TMS15 Asset Health Deficit

Contents

1 Executive Summary

1.1 Purpose of this document

This document presents the evidence to support a step change in capital maintenance in AMP8 to maintain asset health and to address significant risks posed by our asset health deficit.

Thames has a critical need to invest beyond the modelled allowances in maintaining and replacing assets to stop further deterioration and start to bring down the overall asset health deficit.

The headline numbers in this document are in 22/23 prices including central overhead to match our data table submission, however the detailed breakdown of the investment more generally is presented in 17/18 prices excluding central overhead to keep this consistent with our historical spend analysis.

Our expenditure proposals within the PR24 plan are all linked to specific projects in priority areas, costed on a bottom-up basis.

1.2 Background

Asset health is critical to deliver our long-term Vision for 2050 but we have identified significant asset health challenges that pose a risk to public safety, water supply and to the environment.

We agree with David Black (Ofwat statement 23 July 2023) that Thames Water has “deep-rooted problems” and in AMP8 we want to make a fundamental shift in our approach to address these which will take several AMPs to resolve fully.

We have a clear vision to 2050 to improve performance, resilience, and the environment and one of the deep-rooted issues we must address is the capital maintenance spend on our existing assets.

We are confident that Thames’ assets have additional challenges relating to condition and age relative to the rest of the sector and believe Ofwat’s botex models do not reflect Thames’ circumstances adequately and consequently understate the extent of capital maintenance interventions required to address the operational risks and issues identified bottom up across the asset base.

1.3 Numbers at a glance

Table 1 provides a summary of the numbers that feed into the analysis on asset health deficit.

Table 1 - Asset Valuation, Asset Deterioration and Asset Health Deficit number in 2017/18 and 2022/23 prices

£m, 2017-18 prices, excluding central overhead

	Water	Wastewater	Bioresources	Total
Asset Valuation	43.9	101.7	1.6	**147.2**
Asset Deterioration	1.52	1.75	0.26	**3.53**
Asset Health Deficit	10.1	3.6	0.7	**14.4**

£m, 2022/23 prices, including central overhead

	Water	Wastewater	Bioresources	Total
Asset Valuation	58.7	136.1	2.1	**196.9**
Asset Deterioration	2.03	2.34	0.34	**4.72**
Asset Health Deficit	13.5	4.9	0.9	**19.3**

Note that the asset deterioration assessment excludes management and general assets, with the exception of Operational Technology.

We have estimated that our total asset health deficit is £19.3bn (£14.4bn in 2017/18 prices, excluding central overhead). This includes the replacement value of assets no longer reliably performing their function or in such poor or failed condition that they are beyond useful life. It also includes assets for which the risk is above a defined risk threshold for example sewers in the rail environment.

With improved understanding and information, we now estimate that we need to spend a minimum of £4.72bn per AMP (£3.53bn in 2017-18 prices, excluding central overhead) to hold asset deterioration stable across our £197bn asset base (£147bn in 2017-18 prices, excluding central overhead). On its own, this level of spend does not enable us to address the urgent risks we face in AMP8 and that is why this case has been prepared for PR24.

We need to build on the PR19 conditional allowances through a significant step-up expenditure in capital maintenance and targeted investment to £6.6bn to address these risks and bring down the asset health deficit to £17.7bn (£13.3bn in 2017/18 prices, excluding central overhead).

2 Description of the proposed investment

We want to break the cycle of sweating assets and to do this we need to start urgently delivering a programme of targeted capital maintenance interventions that have been identified bottom-up to mitigate the most serious risks. This will cost an additional £1,905m (£1,437m in 2017/18 prices, excluding central overhead).

We have a detailed plan and justification for the level of expenditure in each asset category with clear customer, environmental and resilience benefits. Our expenditure proposals within the PR24 plan are all linked to specific projects in priority areas, costed on a bottom-up basis.

We recognise the need for appropriate customer protection associated with this additional Botex investment and would welcome engagement with Ofwat on the design of such measures.

2.1 AMP8 priority cohorts for additional capital maintenance - Summary

Our overarching view and context on the setting of capital maintenance allowances is presented in Section 4 of this document, with detailed explanations of the investment needs for each asset cohort presented from Section 5 onwards.

We have identified an immediate list of priority asset cohorts that require a significant step-change in capital maintenance in AMP8 as detailed in Table 2.

Our assessment of the additional capital maintenance needed vs historic spend is presented in Table 3.

Table 2 - Mapping of the Asset Health Deficit case to Enhancement Data Tables

	25/26	26/27	27/28	28/29	29/30	AMP8
Water (Data table CW3.134 & CW3.135)						
Service Reservoirs	12.1	14.6	22.9	61.8	29.7	141.1
Metering	19.1	19.7	16.6	15.8	15.9	87.0
Water Operational Technology	6.9	6.9	10.0	15.0	15.3	54.0
Find and fix	58.2	58.2	58.2	58.2	58.2	290.8
Total 17/18 price base	96.2	99.3	107.7	150.7	119.1	572.9
Total 22/23 price base (inc O/H pre FSE)	**120.1**	**124.8**	**136.7**	**195.9**	**153.6**	**731.1**
	25/26	26/27	27/28	28/29	29/30	AMP8
Wastewater (Data table CWW3.185 & CWW.186)						
Wastewater Operational Technology	10.1	19.0	19.0	23.4	23.4	94.9
Critical wastewater assets	13.8	19.4	28.2	33.8	44.3	139.4
Rising mains	0.0	19.8	46.2	33.0	33.0	131.9
Waste Assets Assurance Programme	43.8	87.1	84.9	132.3	149.7	497.8
Total 17/18 price base	67.8	145.2	178.3	222.5	250.3	864.1
Total 22/23 price base (inc O/H pre FSE)	**91.0**	**196.0**	**241.7**	**303.0**	**342.5**	**1,174.3**

Table 3 - Summary of priority asset cohorts and AMP8 spend vs historical spend (2017/18 excluding overheads)

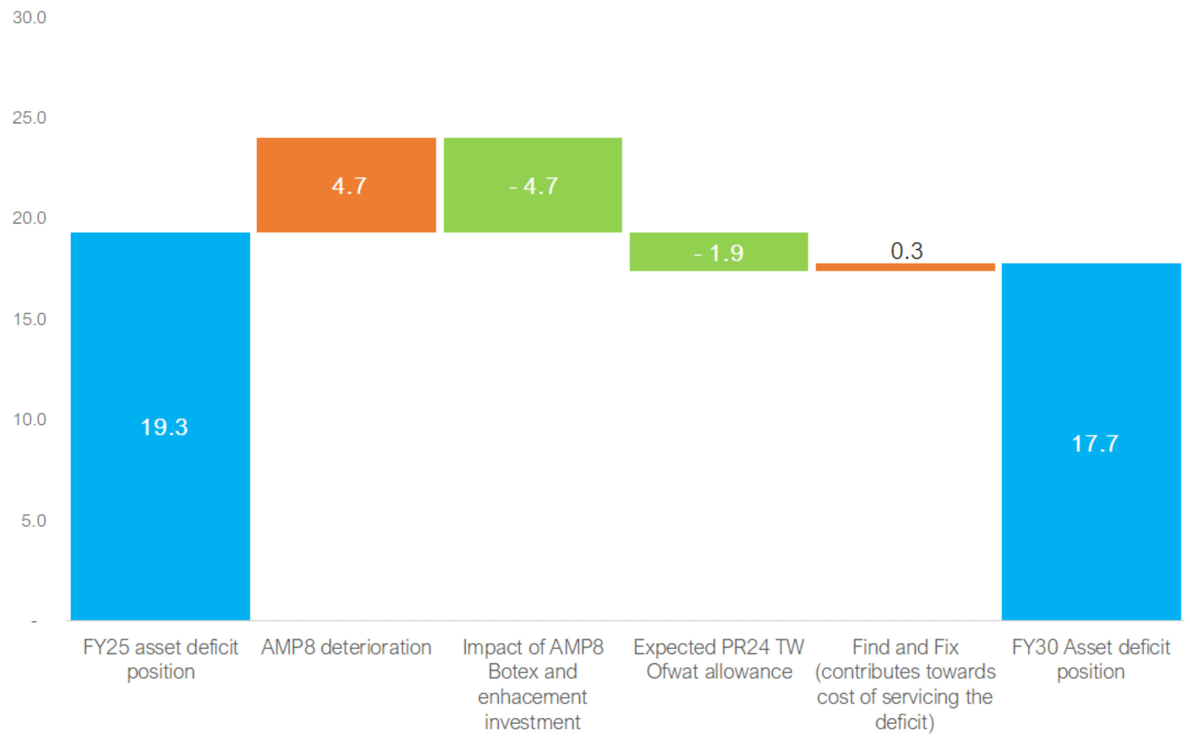
	AMP8 Plan (£m)	Average last 5 years x5 (£m)	Asset Deficit Improvement (£m)	Current Asset Health Deficit	Asset Health Deficit end AMP8
Service Reservoirs	162	21	141	357	216
Metering	119	32	87	1454	1,367
Water Operational Technology	77	23	54	66	12
Find & Fix	291	n/a	n/a	n/a	n/a
Waste Operational Technology	104	9	95	102	7
Critical wastewater assets	461	322	139	1172	1033
Rising Mains	150	18	132	487	355
Waste Asset Assurance Prog	498	n/a	498	1590	1,092
TOTAL	1,862		1,146	5,228	4,082

Our priorities for AMP8 are in response to specific challenges as a result of reaching a tipping point with asset health that requires urgent intervention to address:

- Public safety
- Water Quality
- Environment
- Performance outcomes

Figure 1 shows our plan reduces the level of asset health deficit to £17.7bn by the end of AMP8 assuming spending on capital maintenance increases by £1,905m in AMP8 (note: the additional find and fix investment does not reduce the asset health deficit).

Figure 1 impact of AMP8 on our Asset Health deficit, 2022/23 prices



2.2 Challenges in achieving a balanced plan

In AMP8, the implications of not increasing capital maintenance spend to manage asset health concerns are severe. They include public safety, water quality and compliance with environmental permits. As a result, we have had to make difficult decisions about the pace we can invest in other important programmes to achieve the right balance to protect asset health.

The benefits of the additional investment on AMP8 performance have been aligned within our data table submissions on performance. The wider benefits of our proposals can be broadly summarised as contributing to:

- Reduction in the risk associated with critical assets
- Improved capability and compliance of our sewage treatment works
- An increase in the replacement rate of poor condition and high risk water mains and rising mains
- The avoidance of significant operational disruption and customer impact due to the replacement of obsolete and end of useful life operational technology
- Effective demand management through replacing dumb meters with Smart meters enabling WRMP leakage, PCC and business demand benefits
- Greater resilience in our leakage performance
- Reducing the number of serious pollutions
- Reducing the number of spills from storm overflows

3 Asset Health Deficit Definition and high-level valuation

In this section we focus on the definition and methodology we have used to value the asset health deficit across the water and wastewater asset value chains. This approach takes account of a wide range of factors such as asset condition and not just asset age.

The information presented is an update of the 30 March 2023 briefing paper to Ofwat on asset health deficit and has been prepared using additional evidence and methodology improvements.

There is a detailed description in the appendices section of this paper showing how we have valued the overall asset base; calculated asset deterioration rates and assessed the cost of servicing the asset health deficit:

- Appendix 1 – Valuing the Asset Base describes the basis for the total gross modern equivalent asset value (GMEAV) of our asset base and the approach used across the different asset categories.
- Appendix 2 – Assessment of Deterioration Rates describes the basis and approach for the asset deterioration valuation.
- Appendix 3 – Cost of Servicing the Asset Health Deficit sets out the costs of servicing the asset health deficit and is a new section not in our March 2023 submission to Ofwat.

Where relevant, we have explained the linkages that we have made to the PR09 and PR14 asset inventories and the condition grade assessment undertaken for PR09.

3.1 Definition

We have defined Asset Health Deficit as the solution costs that address the following issues:

1. Assets for which the risk is above a defined risk threshold (e.g., properties at risk of basement flooding due to trunk main bursts)[1]
2. Assets no longer capable of reliably performing their function
3. Non-critical assets in very poor or failed condition and beyond useful life

The corresponding value (and %) of the deficit split by these elements is as follows:

- Assets above risk threshold - £10,281M (53%)
- Assets no longer reliably performing their function - £4,746M (25%)
- Non-critical assets in very poor condition or failed beyond useful life - £4,256M (22%)

We find that assets can sit across more than one of the three elements of our definition i.e., non-critical assets in very poor condition that are not reliably performing their function. The approach we take to understanding our critical assets means that we can look specifically at each asset cohort to establish an appropriate risk threshold.

Table 4 provides examples across a range of asset cohorts where risk thresholds are applied and are driving the need to intervene on asset health in AMP8.

[1] Depending on the risk threshold this could include critical assets in condition grade 4 and 5

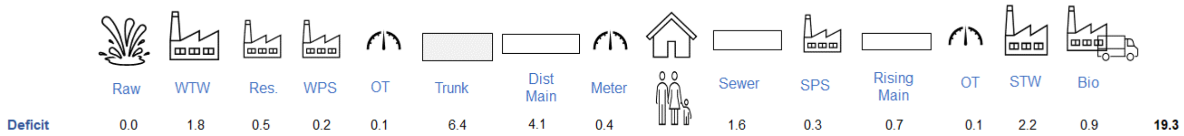
Table 4 - Basis for risk threshold setting

Assets above risk threshold	Risk threshold basis	Key contributory factors	Notes
Assets impacting Water Supply Resilience	Supply interruptions >48 hours	System resilience e.g., single points of failure.	Key risks identified through water supply resilience assessment framework
Assets impacting Drinking Water Quality Risk – (Cryptosporidium)	Final water quality failures >0	Process deficiency e.g., design no longer adequate to standard required	DWI concerned about our London Process Plants
Service reservoirs - Resilience and Drinking Water Quality risk	Asset condition - no. grade 4/5 assets	Asset condition	Out of 269 assets 27 sites are condition grade 4 and 1 is condition grade 5
	Operational flexibility (Ml storage to facilitate outage)	Operational / network configuration	Several service reservoirs cannot currently be taken out of supply
	Water quality (Chlorine residual)	Design limitations e.g., turnover of water	Design improvements identified at sites with poor chlorine residual
Trunk Mains - Basement Flooding risk	Public H&S – risk to life (properties at risk from basement flooding)	Consequence of failure Asset condition	Risk driven, weighted towards consequence with asset condition also considered
Lead pipes – Drinking Water Quality risk	Public Health - no. Lead communication pipes >0	There is no “safe” level of lead in the water supply system	Assets present public health risk and replacement will take decades
Operational risks	Serviceability	Asset condition	Asset health risks building resilience and operational risks if not addressed
Electrical assets	H&S Serviceability	Asset condition and criticality	H&S and pollution risk from sewage pumping stations and STWs
Biogas digester cleaning	H&S risk (e.g., gas explosion) Serviceability	Asset condition	High risk assets, no longer reliable with underlying asset condition concerns
Rising mains risks	Serious pollution risk - no. serious pollutions >0	Consequence of failure Asset condition	Inherently condition driven but risk quantified on pollution impact

3.2 High-level valuation

Figure 2 below is a high-level summary of asset health deficit by asset cohort. Total value is £19.3bn (2022/23 prices). A further breakdown is provided in Table 5 showing the Water and Wastewater split and a categorisation based on the three key drivers for identifying asset health deficit in line with our definition.

Figure 2 - High-level summary of asset health deficit by cohort, 22/23 prices



In our 30 March 2023 paper to Ofwat[1], our valuation included a top-down estimation of the deficit caused by assets in condition grades 4 and 5. We have replaced this top-down assessment with granular information derived from supporting evidence and have categorised the deficit in line with the three elements of our definition in Section 3.1.

Table 5 - Summary of Asset Health Deficit by asset cohort and category, 22/23 prices

Asset Group	Risk	Perf	Condition	Total
Raw water assets			18.59	18.59
WTW	1,694.85		153.43	1,848.28
Network Pumping Stations	153.83		23.54	177.38
Service Reservoirs	214.03		263.52	477.55
Water Operational Technology		87.81		87.81
Trunk Mains and TWRM	6,411.72			6,411.72
Distribution Mains			2,530.45	2,530.45
Customer Meters	1,586.50	358.79		1,945.29
Sub-total Water	10,060.93	446.60	2,989.54	13,497.08
Gravity sewers		1,374.17	194.00	1,568.17
Sewage Pumping Stations	110.09		154.44	265.53
Rising mains		651.19		651.19
Waste Operational Technology		136.98		136.98
STW	109.96	1,322.97	796.73	2,229.66
Bioresources		814.52	119.99	934.51
Sub-total Wastewater	220.05	4,299.83	1,266.16	5,786.03
TOTAL	10,280.98	4,746.43	4,255.70	19,283.11
PERCENTAGE	53.3%	24.6%	22.1%	100%

Roughly half the asset health deficit is across Water assets and relates to unacceptable risk compared to our level of risk tolerance. The remaining asset health deficit is split across assets no longer reliably performing their function (the majority of which is in Wastewater) and non-critical assets in very poor condition or failed beyond useful life, which is dominated by water distribution mains in Water and Sewage Treatment Works in Wastewater.

Sections 5, 6 and 7 present what's driving these deficits across the three categories of Risk, Performance and Condition.

[1] Asset Deficit Valuation.pdf

4 Asset Health and Capital Maintenance Allowances

In this section we show that:

- We have overspent our allowances in the past and are forecasting to overspend in AMP7.
- We have a clear methodology and definition of "Asset Health Deficit" and in assessing this we take account of a range of factors including asset condition and not simply asset age.
- Several asset cohorts across Water and Waste have deteriorated to the point they are impacting safety, performance, and asset risk. They require urgent intervention in AMP8.
- Our bottom-up assessment of individual asset cohorts has identified a large amount of non-linear investment that is needed i.e., doesn't fit neatly with historical run-rate analysis.
- A step change in capital maintenance spend compared to historical run rates is required to hold asset deterioration stable and begin to repair the asset health deficit.
- The benefits of investing to address the asset health deficit will be in performance and/or risk reduction. It will also help to reduce the cost of failure associated with the deficit.

4.1 Our View and Context on the Assessment of Capital Maintenance Allowances

Overview

The botex allowance framework is intended to provide efficient allowances for a portfolio of assets that have a broad spread across their economic life. These allowances are determined based on historical sector-wide trends through Ofwat's botex models. While this works on average, Thames' assets are older than the rest of the industry and our operating conditions are very different leading to assets that are in a worse condition relative to the rest of the industry. In order to maximise economic efficiency and keep bills low over previous AMPs, the approach across industry has been to sweat assets. For Thames to do so this has required substantially more capital maintenance spend than the models suggest and has resulted in us investing more than our allowances in capital maintenance.

Because Ofwat's models are limited by the short time horizon of data and small sample of companies, they cannot reflect all the specific circumstances of companies adequately and consequently for Thames understate the extent of capital maintenance interventions required. Thames has a critical need to invest beyond the modelled allowances in maintaining and replacing assets to stop further deterioration and start to bring down the overall asset deficit.

Botex modelling framework

Efficient botex allowances are based on econometric models that cover a historical period of time, expected in PR24 to cover the 13 years from 2011-12 to 2023-24. These allowances on botex include capital maintenance costs in infra and non-infrastructure of long-term assets.

The econometric models include a set of different cost drivers (e.g. the scale of the network) which are weighted through parameters that represent the industry average effect of each cost driver on company's base costs. These parameters are calculated based on information from all companies in the industry and are calibrated using a 13 year period.

These calibrated historical parameters of the cost drivers are fundamental inputs to determining allowances in AMP8, in addition to forecasts of each of these cost drivers throughout AMP8. Together, these determine the base cost allowances for AMP8. It is important to note that the models are not able to explicitly determine allowances for capital maintenance and only an implicit allowance approach would provide an estimate of the capital maintenance cost allowance.

Ofwat considers that the historical period of 13 years (8 years at PR19[2]) is a good representation of the long-term framework needed to keep providing an efficient level of capital maintenance in the long term or at least in the next 5 years of an AMP. However, it is clear this view is incomplete. In the time period the models are based on, the allowance will only be sufficient to forecast allowances for AMP8 reflecting the conditions and levels of the expenditure in the past 13 years, and on the basis of industry average rather than company-specific circumstances. In reality, estimates of maintenance and investment requirements in assets with a lifespan of over 100 years in some cases cannot be adequately captured in this limited period. The econometric models do not have a long memory of previous decades of investment and maintenance for companies where assets have long-term expected life.

We believe these estimates of capital maintenance costs reflect the expenditures to keep running and operating the business where assets are on average mid-life, in a context where the aim has been to keep bills to a minimum. For example, these costs are mainly reflecting repair expenditures to maintain, rehabilitate and replace fundamental assets of the network to keep providing a standard water and wastewater service to all our customers. This operational approach exploits the maximum economic capacity of the assets (e.g., ageing) to minimise costs (not planning to re-invest until the expected life of the assets are finished or assets are obsolete; not investing today until is necessary to do so; hence the management control argument is limited as it depends on different circumstances of the asset conditions). The ability of companies to do this within the modelled allowances will depend on the condition and age of these assets, which is not accommodated directly. The condition and age of Thames' assets mean we cannot do this with current modelled allowances.

Thames' asset health needs

Our asset health claim is particularly related to capital investment (or asset health investment) where the economic capacity of the assets has been fully exhausted at a large scale across our network relative to other companies, therefore requiring a significant step change in the levels of investment in the next three AMPs purely to hold our asset deterioration stable. The historical 13 year window of the econometric models is unable to capture this context and the fact many of our water and wastewater infrastructure assets are at the end of their life of water and wastewater infrastructure assets. Normally, this capital or "new" investment relates to fixed assets with a very long life such as trunk mains which could have 100 or 150 years of expected life in some cases. For example, at the current replacement rate for sewers and water mains of 0.2% and 0.6% respectively, it will take 500 years and 167 years respectively to replace existing sewers and pipes. Moving to more sustainable levels of mains replacement through a separate allowance is a more efficient way to deliver the long-term upgrade of the network.

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[2] CMA PR19 Final Report paragraph 4.261. https://assets.publishing.service.gov.uk/media/60702370e90e076f5589bb8f/Final_Report_---_web_version_-_CMA.pdf

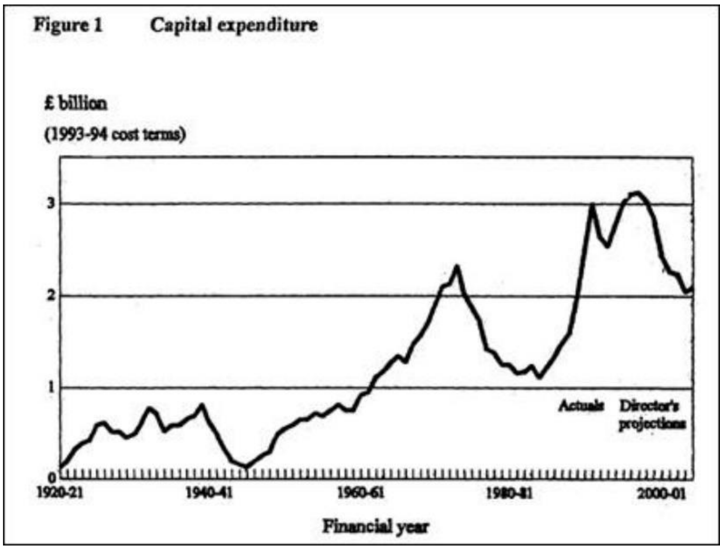
While it could be argued that levels of replacement and hence asset age is under management control, we consider that this is only partially true. This is because management's objective is to operate an economic and efficient network, which maximises the full expected life of the asset to minimise cost and allocate resources efficiently across the business. Levels of replacement are therefore a function of the condition of the network inherited at privatisation, our operating conditions, and costs to replace or refurbish assets.

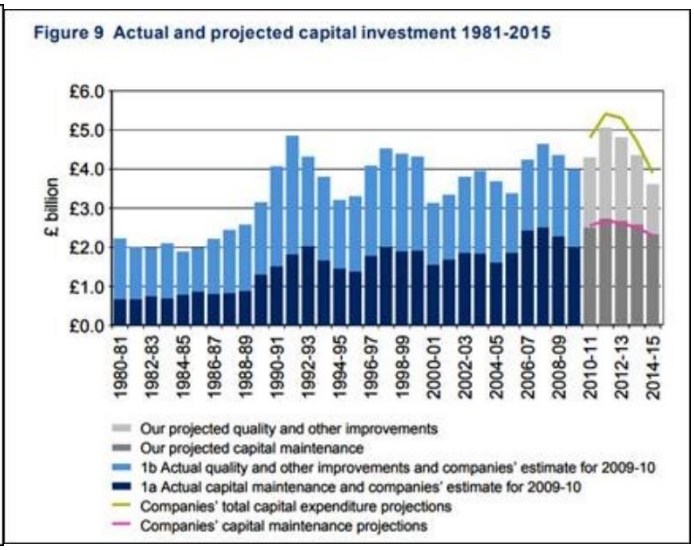
Many of our assets are no longer capable of reliably performing their function; have already passed the defined risk threshold; or are non-critical assets in very poor condition or failed beyond useful life.

1. In our PR24 Methodology consultation response we said that:

    - It is recognised that the current allowances on capital maintenance in the last price reviews have been based on historical data. For example, the allowances for AMP7 are based on a period of eight years from 2012-2019. These allowances that are based on a short period of historical data might be an issue for capital maintenance allowances in the long-term.
    - This is not a new topic. This is an issue that has been present at least since privatisation. In 2003 in a paper published by UKWIR (UK Water Industry Research (UKWIR, 2003) Capital Maintenance Planning: Implications for Maintenance of in the asset base.) stated "*there is a need to consider the impact of differences between future and historical periods in estimating future capital maintenance needs, with particular regard to historical investment cycles and the requirements of large or unusual assets; the structure of this analysis is not well defined, and yet is critical if future service problems are to be averted*".
    - For context, Figure 3 below on the left shows the historical levels of investments over a period of 80 years on capital expenditure (maintenance and investment), while the one on the right shows the capital maintenance levels (dark blue) from 1981 to 2015. These charts suggest potential cyclical patterns at the industry level.

Figure 3 - Historical levels of capital maintenance investment

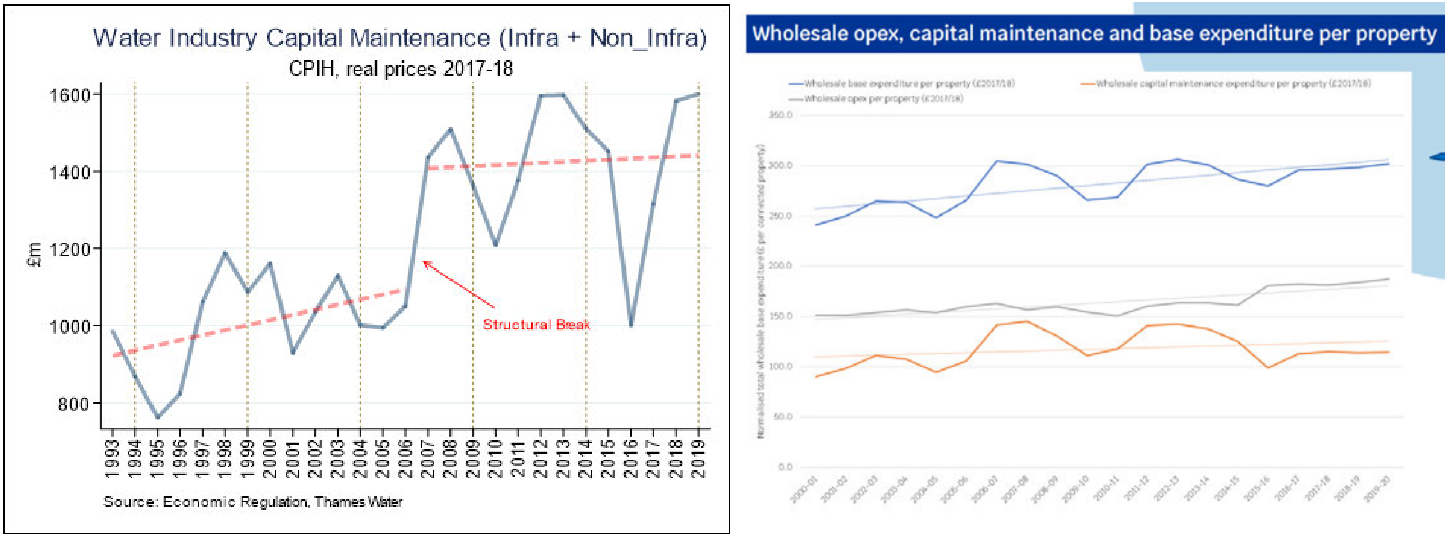




- The left chart above shows the levels of capital maintenance expenditures in the water industry only since privatisation (1994-2019). This chart follows similar patterns as the one presented by Ofwat's charts for the period 1981-2015 in the previous figures.

- Figure 4 below was constructed based on the annual returns and cost assessment data for all companies since privatisation. This is an illustration of the expenditures in the industry. In this capital maintenance time-series for the industry we have tested for cyclical patterns and structural breaks[1].

Figure 4 - Levels of capital maintenance in the water industry since privatisation



- By using a cyclical trend[2], we find evidence of cyclical patterns between 1993 and 2006 with a structural break in 2007. This period is also being followed by a cyclical pattern between 2007 and 2019. Hence, the capital maintenance figure follow a cyclical pattern at the industry level similar to the capex expenditure (maintenance and investment) presented since the 1920's.
- Similarly, the chart on right presented by Ofwat in 2021 in a Cost Assessment Working Group meeting suggest cyclical patterns for capital maintenance during the period 2000-2020.
- We think the cyclical hypothesis should be tested empirically using a long time series at the industry level as the one constructed since the

[1] By running a structural test check, we have identified this in the year 2007.

[2] We test this by incorporating a trigonometric function on the time trend between 1993 and 2019 and found that the cyclical pattern represented by this trigonometric function was statistically significant at the 5% and 10%, for the periods 1993-2006, and 2007-2019, respectively using a cosine function.

> 1920's. It would be really important as a step-forward in our understanding of capital maintenance and asset health investments if we can test empirically for a longer time-series with potential structural breaks along the way. We think that Ofwat could use the historical information they hold for modelling purposes either at the company or industry level. This evidence suggest that long historical cyclical patterns are crucial to be modelled appropriately if we want to forecast sensible allowances for capital maintenance and asset health investment expenditures.

Within this industry long-term cyclical context of capital expenditures, companies also follow different capital maintenance and asset health investment cycles, and the heterogeneity of these companies' cycles are explained by multiple long-term (e.g. materials, age of the network, rate of deterioration) and short-term reasons (e.g. density, weather conditions).

We think that the capital maintenance and asset health investment cycles need to be seen in a very long-term perspective given the long-expected life of the assets in the water and wastewater networks (e.g., 100 years).

4.2 Asset Health is critical to our long-term vision for 2050

Good asset health is critical to our long-term Vision for 2050 but we have identified significant asset health challenges that pose a risk to public safety, water supply and to the environment. The fundamental problem affecting our performance is the condition and age of our system (oldest, corrosive soils, traffic loading etc) as well as the criticality of many of our assets that we need to manage to prevent failure.

Our understanding of these key risks has matured sufficiently and our evidence as to why we need to act now has been built bottom up by individual asset cohort in order to make the case for a step-change in capital maintenance in AMP8. This seeks to address the priority risks whilst aiming to hold deterioration stable across the rest of the asset base.

With improved understanding and information, we estimate that we need to spend £4.7bn per AMP (3.5bn in 2017/18 prices, excluding central overhead) to hold underlying deterioration rates across our £197bn of assets. However, to start reducing the asset heath deficit in the most critical areas we urgently need to deliver a programme of interventions that have been identified "bottom-up" to address the most serious risks in AMP8. This will cost an additional £1,905m in AMP8 (£1.4bn in 2017/18 prices, excluding central overhead).

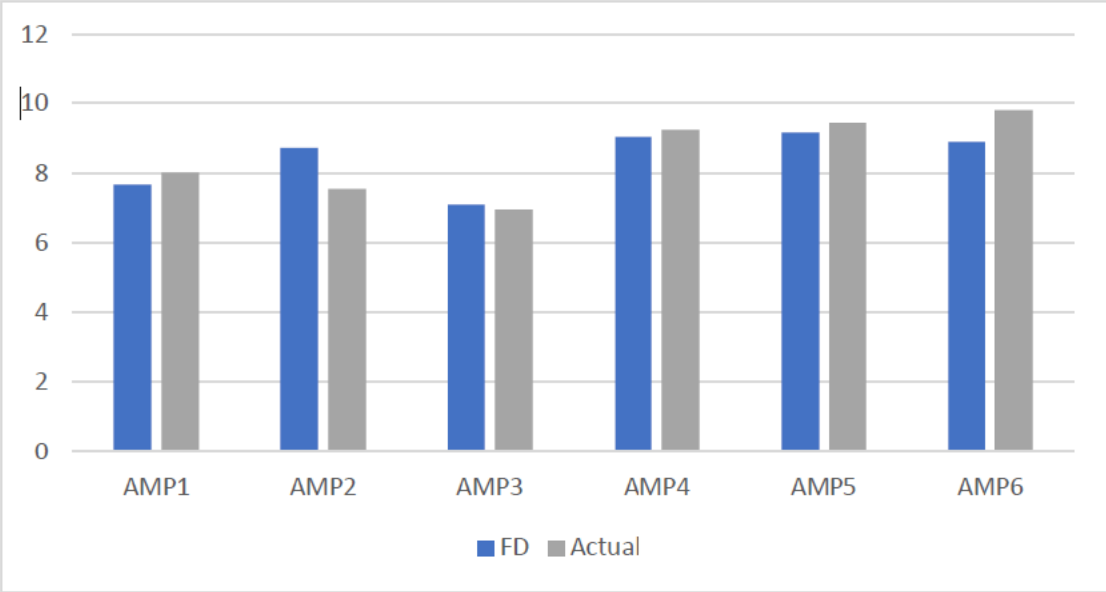
Our assessment of asset health is both in-depth and forward looking and improves on the top-down assessment of asset health that uses headline measures of asset health only. These are lagging indicators and can often mask the true condition and performance of individual asset cohorts.

4.3 We have overspent on a totex basis since privatisation

As shown in Figure 5 , Thames Water has overspent on a totex basis relative to allowances across the full period since privatisation, particularly from AMP4. Thames has significantly underspent in only one period since privatisation – AMP2. Underspend at AMP2 was £1.2bn – mainly capex (c.£800m), which was 'trued-up'. The c.£400m opex savings were retained.

In the last two AMPs (5-6), we have overspent and are forecasting to overspend again in AMP7.

Figure 5 - Historic allowances and expenditure, 17/18 prices £bn



During AMP6 we overspent across wholesale. This overspend was significantly higher in water where the asset health deficit is largest.

Table 6 below shows the Totex actual v allowances in AMP6, with an overspend of 18.7% compared to the allowance, whereas in waste this overspend was 4.1%. We have estimated the likely AMP7 overspend which again shows an overspend, 16.8% in water and 4.1% in waste.

Table 6 - AMP6 and AMP7 Totex, 17/18 prices (excluding TTT, Retail & Water Conditional Allowances)

	AMP6 £m	AMP7 £m *
Total FD Water	£3,725	£4,504
Total Actual Water	£4,420	£5,260
Overspend Water	**18.7%**	**16.8%**
Total FD Waste	£4,205	£4,500
Total Actual Waste	£4,376	£4,683
Overspend Waste	**4.1%**	**4.1%**

* Price control total net Totex (net of grant & contributions)

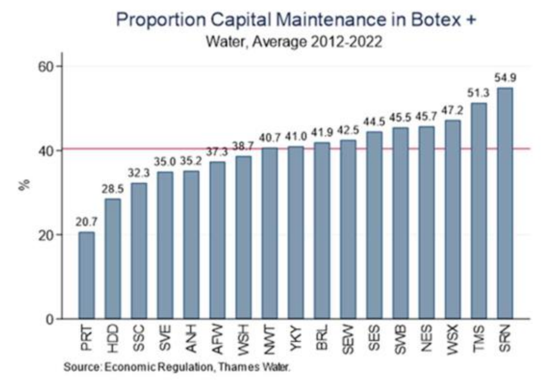
4.4 Thames has a larger share of expenditure on capital maintenance than others

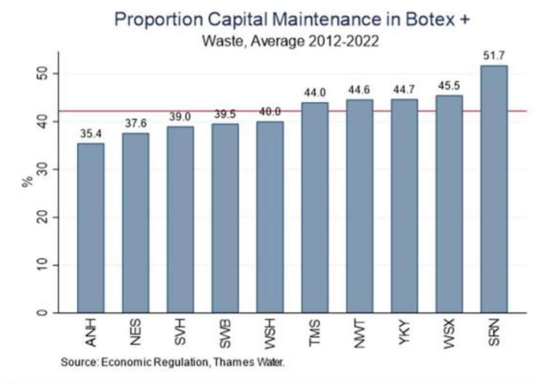
Since PR14, explicit allowances for specific activities within Botex+ (including capital maintenance) have not been produced by Ofwat. However, we can compare Thames Water's spend on capital maintenance as a share of total botex expenditure, compared to other companies. Since 2012, across Water and Wastewater, Thames Water has a larger share of expenditure on capital maintenance than the industry average, particularly in water, where we have the second largest spend (as a share of botex+) of any company.

The cross-company comparison shows that Thames Water spends materially more of its botex allowance on capital maintenance than the industry on average – suggesting that aggregate overspend on totex does not 'mask' an underspend specific to asset maintenance (

Figure 6 - Proportion of Capital Maintenance in Botex+).

Figure 6 - Proportion of Capital Maintenance in Botex+



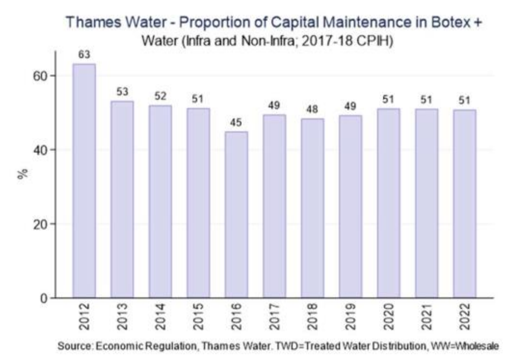


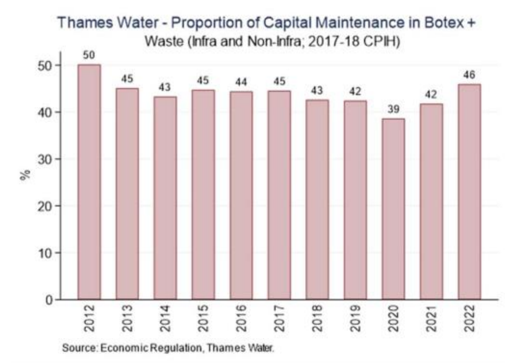
For example, the figure of 51.3% in water suggest Thames Water has spent a higher proportion of Botex+ on capital maintenance than the industry average (40.4%). Our expenditure over the last 10 years in water, which is 10 percentage points (pp) higher than the industry is a sign of overspend in capital maintenance. Even so, this is still not enough to cover all the expectations we require for our assets (leakage, SI, etc.) due to different factors such as the higher rate of deterioration of our network due to ageing (average age of nearly 80 years) versus the industry average of 56 years.

With respect to waste, Thames Water is slightly higher (44%) in the proportion of Botex that is spent in capital maintenance with respect to the industry's average (40%). However, because there is not a discrete capital maintenance allowance, 'above average' capital maintenance expenditure driven by above average age of infrastructure would not be picked up in Ofwat's models which cover the last 11 years.

Thames Water's share of spending on capital maintenance has been consistent during the last 10 years as shown in the Figure 7Figure 7 below across water and waste and has not dramatically changed over time, highlighting the consistency of the capital maintenance programmes.

Figure 7 - Thames Water Proportion of Capital Maintenance in Botex 2012-2022, 17/18 prices





Our analysis shows that within the funding allowances we have not been able to spend the required £4.7bn (2022/23 prices, excluding management and general assets) on capital maintenance every AMP to achieve the required level to maintain stable asset health. This has resulted in an ongoing gradual deterioration of our assets – increasing an asset health deficit and impacting performance & asset risk across our water and wastewater asset cohorts.

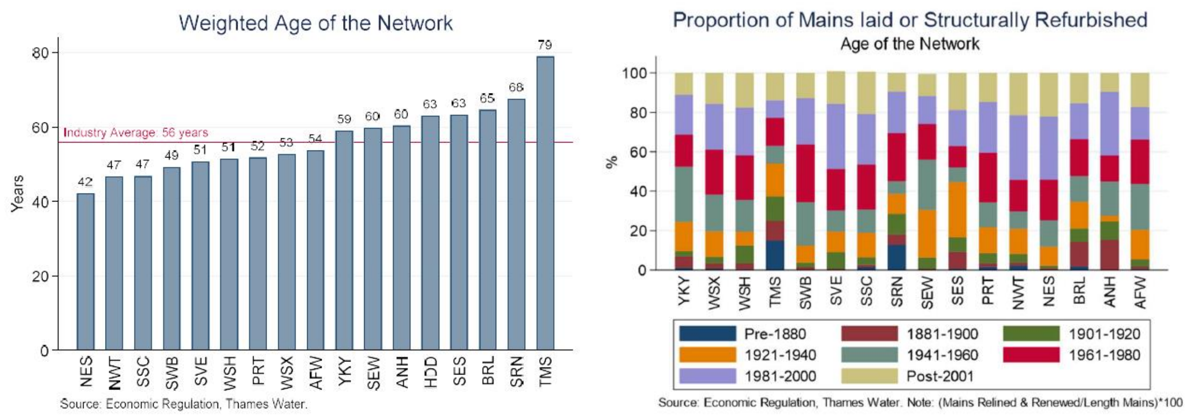
This has not been because we have underspent our allowances, in fact we have overspent our allowances, but due to a combination of factors including – an inherited poor network at privatisation and a desire to keep bills low.

As highlighted in several reports referenced in the Water UK report into "*Options for a Sustainable Approach to Asset Maintenance and Replacement*" [3](June 2022), there is a need for a step up in capital maintenance across the industry.

4.5 Insights on why the Asset Health Deficit has arisen.

Thames Water has some of the oldest network infrastructure (see Figure 8), which combined with aggressive soil conditions in our region, the highest traffic loading and comparatively more connections, mean that the network is likely to have deteriorated further and is deteriorating faster than the industry average.

Figure 8 - Age of the network



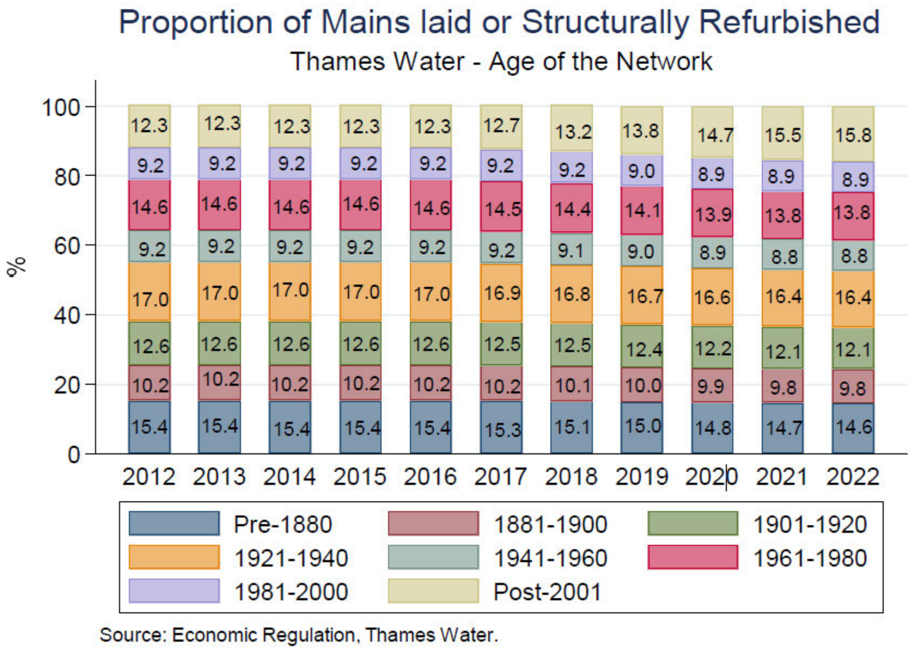
The vast majority of assets across the industry were installed before privatisation. The regulatory framework evolved post privatisation towards enabling companies to deliver efficient, stable asset serviceability (i.e. condition) rather than reaching a common level of asset condition.

Enhancements in condition for both our network and other companies may have arisen as an incidental benefit of investment programmes targeted at delivering other outcomes. For example, our Victorian Mains Replacement programme has undoubtedly resulted in improved asset condition, but it was primarily targeted to reduce leakage and was efficient in doing so.

Thames Water is the only company in the industry where almost 40% of the network dates before 1920's (or more than 100 years; see Figure 8Figure 8 above right). Thames Water has been reducing this proportion in the last ten years consistently (see Figure 9Figure 9 below).

[3] https://www.water.org.uk/publication/options-for-a-sustainable-approach-to-asset-maintenance-and-replacement/

Figure 9 - Proportion of mains laid or structurally refurbished



Since privatisation, our investment in capital maintenance has been broadly comparable to the industry. To a degree, asset maintenance expenditure has varied between AMPs, as the company has adjusted maintenance spend to accommodate in-AMP performance and regulatory priorities within totex. However, over the last ten years capital maintenance has tracked between 45% and 53% of botex in water and in waste it has been between 39% and 46% over the same period.

The transition to a totex / outcome framework did result in a sharper focus on performance drivers. The improvement in maturity of understanding of near-term performance drivers of outcomes is likely to have been stronger from PR14, compared to improvements in maturity of asset management over the same period.

In the latter part of AMP6, it became clear to both the company and its stakeholders that ODI performance was deteriorating on key metrics. Successful network management interventions to improve performance were at risk of being undermined by underlying asset health deficit weakness.

Going into PR19 we recognised the importance of asset resilience investment and put forward proposals based on the maturity of insight we had at the time. This analysis supported both Ofwat and Thames Water recognising the need for a step up in investment in London, which resulted in the Conditional Allowance schemes, including in particular the £300m allowance to improve London's network.

5 Asset Health deficit assets for which the risk is above risk threshold

Assets above risk threshold are those that exceed our tolerance of the risk posed to customers, communities, and the environment. A critical component of our risk management is the setting of the TW risk appetite by the board of directors. This provides a framework to make informed management decisions by evaluating risks against the agreed appetite and associated tolerances and provides the mechanism to escalate risks that fall outside our risk tolerance.

Assets categorised as "above risk threshold" are determined by the most appropriate means for the asset cohort or system in question.

5.1 Water Supply Resilience

Our customers, stakeholders and our Board have told us that supply interruptions greater than 48 hours once in a customer's lifetime are intolerable and must be mitigated. Our vision for 2050 is that customers should not experience a major water supply interruption. A major supply interruption is defined as a supply interruption equivalent to or greater than 48 hours once in a lifetime and above our risk appetite threshold.

A prioritised programme of system reviews has been started and will be completed by the end of AMP7 to establish a water supply resilience baseline. However, work undertaken to date has given us a significant catalogue of low probability high consequence supply risks that we need to address next - thus we have already been able to identify a programme for AMP8 and beyond.

From the work to date, we have identified 166 resilience needs across five water asset groups and developed solutions to mitigate the risks. The solution costs in £m and 2022/23 prices are summarised in Table 7 below. Our PR24 business plan submission will set out the Needs and Solutions that we have prioritised for delivery in AMP8.

Table 7 - Resilience needs across five water asset groups, 22/23 prices

Asset Group/Region	WTW £m	Service Res £m	TWRM tunnels and shafts £m	Water PS £m	Trunk Main £m	Totals £m
London	1,306.3	155.3	1,079.7	148.0	1,983.1	4,672.4
TVHC	84.9	58.8	0.0	5.8	656.0	805.4
Thames Water	1,391.2	214.0	1,079.7	153.8	2,639.1	5,477.8

Note that in our high-level summaries, we have assigned the Thames Water Ring Main asset health deficit to the trunk mains asset group.

5.2 Drinking water quality risks relating to Cryptosporidium

Ourselves and the DWI are concerned about our four Large London Process Plants (LPPs) which use slow sand filtration (SSF) as the principal treatment process. Although SSF is an efficient process, it cannot be relied upon to consistently remove/inactivate Cryptosporidium oocysts – a parasite that can cause a diarrhoeal disease if consumed in drinking water. Despite delivering on operational improvement plans, this parasite is still sometimes detected in final water samples at our (SSF) LPPs - we must act now to address this, as it is an unacceptable situation.

There have been 43 detections of Cryptosporidium in the final water of our large water treatment works in London since 2018, which supply the bulk of water into London. Primarily, the detections occur because the biological treatment process used, although overall very efficient and effective, has inherent treatment deficiencies which under certain environmental conditions can heighten the risk of breakthrough – conditions that exist now, but will be exacerbated by future climate change implications.

To mitigate the risk, we propose to install enhanced Cryptosporidium Protection at the LPPs – namely: Coppermills, Hampton, Kempton Park and Ashford Common WTWs. This enhanced treatment process will take the form of Ultra-violet (UV) contactors installed downstream of the SSFs to fully inactivate any oocysts which get through the existing treatment process. Inactive Cryptosporidium oocysts present no public health risk to consumers.

The current cost estimate to deliver the protection at the four sites is £304m.

5.3 Risk of basement flooding from trunk mains[4].

There is a high health and safety risk from rapid flooding associated with 37,545 basement properties within our network due to the proximity of 343km of trunk mains and after our work on the conditional allowance within AMP7, 328 km will still be high risk at the end of AMP7. Our long-term goal to 2050 is to reduce the health and safety risk associated with our assets for all these basement properties to an acceptable level.

Our valuation of asset health deficit for trunk mains is based on programmes of rehabilitation to replace or slip-line mains these 328 km of asset. Our cost estimates have been taken from our work in development for PR24. We are cognisant of the current cost of rehabilitation of some of our largest trunk main assets and the limitations of current condition assessment technology, both of which we assume to improve under our Best Value Pathway in future AMPs. Hence, for AMP8, our current proposal will address the most critical sections of trunk main in London only, which pose a risk to the largest number of basement properties and carry the highest likelihood of failure.

Our current multi-AMP estimate to draw down this trunk main asset health deficit is shown below. The AMP8 costs are based on a bottom-up schedule of projects.

Table 8 - Multi-AMP draw down of trunk main asset health deficit, 17/18 prices, excluding central overhead (final column in 2022/23 prices includes central overhead)

	AMP8	AMP9	AMP10	AMP11	AMP12	Total	Total in 2022/23 prices
High risk km	12	31	62	94	129	328	328
Cost £m 2017/18 prices	138.0	253.7	380.6	548.2	692.5	2,013.1	2,693.0
Unit cost	£8,628	£8,185	£6,139	£5,832	£5,540	£6,138	£8,210

[4] Separate AMP8 Enhancement Case

5.4 Lead pipes

Lead pipework in contact with drinking water presents an immediate public health risk – the size of the problem on Thames Water's and customers side is vast. By the end of AMP7, Thames Water will have an estimated asset health deficit of 1.1 million lead communication pipes with an unknown number of customer supply pipes, customer plumbing, lead solder and lead fittings also in existence.

The only long-term solution to lead pipes risks is removal. Analysis shows that at the current replacement rate it would take until around 2130 to replace all lead communication pipes. This only solves half the problem as we currently do not replace lead pipes owned by customers, so both the public health and compliance risk would remain. There is currently no agreed regulatory position on how this should be achieved.

Using our AMP7 unit rate, the estimated cost to replace the lead communication pipes that we own is £1.8bn. We have subtracted the value of the lead communication pipes that is included in our distribution mains asset health deficit giving a net estimate for lead comms pipes of £1.6bn.

5.5 Electrical assets.

We have undertaken a detailed engineering study into the low voltage and high voltage assets at our sewage treatment works and some of our large sewage pumping stations. The study has output four priority categories of investment including health & safety with solutions costed at £117m across 83 sites. For the other sewage pumping stations, we have commenced a programme in AMP7 to replace the electrical panels to include remote terminal units (RTU) and flow monitoring equipment. This is in relation to both pumping station performance and health and safety. We have estimated £103m to continue the roll out of this programme.

Due to the safety criticality of the electrical equipment, we have included both items above in our asset health deficit valuation.

For the water electrical assets, the risks have been captured and valued through the operational risks in our Asset Planning System and are included within Section 7.1.

5.6 Gravity Sewers - Critical Assets

Many of our wastewater assets, particularly across London present a major risk to public safety were they to fail.

The scope of the critical assets programme has expanded in recent years, notably in AMP6 as we implemented a consistent framework for classifying assets, condition assessing them and developing plans to improve asset health and reduce associated risk, primarily on the waste network. To date, we have classified just over 4600 waste assets as critical.

The expansion of scope, most notably in condition assessment, is now necessitating an uplift in capital maintenance to remediate assets where defects have been identified.

Our valuation of asset deficit for waste critical assets is based on our current understanding of asset health, informed by extensive condition assessments.

The overall intent of the AMP8 plan is continue implementing risk-based programmes of inspection and remediation but with increased investment to accommodate the expansion of scope to more assets and, the remediation of assets where deficit has been identified through inspection.

The AMP8 plan has been defined based on our current understanding of inspection requirements, asset health and associated risk. The required funding to deliver the programme has been defined through a range of costing methods (e.g., historical costs, bottom-up costing, and decision support tools) proportionate to the maturity and materiality of the cohort in question.

The ultimate benefit of the uplift in capital maintenance will be the reduction in critical asset failure risk through the improvement of asset condition.

6 Asset Health deficit assets no longer capable of reliably performing their function

6.1 Biogas Digesters – inspection and cleaning.

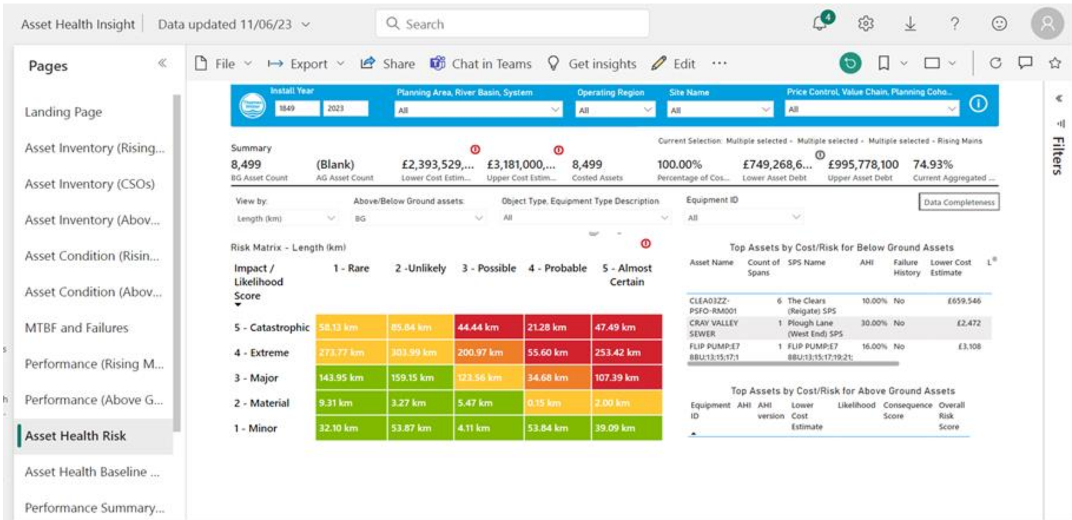
Failure to Manage Digesters and Biogas in Waste Treatment is currently our highest safety risk (PR11.01.01). The main contributor to this risk score is the overdue statutory inspections of 33 digester tanks, out of our total asset fleet of 128 across 25 sites. Our standard requires that these digesters are physically and structurally inspected every 10 years.

Our original AMP8 planning assumed that our inspections in AMP7 were on track and that we would deliver a further 33 inspections over AMP8, totalling £27.5m. However, we now forecast that we need to deliver 67 inspections in AMP8 and based on recent evidence in AMP7, the unit costs have increased and so the cleaning programme is forecast at £117.7m. In addition, £39.3m has been allocated for maintenance works on digester roofs. Therefore, our end of AMP7 asset health deficit on biogas digesters is £129.5m (netting off our original run rate assumption of £27.5m).

6.2 Rising Mains.

Our Asset Health Insights dashboard for rising mains includes all our known rising main spans, each of which is assigned a risk score (likelihood of failure and a consequence of failure in terms of pollution events) and has a replacement value based on the latest EES model. We still have an unknown quantity of S105a rising mains across the estate and although these are typically low risk assets, they do hold an element of asset deficit due to the age and condition some of these rising mains are in. Figure 10 below shows the current risk distribution by length.

Figure 10 - Rising main risk dashboard



The replacement costs in 2017-18 prices excluding central overhead relating to the risks above are shown in Table 9.

The risks that contribute to our asset health deficit valuation of £651m in 2022/23 prices are shaded in the table. This relates to the 485 km of our highest risk rising mains.

Table 9 - Replacement costs by risk, 17/18 prices

Likelihood / Impact	1 – Rare	2 – Unlikely	3 – Possible	4- Probable	5 – Almost Certain
5 - Catastrophic	£47.7	£92.8	£42.5	£22.4	£46.8
4 – Extreme	£254.6	£295.3	£196.3	£65.2	£272.8
3 – Major	£114.3	£121.4	£89.6	£31.3	£79.6
2 – Material	£7.1	£2.3	£4.2	£0.1	£1.6
1 – Minor	£41.3	£76.3	£6.9	£61.2	£53.6

6.3 Operational Technology Assets.

The Department for Digital, Culture, Media & Sport with Ofcom and the mobile network providers have announced the sunsetting of public 2G and 3G wireless networks to create more availability in the radio spectrum for the 5G network and future evolutions of technology. The 2G network is critical to many residential and business customers and emergency services, so the mobile network providers (Vodafone, EE and O2) are working towards a switch-off by 2033. Mobile network providers (Vodafone, EE, O2 and Three) are switching off the 3G network from 2023 given most 3G devices can fallback to 2G (unless large data volumes).

We consider the 2G mobile network is still appropriate for our needs, where we can send regular meter readings at low power to our systems for underground assets in remote locations.

If Thames Water was to take no action, we consider that the 2G switch-off will result in:

- The complete loss of remote visibility and control where 2G/GPRS is the only telecoms solution available.
- An increase in the risk of loss of remote visibility and control where 2G/GPRS is a back-up to fixed line telecoms.

We are replacing faulty 2G assets as part of our base repair and replace programme for each AMP, but this programme will not enable us to convert all 2G assets to alternative technology in time for the switch-off. We have also been replacing some 2G capability as part of our AMP7 response to the switch-off of the copper wire, public switched telephone network (PSTN) by December 2025. At the start of AMP8, our Engineering team have calculated that the incremental costs above the base repair and replace programme to replace all 2G assets is £26.7m.

Obsolete OT assets pose a risk to our operations and customer service. When these assets fail, replacement parts may not be available and hence recovery times can be prolonged, often causing risks to our essential services, through the loss of remote visibility and control. Our Engineering team's assessment of the asset health deficit relating to obsolete OT is £198.0m.

6.4 Basic Customer Meters.

Our demand management strategy is to Smart meter all viable and non-viable connections to aid in targeting leakage, reducing customer side leakage. Smart meters also provide actionable insights into household and business customer behaviours and trends in relation to water consumption. This means our basic meters are not capable of delivering the information that we require of them.

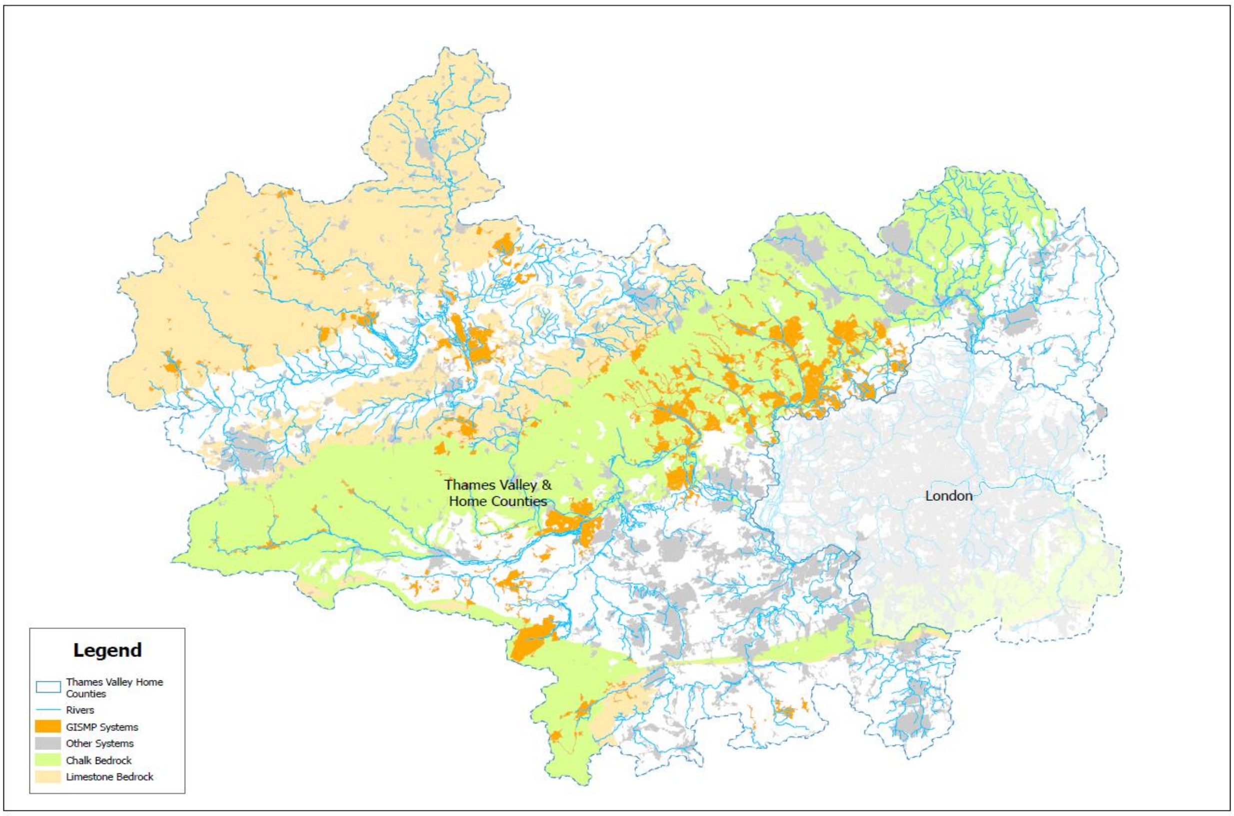
We have used the AR23 meter stock and our Smart meter unit costs that have been developed for PR24 to price the replacement of the basic meters. We have also adjusted the AR23 meter stock downwards to account for the replacements that will be undertaken over the next two years as part of our performance commitment for Replacing existing meters with Smart meters in London. The cost for replacing the 1.26 million household and business basic meters with Smart meters is £359m.

6.5 Assets impacted by groundwater infiltration.

Thames Water's geographic coverage presents unique threats for groundwater infiltration. Figure 11 shows the Geology of the Thames Water region and systems with Groundwater Impacted System Management Plans (GISMPs).

A total of 48% of our foul network in the Thames Valley and Home Counties regions is situated in geology that is highly porous and experiences dramatic seasonal changes in groundwater levels. The structural integrity of these sewers is generally good; however, these assets were never designed to be watertight or to prevent groundwater ingress and need a solution long-term.

Figure 11 – Geology of the Thames Water region and systems with groundwater management plans



In AMP7 we have developed Groundwater Impacted System Management Plans (GISMPs) in consultation with the Environment Agency (EA).

Customers and stakeholders have made it clear that they expect 'Rapid Progress' on improving our storm overflow performance. Our plan for Infiltration management will contribute to reducing Groundwater Infiltration (GI) into sewers contributing to storm overflows with the greatest environmental harm, reducing average annual spills.

To achieve this, we would need to improve the 'watertightness' capability properties of the sewerage network, above industry standard design, in the GISMP systems. Currently and historically, the asset health performance commitment used for sewers is collapses for which we are one of the leading comparative performers in England and Wales. To date our sewer rehabilitation approach has been primarily focussed on rehabilitating structurally impaired sewers (condition grade 4 & 5) and not improving watertightness of sewers.

For the asset health deficit valuation, we have downloaded the sewer and manhole asset inventory for the GISMP catchments. We divided the sewers into cohorts based on diameter and infiltration risk (High, Medium, Low, Very Low). We then assigned costings for sewer relining and sealing of laterals, manholes chambers, and covers using the Engineering Estimating System. In the asset health deficit valuation, we have used the costs for the High, Medium, and Low sections of the catchments. However, we made exceptions in the seven largest catchments where the sewer relining work would cost over £100m. For these areas, we capped the valuation at the lower of £100m or 50% of the costs for the high-risk sewers. The asset health deficit valuation for areas impacted by groundwater infiltration is £1,240m.

This recognises that in some systems, enhancing water tightness of the sewerage network is identified unlikely to be cost beneficial and alternative options such as Sewage Treatment Works (STW) upgrades or wetland options would need to be considered.

6.6 Sewage Treatment Works - Wastewater Asset Assurance Programme (WAAP).

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]
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	[redacted]		[redacted]

7 Asset Health deficit non-critical assets in poor condition or failed

7.1 Various Assets – Operational Risk Register.

We downloaded the operational risks captured in our Asset Planning System. Most of these risks include solution cost estimates. We then applied filters to remove the risks that are linked to the other specific asset health deficit items described in this section. For the service reservoirs, OT, trunk mains, distribution mains, customer meters and rising mains asset groups, we filtered out all operational risks as there would be a significant overlap with the deficits included elsewhere in this section.

Overall, we summed up the information on nearly 10,000 risks with solution cost estimates. We then reviewed our 2023/24 budget information to capture the capital maintenance expenditure that is available to address the operational risks and netted off this forecast spend in 2023/24 and 2024/25 to arrive at a value of the operational risks that are likely to be outstanding at the end of AMP7. This is summarised in Table 11 below by the relevant asset groups.

Table 11 - Operational risks forecast to be outstanding by end AMP7, 22/23 prices

Raw Water	WTW	WPS	Sewers	SPS	STW	Bioresources	**Total**
19	153	24	194	155	797	120	**1,407**

7.2 Service Reservoirs - resilience and water quality risks.

Our service reservoir asset health deficit has three main components:

1. Reservoirs in poor condition and near or at end of useful life
2. Insufficient system configuration to allow the reservoirs to be taken out of service for inspections.
3. Drinking water quality risks

Our Engineering team facilitates inspections of our service reservoir cells and water towers on a periodic basis. We have produced a condition grade score (1-5) for all 269 service reservoirs and water towers. Of these 27 scored a 4 and Putney scored a 5 based on the condition of the embankments/walls and roof structures. We have included the rebuild of Putney Cells 1 and 2 and capital maintenance of the other assets in our asset health deficit valuation. A detailed cost estimate has been prepared for Putney at £65m and we have allowed £104m at the other condition grade 4 sites.

As part of the annual return, DWI have introduced new categories relating to each tank's supply resilience status. This initiated a further review of our service reservoir resilience and has identified more cells which require investment to allow an outage of sufficient length to complete remedial work when required. Work is ongoing in AMP7 and through AMP8. By the end of AMP7, there will be 12 tanks still requiring resilience works (note this includes 6 contact tanks at WTWs). The estimated cost of these works is £58m.

Nine cells have been identified as having chronically poor chlorine residual which means the protective effect it provides is very weak for both the reservoir and the downstream zone increasing risk of a service reservoirs coliform failure or contamination in the network following a leak/burst/depressurisation event. A further seven cells have poor chlorine/turnover which will need interventions to improve. The estimated cost to remediate these risks is £37m.

7.3 Distribution mains condition.

Our water asset health performance in terms of mains repairs per 1,000 km is the worst in England and Wales and about double the industry average. This has a knock-on impact of other performance commitments, particularly leakage and supply interruptions.

During AMP5 and AMP6, we commissioned some projects to review the material deterioration rate of our ferrous water mains[5]. The analysis utilised nearly 1,000 pipe samples and used pit depth analysis to calculate remaining pipe wall thickness. This was used to establish the average remaining life of the ferrous network, which was 101 years.

Life expired ferrous mains are calculated to total 2,798 km at end of AMP7 (out of a ferrous mains stock of 21,000 km and a total distribution mains stock of 28,300 km). We have used this length to quantify the asset health deficit for water distribution mains (i.e., our deficit is assumed to only be on life expired ferrous mains in this analysis).

Table 12 below shows how the cumulative asset health deficit in km varies from AMP3 to AMP7 based on the project output model. The assessed deficit was reduced to 1,664km at the end of AMP4 following our Victorian Mains Replacement programme but has been increasing each AMP period thereafter.

Table 12 - Cumulative multi-amp asset deficit for distribution mains, km

Lengths in km	AMP3 and before	AMP4	AMP5	AMP6	AMP7
Pipe life-expired	2,763	1,244	967	760	737
Cumulative life expired	2,763	4,007	4,794	5,734	6,471
AMP renewal	269	2,074	507	523	300
Cumulative renewal	269	2,343	2,850	3,373	3,673
Asset health deficit km	**2,494**	**1,664**	**2,124**	**2,361**	**2,798**

We applied the current version of EES to our distribution mains decision support tool to price the average renewal rate for our distribution mains in London and Thames Valley Home Counties. We then applied these average unit costs to the 2,798 km and rebased the EES models to 2017/18 prices using CPI-H indices.

This resulted in the 2,798 km having an estimated **asset health deficit valuation of £2,530m**. We note that this is likely to be a lower bound estimation of the asset health deficit as it assumes only 133 km of replacement in Central London, where the unit rates are the highest.

[5] Water Mains Material Deterioration Update, DNV GL Oil & Gas, June 2017

8 AMP8 Priority Service Reservoir condition

In this section we show that:

- Our service reservoir storage volume is low compared to the industry. This makes planning outages and taking reservoirs out of service difficult.
- As a result, we are behind on our annual inspections - any that we do complete show substantial work needed due to the poor condition of the assets.
- DWI enforcement is increasing due to the potential risk to water quality and public safety.
- We need to maintain and bring strategic reservoirs back into service to address this critical risk to water supply (e.g., Putney A at a cost of £47.7m to rebuild and put back into service).
- Our AMP8 spend requirement is £141.1m above the average spend for the past 5 years which has been £21m on average over the last 5 years
- As a result, we forecast asset health deficit will decrease from £357m to £216m

8.1 Need for investment.

We operate a total of 242 service reservoirs and 32 water towers. A breakdown of the size of our estate is provided in Table 13 below:

Table 13 – Breakdown of service reservoirs and water towers

		Band 1	Band 2	Band 3	Band 4	Band 5	Total
Service reservoirs		<=1.0 Ml	1.1-5 Ml	5.1-10 Ml	10.1-25 Ml	>25 Ml	
	nr	47	81	36	46	32	242
Water towers		<=0.5 Ml	0.6-1.1 Ml	1.1-2.5 Ml	>2.5 Ml	~	
	nr	21	9	1	1	~	32

(Source: PR09 Table C3)

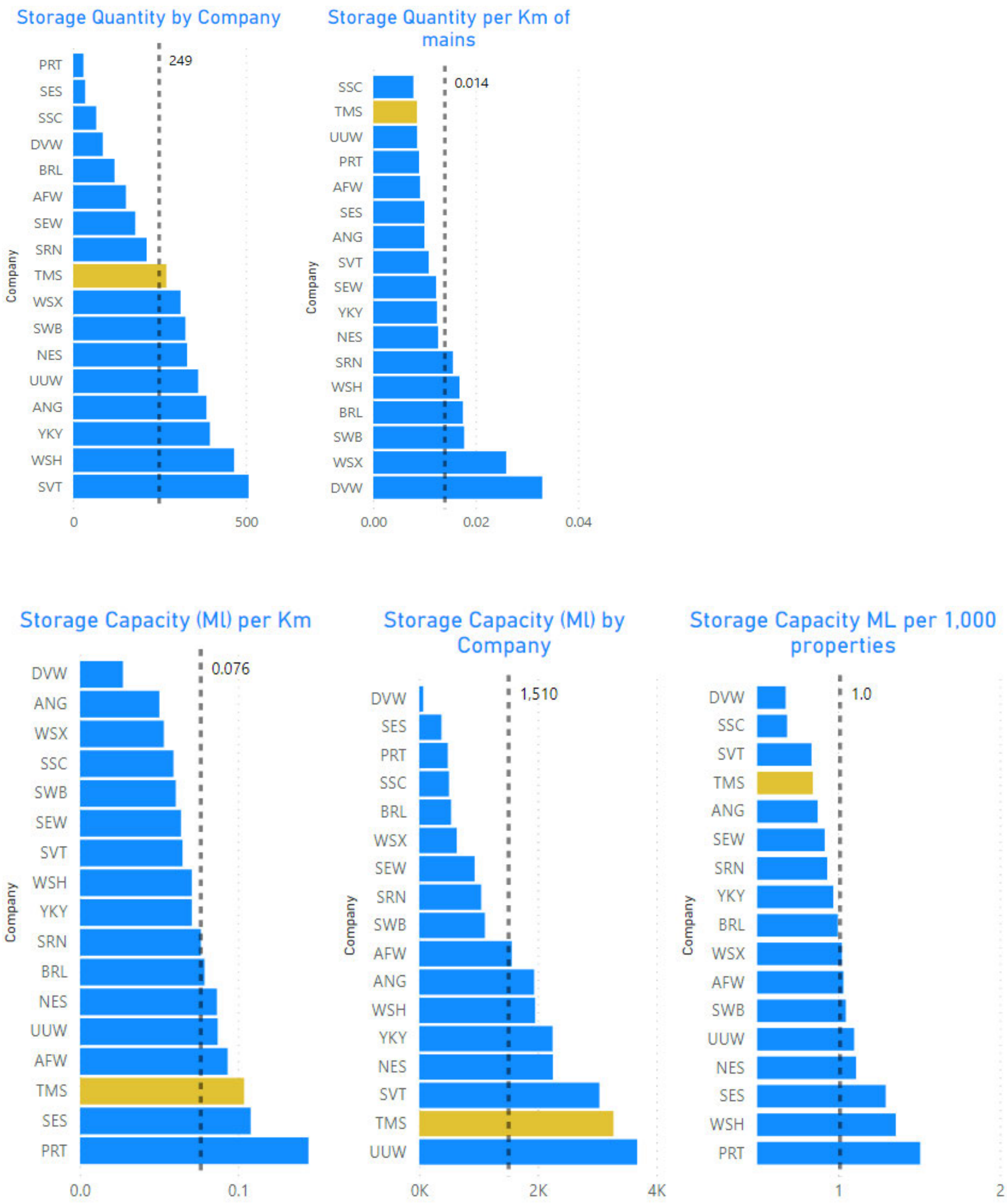
The need for investment is in part driven by the design of the water supply system. We have fewer service reservoirs compared with other companies and we have comparatively few service reservoirs for our size (one of the lowest in terms of reservoirs per kilometre of water main).

The smaller number of larger reservoirs means that our customers are more likely to have a pumped supply rather than a gravity supply – this increases the risk of interruptions to supply and makes the integrity and availability of service reservoirs critical to supplying customers.

Figure 12 below also shows that our storage capacity per property is below-average. This is not an indicator of hydraulic stress but does show that operationally we have less time to respond to events and less flexibility for managing outages which is a risk factor for interruption to supply performance and/or water quality if reservoirs are drawn down towards the bottom water level.

The challenges of system design are exacerbated by the growth in demand for water across our supply area.

Figure 12 – Capacity of service reservoirs



Our analysis has highlighted that we carry a significant asset health deficit with our Service Reservoir assets. In particular, the asset base is ageing, and several reservoirs have reached the end of life and require replacement.

In addition, the demands on these assets have increased because of:

- Expectations from the DWI around condition/ integrity for water quality - 3 areas in particular:
    1. The risk to public health from ingress into tanks which have not been inspected/maintained. This risk varies as not all tanks are the same. We now set our inspection intervals using a risk-based approach and not all are every 10 years, some are 3- or 5-year intervals.

2. The risk to public health that a supply interruption (and associated water quality risks) would have if we are unable to remove a service reservoir asset from service in response to a failure.
3. The focus DWI have on supply resilience having recently taken on SEMD/ alternative water responsibilities from DEFRA.

- Reservoir safety i.e., public safety
- The need to maintain water supply system resilience despite significant population increases and system constraints (e.g., Calm system practices and leakage targeting) that have resulted in the system being less flexible in operation.

8.2 Our plan for AMP8 and why it's efficient.

Our run rate capital maintenance spend on service reservoirs is a total of £21m (based on the average over the last 5 years). In Table 14 below, we present the additional investment we plan to make to close the asset deficit (reported as an additional line in table CW3).

Table 14 - AMP8 Asset Deficit investment in Service Reservoirs, 17/18 prices, excluding central overhead

	25/26	26/27	27/28	28/29	29/30	AMP8
Emerging risks (inc statutory reservoir definition)	1.4	1.8	2.2	2.2	0.9	8.4
Brixton Reservoir: Inadequate Overflow System	0.0	0.0	0.0	0.0	1.5	1.5
Brixton Reservoir: Structural Failure	0.0	0.0	5.6	2.8	2.8	11.2
High Beech Service Reservoir Resilience Study	0.0	0.0	0.0	4.0	1.3	5.3
Additional run rate capital maintenance	3.2	3.2	3.2	3.2	3.2	16.0
Capital delivery service reservoir complex projects	1.9	2.1	2.6	4.6	4.1	15.3
Resilience improvements to 6 Service Reservoirs	3.2	4.1	5.1	5.1	2.2	19.7
DWI notice inadequate turnover 13 reservoirs	2.6	3.4	4.2	4.2	1.8	16.0
Putney Service Reservoir Cell A&B rebuild	0.0	0.0	0.0	35.8	11.9	47.7
					Total	141.1

For our Asset Deficit submission (the costs of which are included in Enhancement data table CW3.134), the reservoir cells being targeted in AMP8 are those highest priority ones. Although resolving the structural and water quality risks on these sites will have a significant impact on our risk profile, there are a number of the remaining 200+ cells with lower priority risks which will need to be addressed over a long term plan. We also need to address the system storage resilience issues through our smart systems and “replumb” programmes of work.

Ageing reservoir replacement.

Putney Cell A has failed structurally, is out of service and requires a rebuild. This cost is estimated at 47.7m (see case study below)

Poor condition assets – We have service reservoirs in London constructed in the mid 19th Century that are showing signs of deterioration, and while operational, planned replacement needs to start on these cells:

- Brixton (additional monitoring), Bourne Hill (very bad ingress, repaired but on increased inspection frequency), Streatham, Hampstead (repeat water quality failures, 1 cell long term out of service due to ingress through walls despite smart roof membrane).

Water Quality results - low chlorine and poor turnover. Nine cells have been identified as having chronically poor chlorine residual which means the protective effect it provides is very weak for both the reservoir and the downstream zone increasing risk of a service reservoirs coliform failure or contamination in the network following a leak/burst/depressurisation event.

- Cells included; Okus, Wooton, Worsham, Blacklains, Headington, Sewardstone, Farnborough, Knockholt, West Wickham.
- Note: An additional 7 cells (mostly London) have been identified as having poor chlorine/turnover which will need an intervention to mitigate this risk. These are: Bishops Wood – turnover issue (raised on multiple occasions to aid with low residual chlorine levels), Cockfosters – Turnover/chlorine residuals, Crystal Palace – Turnover/chlorine, Darnicle Hill – chlorine, Eltham – chlorine, Oxleas Wood – Turnover, Stokewood (TV) – Turnover/Chlorine]

We already have a notice – TMS- 2022 – 00001 – Tank Inspection and Cleaning, which covers 53 of our tanks (counted per cell, not per site) with a commitment:

- For any cells not inspected in the last 10 years, complete the enabling works required to allow the inspection and repairs and then complete the internal inspections (44)
- For any cells which *have* been inspected in the last 10 years but *could not now* for any reason e.g., supply resilience, there is a requirement to complete the enabling works required to allow removal from supply once again (9).

Putney Cell A and B Case Study

Putney Reservoir (Cell A and B) is a partially buried brick-arch vaulted service reservoir, located in Putney Heath, London and was completed in 1900. The reservoir is formed with two equally sized cells that share a common dividing embankment / wall. The reservoir is flanked on all sides by earth embankments and the lowest natural ground level at the reservoir is located at the north east corner.

The reservoir has a storage capacity of 50,000 m3, of which 35,000 m3 is assessed to be escapable and above natural ground level. The total surface area of both cells is stated to be 10,512 m2 at its Full Supply Level. The reservoir acts as a balancing reservoir for the Putney zone in the south west London supply area. Water can be supplied to the reservoir by pumping from three shafts on the London Water Ring Main – Park Lane shaft (45 Ml/day), Battersea shaft (45 Ml/day) and Surbiton shaft (50 Ml/day). There is also an “infusion” at Crescent Road from Hampton WTW, with a maximum potential pumping rate of 70 Ml/day. All flows arriving at the site are split into the four cells (A to D) and all cells are operated conjunctively.

An inspection was carried out in September 2021. The Survey Engineer’s notes and recommendations are summarised below.

…The condition of Compartment A however is more alarming and I do not recommend putting this compartment back in operation for the foreseeable future to allow further surveys and investigation of the roof cracking to the northern bay and a review of the long term options to remediate or replace this structure. My formal recommendations are likely to include a restricted water level equating to zero depth in Compartment A until works are undertaken to safeguard the roof. I inspected Compartment A on 23rd September 2021, along with the Supervising Engineer and a structural engineer from Stantec. Visual examination of the northern bay revealed new movement of the north-west corner bay, new open voids in the north-west bay end wall and sloping concrete slab and visual confirmation that at least the lower brick in the roof arch was persistently open along the full length of the arch by around 15 mm (estimate). The brick arch could also be viewed 'end on' via the two end bays where previous reconstruction of a flat slab provides access and from what I could tell, the norther half of this arch has flattened considerably. Please refer to the photos attached. In order to quantify the visual observations it was agreed with the Supervising Engineer that the following course of action should be taken immediately:

1. *Undertake the planned laser scan of all bays on the north end of Compartment A so that comparison with the earlier laser scan can be carried out and movement quantified.*
2. *Following the laser scan above, erect scaffolding in the north-west corner bay, Open Bay 3,*
3. *Open Bay 6 and the north-eastern corner bay to provide safe access to the roof arch so that the cracks can be measured and the depth of cracking into the arch soffit measured.*
4. *Excavate 4 No. slit trenches across the roof arch to carefully expose the brick arch extrados for*
5. *visual examination to assess whether cracking penetrates the full depth of the arch.*
6. *Continue monthly roof surveys of Compartment A and Compartment B.*
7. *Install blank flanges to the inlet and outlets of Compartment A to provide double isolation while the compartment is out of service and continue supervision of the structure as per the current regime.*

8. *Modify the temporary fencing on the roof to just the first three bays from the northern side of Compartment A to allow the remainder of the roof to be mowed. The cordoned off area shouldbe strimmed rather than mowed.*
9. *Stantec to review the previous optioneering report for the reservoir in light with the additional information gathered above.*

8.3 Valuing the step-change in capital maintenance

We plan to invest £162M to maintain our service reservoirs in AMP8. This is £141M above the average spend over the past 5 years. The historical spend on service reservoirs is shown in Figure 13 and the historical average in Table 14.

Figure 13 - Historical and forecast capital maintenance on service reservoirs.

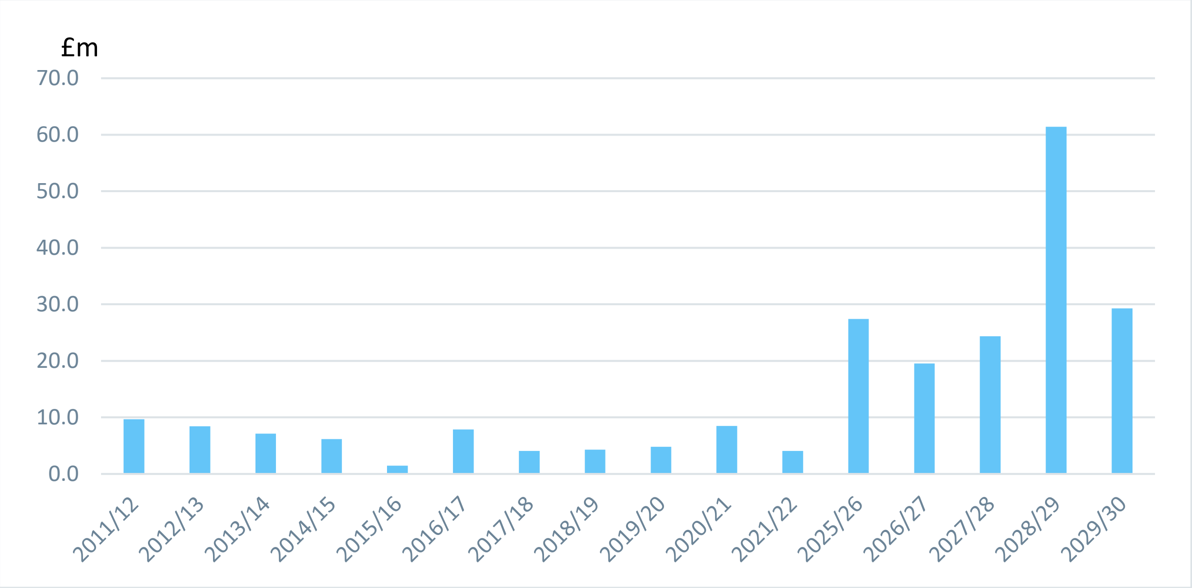


Table 15 - Average capital maintenance spend on service reservoirs, 17/18 prices

	£m
Average spend last 5 years (x5)	21
Long-term average (x5)	27
AMP8 forecast spend	162
Asset Deficit Cost Adjustment	141

8.4 Benefits of the step-change in capital maintenance

- Improved water quality through turnover and residual chlorine amounts will maintain the current Water Quality CRI and customer contacts performance
- Water supply resilience improvements for low probability high consequence events
- Safety improvements to operational staff and public

9 AMP8 Priority - Customer Meter replacement

In this section we show that:

- Smart metering underpins our Water Resources Management Plan (WRMP) and demand reductions needed to balance supply.
- We have submitted an Enhancement Case for Metering and Demand Reduction. The programme requires us to install new smart meters, but also to replace existing dumb meters with smart meters.
- Swapping out old analogue meters and replacing them with digital meters is all capital maintenance and asset health deficit in our plan. Only the Local Communication Equipment (the device that allows the digital meter to communicate with our smart network) is enhanced spend under our Metering and Demand Reduction enhancement case.
- In the past, we were able to take a risk-based approach to replacing analogue meters as they age. But we will need to replace digital meters in fixed intervals going forward – digital meters have finite battery lives, and if batteries fail, we will lose billing data. Local Communication Equipment will also need to be replaced going forward.
- We are therefore in transition to a more costly asset base for meters, but this is offset by the additional benefits that smart meters give us.
- We are forecasting to invest £87m above run-rate meter replacement levels in AMP8. A cost adjustment is needed whilst we are in transition and in recognition of the asset health deficit that has built up for this cohort.
- As a result, we forecast asset health deficit for customer meters will decrease from £268m to £181m.

9.1 Need for investment.

Underpinning our WRMP is the need to increase smart meter penetration for households and non-households. Doing so will deliver demand reduction activities to achieve Per Capita Consumption (PCC) and Business Demand targets set by Ofwat and Defra.

These demand management enhancements are required to increase the resilience in the supply of water to our customers and to deliver environmental improvements.

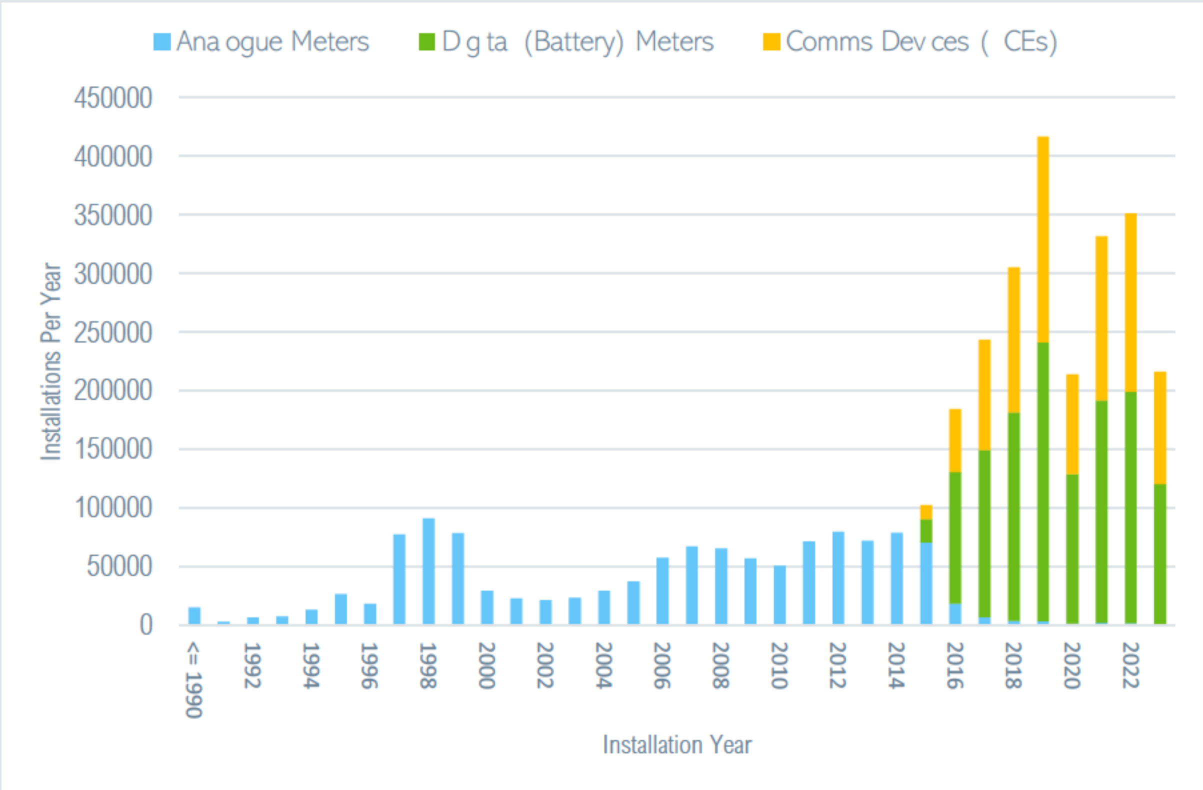
Thames Water's smart meter rollout programme through AMP6 and AMP7 has led the sector in smart meter technology selection, scale of installation volumes, and insight sharing with regulators and the industry on water consumption, leakage, and wastage.

We have submitted an Enhancement Case to continue our metering programme in AMP8. The programme requires us to install new smart meters, but also to replace existing dumb meters with smart meters.

In Figure 14 below we show the number of meter installations that we have completed since privatisation. In the past, analogue meters have been installed – these meters are not smart, they require a manual meter read from either our customers or meter reader. We gain no insight on customer usage, wastage and potential leakage on customer supply pipes in between analogue meter reads. We need to replace the old analogue meters with digital ones and then connect a Local Communication Equipment (LCE) device to the new digital meter, which allows us to start monitoring customer usage in near real-time.

Swapping out old analogue meters and replacing them with digital meters is all base maintenance and asset health deficit in our plan. Only the Local Communication Equipment (the device that allows the digital meter to communicate with our smart network) is enhanced spend under our meter replacement programme.

Figure 14 Number of analogue and digital meter installations per year



9.2 Our plan for AMP8 and why it's efficient.

Our base plan for AMP8 assumes £32m for meter replacement (based on historical run rate spend over the last 5 years) and covers meter replacements. Our asset deficit submission (costs of which are report in table CW3.134) is summarised in the table below. These costs sit outside of our Enhancement Case for Metering and Demand Reduction and include the step up in the cost of household and non-household meter replacement in AMP8, to meet our WRMP targets.

Table 16 - AMP8 Asset Deficit investment in metering, 17/18 prices

	25/26	26/27	27/28	28/29	29/30	AMP8
Additional Bulk Metering	3.7	3.6	0.0	0.0	0.0	7.3
Household Smart Upgrade Programme	12.6	12.6	12.6	12.6	12.6	62.8
Non Household Smart Upgrade Programme	1.4	1.4	1.4	1.4	1.4	7.0
Smart metering platform	1.4	2.1	2.6	1.8	2.0	10.0
						87.0

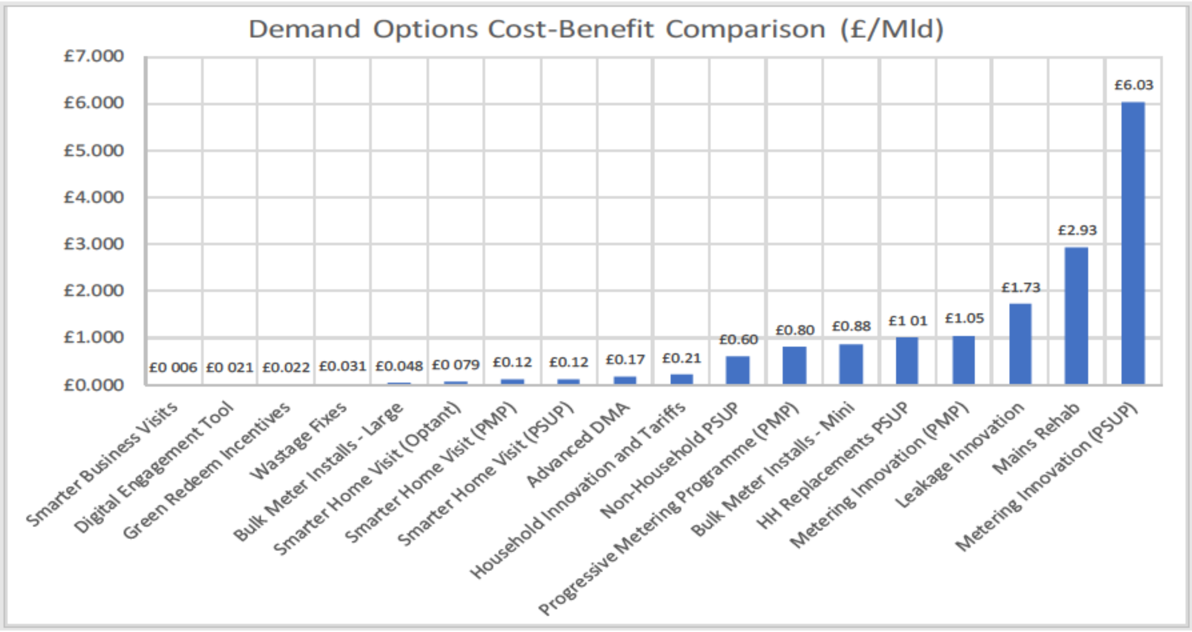
The process that we have undertaken for identifying, screening, and developing demand options is described in detail in Section 8 of our WRMP, while Section 7 of our WRMP covers our supply-side options.

We made the decision to use Advanced Meter Infrastructure (AMI) smart meter technology, phasing out analogue meters in PR14 and PR19. Our 2019 WRMP assessed all demand and supply side options, concluding that at £3.94m/ Mld, smart metering was a more cost beneficial long-term investment than traditional analogue meters (£4.7m/ Mld). Since the commencement of the Defra-approved compulsory Progressive Metering Programme (PMP), Thames Water has only procured and installed AMI smart meters.

For our current WRMP, we assessed key demand reduction options within bands of potential Ml/d reduction capabilities. Smart metering is one of the most cost-effective options to deliver measurable demand reduction across both household and non-household properties (see Figure 15 below).

The case for smart metering is further strengthened as the increase in smart meter penetration and utilisation of hourly data, are the critical enablers for all other demand reduction options – such as on-site water efficiency, customer engagement, and both customer-side wastage and network leakage identification and fixes. These £/Mld cost benefits will continually be reviewed and updated through the remainder of AMP7 and AMP8.

Figure 15 - Comparison of demand reduction options in dWRMP24



Replacing old dumb analogue household meters with digital smart meters

The largest part of the AMP8 smart metering programme will be the upgrade of existing basic analogue meters with Advanced Metering Infrastructure (AMI) smart meters. The meter replacement costs are base maintenance and the asset deficit reduction. The cost of the Local Communication Equipment (LCE) is enhancement.

The smart meter technology uplift enhancement will give hourly consumption meter reads to identify continuous flows (supply pipe leakage and/or internal wastage leaks), enabling proactive customer engagement to drive self-fixes or initiation of Thames-led continuous flow fix intervention. Once the LCE is added to the replacement digital meter, we are expecting to deliver 12.2 ml/d of leakage benefit (Table 17). A further 3.3 ml/d in consumption reduction will be delivered through digital customer engagement. In our business plan, these benefits are assigned to the Metering and Demand Reduction enhancement case but they cannot be realised without the £87m enabling investment to reduce the asset health deficit.

Table 17 – Demand management benefits from household smart upgrade programme

Meter Type	No. Installs	Leakage Benefit (Ml/d)	Usage Benefit (Ml/d)	Wastage Benefit (Ml/d)
Household Smart Upgrade Programme	645,491	12.20	3.3	~

Replacing old dumb analogue non-household meters with digital smart meters

The market operator for the non-household retail market in England (MOSL) Interim Metering Strategy[6], recommends that water companies accelerate the rollout of smart meters to non-household customers.

Supporting the MOSL strategy will require a step up in meter replacement from analogue to digital and connection to our smart network. The meter replacement costs are base maintenance plus the asset deficit reduction. The cost of the Local Communication Equipment (LCE) is enhancement. In our business plan, the benefits shown in Table 18 are assigned to the Metering and Demand Reduction enhancement case but they cannot be realised without the £87m enabling investment to reduce the asset health deficit.

Table 18 - Demand management benefits from non-household smart update programme

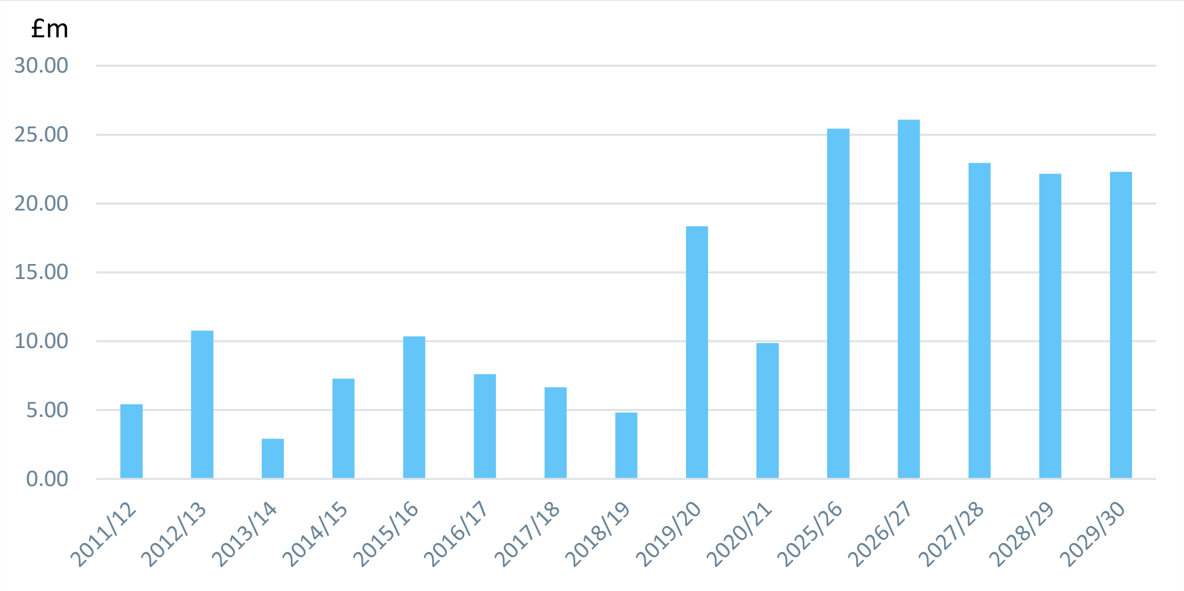
Meter Type	No. Installs	Leakage Benefit (Ml/d)	Usage Benefit (Ml/d)	Wastage Benefit (Ml/d)
Non-household Smart Update Programme	109,449	1.70	3.00	

[6] MOSL – Strategic Panel. Interim Metering Strategy (April, 2023). https://mosl.co.uk/news-and-events/news/press-releases/panel-metering-strategy-urges-companies-to-accelerate-adoption-of-smart-meters

9.3 Valuing the uplift in capital maintenance

Figure 16 - Historical and forecast meter replacement costs below shows our historical and forecast meter replacement costs.

Figure 16 - Historical and forecast meter replacement costs



In valuing the Asset Health Deficit cost adjustment for this cohort, we have deducted the average spend from the last 5 years from the forecast AMP8 spend:

Table 19 - Average capital maintenance spend on meter replacement, 17/18 prices

	£m
Average spend last 5 years (x5)	32
Long-term average (x5)	33
AMP8 forecast spend	118
Asset Deficit Cost Adjustment	**87**

9.4 Benefits of the uplift

Figure 17 and Figure 18 below show the reductions in per capita consumption and business demand that our enabled by our smart metering programme – replacing dumb analogue meters in AMP8 is a key programme that underpins this and is necessary if we are to continue to increase meter penetration given that the early phases of the programme targeted previously unmetered properties.

Figure 17 - Forecasted PCC reduction glidepath against National Water Targets

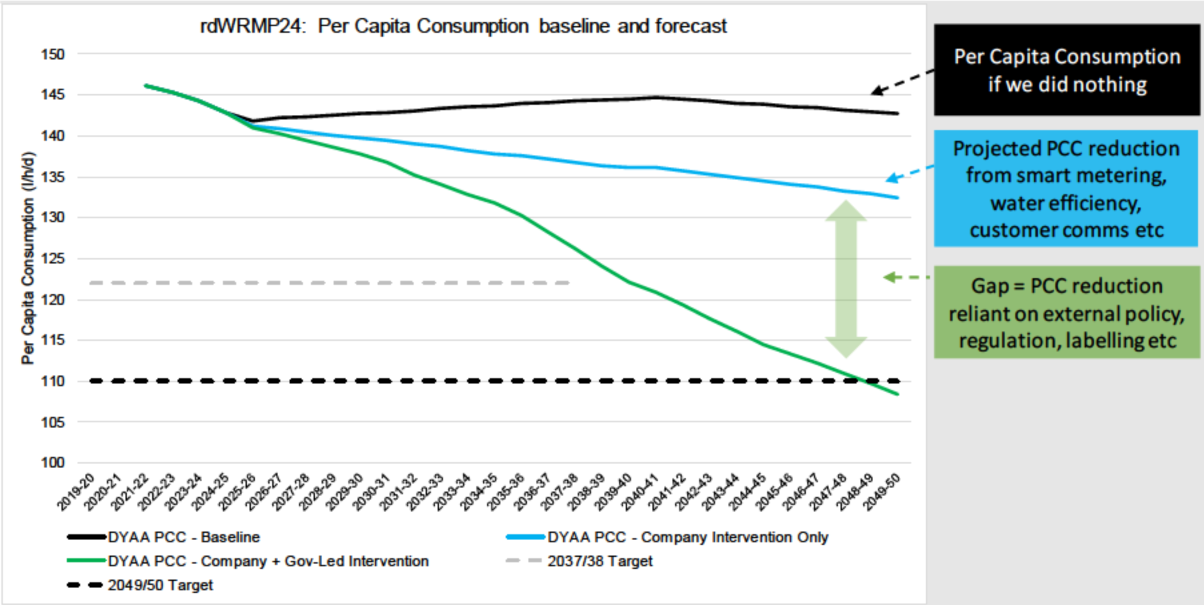
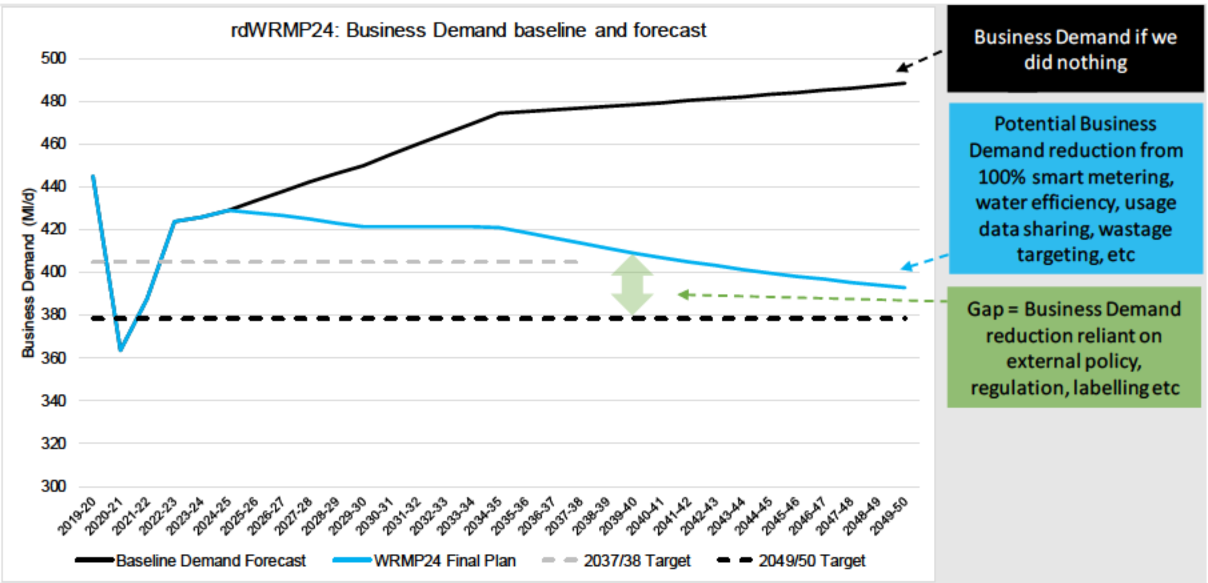


Figure 18 - Forecasted Business Demand glidepath against National Water Targets



10 AMP8 Priority Obsolete Operational Technology

In this section we show that:

- Our Operational Technology asset cohort includes all the infrastructure needed to monitor and control our assets (such as Programmable Logic Controllers, Remote Terminal Units and Human Machine Interfaces). These all allow our operators to control assets in the field and relay information back to our control room, so that we can deliver service to customers and manage incidents.
- The Operational Technology cohort is aging. The number of repair jobs that we are having to do on the estate is rising. Service failures from this cohort are increasingly impacting customers and the environment.
- Until now, repairs to failing Operational Technology assets have predominantly been completed using our own internal spare parts inventory – spares that we have collected from assets that have failed in the past.
- We reached a tipping point where Operational Technology needs to be replaced as we cannot continue to repair these assets in-house with our own parts.
- In AMP8, water SCADA requires an additional £54m above run rate levels, wastewater SCADA requires £95m.
- As a result, we forecast the asset health deficit will decrease from £168m to £19m.

10.1 Need for investment.

Our Operational Technology estate enables us to monitor and control our asset base to deliver service to customers, communities, and the environment. Reliable and accurate data is essential for our team when managing incidents such as burst water mains or pollution incidents.

Figure 21 below shows some of the key assets that need to be replaced:

- Programmable Logic Controllers – these devices contain the control logic for our assets – when to start and stop pumps and open and control valves. They are the brain of our asset base
- Remote Terminal Units – these devices communicate signals (mostly via mobile telephone networks) between our sites and the control room.
- Human Machine Interface – these allow our operators to control processes on site and interrogate key performance information.

Figure 19 - Operational Technology below we present a schematic of the various components that make Operational Technology, how they communicate with one another and enable water and wastewater services to be delivered.

Reliable and accurate data is essential for our team when managing incidents such as burst water mains or pollution incidents.

Figure 21 below shows some of the key assets that need to be replaced:

- Programmable Logic Controllers – these devices contain the control logic for our assets – when to start and stop pumps and open and control valves. They are the brain of our asset base
- Remote Terminal Units – these devices communicate signals (mostly via mobile telephone networks) between our sites and the control room.
- Human Machine Interface – these allow our operators to control processes on site and interrogate key performance information.

Figure 19 - Operational Technology Estate and Infrastructure

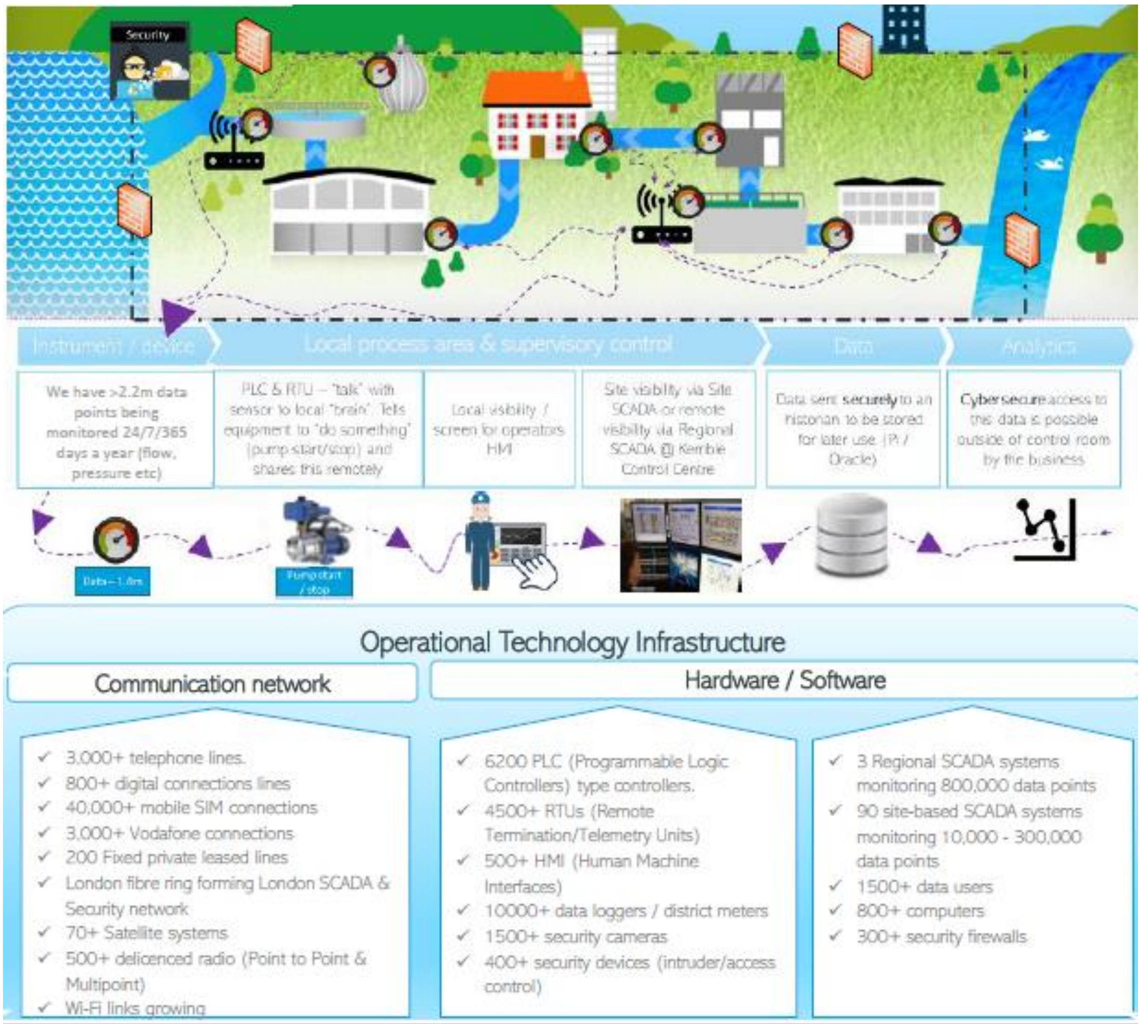


Figure 20 - Site control room at Mogden Sewage Treatment Works and Operational Control Room at Kemble Court

Figure 21 - Key Operational Technology assets that are in need of replacement

Programable Logic Controllers (PLC)

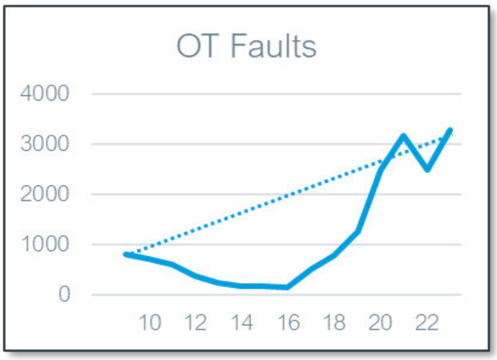
Remote Terminal Units (RTU)

Human Machine Interface (HMI)

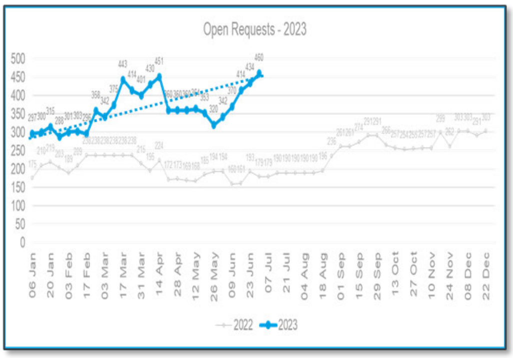
Reliability of Operational Technology

Figure 22 below shows reliability trends for Operational Technology, which demonstrate a deteriorating trend that needs to be addressed.

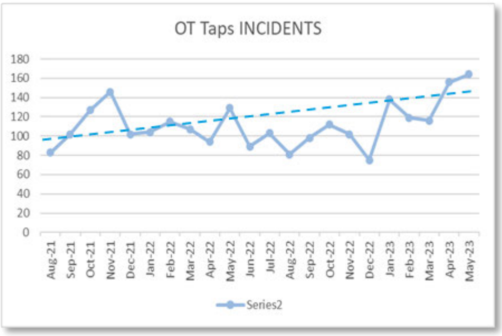
Figure 22 - Deteriorating trend in reliability of Operational Technology



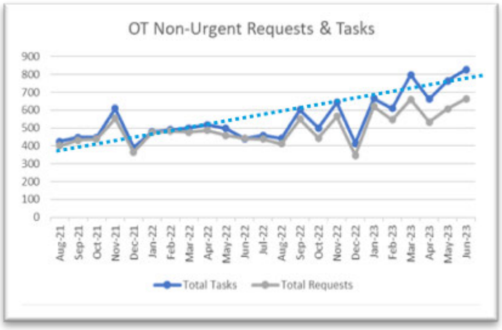
>330% increase in OT faults since 2010
20-50% of faults are repeat issues.



>160% increase in OT requests and backlog of work from this time last year.

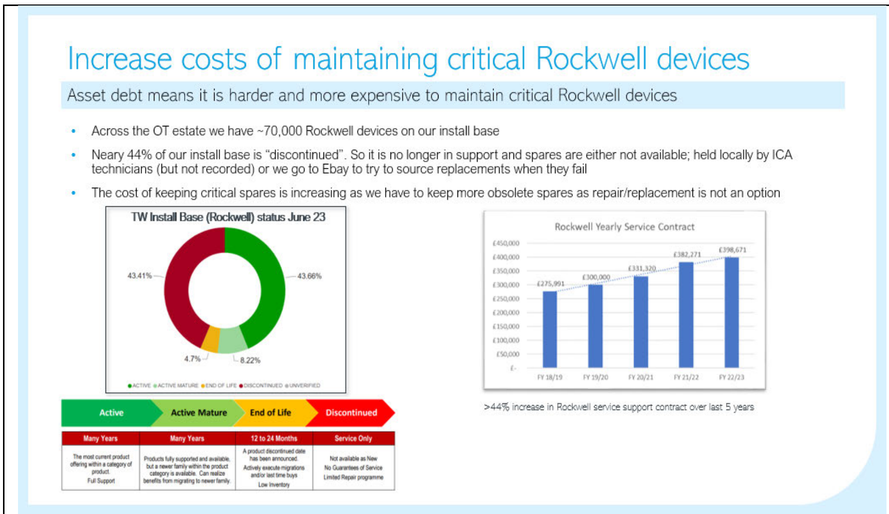


>100% increase in OT Incidents in last 2 years



>95% increase in non-urgent work needed because of increasing issues in last 2 years

Figure 23 - Example – maintaining Rockwell devices



44% of install base is discontinued.

44% increase in maintenance support costs over last 5 years

Parts unavailable and being sourced from e-bay

10.2 Our plan for AMP8 and why it's efficient.

Our base plan for AMP8 includes run-rate spend of £22.6m for replacing water SCADA assets and £8.9m for replacing wastewater SCADA assets. This is based on an average of historical spend over the last 5 years.

Table 20 - SCADA Asset Deficit recovery programme AMP8, 17/18 prices

	25/26	26/27	27/28	28/29	29/30	AMP8
Water SCADA obsolescence	6.9	6.9	10.0	15.0	15.3	54.0
Wastewater SCADA obsolescence	10.1	19.0	19.0	23.4	23.4	94.9

	Water	Wastewater
PLC	38.7	46.4
RTU	4.5	20.9
HMI	2.8	3.5
Site SCADA	6.0	13.7
PLC Network	2.1	10.4
Total	54.0	94.9

The table above summarises the Operational Technology investment required in AMP8 to close the asset deficit, which is included in Enhancement tables (CW3.134 and CWW3.185)

A detailed line by line plan breaking this spend down further is available in Appendix 5.

10.3 Valuing the uplift in capital maintenance

In the figure below we present historical investment in Operational Technology and the uplift that is forecast for AMP8.

Figure 24 - Historical and forecast investment in Operational Technology

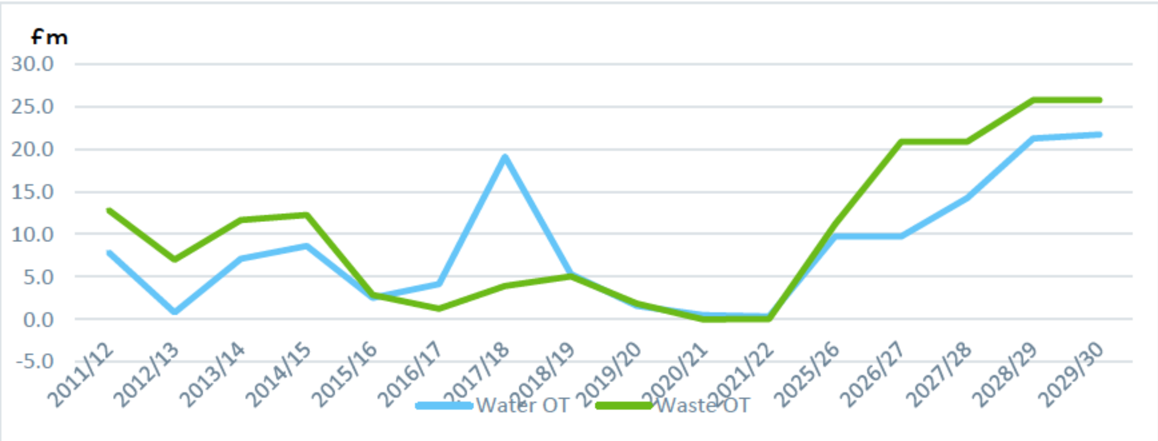


Table 21 – AMP8 Asset Deficit Adjustment for Operational Technology, 17/18 prices

	Wastewater Operational Technology £m	Water Operational Technology £m	Total £m
Average spend last 5 years (x5) [17/18]	22.6	8.9	31.5
Long-term average (x5) [17/18]	23.5	24.6	48.1
AMP8 forecast spend	117.5	62.9	180.4
Asset Deficit Cost Adjustment [22/23]	**94.9**	**54.0**	**148.9**

11 AMP8 Priority Cohort - Sewers/ Critical Assets

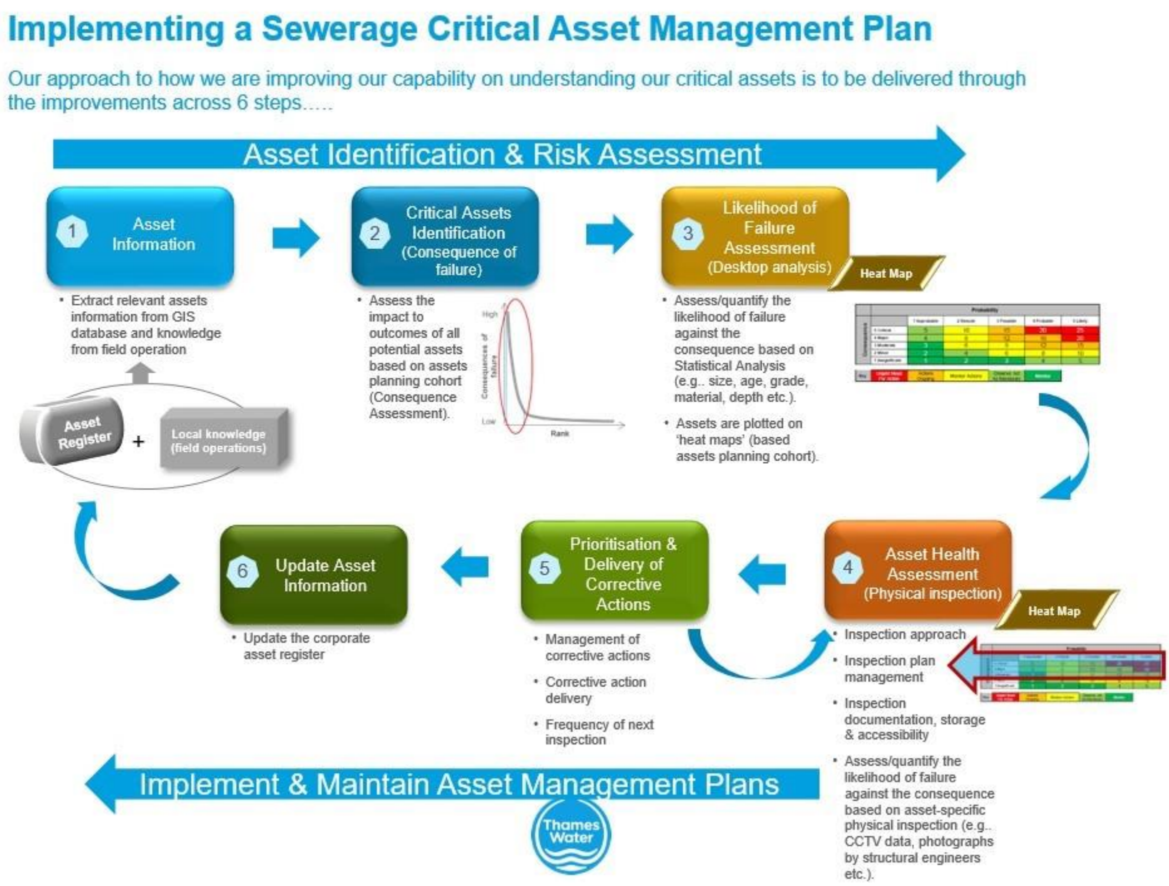
In this section we show that:

- Many of our wastewater assets, particularly across London present a major risk to public safety were they to fail.
- Our understanding of the overall scope of assets affecting public safety, the likelihood and consequence of their failure, and the commensurate maintenance costs is maturing.
- Securing adequate funding to address deficit on our waste critical assets is crucial to protect the wider waste network capital programme from reprioritisation that would otherwise be necessary to facilitate work on these high consequence assets.
- We will need to invest £139m above historical levels in AMP8 to manage this risk
- As a result, we forecast asset health deficit will decrease from £1,172m to £1,033m

11.1 Need for investment

In AMP6 we implemented a consistent framework for classifying and developing plans to improve asset health and reduce risk associated with critical assets, primarily on our waste network (Figure 25 - Critical Asset Management Planning Framework). This framework follows the progressive broadening of scope over previous AMPs to proactively monitor and manage the deficit of those assets that pose risk of high impact, low probability events.

Figure 25 - Critical Asset Management Planning Framework



To date, the scope of the waste critical asset programme has primarily evolved in response to public health and safety risks posed by the location and health of our assets. Protecting public safety is an essential part of our corporate responsibility and statutory duties and, owing to the potential for catastrophic health and safety impact, assets assessed as critical have additional levels of internal assurance.

Critical assets require a proactive management approach that effectively manages the risks they pose to 'As Low As Reasonably Practicable' (ALARP). As the consequence of failure is largely static and driven by physical location, risk is primarily managed through the reduction of likelihood of failure. Our approach is to deliver iterative programmes of inspection and maintenance that are timely and effective in assessing and then improving asset health and therefore reducing the likelihood of asset failure. As such, the programme is risk-driven as opposed to performance driven.

The scope of the critical assets programme has expanded in recent years, particularly since AMP6 (Table 22 Critical Asset Programme scope expansion since AMP3 (grey shading indicates scope introduced)Table 22). This expansion of scope, most notably in condition assessment, is now necessitating an uplift in capital maintenance to remediate assets where defects have been identified through a growing survey and inspection programme.

We need to spend more than historical levels to address the deficit that is becoming better understood. The evolving materiality of the critical assets programme requires a funding uplift to ensure sufficient base maintenance remains for the delivery of wider waste network capital maintenance activities intended to improve performance (pollutions and flooding).

Based on our appetite to inspect more assets and the latest view of critical asset health and associated risk, securing adequate funding to address deficit on our critical assets is crucial to protect the wider waste network capital programme from reprioritisation (exemplified in Section 0) that would otherwise be necessary to accommodate work on these high consequence assets.

Table 22 Critical Asset Programme scope expansion since AMP3 (grey shading indicates scope introduced)

Cohort	Strategic Planning Driver	AMP3	AMP4	AMP5	AMP6	AMP7	AMP8
Sewers in the Rail Environment (SRE)	Structural failure presents risks to structural integrity and safety of the rail assets and service.						
Northern Outfall Sewer (NOS)	Risk to public safety should the asset fail. Includes risk to service delivery, risk of failure when carrying vehicles and inability to use its bridges due to degradation or inadequate load bearing capacity.						
Vehicle Bridges at TWUL operational sites	Risk to safety should the asset fail when carrying vehicles. Inability to use the bridge due to degradation or inadequate weight bearing capability will impact on service delivery.						
Visible pipe Crossings	Risk to public safety through trespass if easily accessible to climb on. Structural degradation can lead to sewer failure which presents risk to river / road services beneath.						

Cohort	Strategic Planning Driver	AMP3	AMP4	AMP5	AMP6	AMP7	AMP8
High Consequence Sewage Pumping Stations and their rising mains	Risk of severe flooding from catastrophic failure, especially during storm, including concern for public safety related to depth of flooding in public areas.						
Penstocks	Risk of severe flooding if devices cannot be operated when required, especially during storm, including concern for public safety related to depth of flooding in public areas and inhabited basement properties.						
Critical Gravity Sewers (excluding SRE assets)	Structural failure presents risk to structural integrity and safety of the public assets and service.						
Balancing Ponds	Risk of severe flooding if asset fails, especially during storm, including concern for public safety related to flooding in public areas.						

Asset Condition and Risk

Table 23 depicts asset condition across the waste critical asset cohorts where available. Taking Grade 4 and 5 condition assets as deficit (and trespass risk from visible pipe crossings forecast to be remaining by the end of AMP7), the deficit currently understood to exist on critical assets is estimated to be £194m.

£60m deficit is included in this number for assets where information is currently unavailable to determine condition. Two asset cohorts that are most material are anticipated to be wedgeblock tunnels (falling under critical gravity sewers) and penstocks, for which further risk assessment and inspection is ongoing. Our understanding of condition is dynamic as assets continue to be identified and condition surveys are completed. As the programme continues to progress, it is expected that the confidence of the £60m estimate will be improved.

The significantly better condition of gravity sewers crossing rail compared to other cohorts and sub-cohorts is noteworthy. This reflects a 20-year programme of proactive inspection and remediation that has been successful in improving the health of these assets and reducing the risk to rail.

Overall, asset condition is poorer for those cohorts and sub-cohorts which are more recent additions to the programme. For example, gravity sewers parallel to rail are an AMP7 addition to the programme. As these assets are surveyed, a high proportion (18%) are being identified as Grade 4 and 5 condition (very poor and poor condition as indicated in.

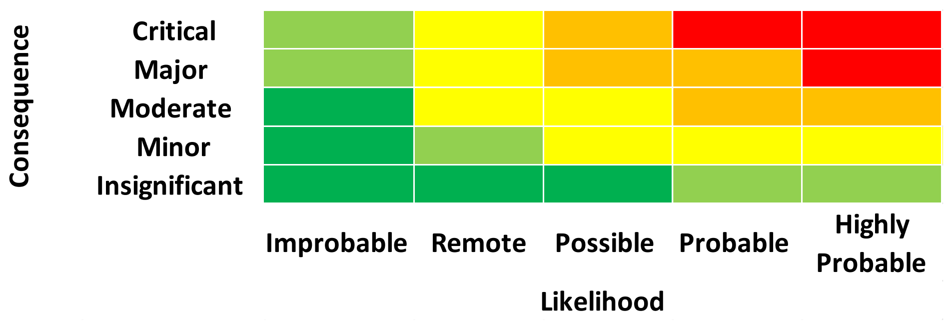
Condition is a primary driver of the likelihood of failure, which is used (alongside consequence) to prioritise assets for inspection and remediation through the form of a risk heatmap (Figure 26). Heatmaps are produced per cohort as inherent differences in asset types require different risk factors to be quantified.

Table 23 Asset condition by critical asset cohort[1]

Cohort	Sub Cohort	No. critical assets[2]	Condition (% of assets) Very poor	Poor	Fair	Good	Very Good	Notes
Sewers in the Rail Environment	Gravity sewers crossing rail	2854	1%	6%	6%	36%	51%	Condition based on CCTV survey of 2823 assets. Reflects 20-year investment programme to inspect and remediate assets.
	Gravity sewers parallel to rail	1169	3%	15%	12%	17%	53%	Surveys ongoing AMP7. Condition based on CCTV survey of 266 assets to date.
	Rising mains crossing rail	155	28%	14%	13%	30%	15%	Condition survey due to commence AMP7. Condition predicted based on Asset Health Index (AHI) as detailed in Section 12.1.
Northern Outfall Sewer	NOS Bridges	21	9%	43%	48%	0%	0%	Condition based on inspection of all assets and reflects condition of critical bridge components
Vehicle bridges	Vehicle bridges	129	7%	7%	12%	24%	50%	Condition based on inspection of 114 assets and reflects condition of critical bridge components
Visible pipe crossings	Visible pipe crossings	172	15%	20%	20%	14%	31%	Condition based on inspection of all assets.
High consequence SPS	Associated rising mains	54 stations (34 with rising mains)	53%	12%	12%	17%	6%	Condition predicted based on Asset Health Index (AHI) as detailed in Section 12.1. Work ongoing AMP7 to better understand condition.
Penstocks	Penstocks	TBC	15%	3%	3%	3%	76%	Risk assessment to confirm criticality on assets outside London Trunk Sewer network in development. Condition based on operational inspection of 305 London trunk sewer assets.
Balancing Ponds	Balancing Ponds	50	0%	26%	56%	18%	0%	Condition based on inspection of all assets.

[1] Survey and condition grade classification methods differ between cohorts but are mappable to 1-5 condition score.
[2]Best current view. Numbers of classified critical assets can change based on better information and enhanced risk assessment.
[3]The condition of all assets at the high consequence SPS are not included as AMP6 assessment was risk and control driven as opposed to looking at each individual asset's condition.
[4]The condition of critical gravity sewers (excluding SRE assets) is ongoing in AMP7 and therefore not included.

Figure 26 - Risk Heatmap

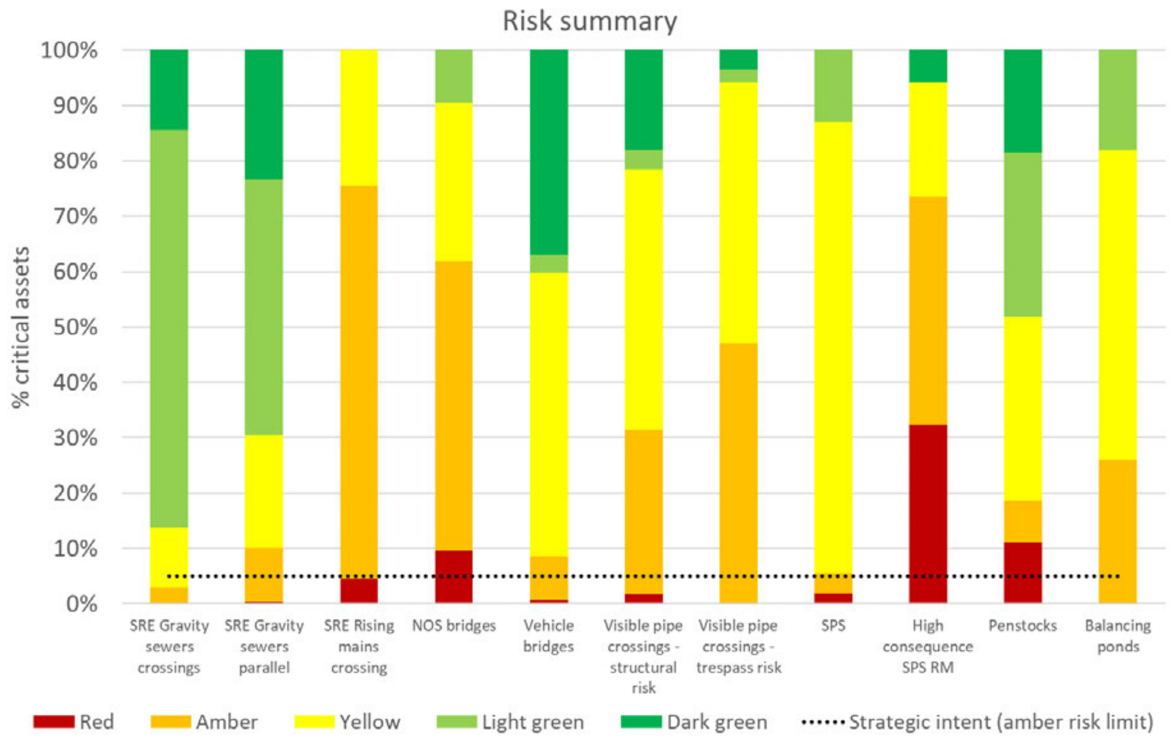


Our strategic ambition is to, by 2050, have no assets in the red area of the heatmap, and a maximum of 5% assets in the amber.

The risk position by cohort in relation to this strategic ambition is illustrated in Figure 27. As with asset condition, risk regularly changes as assets are risk assessed, condition assessed and remediated. However, based on our developing understanding of condition and risk, there is a need to move quicker to remediate assets now evidenced to be of poor condition.

To address the dynamic nature of this work, critical assets are managed through a risk-based programme approach. Risk assessments are updated as assets are inspected, and remediation prioritised based on quantified risk, in line with the heatmap approach.

Figure 27 - Risk summary by critical asset cohort in relation to 2050 strategic intent



11.2 Our plan for AMP8 and why it's efficient.

AMP8 Plan

The overall intent of the AMP8 critical assets plan is to continue with risk-based programmes of inspection and remediation but with increased investment to accommodate the expansion of scope to more assets and, the remediation of assets inspected but not yet remediated (Table 24 AMP8 intent by cohort).

Table 24 AMP8 intent by cohort

Cohort	Assets	AMP8 Intent
Sewers in the Rail Environment (SRE)	Gravity sewers that cross railway and are within the rail zone of influence (referred to above as 'parallels'). Rising mains crossing railway. Pipe bridges within the London Underground Network and on Network Rail land	To continue with a risk-based programme of inspection and remediation but with increased investment to accommodate the expansion of scope to more assets in the rail zone of influence (gravity sewers parallel to rail and rising mains crossing rail – first surveys required).
Northern Outfall Sewer (NOS)	The NOS is the 7.5km gravity sewer consisting of 4 and 5 2.7m diameter barrels that feeds Beckton STW. It has 10 bridges crossing over water, rail or roads and 11 crossings under roads and rail	Continue the bridge inspection and remediation programme (larger no. of smaller remediation schemes compared to 3x large schemes commenced in AMP7). Broaden the scope of work beyond inspection and remediation of the bridge structures to understand also, sewer barrel condition and to assess the risks and resilience associated with the NOS more widely to develop a long-term management plan.
High Consequence SPS	High consequence sewage pumping stations and their associated rising mains	Improve the resilience, health and safety and environmental performance of Lots Road SPS through replacement of 90-year-old diesel engines, which currently power the storm pumps, with electric engines (to include start-up automation, reduced exhaust emissions and improved station reliability).
'Other' critical assets	Critical gravity sewers (excluding SRE) including wedgeblock tunnels, penstocks, visible pipe crossings, vehicle bridges at operational sites, balancing ponds	Continue inspections of critical assets already identified. Improve maturity against critical asset planning framework through further risk assessments, asset register verification and inspections. Undertake risk-based remediation and rehabilitation, especially of assets monitored since AMP6 that have seen limited investment to date.

We will continue our programme approach to critical asset management in AMP8, focusing on the outcome of risk reduction by continuing to risk assess assets following consistent methodologies, condition assess them and prioritise subsequent remediation activity accordingly with this programme approach, the AMP8 plan and required funding (detailed in Table 25).

A breakdown of our AMP8 Asset Deficit uplift in capital maintenance of wastewater critical assets is provided in the table below.

has been defined based on our current understanding of inspection requirements, asset health and associated risk. As highlighted above, it is a dynamic programme that will continue to evolve as asset health insight matures through continued and increased monitoring.

A breakdown of our AMP8 Asset Deficit uplift in capital maintenance of wastewater critical assets is provided in the table below.

Table 25 - AMP8 critical asset plan

	25/26	26/27	27/28	28/29	29/30	AMP8
Northern Outfall Sewer	0.2	0.2	2.3	6.0	21.7	30.5
Balancing Ponds	0.0	0.5	0.5	0.5	0.5	2.1
Critical gravity sewers	0.0	0.7	0.7	0.7	0.7	2.9
Critical penstocks	0.0	1.7	5.1	5.1	0.0	11.9
Sewers in the Rail Environment	4.9	4.9	4.9	4.9	4.9	24.7
Pipe crossings - structural/trespass risk	0.0	0.0	0.0	3.5	3.5	7.0
Other (e.g. wedgeblock / penstocks)	8.6	11.2	14.6	12.9	12.9	60.2
					Total	139.4

Costs and efficiencies

A range of costing methods have been used to determine the AMP8 plan. Costing level is proportionate to cohort maturity and materiality.

SRE costs have been derived using historical run rates accounting for improving efficiency in the programme.

Reflecting the detail of understanding and materiality of investment required on the NOS bridges, schemes have undergone bottom-up costing.

Similarly, for the remaining, less mature cohorts, historical costs have been used where available to inform future funding requirements and where specific schemes are identified, bottom-up costs developed. For less mature programmes, decision support tools have been used where available and thereafter, statistical methods.

Efficiency challenges and response

The nature and geographic location of these critical assets challenges us to deliver efficient costs, particularly when working on the NOS and in the rail environment.

The conglomeration of sensitive, challenging and economically important transportation routes which the NOS crosses, coupled with Beckton being, by far, the largest sewage works in the UK (with consequently the largest input flow), make the NOS bridges particularly complex assets to work on. They require unique and innovative solutions that enable us to manage these assets whilst also accommodating the requirements of other stakeholders to minimise transport disruption.

For example:

- Seven of the NOS bridges go over or under major roads, four of which are A roads with traffic flows of between 16,000 and 35,000 motor vehicles per day and one of which has a traffic count as high as 131,000 vehicles per day.
- Three bridges cross national and underground railway lines which poses significant engineering challenges for working on these structures and introduces rail possession constraints and costs. For instance, on the Jubilee Line, Engineering hours are routinely restricted to two hours overnight, four days a week. A weekend possession (closure) is

only obtainable in extreme circumstances owing to the strategic importance of the line and would cost £673k. Any closure at our bridge location would also block depot access and therefore result in degraded service on the rest of the line.

- We must also meet the requirements of the Lee Tunnel Operating Agreement[7] in our operation of the NOS. Maintaining the required capacity when barrels of the NOS must be closed for repair or maintenance limits the engineering options and thus challenges time and cost of any such operations.

The SRE programme is subject to similar rail possession challenges as the NOS bridges, however, to a generally less extreme extent than those associated with the Jubilee Line on the NOS. To illustrate, to date in AMP7, nearly £1.3m has already been spent on rail possession costs to facilitate works.

These challenges result in higher efficient costs than can be achieved elsewhere across our activities. For example, the SRE gravity sewer remediation programme is currently operating at an average unit rate of £5,400 per metre compared to the non-SRE remediation average unit rate of £407.

Despite this, efficiency will be ensured through key mechanisms:

1. **Programme delivery approach.** This has been demonstrated to provide the most efficient approach in terms of both costs and risk reduction. The SRE programme was brought under a single project delivery team in AMP6. This has delivered significant benefit for risk reduction and efficiency through an accelerated remediation programme, a reduction in inspection backlogs and successful inspections at locations which were previously deemed prohibitively complex to access. The AMP7 programme is currently operating at 11% efficiency on AMP6 costs. We are working towards this programme delivery approach for all critical asset cohorts as we mature asset management capability across newer cohorts.
2. **Competitive tendering and procurement.** We will continue to deliver these projects through our robust procurement processes that ensure value for money, quality and timely programming. For example, contractors for AMP7 work on the NOS bridges were selected based on key criteria (budget, pace of delivery, efficiency through shared resources and lower technical risk) reducing potential costs by just over £1m (outturn costs).
3. **Timely intervention.** Responding to risks in a timely and sufficiently proactive manner is fundamental to delivering efficient costs. Not only does it ensure timely implementation of risk controls, but more time to act affords greater solution flexibility and more available options that can be extremely beneficial when working in environments with access constraints. For example, short-term risk mitigation on bridges on the NOS has been necessary in AMP7 and will total in the region of £6.9m (outturn costs). This is a key consideration behind the AMP8 uplift in capital maintenance as the need to act becomes increasingly time sensitive as critical asset health becomes better understood. Material investment in the deficit in AMP8 will reduce the risk of emergency costs being incurred where the risk associated with poor asset condition increases beyond our risk tolerance.

[7] Lee Tunnel Operating Techniques relating to Tideway CSO 10th August 2012

11.3 Valuing the uplift in capital maintenance

Due to the criticality of these assets and the significant health and safety risks they pose, these are must-do activities, but they do not attract performance benefit.

Inadequate funding of this programme materially risks successful delivery of the critical asset risk reduction outcome, and concurrently, risks delivery of the wider waste network capital programme through the risk of re-prioritisation should risks outside our tolerance exist. In particular, the need to ensure sufficient funding for both critical asset risk management and pollution reduction is highlighted.

To protect the critical assets programme and ensure delivery of our pollution reduction targets, the uplift in capital maintenance under gravity sewers is based on the capital investment required to deliver the whole critical asset programme (excluding activities to manage deterioration or where deficit is covered elsewhere) and pollution reduction activities.

The valuation of the uplift in capital maintenance is summarised in Table 26 below with historic capital maintenance spend included for reference.

Table 26 - Average capital maintenance spend on critical assets, 17/18 prices

	Critical Assets £m 17/18 primary	Gravity Sewers excl. critical assets £17/18m primary	Gravity Sewers Total £m 17/18 primary
Average spend last 5 years (x5)	61	261	322
Long-term average (x5)	51	248	299
AMP8 forecast spend	110	351	461
Asset Deficit Cost Adjustment	**96***	**43****	**139**

**SRE rising main capital maintenance excluded as covered by rising main uplift detailed in Section 12. Capital maintenance excluded where AMP8 plan is to manage deterioration. **Pollution reduction activity.*

11.4 Benefits of the uplift

The ultimate benefit of the uplift in capital maintenance will be the reduction in critical asset failure risk through the improvement of asset condition.

The plan as currently forecast for AMP8 is intended to address the majority of the £194m deficit that is currently understood to exist on these assets.

12 AMP8 Priority - Rising Main Replacement

In this section we show that:

- A key part of our strategy for rising mains is to replace sections or entire mains where the likelihood and consequence of a pollution is high or very high and there is previous history.
- We are experiencing an increase in bursts compared with historical levels.
- The number of pollution incidents caused by failing rising mains is the highest in the industry and the condition of our rising mains is deteriorating.
- We need a step change increase of £132m in capital maintenance to reduce our asset health deficit and to address the pollution performance trend we are seeing linked to asset condition.
- As a result, we forecast asset health deficit will decrease from £487m to £355m

12.1 Need for investment

Our Strategy

Rising mains make up 3% of our wastewater network by length but are responsible for 20% of bursts/collapses (90/year), 9% of network pollutions (18/year), 0-2 serious pollutions/year and a small proportion (less than 1%) of flood incidents.

Responding to bursts can also be extremely expensive and disruptive to wider operations. For example, one burst in 2022 cost more than £2m to repair a 10m section of pipe. To mitigate the environmental impact whilst repairs were undertaken, we deployed 50 tankers of which 25 stayed on working around the clock for two weeks until repairs had been completed.

Our **strategic goals** for rising mains are to **eliminate serious pollutions** and **maximise whole life value (benefit-cost)**, driving improved pollution and collapse performance and stable asset health as a result.

Our strategy to achieve these goals is built around the four Rs of resilience:

1. **Reliability** - The keystone of our strategy is the rehabilitation of unreliable mains (as identified from root cause analysis of historic failures and where appropriate condition inspection). The strategy for high consequence mains is to proactively replace all mains with a systemic failure mode unless risk can be sufficiently addressed through other measures e.g., redundancy and monitoring. The strategy for low-medium consequence mains is to proactively rehabilitate mains based on whole life value. As a result of our strategy, we expect burst rates to be industry leading (when normalised by length of rising main) by 2030 (65 bursts/year), and to fall further to 40/year by 2050.
2. **Resistance** - We will protect our assets from deterioration and shocks to the system by continuing to develop air valve inspection/maintenance plans developed in AMP7, and by installing variable speed drives and soft start motors where appropriate.
3. **Redundancy** - We will build redundancy into our systems by 'twinning' mains and adding cross-connections where appropriate. We will ensure redundancy for the highest consequence sections mains, but also look for cost-effective opportunities to provide redundancy for lower consequence mains.
4. **Response and Recovery** - We will optimise our response to incidents, focusing on:
   i) awareness of when bursts have occurred (e.g., using new and existing monitoring technologies).

ii) response capability (e.g., improved response plans, installing connection points on the SPS and along the main so we can bypass the burst using rider sections, avoiding the need for expensive and disruptive tankering).

The focus of our strategy will change over time, in particular:

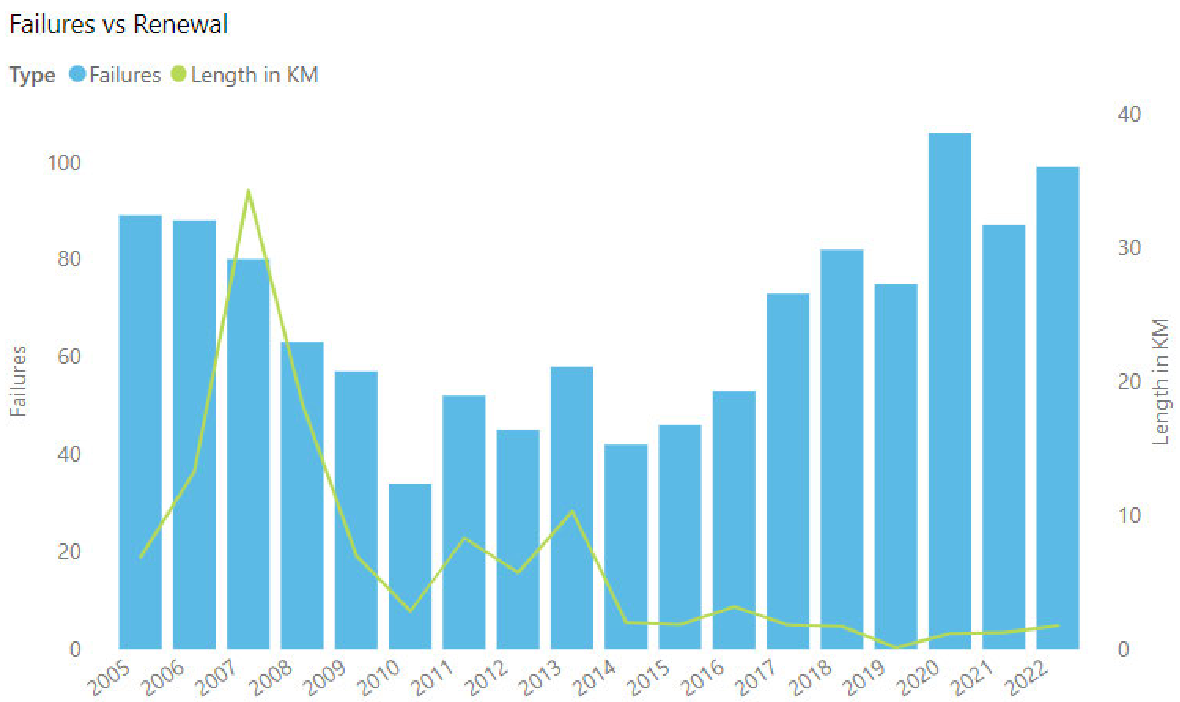
- as technology evolves allowing cheaper and more effective flow/pressure monitoring and inspections;
- as our insight and modelling improves allowing us to target interventions more cost effectively; and
- as our mains replacement programme pivots from reactive replacement based on failure history, to proactive replacement based on insight from modelling and condition surveys.

Historical and comparative performance

Figure 28 below shows our historical rising mains replacement lengths and trend on failures. Burst rates have increased by 70% over the last 7 years, as rising mains installed in the latter half of the 20th Century have reached the end of their serviceable lives and investment since our last major rehabilitation programme between 2006 and 2008 has not kept pace with deterioration.

More than 70% of bursts are on mains that have failed previously, including 143 rising mains that have been diagnosed as having a systemic mode of failure based on pipe autopsies following a burst.

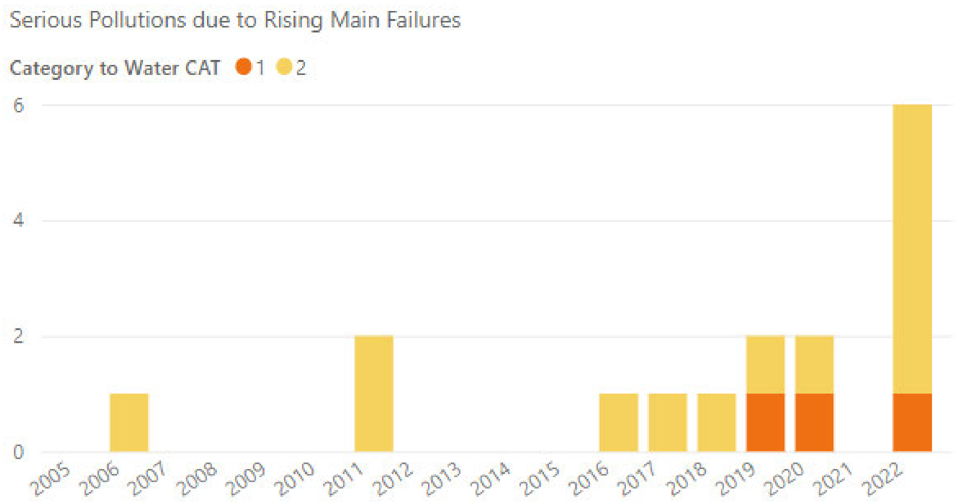
Figure 28 - Rising main bursts vs renewals



Rising mains tend to be located in low-lying areas where sewage needs to be pumped in order to reach the sewage treatment works. For this reason, rising mains tend to be in close proximity to watercourses – when they fail there is a high likelihood of a pollution occurring.

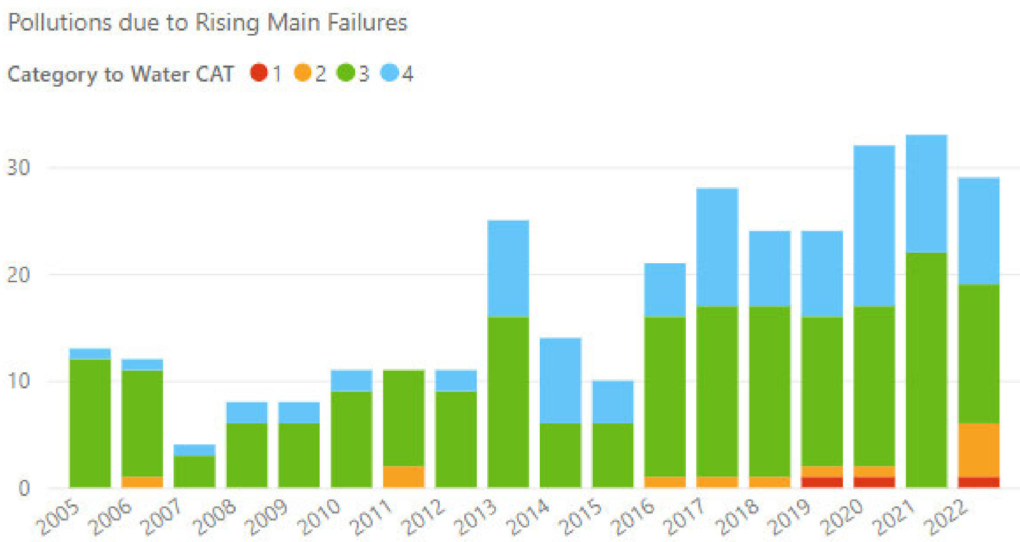
Figure 29 below shows that we are experiencing an increase in serious (Category 1 and 2) pollutions due to rising main failures.

Figure 29 - Serious pollution performance (number of) attributed to rising main failures



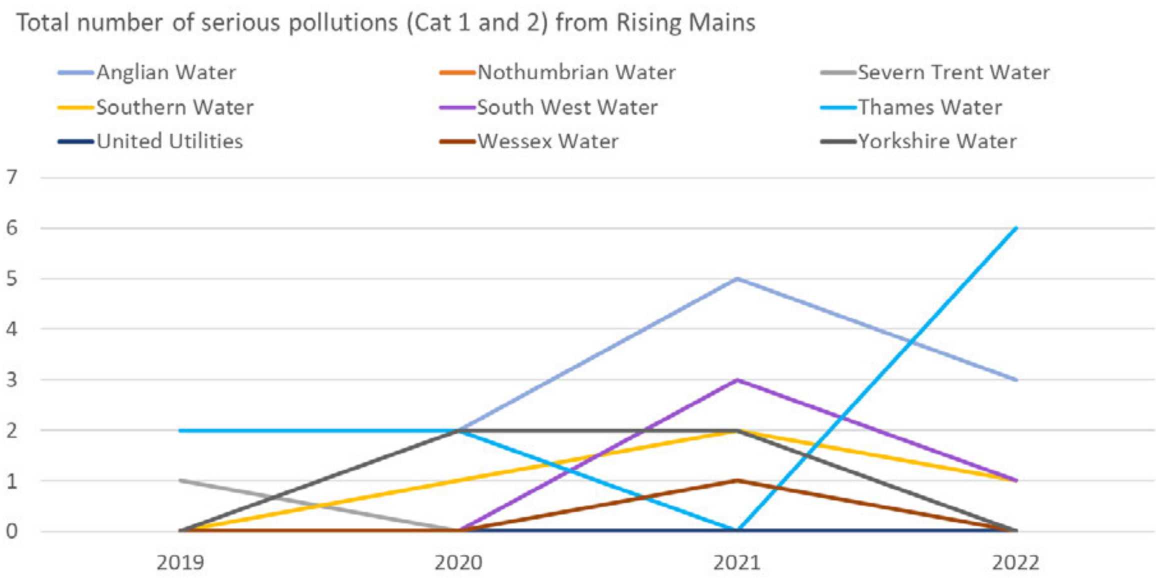
Furthermore, the overall trend in pollution incidents attributed to our rising mains is worsening (see Figure 30 below). Deterioration in pollution performance is likely to be exacerbated as the Environment Agency updates its reporting and guidance and more Category 4 pollution incidents are reported as 3 going forward.

Figure 30 - All pollution incidents attributed to rising main failures



We have also compared our rising main pollution performance with other companies over the last three years. The results are presented in Figure 31 below and show that in the last Report Year, our performance for Category 1 and 2 pollution incidents was the worst in the industry.

Figure 31 - Industry comparison of serious pollution incidents caused by rising mains.



Note, the 2020 Thames Water figure of two serious pollutions presented differs from the EPA reported figure of one. In the EPA an additional serious pollution in 2020 should have been attributed to rising mains.

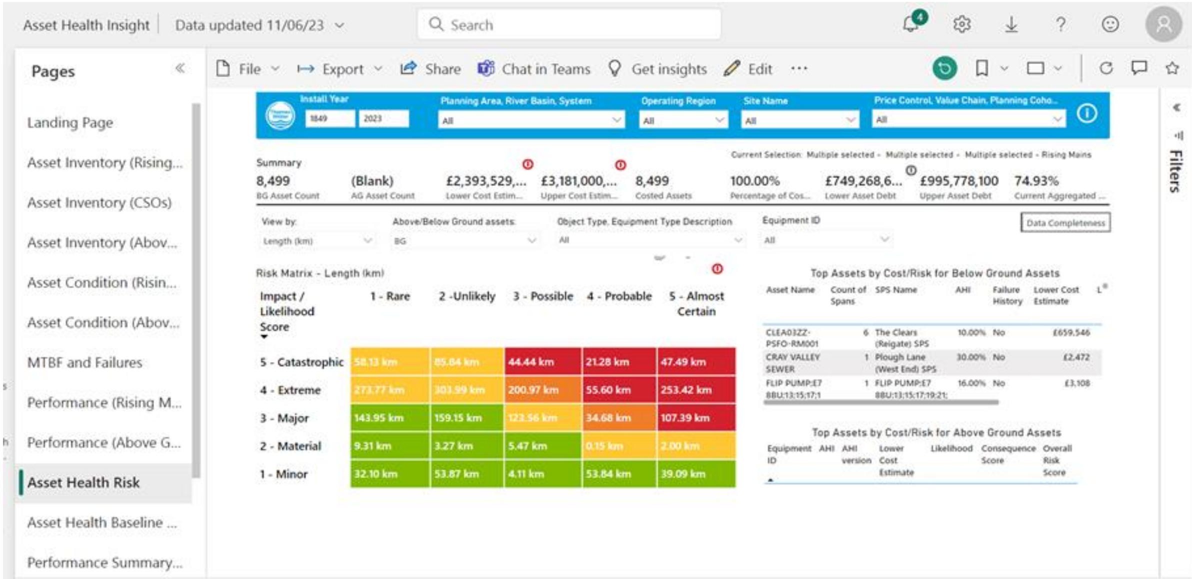
Asset Health and Risk

We have recently matured our understanding of rising main asset health through the development of an asset health index (AHI). The approach uses deterioration models to give a long-term view of the expected residual service life of an asset, taking account of both effective age (the age of the asset adjusted to reflect its condition, performance and refurbishment history) and economic life (the number of years that a typical asset of a given type is economically 'useful').

This approach is similar to the United Utilities method that was highlighted by Ofwat as a best practice example in their Asset management maturity assessment (report published in September 2021). This measure was also highlighted as one of the recommended asset health measures by the recent Future Asset Planning research project by UK Water Industry Research (UKWIR).

The AHI is taken as likelihood of failure and combined with consequence of failure (in terms of pollution impact) to provide a risk assessment across the rising main asset base. It is this risk assessment which has informed the asset deficit calculation. The below (Figure 32) excerpt is from our rising main Asset Health Insights dashboard.

Figure 32 - Rising Main Asset Health Insight Dashboard, km of rising main by risk



As rising mains are pressurised, below ground, infrastructure assets, they are challenging to inspect. Consequently, it is very difficult to accurately determine the health of these assets.

We are working with the industry to support the development of new in-situ inspection techniques, but, in the meantime, we run a programme that inspects sections of pipe when they fail. Often described as a pipe autopsy or post-mortem, this information is used to determine whether the mode of failure was caused by a localised or systemic issue and is used to determine the need to replace the rest of the asset.

We know from this activity that we have systemic issues on our rising mains that necessitate asset replacement.

12.2 Our plan for AMP8 and why it's efficient.

We use all the insight available to us described above to maintain a prioritised list of rising mains that we need to replace. The rising main prioritised list comprises all known rising mains with asset health risks. The assets in the priority list are either:

- beyond their useful economic life, which is calculated by using estimated age and material data taken from our corporate GIS system; or
- have experienced one burst with a known and repeatable cause of failure: or
- two bursts (cause of failure does not need to be known).

These records can be combined to produce an Asset Health Index which is a new leading asset health measure.

The prioritisation methodology is aligned to our rising mains strategy, critical assets strategy and asset health strategy, contributing to our 2050 vision to keep all untreated sewage out of our rivers. The strategic goals for rising mains are to:

- Eliminate serious pollutions and.
- Maximise whole life value (benefit-cost)

This will drive improved pollution and collapse performance and stable asset health as a result. Our critical assets strategy seeks to improve the limited information on the condition of the rising mains in the railway environment and then instigated action to control risk or remediate assets which have the highest likelihood and consequence of failure.

The primary performance data sources for the prioritisation are the Asset Health Insight dashboard. This uses the information from a burst tracker which captures all verified rising main bursts from the mid-1990s onward, and the pollution tracker which captures the verified NIRS pollutions caused by rising main failure. Performance data is complemented by good understanding of failure mode and root cause of failure from pipe autopsies of failed pipe sections that have been taken since 2000.

The primary investment driver for rising main investment is serious pollutions. Therefore, rising mains which have recorded category 1 or category 2 pollutions in the last five years are the highest priority. Then rising mains are prioritised by a weighted score of: bursts in the last 5 years, total recorded bursts, category 3 and category 4 pollutions in the last five years and total recorded pollutions. For example, a rising main with only 1 burst causing a category 3 pollution in the last 5 years will be ranked higher than a main with only 1 burst that does not cause a pollution. Where there are rising mains with the same score, the mains are then prioritised by the number of "no regrets" drivers which are: confirmed asset deficit, history of serious pollution (Category 1 or 2) in the last five years, High Consequence Pumping Stations, Sewers which cross the Rail Environment and significant operational mitigation risk. The prioritised list is then reviewed by subject matter experts in the business including Operations in our quarterly Asset Health Reviews to ensure our priorities represent operational realities and we take into account for any other mitigating factors (e.g. excessive mitigation complexity, customer impacts).

Optioneering efficiency

The solutions we have selected in our AMP8 rising mains replacement strategy are efficient because they will replace the rising mains that pose the biggest pollution risk. The rising main replacements we are proposing in AMP8 have had their root cause of failure assessed. All of them have a failure mode where partial or full replacement is the most efficient option. This is because a patch repair would not reduce risk as whole sections of rising main have been identified as being at high risk of failure. This is determined from the asset deficit of the main based on age and material and/or pipe autopsies from previous bursts on these rising mains.

All rising mains that will be replaced either have or will be approved at a technical governance meeting. At the meeting technical experts from a diverse range of teams across Thames Water, including Asset Management, Operations and Capital Delivery agree which rising mains or rising main sections should be progressed based on their prioritisation.

Every AMP there are a proportion of rising main replacements that happen because of unexpected bursts. These are classed as emergency works and reactive works. For AMP8 it is assumed there will be a similar amount of emergency and reactive rising main replacement.

The three cost options were considered in the development of the strategy for PR24. These are shown in Table 27 below.

Table 27 - Cost options in developing the strategy for PR24

Scenario (£m)	Emergency Length (km)	Emergency Cost (£m)	Reactive Length (km)	Reactive Cost (£m)	Total reactive and emergency cost	Planned Length (km)	Planned Cost (£m)
100	1.2	7.34	21.88	77	84.34	12.20	15.66
150	1.2	7.34	21.88	77	84.34	51.14	65.66
200	1.2	7.34	21.88	77	84.34	90.08	115.66

- £100m – Not selected as it would replace the eight highest risk mains but not all rising mains which have caused a pollution in the last five years.
- £150m - The preferred option because it will fund the replacement of the highest priority rising mains replacing all the rising mains which have caused a Serious Pollution or Pollution in the last five years.
- £200m – Isn't cost beneficial in the context of the financeability and deliverability of the wider plan. It would fund the replacement of additional rising mains but none of the additional rising mains have caused a Serious Pollution or Pollution in the last five years.

We have considered a range of options for rising mains replacement in AMP8

- Invest £150m to replace 86 km of RM (with £132m in this asset health deficit case).
- The programme of replacement will be continued in the same way as initiated in AMP7. Mains are prioritised for replacement using a risk-based approach with pollutions as the primary driver.
- The intent for AMP8 is to replace the highest risk mains.

Table 28 below shows the annual profile of spend on rising mains replacement to close the Asset Deficit in AMP8. We have included £17.5m in our base plan. The additional capital maintenance below has been included in the Enhancement data table CWW3.184

Table 28 - AMP8 investment in rising mains to close the Asset Deficit

	25/26	26/27	27/28	28/29	29/30	AMP8
Rising mains	0.0	19.8	46.2	33.0	33.0	131.9

Why replacement?

In line with our strategy, we are committed to managing rising main resilience, of which asset reliability is key. In light of current asset health and performance, asset replacement is the most appropriate solution where we understand asset health to be poor and the consequence of failure to be high.

Whilst we are also working to improve the remaining 3 Rs of resilience; resistance, redundancy and response and recovery as set out above, these alone are inadequate for assets outside risk tolerance with known systemic asset health issues.

12.3 Valuing the uplift in capital maintenance

In Figure 33 we show historical investment in rising mains capital maintenance and forecast investment in AMP8. The trend shows a clear increase in investment to arrest the increase in rising main bursts and consequential pollution incidents. We have valued the Asset Health deficit cost adjustment as the AMP8 efficient plan less the average spend over the last five years (Table 29).

Figure 33 - Historical and forecast investment in Rising Mains

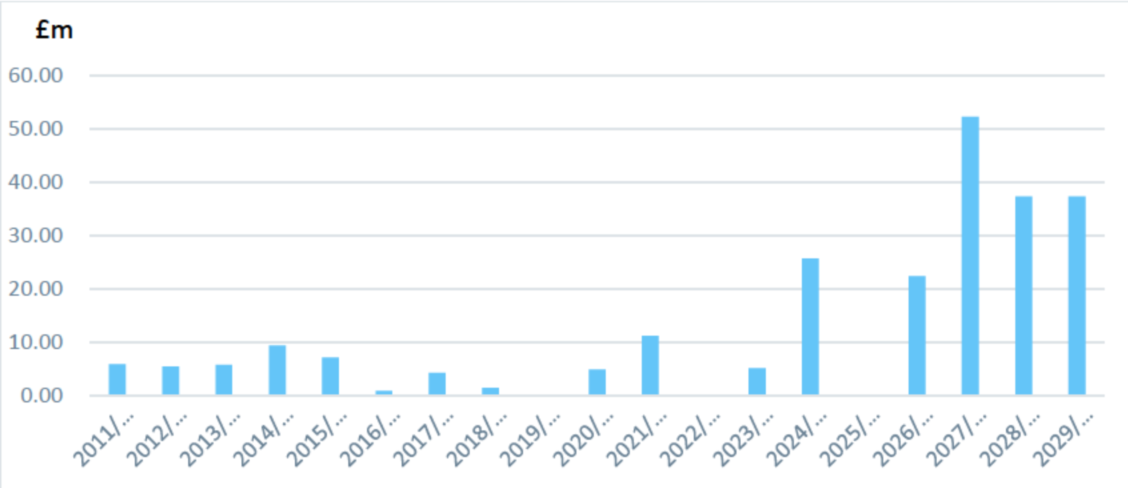


Table 29 - Average capital maintenance spend on Rising Mains, 17/18 prices

	£m
Average spend last 5 years (x5)	17.5
Long-term average (x5)	23.0
AMP8 forecast spend	149.4
Asset Deficit Cost Adjustment	**131.9**

12.4 Benefits of the uplift

In line with our commitments, we are forecasting that this investment will lead to improved performance in pollutions, serious pollutions and sewer collapses.

With this investment, we have forecast that by 2029-30, there will be:

- Eight fewer total pollution incidents
- Four fewer serious pollution incidents
- Thirteen fewer collapses, in 2029-30 and through the period 2030-31 to 2034-35 than there otherwise would be without this investment.

These benefits are factored into our performance commitment forecasts on pollution, serious pollution and collapse performance.

13 AMP8 Priority - Sewage Treatment Works (Wastewater Asset Assurance Programme)

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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14 AMP8 Priority - Leakage Find and Fix

In this section we show that:

- This claim is for additional costs of leakage find and fix activity - above and beyond what we believe is funded through Ofwat's base allowance. This claim does not close our Asset Deficit. Rather, it addresses a symptom of it - the cost of which results in us deferring other planned investment causing detrimental impact for customers, communities and the environment.
- Because of the current asset health of our water network, we invest more in find and fix activities than other companies to offset leakage recurrence (the rate of leakage breakout across our network).
- Poor asset health also means that our network is not resilient to weather events (such as freeze thaw or drought). The only lever we have at our disposal to recover leakage after a weather event is doing more find and fix activity. Our plan for AMP8 is to be proactive – to offset the likely impact of weather. In AMP8, we are planning to deliver a higher level of leakage benefit through find and fix every year. The total cost of find and fix in our AMP8 plan is £504.0m with a unit cost of £0.243m/Ml of leakage benefit.
- We have also proposed a cost adjustment claim for mains replacement. However, this is the beginning of a multi-AMP investment programme to restore asset health, and benefits will take time to materialise.
- We have worked out an 'implicit allowance' for find and fix activity, which we consider is approximately 50% of what we need to spend on find and fix to offset leakage recurrence. We value the implicit allowance at £213.2m
- The value of our claim is our AMP8 find and fix plan less the implicit allowance, which is £290.8m.

Appendix 4 contains further details of the cost of servicing the asset health deficit which is the section of the document that describes the cost of servicing the asset health deficit.

14.1 Need for Investment

Our water network is the oldest in England and Wales with over 80% of the current pipes installed in London pre-dating privatisation. Our network is under the most stress, with the highest hydraulic load and volume per length of main.

Our water distribution mains are old and in poor condition and make up a large element of the asset health deficit on Water (13%). There is a clear linkage between the asset health deficit and the performance and costs we see.

One of the most significant costs of servicing the asset health deficit on our Water mains is the cost of finding and fixing leakage to offset leakage recurrence.

There is also additional work associated with leakage recovery events. Following these events plans are put in place to recover leakage performance. This includes capital expenditure, resulting in reprioritisation of the capital programme.

There are ODI penalties for missed performance targets.

14.2 Our Find and Fix plan for AMP8 and Asset Deficit Claim

Table 31 below explains the build-up for our AMP8 find and fix plan to hit our leakage target and retain sufficient activity to proactively plan to offset future weather events. The table deducts our assessment of the implicit allowance from our AMP8 plan. The remaining amount £290.8m of the value of our claim for Asset Deficit, which has been included in Data Table CW3.134 and CW3.135.

Table 31 - Bridge from our AMP8 find and fix plan to asset deficit claim

	Unit	25/26	26/27	27/28	28/29	29/30	AMP8
Leakage benefit to offset recurrence	Ml	351.0	351.0	351.0	351.0	351.0	1755.0
Proactive find and fix to offset weather	Ml	63.8	63.8	63.8	63.8	63.8	319.1
Total find and fix leakage benefit	Ml	414.8	414.8	414.8	414.8	414.8	2074.1
Unit cost of find and fix	£m/Ml	0.243	0.243	0.243	0.243	0.243	
AMP8 find & fix opex	£m	50.4	50.4	50.4	50.4	50.4	252.0
AMP8 find & fix capex	£m	50.4	50.4	50.4	50.4	50.4	252.0
AMP8 find and fix totex	£m	100.8	100.8	100.8	100.8	100.8	504.0
Implicit allowance find and fix opex	£m	21.3	21.3	21.3	21.3	21.3	106.6
Implicit allowance find and fix capex	£m	21.3	21.3	21.3	21.3	21.3	106.6
Implicit allowance find and fix totex	£m	42.6	42.6	42.6	42.6	42.6	213.2
Asset deficit claim find and fix opex	£m	29.1	29.1	29.1	29.1	29.1	145.4
Asset deficit claim find and fix capex	£m	29.1	29.1	29.1	29.1	29.1	145.4
Asset deficit claim find and fix totex	£m	58.2	58.2	58.2	58.2	58.2	290.8

Fundamental to our AMP8 find and fix plan is our planning assumption of £0.243m/Ml of leakage benefit derived from find and fix activity. This has been derived from our annual budgeting process and leakage recovery plan presented to our Board. To offset leakage recurrence, we need to delivery 351 Ml of leakage benefit through repairing leakage mains, customer communication and supply pipes and fittings every year. We have spent considerable time focussing on delivering this activity as efficiently as possible. During AMP7, we have brought our repair gangs in-house and we are changing our approach to target larger leaks.

Experience shows us that delivering 351 Ml of leakage benefit each year is still not enough. We are not resilient to weather events such as freeze thaw and drought – both of which occurred during 2022/23. To get our leakage performance back on track in AMP7, the only viable course of action available to us has been to do more find and fix activity.

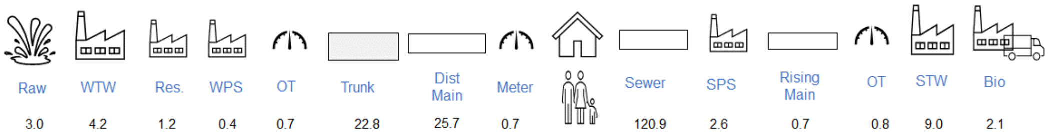
We want to be more proactive in AMP8. To get on the front foot in our annual planning and hit our leakage performance commitment, we will be increasing find and fix activity to deliver an additional leakage benefit of 63.8 Ml each year, to offset the detrimental impact of weather events, when they hit us. Delivering a total leakage benefit of 2,074.1 Ml through find and fix in AMP8 will cost £504m. We have assumed that 50% of this totex will be capitalised, commensurate with our current planning.

We have calculated the implicit allowance for find and fix activity. Details of our calculations can be found in Appendix 4. Our conclusion is that if our network had average asset health then we need to do approximately 50% of the 351 Ml to offset leakage recurrence. Using our unit cost of £0.243 / Ml results in an implicit allowance of £213.2m

Deducting the implicit allowance from our AMP8 find and fix plan results in an Asset Deficit claim of £290.8m in AMP8.

15 Appendix 1 Valuing the Asset Base

15.1 Valuing the Asset Base – GMEAV



	Raw	WTW	Res.	WPS	OT	Trunk	Dist Main	Meter	Sewer	SPS	Rising Main	OT	STW	Bio	
GMEAV	3.0	4.2	1.2	0.4	0.7	22.8	25.7	0.7	120.9	2.6	0.7	0.8	9.0	2.1	**196.9**

£BN, 2022/23 prices numbers may not add to total due to rounding

At PR09, companies included an asset inventory submission in their final business plans. This provided a review and report on both water and wastewater asset stock by quantity, condition grade and gross modern equivalent asset value as of 31 March 2008.

The work undertaken for the PR09 submission was comprehensive. All assets were verified against corporate systems and asset surveys were completed by both external and internal work teams. We carried out detailed physical investigations on 100% by value of our water non-infrastructure asset stock. We surveyed 68% of the treatment assets and 39% of sewage pumping stations for the wastewater non-infrastructure asset stock. Detailed desktop investigations of other assets were carried out. This data was used to complete the Asset Inventory tables and it enabled analysis of the condition of our asset stock. In addition, a full asset revaluation was completed.

At PR14, the asset inventory tables were updated in terms of quantities and asset value but the requirement to report condition grades was dropped. Since PR14 asset inventories by quantity have been updated in the annual return tables.

15.1.1 Valuations derived from the historical asset inventories.

15.1.1.1 Coverage of assets using this approach

The assets covered in this section are:

- Storage Reservoirs
- Intake Pumping Stations
- Source Pumping Stations
- Booster Pumping Stations
- Service Reservoirs and Water Towers
- Water Treatment Works (WTWs)
- Sewage Pumping Stations (SPSs)
- Sewage Treatment Works (STWs)

The analysis undertaken excludes a small proportion of the asset base including management and general assets, intangible assets, and some network ancillaries.

15.1.1.2 Step 1 – PR09 asset inventory

We extracted the bottom-up asset level valuation data from the feeder database used to populate the PR09 asset inventory data tables. In the PR09 asset inventory. For example, WTWs had a GMEAV of £2,371m in 2007/08 prices as set out in FBP Table C3.1.

For WTWs, this was built up from 5,716 rows of financial valuations with depreciation codes and asset lives that enabled current cost depreciation calculations to be undertaken. The GMEAV sum of the 5,716 rows in the database is £2,195m in 2005/06 prices. We used RPI to adjust this to 2007/08 prices resulting in £2,371m.

The £2,371m entered in PR09 Table C3.1 included an adjustment factor (0.88 for WTWs). This adjustment was made to replacement costs calculated in Thames Water's Engineering Estimating System (EES). The logic for applying the adjustment at PR09 was that the project data which was used to calibrate the EES models primarily included smaller (perhaps asset level) replacement and refurbishment projects which were not reflective of the site wide new build cost that GMEAV seeks to capture.

For this analysis where real-life investment programmes on a site are delivered in a manner like the projects used to calibrate EES, this adjustment is inappropriate. Removing this adjustment factor results in a WTW GMEAV of £2,812m in 2007/08 prices.

15.1.1.3 Step 2 – PR14 asset inventory

GMEAVs were updated in PR14 Tables W5 and S5. This was £3,001m for WTWs in 2012/13 prices (sum of the water treatment lines plus the treated water storage line, which we used for atmospheric contact tanks at WTWs). We inflated the PR09 asset inventory value of £2,371m (inclusive of the adjustment factor) using the CPI-H index to give a PR09 value of £2,732M. Therefore, the valuation of WTWs increased by 9.9% in the five-year period between PR09 and PR14. We made a top-down assumption that this increase was due to the net outcome of asset additions and disposals and that the asset lives in the asset additions and disposals were of the same proportion as per the PR09 asset base for WTWs.

We applied the 9.9% 'asset additions' adjustment to the PR09 asset valuation (without adjustment) and we also removed the 14.59% central overhead rate at PR14 that was applied to the capital programme. This resulted in a WTW GMEAV of £3,107m in 2012-13 prices.

15.1.1.4 Step 3 – Update to 2017/18 prices

We inflated the PR14 valuation of WTWs to 2017-18 prices using CPI-H. This resulted in a GMEAV of £3,352m in 2017/18 prices.

15.1.1.5 Step 4 – Account for additions and disposals since PR14

We reviewed our annual return financial data for the period from PR14 to 2021/22. We identified the enhancement additions project expenditure and asset disposals per year relating to the relevant asset groups. We then used the CPI-H index to convert the project costs and asset disposals to 2017/18 prices. For water treatment works, this increased the GMEAV to £3,447m, an increase of £95m.

15.1.1.6 Step 5 – Account for overlap with OT valuation

In this analysis, we have accounted for Operational Technology (OT) as a separate asset group. To reduce the risk of double-counting OT assets in the asset valuation, we deducted the value of short-life ICA assets from the valuations of raw water assets, booster pumping stations, service reservoirs and water towers, water treatment works, sewage treatment works and sewage pumping stations. Overall, the deductions of £1,038m in 2017/18 prices are slightly lower than our valuation of OT, which is £1,100, reflecting that some of the OT estate is related to the water and sewerage networks.

For water treatment works, the OT deduction was £294m, taking the final GMEAV of this asset group to £3,153m in 2017/18 prices.

15.1.1.7 Step 6 – Account for adopted private pumping stations

For sewage pumping stations, we used the March 2023 gross book value (fair value) of £23.6m for eligible adopted stations, which is in 2017/18 prices.

15.1.1.8 Step 7 – Update to 2022/23 prices

We inflated the valuations to 2022/23 prices using CPI-H and applied the current forecast of central overhead of 13.3%.

15.1.1.9 Summary of results

We have applied the above methodology for the main above ground asset groups and raw water assets. The results are summarised in the table below which shows a total GMEAV of £20,536m.

£m 2022/23 prices	Raw Water	WTW	Service Reservoirs	Water Pumping Stations	Sewage Pumping Stations	Sewage Treatment	Sub-Total
GMEAV	3,040	4,218	1,176	427	2,633	9,043	20,536

We have noted that the GMEAV of service reservoirs at PR14 is likely to be a significant under-estimate based on our recent study costs for a rebuild of two reservoir cells in condition grade 5.

15.1.2 GMEAV of the other asset groups

15.1.2.1 Coverage of assets using this approach

The assets covered in this section are:

- Trunk mains
- Distribution mains
- Customer meters
- Gravity sewers
- Rising mains
- Sludge treatment and disposal
- Operational technology

15.1.2.2 GMEAV of trunk mains

Our trunk mains decision support tool includes a link to the latest EES model. The GMEAV of trunk mains is £22,806m.

15.1.2.3 Valuation of distribution mains

Our distribution mains decision support tool includes a link to the latest EES model. The GMEAV of distribution mains is £25,687m. Note this includes communication pipes.

15.1.2.4 *Valuation of customer meters*

We have used our revenue meter stock as reported in Table 4R of the 2023 annual return (AR23) as the basis for the GMEAV. In addition, we used our DMA fingerprinting application to obtain the number of non-revenue bulk meters that are fitted to bulk connections to aid our understanding of consumption.

We then referred to our ongoing work on PR24 to obtain unit rates for two types of meter replacements:

- Household Smart meter (also used for bulk meters)
- Business Smart meter

Applying these rates to the metering inventory gives a GMEAV of £665m.

15.1.2.5 *Gravity sewers*

We used the asset inventory valuations at PR14 for critical sewers, non-critical sewers, combined sewer and emergency overflows, and other sewer structures. We then removed the PR09 adjustment factor described above and the central overhead rate at the time and then inflated the values to 2017-18 prices.

Then we inflated to 2022/23 prices and included the current forecast of the central overhead rate.

The valuation and length of non-critical sewers was used to derive a replacement unit rate. We then applied 50% of the non-critical sewers unit rate to the 40,000 km of formerly private sewers and lateral drains (s105A sewers) that were not included in the PR14 valuation. Applying this methodology, which includes S105A sewers gives a GMEAV of £120,903m.

15.1.2.6 *Rising mains*

Our rising mains decision support tool includes a link to the latest EES model. The GMEAV of rising mains is £2,695m.

15.1.2.7 *Sludge treatment and disposal*

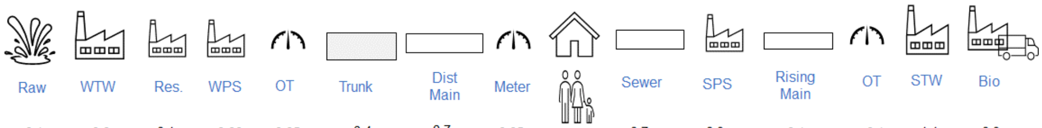
We used our September 2022 submission to Ofwat for the gross valuation of Bioresources assets. We then applied CPI-H indices and the adjusted for the forecast central overhead rate to give a GMEAV of £2,123m.

15.1.2.8 *Operational technology (OT)*

We used our Engineering team's estimate of the GMEAV of £1,100m for OT assets in 2017/18 prices and then inflated this to 2022/23 and added central overhead. This results in a valuation of £1,471m in 2022/23 prices. As described above, we deducted the value of short-life ICA assets from the valuations of raw water assets, booster pumping stations, service reservoirs and water towers, water treatment works, sewage treatment works and sewage pumping stations to avoid double-counting.

16 Appendix 2 Assessment of Deterioration Rates

16.1 Assessment of deterioration rates



	Raw	WTW	Res.	WPS	OT	Trunk	Dist Main	Meter		Sewer	SPS	Rising Main	OT	STW	Bio	
Deterioration	0.1	0.6	0.1	0.06	0.05	0.4	0.7	0.05		0.7	0.3	0.1	0.1	1.1	0.3	**4.7**

£BN, 2022/23 prices numbers may not add to total due to rounding

16.1.1 Valuations using standard asset lives

16.1.1.1 Coverage of assets using this approach

The assets covered in this section are:

- Storage Reservoirs
- Intake Pumping Stations
- Source Pumping Stations
- Booster Pumping Stations
- Service Reservoirs and Water Towers
- Water Treatment Works (WTWs)
- Sewage Pumping Stations (SPSs)
- Sewage Treatment Works (STWs)

The analysis undertaken excludes a small proportion of the asset base including management and general assets, intangible assets, and some network ancillaries.

16.1.1.2 Step 1 - Calculating annual deterioration based on PR09 asset inventory

From the PR09 asset inventory data, we used the depreciation categories and the ‘useful economic lives’ associated with these categories to determine the annual depreciation of the GMEA value for all assets in 2007/08 prices.

16.1.1.3 Step 2 – PR14 asset inventory

We assumed that the asset life mix at PR09 and PR14 were the same. We then used the updated PR14 valuation of GMEA to update the annual depreciation in 2012/13 prices.

16.1.1.4 Step 3 – Update to 2017/18 prices

We inflated the PR14 valuation of annual depreciation to 2017/18 prices using the CPI-H index.

16.1.1.5 Step 4 – Account for additions and disposals since PR14

We reviewed our annual return financial data for the period from PR14 to 2021/22. We identified the enhancement additions project expenditure and asset disposals per year relating to the relevant asset groups, complete with the asset class information. We then calculated the depreciation linked to the additions and disposals using the ‘useful economic life’ for the asset class. We then used the CPI-H index to convert the depreciation to 2017/18 prices.

16.1.1.6 Step 5 – Account for overlap with Operational Technology valuation

In this analysis, we have accounted for Operational Technology (OT) as a separate asset group. To reduce the risk of double-counting OT assets in the asset valuation, we deducted the value of short-life ICA depreciation from the valuations for raw water assets, booster pumping stations, service reservoirs and water towers, water treatment works, sewage treatment works and sewage pumping stations.

16.1.1.7 Step 6 – Account for adopted private pumping stations

For sewage pumping stations, we used the March 2023 gross book value (fair value) of £23.6m for eligible adopted stations, which is in 2017/18 prices and our financial 'useful economic life' for these stations to calculate the depreciation.

16.1.1.8 Step 5 – Judgement of effective asset management

We applied a judgement that effective asset management would enable deterioration to be offset through operational and maintenance interventions that were 15% less than the value of the annual depreciation of the medium and long-life assets.

16.1.1.9 Step 6 – Update to 2022/23 prices

We inflated the valuations to 2022/23 prices using CPI-H and applied the current forecast of central overhead of 13.3%.

16.1.1.10 Summary of results

We have applied the above methodology for the main above ground asset groups and raw water assets. The results are summarised in the table below which shows a total 5-year deterioration estimate of £2,304m.

£m 2022/23 prices	Raw Water	WTW	Service Reservoirs	Water Network Pumping	SPS	STW	Sub-Total*
Assumed deterioration	116	624	88	62	295	1,119	2,304

16.1.2 Valuations of the deterioration for the other asset groups

16.1.2.1 Coverage of assets groups using this approach

The assets covered in this section are:

- Trunk mains and distribution mains
- Customer meters
- Gravity sewers
- Rising mains
- Sludge treatment and disposal
- Operational technology

16.1.2.2 Valuation of trunk mains and distribution mains deterioration

16.1.2.2.1 Step 1 – Deterioration rate and length

During AMP5 and AMP6, we commissioned some projects to review the material deterioration rate of our ferrous water mains. The analysis utilised nearly 1,000 pipe samples and used pit depth analysis to calculate remaining pipe wall thickness. This was used to establish the average remaining life of the ferrous network, which was 101 years. At company level, the deterioration rate between 2020 and 2030 was calculated to be 1,680 km or 0.53% per annum (based on our total mains length of 31,750 km on 31 March 2021).

For trunk mains, this gives a 5-year deterioration rate of 90 km when applied to our whole trunk mains length and for distribution mains a 5-year rate of 750 km.

We believe our estimates of deterioration are appropriate for this analysis. However, we note we have made a significant assumption that our non-ferrous mains are not deteriorating and that the only deterioration mode is material deterioration.

16.1.2.2.2 Step 2 – Value the deterioration

We used the unit rates for replacement based on the London and Thames Valley average rates determined by our AIM decision support tool and EES.

16.1.2.2.3 Step 3 – Judgement of effective asset management

For trunk mains we applied a 40% asset management factor to effectively reduce the length of main in a 5-year period from 90 km to 54 km. This was on the basis that the distribution mains have a higher failure rate than trunk mains and hence the 0.53% per annum deterioration is likely to be low for distribution mains and high for trunk mains.

For distribution mains, we did not apply an asset management factor due to the exclusion in this analysis of other failure modes. As we have seen this year in our mains repair performance, our pipes are vulnerable to other failure modes (or factors that combine with material deterioration) including ground movements due to drought or freeze-thaw conditions.

16.1.2.2.4 Step 4 – Update to 2022/23 prices

This results in a **5-year deterioration estimate for trunk mains of £363m.**

This results in **5-year deterioration estimate for distribution mains of £681m**.

16.1.2.3 Valuation of customer meters deterioration

For our basic household and non-household meters, we have not assumed deterioration as they are all assumed to be in asset health deficit due to their limited functional capability.

We used our PR24 unit rates for Smart meters to give the assumed annual cost of meters reaching end of useful life. As many of our Smart meters are new, we have have assumed nil deterioration for half of our stock. For the other half, we have assumed a 15-year life. This results in **5-year deterioration estimate for Smart meters of £49m**.

16.1.2.4 Valuation of gravity sewers deterioration

Our gravity sewer performance based on collapse rate is currently the best in England and Wales and is relatively stable[8]. Therefore, we have assumed that our current levels of maintenance expenditure in AMP7 on gravity sewers, sewer structures and overflows is sufficient to maintain stable asset health.

This gives a **5-year deterioration value of £710m**. We note that this rate of expenditure implies that sewerage assets, excluding rising mains, have a life of 850 years.

16.1.2.5 Valuation of rising mains deterioration

Our recent rising main burst performance, as reported in our annual returns shows a deteriorating trend, despite overall sewer collapses being stable.

Total nr	AR15	AR16	AR17	AR18	AR19	AR20	AR21	AR22	AR23
Sewer rising main bursts	37	48	58	70	82	79	97	82	106

We are working on developing rising main condition assessment and monitoring tools to help develop deterioration models. In the meantime, we have used a design life of 100 years for cast iron rising mains as a proxy for a 1% deterioration rate.

We applied this deterioration rate to our rising main valuation and then applied a 15% effective asset management factor as we will utilise our rising mains dashboard to facilitate risk-based investment decision making. This gives a **5-year deterioration value of £115m.**

16.1.2.6 Sludge treatment and disposal deterioration

We used our September 2022 submission to Ofwat for the gross valuation of Bioresources assets which included the assessment of CCA depreciation. We then applied CPI-H indices and a 15% asset management factor and adjusted for the forecast rate of central overhead from the depreciation value. This gives a **5-year deterioration value of £344m**.

16.1.2.7 Valuation of OT deterioration

We used the average of our Engineering team's estimate of the maintenance that will be required in AMP8 and AMP9 resulting in a **value of in a deterioration value of £153m.**

[8] Historical performance trends for PR24_V1.1, Ofwat, 2023

17 Appendix 3 Cost of Servicing the Asset Health Deficit

17.1 Cost of servicing the asset health deficit

Since our March 2023 submission on asset health deficit to Ofwat, we have undertaken further work to qualify and quantify the cost of servicing the asset health deficit. This high cost takes multiple forms. These include Section 209 insurance costs, reactive capital projects to rehabilitate pipes that have high burst rates, having to spend more to offset leakage recurrence than any other company, additional work associated with leakage recovery events, ODI penalties for missed performance targets and pollutions fines and costs.

The costs presented in this section are in 2017/18 prices. We have included £290.8m of these costs relating to finding and fixing leaks as described in Section 14. Sections 17.1.1 and 17.1.2 contain further information on this.

There are further costs of servicing the asset health deficit that will need to be covered by our Botex plans. Some quantified examples are in Sections 17.1.3 to 17.1.5.

Sections 17.1.6 and 17.1.7 explain our proposals to address the potential cost of failure associated with ODIs.

17.1.1 Finding and fixing leakage to offset recurrence

Problem statements:

Our water network is the oldest in England and Wales with over 80% of the current pipes installed in London pre-dating privatisation. Our network is under the most stress, with the highest hydraulic load and volume per length of main. Our network has poor asset health, with the highest levels of leakage and mains repairs compared to other companies. Consequentially, we spend significantly more on reactive operating cost activities to maintain leakage levels relative to other companies.

Principal asset health deficit linkages – Distribution mains condition; Distribution mains deterioration

Industry Comparison – Our PR24 Cost Adjustment Claim for mains replacement sets out industry comparisons for three metrics:

1. 2021/22 3-year average leakage per km of potable main (linked to PR19 common performance commitment)
2. Number of mains repairs per 1,000km (PR19 common performance commitment)
3. Average water network operating cost per length of main 2011/12 to 2021/22 (£m, 22/23 prices)

The results of these comparisons are summarised in the table below.

Metric	Industry average	Thames Water	Thames Water vs Industry Average
1. Leakage per km	8.72	19.09	2.19
2. Mains repairs per 1,000 km	126*	223*	1.77
3. Operating cost per length of main	3.73	7.80	2.09
Average	-	-	**2.0**

**Source: Discover Water*

Based on this comparative position, we have assumed that if our water mains asset health improved to the industry average, our leakage recurrence would be half of today's level.

Current position – We presented our current leakage recovery plan in a paper to the Thames Water Board in November 2022. In this paper, the base leakage recurrence level for 2023-24 and 2024-25 is set at 351 Ml/d per year and the outturn costs to find and fix the leaks is stated at £287k per Ml/d (or £243k per Ml/d in 2017-18 prices using the CPI-H index).

Impact on Botex

Based on the current position and the industry average comparison, the annual costs of the asset health deficit in terms of finding and fixing leaks is 50% of 351 Ml/d find and fix at £243k per Ml/d. This totals £42.6m per annum for proactive leakage control.

Counterfactual

The counterfactual is presented in the industry comparison section above.

Cost of servicing the asset deficit

Due to our leakage recurrence per km being twice the industry average, we estimate that we spend £213m more on base find and fix activity than we would if our water network performed at the average level.

These find and fix costs constrain the funding available to replace the poor performing mains that would help offset deterioration and over time improve performance and reduce the asset health deficit. **The find and fix costs associated with the asset health deficit in this analysis is the £213m.**

We also note that in this analysis, we have not quantified the additional costs that we incur in relation to fixing reactive leaks when compared with the industry average.

17.1.2 *Leakage Events*

Problem statement – Our water network is prone to increased rates of breakage in drought and freeze thaw weather events, resulting in increased levels of leakage that take a significant time and effort to recover from.

Due to the three-year average measurement of this performance commitment, we require significant outperformance in 'normal' years to build up the performance headroom to negate the annual average increase in a weather affected year.

Principal asset health deficit linkages – Distribution mains condition; Distribution mains deterioration

Cost of servicing the asset deficit
In response to the summer drought of 2022, and resulting increase in leakage, we implemented a substantial and ambitious Leakage Recovery Plan. This will continue through the remainder of AMP7 and see benefits as we enter AMP8. We have estimated that the find and fix component of our leakage event recovery costs are £78m. In AMP8 we want to retain the extra find and fix capability funded by the recovery plan to build up the performance headroom required to keep leakage three-year average performance on track through future weather events.

17.1.3 Claims and Section 209 Insurance costs due to water mains bursts

Problem statement - The high failure rate of our water network assets (trunk mains, distribution mains, communication pipes and ancillaries) leads to claims and annual insurance costs that are far higher than for an efficient company.

Principal asset health deficit linkages – Risk of basement flooding; Distribution mains condition; Trunk mains deterioration; Distribution mains deterioration

Current position – For 2023-24, our insurance programme includes approximately £5m in current prices for Section 209 insurance that covers claims resulting from water asset bursts. For each claim, we are liable for the first £10m. If the total of the claims exceeds £55m in the year, we are insured for the costs above £55m.

Historical analysis – The table below shows the number of individual claims and the total claim cost assuming the 2023-24 insurance rules apply. The costs are re-baselined to 2017/18 prices using the CPI-H index and considering the claim set-up date rather than the event date.

	AMP5 annual average	AMP6 annual average	AMP7 annual average* (Apr21-Mar23)
No of Claims	617	938	699
Total Claim value £m	13.4	19.9	20.2
2023-24 S209 insurance £m	4.0	4.0	4.0
Total Thames costs	21.4	23.9	24.2

Some claims still outstanding and not provisioned for in table

Impact on Botex
Based on the above analysis, we have used the AMP6 average to assess the flooding claims and Section 209 insurance costs for Thames Water at £120m per AMP

Counterfactual
All companies will have Section 209 insurance and are likely to have clean water flooding claims.

Cost of servicing the asset deficit
We have assumed that our costs are 4 times higher than an efficient company with healthier water network assets and lower average property prices and rental prices than in the Thames Water region. Therefore, the insurance costs associated with the asset health deficit in this analysis is £90m.

17.1.4 Water capital programme reprioritisation

Problem statements:

Following critical trunk main asset failures, solutions to mitigate the risk of repeat failures result in reprioritisation of the capital programme.

Drought events expose the asset health deficit in our water production assets. Capital maintenance solutions are added to the plan to improve resilience, resulting in reprioritisation of the capital programme.

Following leakage events, leakage recovery plans are put in place to recover leakage performance. This includes capital expenditure, resulting in reprioritisation of the capital programme.

Principal asset health deficit linkages – Risk of basement flooding; Operational risks; Trunk mains deterioration; Distribution mains deterioration; Water treatment works deterioration.

Current position – Following our acceptance of the PR19 final determination, our internal AMP7 business plan was signed off by our Board in March 2021. We have compared this version of the plan with the latest Year 4 budget version. This shows we have increased expenditure on reactive projects, as itemised in the table below.

Main Asset Groups	Project / programme	IBP2b AMP7 £m	2023-24 Budget AMP7 £m	Note
Trunk mains	Millennium Main, South London Westhorne Avenue, South London Queens Drive, North London Baker Street, North London Lee High Road, North London Osney Bridge, Oxford	11.3	48.1	A combination of issues emerging since the IBP2b and projects requiring significant extra scope following appraisals of asset condition and risk
WTWs	Drought resilience works Shalford WTW resilience Slough/Wycombe/Aylesbury WTW resilience Thames Gateway WTW	18.9	69.9	Drought event exposed risks, local supply demand resilience and Gateway scope of works
Distribution mains	Leakage Event Recovery	-	-	£78m included in section 17.1.3
	TOTAL	30.2	118.0	

Impact on Botex

The reactive driven Botex expenditure that has emerged since the IBP2b is £87.8m, excluding the leakage recovery event costs.

Counterfactual

All companies will have reactive events. Cost sharing in place to account for expenditure above PR19 allowances.

Cost of servicing the asset deficit
At present, these reactive costs result in deferrals of planned capital maintenance works that would help offset deterioration. Deferring planned capital maintenance to the next AMP perpetuates our asset health deficit. Therefore, the reactive costs associated with the asset health deficit in this analysis is the full £87.8m.

17.1.5 Sewerage capital programme reprioritisation

Problem statements:

Following rising mains bursts, solutions to mitigate the risk of repeat failures result in reprioritisation of the capital programme.

The Northern Outfall sewer (bridges) is a very critical asset in North London. Remedial works of the NOS bridges can result in significant reprioritisation of the capital programme.

Principal asset health deficit linkages –Rising mains risks; Rising mains deterioration; Gravity sewer deterioration.

Current position – Following our acceptance of the PR19 final determination, our internal AMP7 business plan was signed off by our Board in March 2021. We have compared this version of the plan with the latest Year 4 budget version. Expenditure on sewerage has increased significantly in part due to the Wastewater Asset Assurance Programme (WAAP). We have not included the WAAP programme in this section.

We have also had to accommodate some reactive network expenditure and some maintenance recovery work at two of our largest STWs. These are itemised in the table below.

Main Asset Groups	Project / programme	IBP2b AMP7 £m	2023-24 Budget AMP7 £m	Note
Rising mains	West Hyde rising main	-	29.4	Issues emerged post IBP2b
	London Road, Newbury rising main	-		
	Haydon End, Swindon rising main	-		
Northern Outfall Sewer	Corporation Street bridge remediation	19.6	42.5	Solution complexity underestimated in IBP2b
	Manor Road bridge remediation			
	Stratford High Street bridge remediation			
STWs	Mogden STW recovery project	-	14.0	Issues emerged post IBP2b
	Crossness STW recovery project	-		
	TOTAL	19.6	85.9	

Current position – Following our acceptance of the PR19 final determination, our internal AMP7 business plan was signed off by our Board in March 2021. We have compared this version of the plan with the latest Year 4 budget version. Expenditure on sewerage has increased significantly in part due to the Wastewater Asset Assurance Programme (WAAP). We have not included the WAAP programme in this section.

Impact on Botex
The reactive driven Botex expenditure that has emerged since the IBP2b is £66.3m.

Counterfactual
All companies will have reactive events. Cost sharing in place to account for expenditure above PR19 allowances.

Cost of servicing the asset deficit
At present, these reactive costs result in deferrals of planned capital maintenance works that would help offset deterioration. Deferring planned capital maintenance to the next AMP perpetuates our asset health deficit. **Therefore, the reactive costs associated with the asset health deficit in this analysis is the full £66.3m.**

17.1.6 Water Supply Interruptions ODI Penalties

Problem statement - The poor asset health and high failure rate of our water assets leads to large outcome delivery incentive penalties.

Principal asset health deficit linkages – Risk of basement flooding; Water supply resilience; WTW deterioration; distribution mains condition; Trunk mains deterioration; Distribution mains deterioration

Current position – While we have improved our underlying supply interruptions performance, our recent history shows we remain vulnerable to large events due to asset health deficits. These large events contribute a significant proportion of our reported performance.

Historical analysis – Since 2016/17, there have been 43 supply interruption events with an impact of greater than 20,000 property hours. Of these 23 were in London and 20 were in Thames Valley & Home Counties. The events are listed below.

Year	London	TVHC
2016/17	**36k**: Kingston Road, 30" burst main, Surbiton zone **36k**: Lee High Road, 24" burst main, Oxleas Wood	-
2017/18	**349k**: Woodfield Avenue, Norwood, Freeze thaw, 12+18" burst mains **110k**: Bromley Event, 18" burst main, multiple zones **43k**: Crystal Palace reservoir, freeze thaw **29k**: Goldhawk Road, 30" burst main, Barrow Hill **28k**: St Johns Road 36" burst, Crouch Hill, Maiden Lane **20k**:Lapse Wood Walk, 7" burst main, Crystal Palace Booster zone **21k**: Grosvenor Square, 5" burst main, freeze thaw,Shoot Up Hill **33k**: Goose Green power failure	**40k**: Sheeplands WTW event, Bowsey Hill & Sheeplands zones **46k**: Burghfield Tower power failure **29k**: Earley Booster power failure **26k**: Tilehurst, 12" burst main, Earley Booster / Tilehurst **24k**: East Wichel Way 12" burst main, Overtown **41k**: Sibford, water supply failure
2018/19	**36k**: Lavender Avenue 24" burst, Russell Hill **35k**: Stanstead Road, Croydon, 7" burst **24k**: Brentfield Gardens, Mill Hill, 24" burst **21k**: Southlands Grove, 12" burst, Farnborough	**47k**: Ashendon Event, 12" burst main **22k**: Blackdown incident, burst main **20k**: Longlands Reservoir, 10" burst main
2019/20	**309k**: Hampton WTW Booster, Hampton Country **110k**: Queen's Drive, 36" burst main, Maiden Lane **34k**: Raynes Park / Putney booster, WIMBC	**47k**: Boars Hill 12" burst third party, Boars Hill zones **38k**:Earley Booster failure, Earley Booster zone **24k**: Hagbourne Hill 12" burst main
2020/21	**307k**: Woodford 42" burst main	**117k**: Fobney WTW outage, Earley / Tilehurst Tower

		44k: Hagbourne Hill, 355m burst main, Wantage zones 34k: Netley Mill WTW outage, East Guildford
2021/22	201k: Westside 24" burst main, Mill Hill 26k: Rosendale Road 18" burst main, Crystal Palace 22k: Earls Path 15" burst main, High Beech zone	72k: Netley Mill WTW outage, East Guildford
2022/23	121k: Belsize Road trunk main burst, North London 28k: Finchley Road burst, North London	376k: Oxford network event 118k: Netley Mill WTW, East Guildford 43k: Ladymead WTW, Guildford 53k: New Mill Lane, Burfood Booster, OX29

During AMP6, our performance commitment definition for water supply interruptions included a cap of 20,000 property hours for a single event. In AMP6, this cap no longer exists in the common industry-wide definition.

The impact on our performance of removing this cap, based on the events in the table above is an average of over 00:05:00 MM:HH:SS per year since 2016-17. Furthermore, severe weather events (e.g., freeze thaw and droughts) can result in additional impacts of circa 00:03:30 HH:MM:SS.

Counterfactual

The upper quartile performance in England and Wales for 2021-22 was 00:03:43 HH:MM:SS, ahead of the industry standard target 00:05:00 in 2024-25.

Cost of servicing the asset deficit

With respect to the proposed ODI framework for PR24, we have proposed an alternative approach, which we believe delivers a more balanced approach to risk, whilst delivering significant performance improvements and allowing maximum allowances to be invested in both the asset base and delivering service to customers. For further details please refer to TMS41 Aligning Risk and Return.

17.1.7 Sewerage ODI Penalties

Problem statement – The asset health deficit exposes us to potentially large ODI penalties for Total Pollution Incidents, Serious Pollution Incidents and Discharge Permit Compliance

Principal asset health deficit linkages – Wastewater Asset Assurance Programme (WAAP)

Cost of servicing the asset deficit

With respect to the proposed ODI framework for PR24, we have proposed an alternative approach, which we believe delivers a more balanced approach to risk, whilst delivering significant performance improvements and allowing maximum allowances to be invested in both the asset base and delivering service to customers. For further details please refer to TMS41 Aligning Risk and Return.

18 Appendix 4 - Asset Management Maturity Assessment

We have assessed our asset management maturity in specific relation to asset health and the understanding of asset health deficit at a granular level across all asset cohorts. Maturity has been informed by systematic asset health capability assessments, completed across 99 cohorts that have been subsequently aggregated and mapped to the value chain.

When assessing asset deficit we asked, "do we understand asset health deficit and at what level of granularity (asset or value chain level)?" and scored maturity accounting for capability in relation to key areas such as the use of defined processes and data systems, documentation of processes, associated controls and governance and knowledge of data quality issues or assumptions.

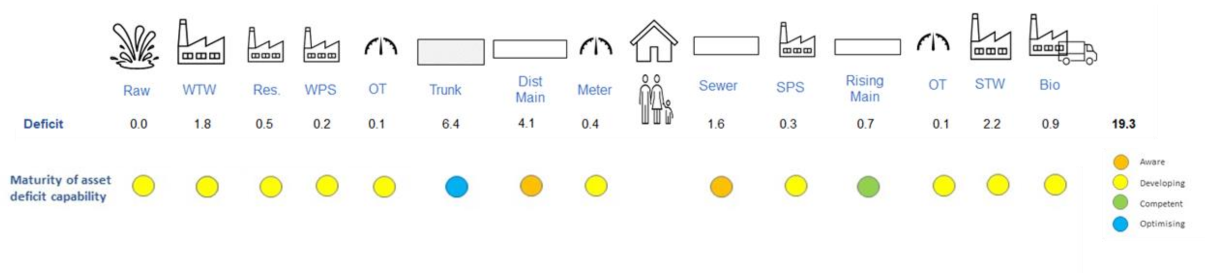
It is emphasised that this activity was completed independently of the wider Ofwat Asset Management Maturity Assessment (AMMA) workstream and intended to determine a granular, bottom-up baseline view of asset health capability from which an improvement plan could be developed.

Though independent to AMMA, responses were scored across all cohorts using the AMMA scoring descriptors as follows:

- Unaware – the organisation does not currently have any relevant processes in place and is unable to demonstrate an understanding of the issue.
- Aware - the organisation is aware of the need to have processes in place and has set out a plan or process to consider this aspect across their activities. There is evidence of intent to progress this plan.
- Developing - the organisation has begun to develop processes, but they are not fully embedded or realised. The organisation has identified the means of systematically and consistently defining the issue and identified what is needed to be monitored. There is evidence of this being progressed with credible and resourced plans in place.
- Competent – the organisation has a fully articulated process in place. The organisation can demonstrate it has an embedded understanding of the issue and established processes for monitoring across all activities.
- Optimising - the organisation has executed the processes it has in place consistently over several years. The processes are repeated, measured, evaluated and continuously improved to meet current and projected business goals.
- Leading - the organisation can demonstrate innovative and leading practice in this area of asset management. If the company selects this level of maturity, it is expected that they will provide details of the innovation and the benefits it brings customers, the company and the environment. The company can share examples of best practice.

The findings are summarised in Figure 36 below illustrating a bottom-up view of maturity in specific relation to the asset health deficit capability. The maturities shown are an aggregation of all the cohorts assessed under each part of the value chain with the most frequently scored maturity presented. An exception to this is trunk mains, where risk is the key determinant of deficit (Section 3.1) and therefore maturity is driven by our understanding of risk and associated replacement costs.

Figure 36 - Assessment of the maturity of our asset health deficit analysis



This shows us:

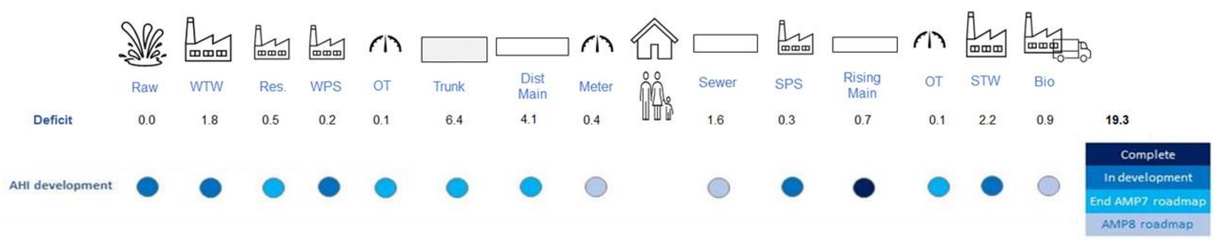
- Asset health deficit capability is most mature for trunk mains and rising mains. As noted, trunk mains deficit is driven by risk and we are particularly mature in this area, owing to our trunk mains risk model. For rising mains, we are "Competent", primarily owing to the development and implementation of the Asset Health Index (AHI) and associated asset health insights dashboard as outlined in Section 12.
- For most other cohorts, maturity is deemed, overall, to be "Developing" as we are in the process of calculating AHI and developing asset insight dashboards in line with the framework already established for rising mains.
- For Distribution Mains and Sewers, AHI will also be developed, but the above asset deficit maturity is shown as "Aware". The aggregation of results masks areas of good practice, for example on critical asset cohorts and distribution mains where risk is well understood but improvement opportunities have been identified on ancillary sub-cohorts, and with the embedment of good practice in business-as-usual process.

As noted, we are working on the development of an Asset Health Index (AHI) for cohorts across the value chain. The approach uses deterioration models to give a long-term view of the expected residual service life of an asset and takes account of both *effective* age (the age of the asset adjusted to reflect its condition, performance and refurbishment history) and economic life (the number of years that a typical asset of a given type is economically 'useful').

This approach is similar to the United Utilities method that was highlighted by Ofwat as a best practice example in their Asset management maturity assessment (report published in September 2021). This measure was also highlighted as one of the recommended asset health measures by the recent Future Asset Planning research project by UK Water Industry Research (UKWIR).

Figure 37Figure 32 summarises our roadmap for the maturing of our approach across the value chain in particular relation to development of AHI.

Figure 37 - Roadmap for development of AHI across the value chain



This shows us:

- AHI has been developed for rising mains and is now in use as a decision support tool for planning and management of risk;
- AHI development work has already commenced on cohorts shown as “in development” with completion due this AMP;
- Similarly, cohorts shown as “End AMP7 roadmap” are also due for completion this AMP but work has not yet commenced; and
- Those shown as “AMP8 roadmap” are planned to be started and completed in AMP8.

19 Appendix 5 SCADA Detailed Plan

Wastewater Programme

PLC	Driver	STW			SPS			Primary 17/18 FYA (Latest & IBP4)
		Number	Unit Cost	Total Cost	Number	Unit Cost	Total Cost	
PLC per AMP run rate	**Evergreen**	500	£60,000	£30,000,000	50	£40,000	£2,000,000	£21,869,688.39
Obsolete PLC replacement , high risk	Obsolescence	660	£60,000	£39,600,000	99	£40,000	£3,960,000	£29,770,113.31
Obsolete PLC replacement , low risk	Obsolescence	330	£60,000	£19,800,000	33	£40,000	£1,320,000	£14,433,994.33
Obsolete PLC replacement in package plant	Obsolescence	330	£60,000	£19,800,000	0	£40,000	£0	£13,531,869.69
Obsolete PLC replacement overlap with PLC per AMP	double counting	-500	£60,000	-£30,000,000	-50	£40,000	-£2,000,000	-£21,869,688.39
Overlap with Capital Projects								-£5,773,597.73
Silver PLC Total Scope		891		£53,460,000	115		£4,600,000	**£51,962,379.60**

RTU	Driver	STW			SPS			Primary 17/18 FYA (Latest & IBP4)
		Number	Unit Cost	Total Cost	Number	Unit Cost	Total Cost	
RTU per AMP	Evergreen	88	32,000	2,816,000	724	24,000	17,376,000	£13,799,773.37
Small SPSs per AMP	Evergreen	0	8,000	0	500	8,000	4,000,000	£2,733,711.05
FLIPs RTU per AMP	Evergreen	0	8,000	0	500	8,000	4,000,000	£2,733,711.05
Obsolete RTU replacement , high risk	Obsolescence	53	32,000	1,696,000	868	24,000	20,832,000	£15,396,260.62
Obsolete RTU replacement , low risk	Obsolescence	18	32,000	576,000	290	24,000	6,960,000	£5,150,311.61
Obsolete RTU replacement overlap with RTU per AMP	double counting	-88	32,000	-2,816,000	-724	24,000	-17,376,000	-£13,799,773.37
Overlap with Capital Projects								-£2,601,399.43
Silver RTU Total Scope		65		£2,080,000	1,402		£28,208,000	**£23,412,594.90**

HMI	Driver	STW	SPS	

		Number	Unit Cost	Total Cost	Number	Unit Cost	Total Cost	Primary 17/18 FYA (Latest & IBP4)
HMI per AMP, high risk	Evergreen	108	£15,000	£1,620,000	6	£15,000	£90,000	£1,168,661.47
HMI per AMP, low risk	Evergreen	132	£15,000	£1,980,000	9	£15,000	£135,000	£1,445,449.72
HMI in package plant per AMP	Evergreen	160	£15,000	£2,400,000	10	£15,000	£150,000	£1,742,740.79
Overlap with Capital Projects								-£435,685.20
Silver HMI Total Scope		173		£2,595,000	10		£150,000	**£3,921,166.78**

Site SCADA	**Driver**	**STW**			**SPS**			**Primary 17/18 FYA (Latest & IBP4)**
		Number	**Unit Cost**	**Total Cost**	**Number**	**Unit Cost**	**Total Cost**	
Obsolete Site SCADA, small	Obsolescence	2	£580,000	£1,160,000	0	£580,000	£0	£792,776.20
Obsolete Site SCADA, medium	Obsolescence	0	£820,000	£0	0	£820,000	£0	£0.00
Obsolete Site SCADA, large	Obsolescence	7	£1,150,000	£8,050,000	0	£1,150,000	£0	£5,501,593.48
Site SCADA, HMI	Evergreen	0	£30,000	£0	1	£30,000	£30,000	£20,502.83
Site SCADA, small	Evergreen	7	£580,000	£4,060,000	1	£580,000	£580,000	£3,171,104.82
Site SCADA, medium	Evergreen	5	£820,000	£4,100,000	0	£820,000	£0	£2,802,053.82
Site SCADA, large	Evergreen	6	£1,150,000	£6,900,000	0	£1,150,000	£0	£4,715,651.56
Overlap with Capital Projects								-£1,700,368.27
Silver Site SCADA Scope				£10,716,000	0		£115,900	**£15,303,314.45**

PLC Networks	**Driver**	**STW**			**SPS**			**Primary 17/18 FYA (Latest & IBP4)**
		Number	**Unit Cost**	**Total Cost**	**Number**	**Unit Cost**	**Total Cost**	
Obsolete PLC Network, HMI	Obsolescence	0	£100,000	£0	0	£100,000	£0	£0.00
Obsolete PLC Network, small	Obsolescence	10	£300,000	£3,000,000	0	£300,000	£0	£2,050,283.29
Obsolete PLC Network, medium	Obsolescence	7	£680,000	£4,760,000	0	£680,000	£0	£3,253,116.15
Obsolete PLC Network, large	Obsolescence	6	£1,200,000	£7,200,000	0	£1,200,000	£0	£4,920,679.89
Poor PLC Network, HMI	Evergreen	0	£100,000	£0	0	£100,000	£0	£0.00
Poor PLC Network, small	Evergreen	1	£300,000	£300,000	0	£300,000	£0	£205,028.33
Poor PLC Network, medium	Evergreen	1	£680,000	£680,000	0	£680,000	£0	£464,730.88

Poor PLC Network, large	Evergreen	2	£1,200,000	£2,400,000	0	£1,200,000	£0	£1,640,226.63
Good PLC Network, HMI	Evergreen	0	£17,500	£0	1	£17,500	£17,500	£11,959.99
Good PLC Network, small	Evergreen	1	£52,500	£52,500	1	£52,500	£52,500	£71,759.92
Good PLC Network, medium	Evergreen	1	£119,000	£119,000	0	£119,000	£0	£81,327.90
Good PLC Network, large	Evergreen	2	£210,000	£420,000	0	£210,000	£0	£287,039.66
Overlap with Capital Projects								-£1,298,615.26
Silver Site SCADA Scope Total		24		£16,160,000	0		£0	**£11,687,537.36**
Telecoms & Infrastructure								**£11,213,006.91**
							Total	**£117,500,000.00**

Water Programme

PLC	Driver	WTW			Network			Primary 17/18 FYA (Latest & IBP4)
		Number	Unit Cost	Total Cost	Number	Unit Cost	Total Cost	
PLC per AMP run rate	Evergreen	375	£60,000	£22,500,000	25	£40,000	£1,000,000	£16,060,552.78
Obsolete PLC replacement , high risk	Obsolescence	643	£60,000	£38,580,000	49	£40,000	£1,960,000	£27,706,162.11
Obsolete PLC replacement , low risk	Obsolescence	248	£60,000	£14,880,000	17	£40,000	£680,000	£10,634,136.22
Obsolete PLC replacement in package plant	Obsolescence	99	£60,000	£5,940,000	0	£40,000	£0	£4,059,561.00
Obsolete PLC replacement overlap with PLC per AMP	double counting	-375	£60,000	- £22,500,000	-25	£40,000	- £1,000,000	- £16,060,552.78
Overlap with Capital Projects								-£4,239,985.93
Silver PLC Total Minimum Scope		786		£47,160,000	57		£2,280,000	**£38,159,873**

RTU	Driver	WTW			Network			Primary 17/18 FYA (Latest & IBP4)
		Number	Unit Cost	Total Cost	Number	Unit Cost	Total Cost	
RTU per AMP	Evergreen	76	£32,000	£2,432,000	45	£24,000	£1,080,000	£2,400,198.36
Obsolete RTU replacement	Obsolescence	0	£45,000	£0	81	£45,000	£3,645,000	£2,491,094.25
Obsolete RTU replacement overlap with RTU per AMP	double counting	0	£45,000	£0	0	£45,000	£0	£0.00
Overlap with Capital Projects								-£489,129.26
Silver RTU Total Minimum Scope		76		£2,432,000	126		£4,725,000	**£4,402,163**

HMI	Driver	WTW			Network			Primary 17/18 FYA (Latest & IBP4)
		Number	Unit Cost	Total Cost	Number	Unit Cost	Total Cost	
HMI per AMP, high risk	Evergreen	63	£15,000	£945,000	16	£15,000	£240,000	£809,861.92
HMI per AMP, low risk	Evergreen	78	£15,000	£1,170,000	20	£15,000	£300,000	£1,004,638.83
HMI in package plant per AMP	Evergreen	94	£15,000	£1,410,000	24	£15,000	£360,000	£1,209,667.17
Overlap with Capital Projects								-£302,416.79

Silver HMI Total Minimum Scope		141		£2,115,000	36		£540,000	**£2,721,751.13**

Site SCADA	**Driver**	**WTW**			**Network**			**Primary 17/18 FYA (Latest & IBP4)**
		Number	**Unit Cost**	**Total Cost**	**Number**	**Unit Cost**	**Total Cost**	
Obsolete Site SCADA, HMI	Obsolescence	0	£30,000	£0	0	£30,000	£0	£0.00
Obsolete Site SCADA, small	Obsolescence	2	£580,000	£1,160,000	0	£580,000	£0	£792,776.22
Obsolete Site SCADA, large	Obsolescence	0	£1,150,000	£0	0	£1,150,000	£0	£0.00
Site SCADA, HMI	Evergreen	15	£30,000	£450,000	0	£30,000	£0	£307,542.50
Site SCADA, small	Evergreen	0	£580,000	£0	0	£580,000	£0	£0.00
Site SCADA, large	Evergreen	7	£1,150,000	£8,050,000	0	£1,150,000	£0	£5,501,593.61
Overlap with Capital Projects								-£660,191.23
Silver Site SCADA Minimum Scope		2		£2,010,000	0		£0	**£5,941,721.10**

PLC Network	**Driver**	**WTW**			**Network**			**Primary 17/18 FYA (Latest & IBP4)**
		Number	**Unit Cost**	**Total Cost**	**Number**	**Unit Cost**	**Total Cost**	
Obsolete PLC Network, HMI	Obsolescence	9	£10,000	£90,000	N/A	N/A	N/A	£61,508.50
Obsolete PLC Network, small	Obsolescence	1	£300,000	£300,000	N/A	N/A	N/A	£205,028.33
Obsolete PLC Network, large	Obsolescence	0	£1,200,000	£0	N/A	N/A	N/A	£0.00
Poor PLC Network, HMI	Obsolescence	3	£10,000	£30,000	N/A	N/A	N/A	£20,502.83
Poor PLC Network, small	Obsolescence	0	£300,000	£0	N/A	N/A	N/A	£0.00
Poor PLC Network, large	Obsolescence	2	£1,200,000	£2,400,000	N/A	N/A	N/A	£1,640,226.67
Good PLC Network, HMI	Obsolescence	3	£1,750	£5,250	N/A	N/A	N/A	£3,588.00
Good PLC Network, small	Obsolescence	1	£52,500	£52,500	N/A	N/A	N/A	£35,879.96
Good PLC Network, large	Obsolescence	2	£210,000	£420,000	N/A	N/A	N/A	£287,039.67
Overlap with Capital Projects								-£225,377.40
Silver Site SCADA Minimum Scope Total		12		£1,600,000	N/A	N/A	N/A	**£2,028,396.56**

Telecoms/ Loggers & Infrastructure								**£9,646,094.47**
							Total	**£62,900,000.00**

Thames Water