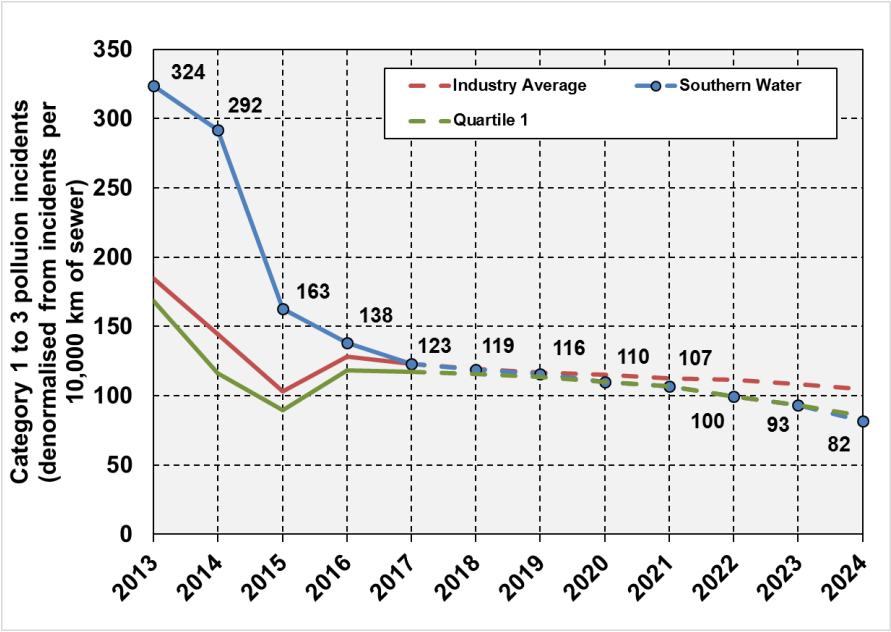
Figure 15: Summary of Projected Pollution and Flooding Performance for AMP7[7]

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

5.4.1. Pollution Incidents

Figure 16 shows our forecast improvement towards Quartile 1 performance for pollution incidents as discussed in TA.12.WW07 Flooding and Pollution Strategies.

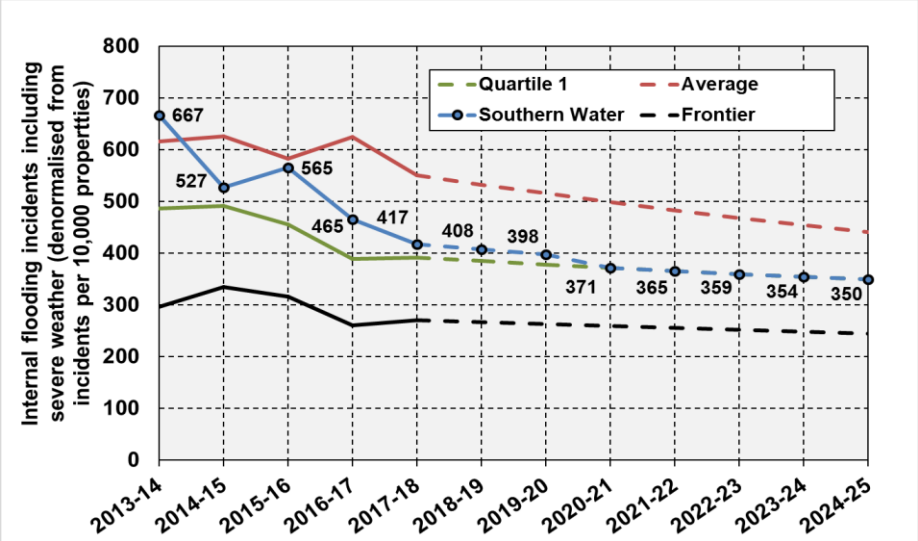
Figure 16: Forecast AMP7 Performance for Category 1 to 3 Pollution Incidents[7]



5.4.2. Internal Flooding Incidents

Figure 17 shows how this investment supports an improvement towards Quartile 1 performance for internal flooding while also improving external flooding.[7] This would lead to an enhanced customer experience in AMP7 and AMP8.

Figure 17: Forecast AMP7 Performance for Internal Flooding Incidents Including Severe Weather[7]



5.4.3. Resilience

Our region has 700 miles of heavily populated coastline[21] and consequently a large number of pumping stations are close to the coast. Predicted sea level rises[22] will increase the risk of flooding at these facilities. We need to increase the resilience of our wastewater pumping stations to the future trends and pressures (See Section 4.2) based on the principles of resilience shown in Figure 18.

Figure 18: The 4 Rs of Resilience

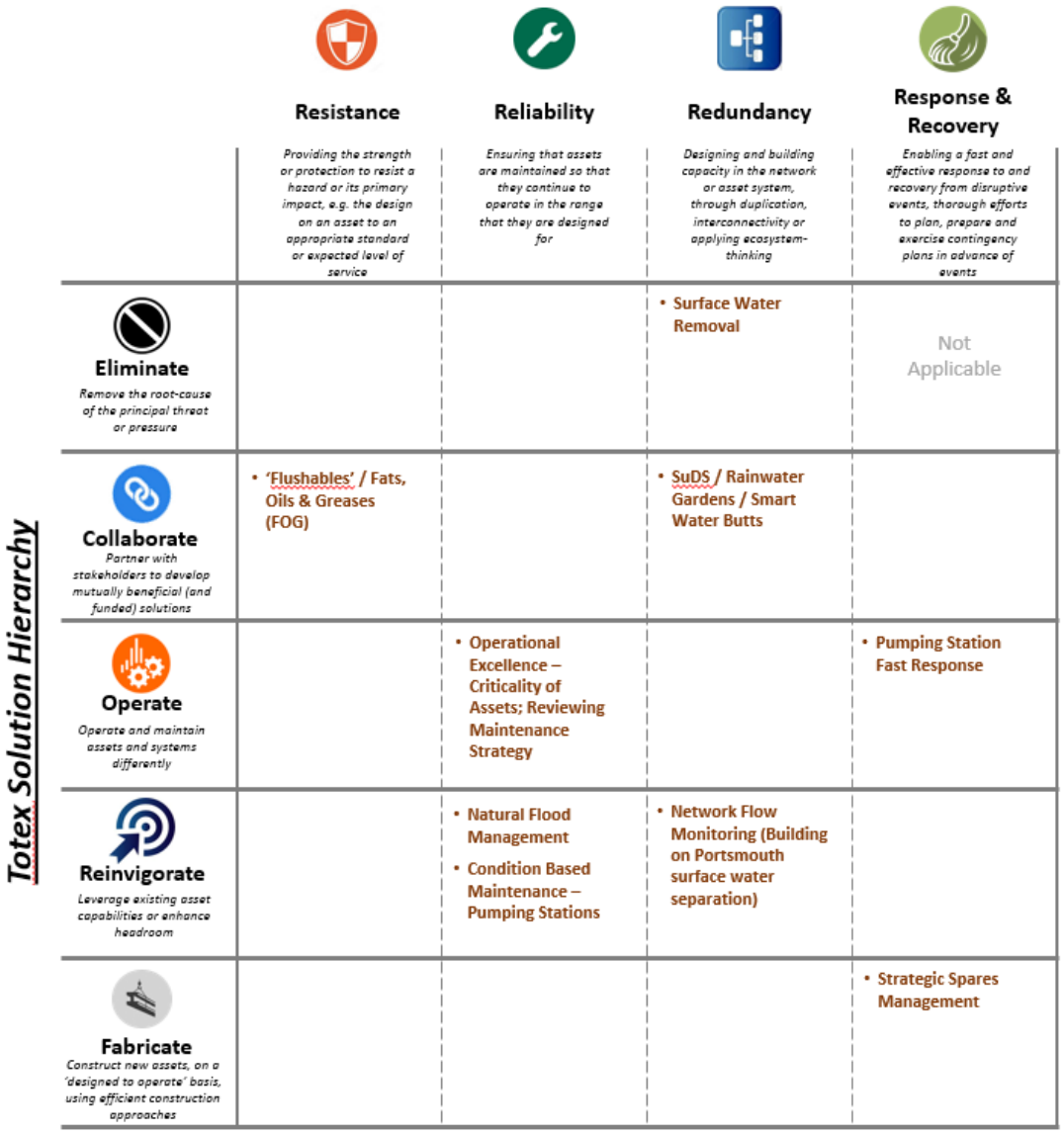


Figure 18 shows how resistance of our pumping stations to FOG will be improved through targeted FOG education. Pumping station reliability will be improved through condition based maintenance and additional alarms to warn of issues. Through additional flow monitoring we will improve our response to incidents whilst also providing information on spare capacity to manage high storm flows to inform our intelligent sewers network.

5.5. Value 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.

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 and pollution incidents. 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 9: 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
Pollution incidents	Incident	£708,481	£539,656	£877,305

Based on our customers' willingness to pay information provided in Table 9 we have determined the whole life costs[31] over 20 years[32] for four investment options for WPS maintenance. Further details of the plan options are provided in Section 5.2.

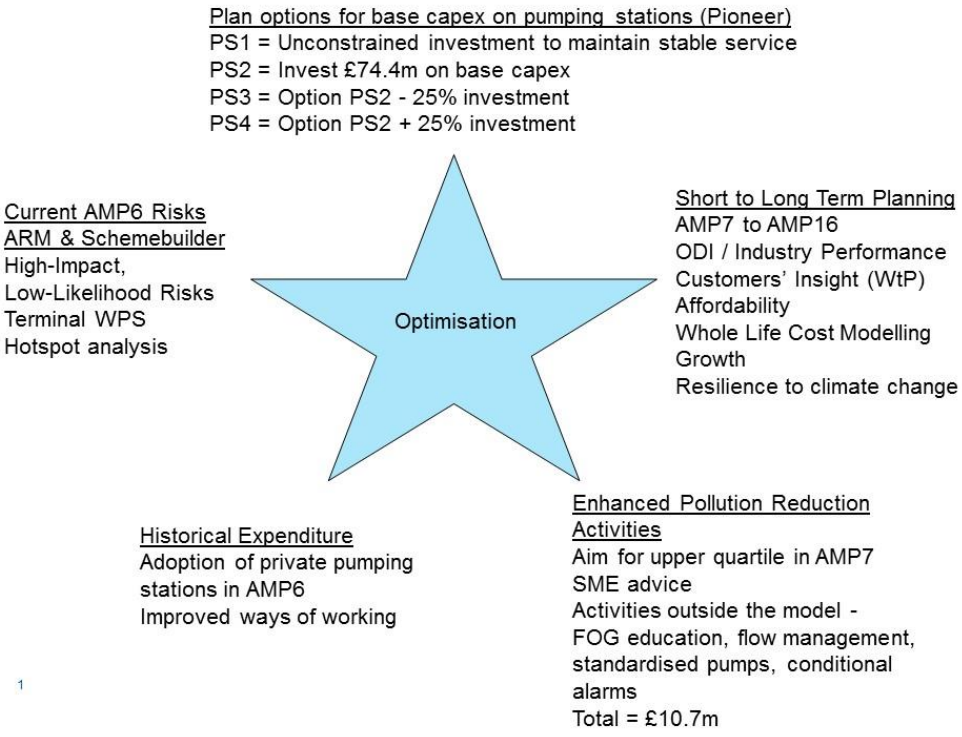
[31] Whole life cost model v8.9 for WPS (SW, 2018)

[32] 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

6. Costing Strategy

Figure 19 shows how we have optimised and balanced our proposed expenditure in AMP7 against a range of historical and future issues affecting the maintenance of wastewater pumping stations, using 5 point triangulation.

Figure 19: Costing Strategy



The costs shown in this business plan have been derived using one of the following methods:

- **Historic spend projection.** These costs are mainly for Opex investment where future costs will be a continuation of historical expenditure. We have 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 wastewater pumping station maintenance 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 have used Schemebuilder or detailed costing using cost curves where there is a high level of information on the scope of the scheme. These costs have the highest level of confidence.
- **Simple scheme cost based on a high level estimate**. These costs are for new work programmes where there is limited knowledge and less confidence in the likely cost. We have based the costs on advice from subject matter experts and estimated costs in studies we have commissioned on intelligent sewers.

7. Key Risks and Opportunities

7.1. Risks

- There is a risk that the industry upper quartile performance for pollution and flooding incidents may improve at a higher rate than forecast. This will mean we will have to incur considerable additional expenditure in order to achieve upper quartile performance and deliver our targeted level of customer service.

- There is a risk some of the technologies and analytics led performance improvement strategies we have selected may not prove to be as effective as we expect. This will mean we have to make greater use of expensive traditional engineering solutions to deliver our target levels of customer service. We will monitor progress and adapt throughout AMP7.

- There is a risk that sea level rises and more extreme storms will increase the risk of flooding coastal areas. This will mean we have to incur considerable levels of additional expenditure in order to deliver our target levels of customer service.

7.2. Opportunities

- There is an opportunity that as we replace ageing pumps with more efficient pumps, the power savings arising will be greater than we have planned. This will result in additional cost savings and further reduce our carbon emissions in AMP7.

- There is an opportunity that the improvements in telemetry, automation and control as part of our 'intelligent sewers' strategy will prove to be more effective than we anticipate. This will allow us to reduce flooding and pollution incidents further than anticipated, thereby delivering high levels of customer service and reduce our impact on the environment.

8. Appendix 1: List of Named Schemes

Table 10: Major Schemes in AMP7[2]

Scheme Name	AMP7 Capex Total	Total AMP7 Opex AFC	AMP7 Totex	AMP8 Capex
Portobello WPS Coastal Flood Resilience	5.066	0.05	5.116	0