PR24

NORTHUMBRIAN WATER living water | ESSEX&SUFFOLK WATER living water

# A3-07 MEETING LEAD STANDARDS

## NES20

## TABLE OF CONTENTS

# 1. INTRODUCTION

The purpose of this document is to describe our approach to determine the interventions and investment required to manage the risk of customers' exposure to lead in drinking water between 2025 and 2030, in line with our long-term strategy goal to be lead free by 2050.

We have an obligation to manage customer exposure to levels of lead below a statutory limit in the Water Supply (Water Quality) Regulations 2016 (10µg/l).

Our current policy for meeting the UK lead standard of 10µg/l is through plumbosolvency (the dissolution of lead into water) control and our commitments to replace lead communication pipes. Plumbosolvency control has the main benefit of providing a level of protection against all lead pipework, including that owned by the customer and throughout the property. We currently achieve this through phosphate dosing and pH control with sodium hydroxide at the water treatment works.

We have, for several years, replaced our lead communication pipes if: there is a sample result at the customer tap greater than 4µg/l; ad hoc replacement at the request of the customer; and when they are 'opportunistically' found during mains structural rehabilitation schemes. Our AMP7 programme aims to deliver 3,730 service pipe replacement across the three priority areas to inform our AMP8 programme planning. This business case describes how we intend to increase our lead replacement programme during AMP8 and how the associated expenditure will take us beyond our current obligations and further protect public health. This is in response to the need to increase the pace of our lead replacement programme.

Parliament's Environment Committee has approved a report to tighten the lead standard in drinking water from 10µg/l down to 5µg/l. This was reinforced by the DWI in its Long-Term Lead Reduction Strategy paper published in 2021[1]. Whilst there is no specific deadline set out for this change in the level, the paper suggests that "10 years is a reasonable but minimum timeframe over which water companies could complete the remediation of lead service pipes in high-risk zones", so potentially by 2035. In addition, this would require replacement of lead pipes up to the compliance sample point, which is the customer tap. Water UK is considering a target of 'lead free' by 2050 for its members. To achieve the new lead standard and the strategic policy, we need to make the pace of intervention (removal) sustainable and at an appropriate level to meet our 2050 goal.

We will work towards our long-term strategy to remove all of our lead communication pipes and Water UK's ambition to be 'lead free' by 2050 through a risk-based approach to managing lead by prioritising both those customers most vulnerable to its effects and those properties at highest risk of non-compliance. This long-term target is reflected in our Long Term Delivery Strategy (LTDS). We will mitigate the risk of lead exposure in those priority areas by going beyond our current responsibility and replacing the full length of service pipe including the customer's lead supply pipe, which has wider benefits

[1] Long-term Strategies to Reduce Lead Exposure from Drinking Water – DWI - February 2021

in reducing the risk of asset failure. Customers support an increase in this investment, which is underpinned by their concerns regarding impact on public health.

To support a sustainable strategy, we will reduce our phosphate dependency through full lead service pipe replacement in discrete rural areas enabling the elimination of phosphate dosing in those areas. This will provide savings on operation, maintenance and future asset replacement of dosing units and chemical storage. While still in place, phosphate dosing will continue to incur operational and maintenance costs and due to its environmental impact will require removal from wastewater. We recognise phosphate dosing is not a permanent solution to the risks posed from lead pipes, and its impact on receiving wastewater treatment works can be challenging to manage, particularly as discharge permitting standards become increasingly stringent.

This case aligns with our NWG Lead Service Pipe Strategy which we believe positions us amongst a leading group of water companies. As members of the WaterUK Lead Steering Group we benefit from industry insight and are actively working in collaboration with other companies sharing good practice and effective ways of working. The evolution and refinement of our approach to lead removal during AMP7 provide the foundations for an increasingly focused, sustainable, and holistic approach during AMP8 and beyond.

This business case relates to Ofwat Data Table CW3 lines for 'Meeting lead standards' (lines CW3.106 to CW3.114).

## 1.1. SUMMARY OF COSTS

Table 1 below shows a summary of our enhancement costs for our AMP8 Lead Replacement Programme. Costs are 100% capex and reflect our preferred solution to address 11,271 property connections and deliver a step change in line with DWI and customer expectations.

**TABLE 1: LEAD REPLACEMENT ENHANCEMENT COST SUMMARY**

| Type of property | Capex (£m) | Opex (£m) |
|---|---|---|
| Northumbrian Water | 30.862 | - |
| Essex & Suffolk Water | 15.961 | - |
| **Total** | **46.823** | **-** |

# 2. NEED FOR ENHANCEMENT INVESTMENT

## 2.1. CUSTOMER AND STAKEHOLDER EXPECTATIONS

### 2.1.1 DWI

The DWI is responsible for monitoring regulatory sample results taken as part of our sampling programme for compliance with the Water Supply (Water Quality) Regulations 2016. Our lead samples are programmed and taken from randomly selected customer taps, to include a mix of public, commercial and domestic properties. Samples are taken throughout the year, and in-line with the regulatory requirements the total number of samples per annum is approximately 800.

When a sample result exceeds 10µg/l, we are required to inform the DWI via a monthly data-return process. Typically, lead sample failures are isolated to the sampled property or the immediate locality. Any consequential risk index score is included as part of the Compliance risk index (CRI) score.

The DWI is responsible for assessing incidents and events we report via the monthly data-return. Lead sample results tend not to be notified as events, unless a 'do not drink' (DND) notice is triggered. To manage compliance with DWI standards we monitor performance against our own internal lead trigger level of 4µg/l. Where results exceed this threshold, we carry out the following actions to determine cause and mitigate further impact:

- review water quality information such as pH and phosphate levels
- replace the communication pipe
- collect resamples following communication pipe replacement

The same actions are taken in the event that a sample taken for operational or customer concern reasons returns a result above the 4µg/l internal trigger level, but these are not notifiable to the DWI.

While the DWI acknowledges the challenge associated with delivering large scale programmes for lead pipe replacement, it is pushing for a step-change in the rate of replacement in AMP8. We have engaged with the DWI and it is supportive of our NWG Lead Service Pipe Strategy for lead pipe replacement and our level of ambition for AMP8 investment.

### 2.1.2 Customers

Our customer engagement highlighted customer concerns about the health risks associated with lead in the network. There is no safe level of lead absorption and lead has been shown to have several negative health consequences, including affecting cognitive development in children. The DWI paper published in 2021 (DWI14372.2/16866-0) states: *'There is sufficient scientific evidence to quantify the adverse human health effects of chronic low-level exposure to lead on neurodevelopment (measured by IQ detriment), cardiovascular disease (CVD: measured by hypertension), and chronic kidney disease (CKD: measured by renal filtration function).'* The study outlined in the DWI report used these metrics to

assess the impact of lead in drinking water, concluding that: *'in both England and Wales, the most significant components to total benefit components from reduced lead exposure from drinking water, in monetary terms, are (a) avoided reduction in lifetime earnings from IQ detriment, and (b) avoided CKD morbidity and mortality. Other benefits include avoided health impacts from CVD caused by lead exposure'.*

In preparation for submission of the PR24 business case we conducted customer affordability and acceptability testing with our customers in both the Northumbrian Water and Essex & Suffolk Water regions. In carrying out our customer engagement, we followed the guidance provided by Ofwat and the Consumer Council for Water (CCW) for high quality research and used the Water Forum (WF) and Customer Engagement Panel (CEP) to provide an independent challenge of our approach. We discuss our research and decision making in more detail in **our line-of-sight document** (NES45).

The purpose of the research was to gain customer feedback on a range of potential investment scenarios for lead pipe replacement in AMP8. These scenarios comprised a 'must do' plan (reflective of maintaining AMP7 levels of replacement), a 'preferred' plan and an 'alternative' plan, with each scenario reflecting a different level of investment and customer bill impact.

In summary:

- Participants were surprised to learn that lead pipes are still present in the network.
- Some participants across the regions felt that lead pipe removal should be treated as a high-priority due to the associated health risks.
- There was strong interest in how the company deals with the dangers of lead by using phosphates.
- Participants highlighted the importance of public health and of removing lead pipes, however many participants in Suffolk stated they didn't feel that this should be paid for by customers. Suffolk participants also wished to be provided with more information about lead pipes, such as the percentage in their area, the progress that has been made so far, and the extent to which it impacts health.
- Customers were in favour of the 'alternative' plan with the higher lead pipe replacement number.

A ranking exercise was undertaken to determine what matters most to customers and therefore which areas they would support greatest investment in:

**What matters most:** The removal of lead pipes was considered the most important area when presented as a mean overall for participants of Essex & Suffolk Water (25 of 159 votes, 16%), and the second most important area when presented as a mean overall for Northumbrian Water participants (21 of 168 votes, 13%).

**Areas requiring the most investment:** participants in Northumbrian Water and Essex & Suffolk Water placed 'Investment to reduce lead pipes in the network because of the health risk' in first place (out of all the possible options in our "preferred" plan for Water).

The removal of lead pipes is an important issue for customers, due to the potential health risks. In our research, the majority of customers included this in their "ideal" plan (**enhancements and other service area summaries**, NES43). However, Ofwat and CCW Preferences Research (2022) showed that replacement of lead pipes was largely not visible to customers, and therefore was not a top priority (**enhancements and other service area summaries**, NES43). One of the service areas tested within the main research was 'The presence of lead in pipes.' Overall, this ranked as of 'some importance/impact'. The potential health consequences of lead pipes were a concern for customers, especially due to the potential impact on children and pregnant women. But largely, the replacement of lead pipes within the network was not visible, meaning customers would not notice any difference or behave any differently on a day-to-day basis on account of water company action. So, while upgrading pipes is within a water company's mandate, in reality it is not a top priority for our customers.

Our pre-acceptability research showed that customers preferred to invest now in lead pipe replacement. We provided several alternative options, and customers preferred faster investment that would meet the Water UK long-term target. We did not identify lead replacement as a specific issue for our **Affordability and Acceptability Testing qualitative research** (NES49), but customers supported our preferred plan including a "medium" lead replacement programme.

Customer research during the PR19 cycle was carried out using a different methodology but also concluded that customers were highly supportive of lead pipe replacement, with 88% of customers voting in support of the enhanced business case package. The latest research for PR24 illustrates that customer support for investment to remove lead from the network remains high, with increased customer support for a greater scale of investment in AMP8. In our "pre-acceptability" customer research, we discussed three options with customers: Continue at AMP7 replacement rates; Accelerated programme; or increasing to a run-rate that would deliver the potential Water UK ambition to be lead-free by 2050. Customers supported the largest option for lead replacement.

Recent press interest in the Suffolk Town of Eye with **a headline including 'lead poisoning'** demonstrated how volatile and emotive the lead challenge can be. We were able to fund lead pipe replacement in the area to address customer concerns via our AMP7 replacement programme. Due to the flexibility of the AMP7 programme, we were able to act quickly, replacing customers lead supply pipes and providing assurance through customer support.

We have considered this carefully and believe our regulators would not support a "high" option – even if customers prefer this. Customers were concerned about health risks, but their concern is higher than the DWI assessment of benefits and risks would suggest, perhaps as it has been difficult to explain the effectiveness of plumbosolvency control. We did not think our customer evidence was sufficient to justify an increase above the DWI supported option, as it is likely to be sensitive to the way this issue is explained and understood. We were also not convinced that the "high" option could be delivered in practice from 2025, as the supply chain for domestic pipework would not be sufficient to deliver this work (and would take more time to increase).

We discussed this with the Water Forum, who **challenged us to do more** (NES47) – as customers supported a higher option. In response, we increased our "medium" option to include tackling more vulnerable customers so that all of these customers would be lead-free by 2030 (according to our estimates – there are likely to still be some isolated cases we can't find). This does not provide activity as much as the "high" option, which would have meant tackling lead in more "hot spot" local areas, but it means that our lead programme is several times larger than in 2020-25.

### 2.1.3 Environment Agency

The Environment Agency (EA) does not have a position on customer lead exposure and legacy pipe materials. However, the EA does have a responsibility for river health and a significant contributor to poor river health is phosphate. Our wastewater treatment plants have discharge permits which specify consents for many parameters of which phosphate is one. A proportion of phosphate dosed to potable water can make its way through WwTW processes, where the site is not optimised to remove phosphate.

A focus of our lead replacement programme is 'phosphate disengagement', where investment in specific, often rural areas of the network allows us to reduce, prevent the need for new installations, or remove plumbosolvency dosing at some of our WTWs, which in turn reduces the downstream impact on WwTW processes. By optimising the plumbosolvency control dosing at WTWs to use the minimum necessary we are balancing public health, consumption of a finite resource and environmental requirements.

## 2.2. CURRENT AND HISTORICAL PERFORMANCE

### 2.2.1 Plumbosolvency control

Lead control is currently achieved through a source to tap approach via chemical (water conditioning) and physical (replacement) intervention. All our large WTWs have plumbosolvency control whereby treated water is dosed with orthophosphoric acid with over 99.6% of our input into the network receiving a dose. Dosing has been optimised since implementation in AMP2 & AMP3 where doses of approximately 2mg/l were common and has now been optimised down to 0.6-1.8mg/l depending on the water quality and the supply area. Optimisation, along with the stabilisation of lead compliance can be seen from the charts below for both Northumbrian (Figure 1) and Essex & Suffolk regions (Figure 2), where the blue bars show percentage compliance against the 10µg/l standard.

FIGURE 1: LEAD COMPLIANCE IN NORTHUMBRIAN WATER REGION

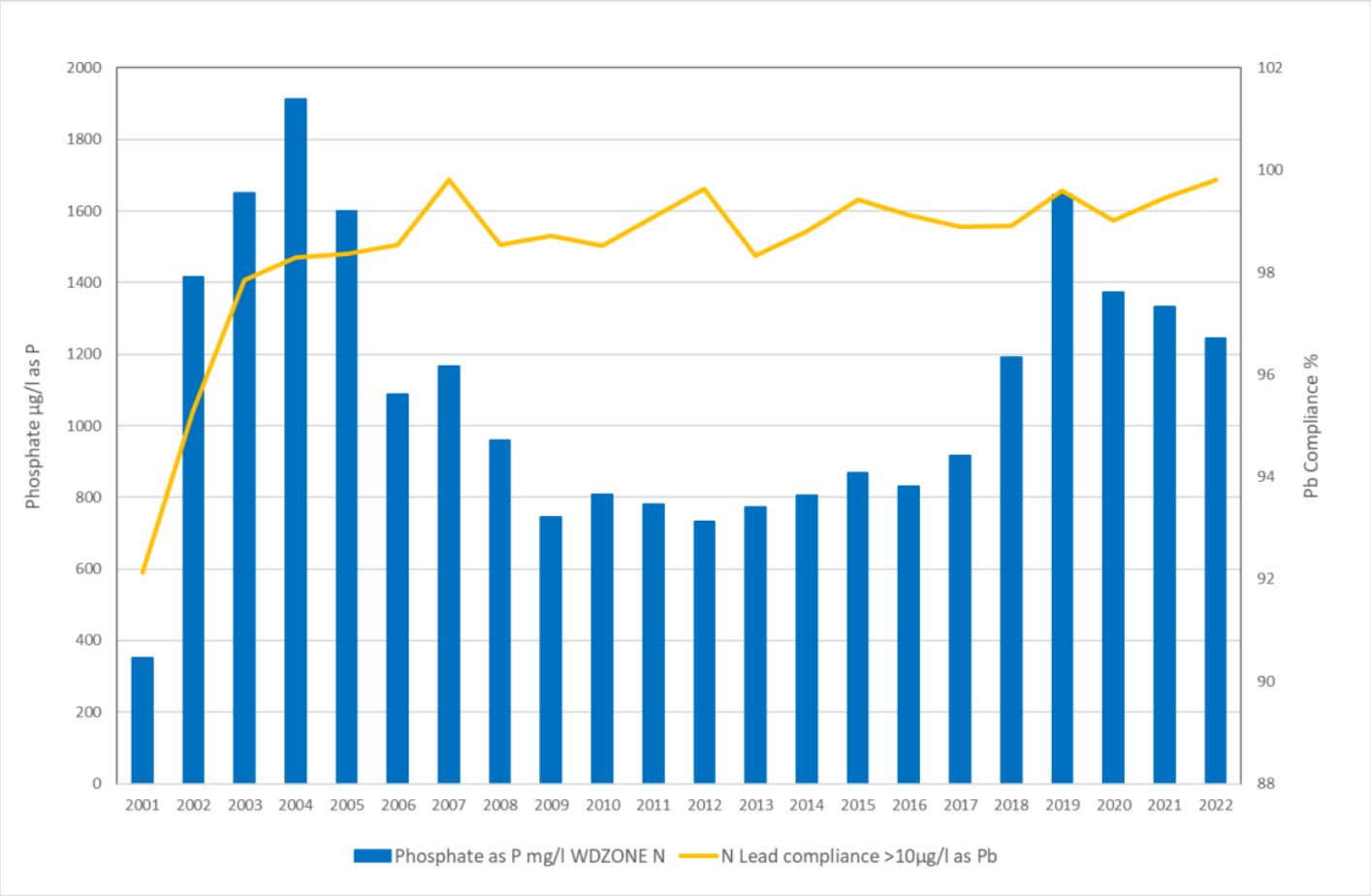
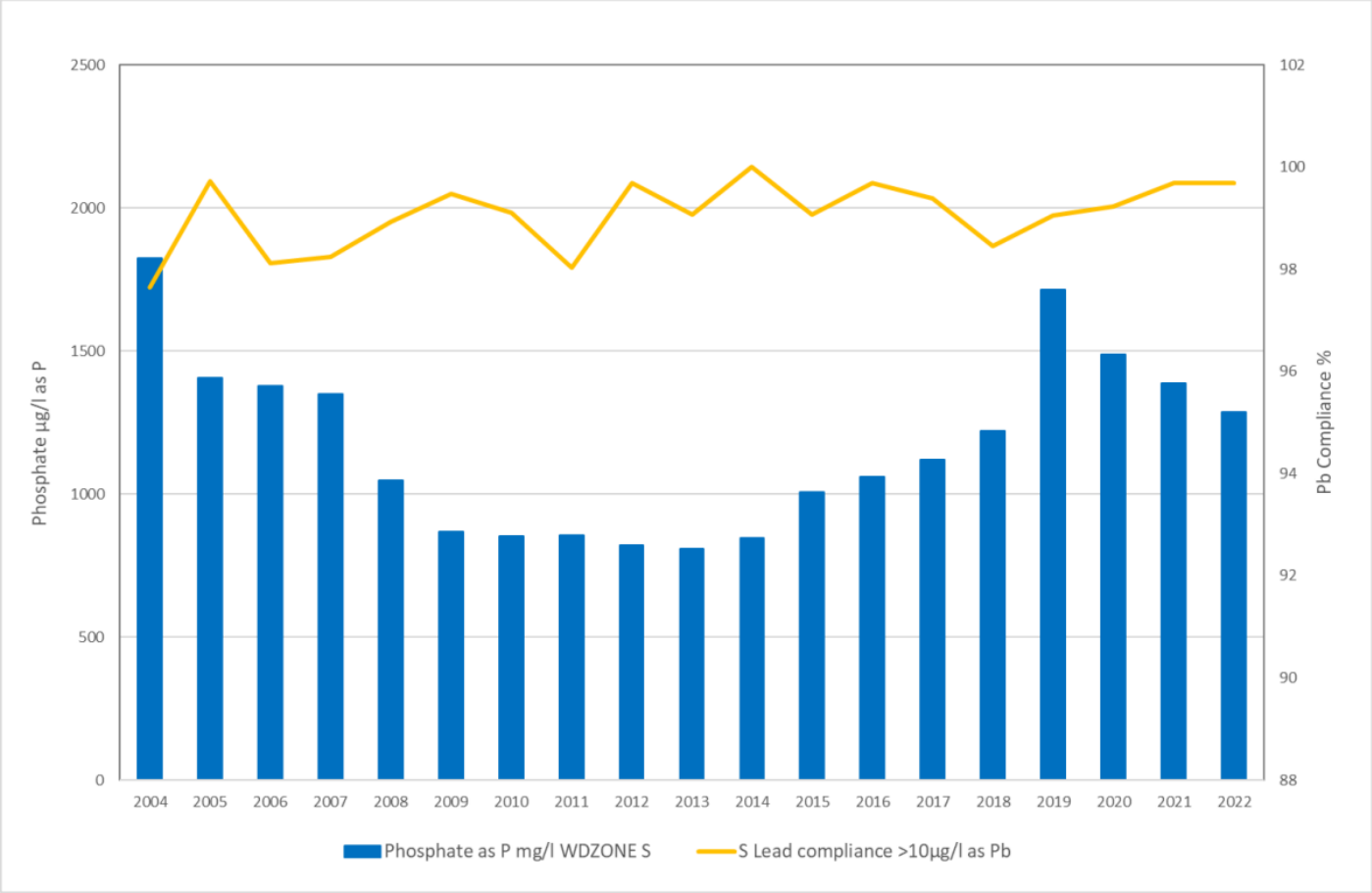


FIGURE 2: LEAD COMPLIANCE IN ESSEX AND SUFFOLK WATER REGION




During AMP6, new sodium hydroxide dosing plants for pH control were installed for water conditioning and to further support plumbosolvency control. The work is completed at four WTWs (Broken Scar and Mosswood, Warkworth and Wear Valley) Sodium hydroxide dosing at these sites, is estimated to be £204,000 OPEX per annum. In 2017, phosphoric acid was dosed across NWG at £1,001,208 OPEX (cost of chemical). Both these costs at the current target dose are considered base maintenance.

No further investment to improve plumbosolvency dosing and control was required in AMP7.

### 2.2.2 Communication pipe replacement process

We have a long-established process for reactive replacement of lead communication pipes, driven by our policy. Interventions to control lead through reactive replacement include:

- Replacement of communication pipes when the sample result (any sample type) is >4µg/l.
- Replacement of all lead pipes when carrying out mains structural rehabilitation (opportunistic replacement).
- Ad hoc replacement of lead communication pipes at customer request.

- Informing customers when their property has exceeded the 4µg/l level and recommending they replace their supply pipe. Provision of health advice by advising customers flush water to waste before consumption/cooking purposes.
- We have defined a specific role within our water team to ensure delivery of lead policy and engage with health authorities to continue to raise awareness of lead pipes with vulnerable groups.

In 2022/23 in both north and south regions we replaced 92 lead pipes as a result of our lead policy - these are reactive replacements associated with water quality triggers. During mains replacement schemes we 'opportunistically' replaced between 1000 and 3000 lead communication pipes annually. All of the above are current policy and considered base maintenance.

## 2.3. AMP7 ENHANCEMENT

For AMP7 we are delivering an enhancement programme for the proactive replacement of 3,730 lead pipes. The overall programme is comprised of the following three sub-programmes:

- Vulnerable groups
- Phosphate disengagement (formerly called 'Rural Supplies')
- Hot-spots

The exact split between the three categories is subject to some variation as numbers of properties to be addressed in each category are estimated, and the reality on site may be different.

### 2.3.1 Vulnerable groups

As a priority, we want to protect those most vulnerable to the effects of lead in drinking water by focusing on lead pipe replacement in public buildings. Children are especially at risk of health impacts from ingesting lead, which can affect cognitive development and reduce average life expectancy. The scope of this sub-programme covers educational buildings (schools, colleges), childcare services (including childminders), and community establishments including places of worship. At these properties our objective is to replace the lead communication pipe and the supply pipe up to one tap, ensuring that there is at least one supply of wholesome water within the building. The replacement of any remaining lead pipe within the property itself is the responsibility of the property owner, and advice is given by our teams to ensure remaining risk is mitigated effectively.

We are working collaboratively with local authorities to raise the profile and importance of lead pipe replacement. Our AMP7 programme aims to address vulnerable properties based on prioritisation carried out via our lead risk assessment study.

### 2.3.2 Phosphate disengagement

We recognise phosphate dosing is not a permanent solution to the risks posed from lead pipes. It is a finite resource with an environmental impact, including posing a challenge to receiving wastewater treatment works with increasingly stringent discharge consents. If customers consent to full lead replacement up to the consumption point, phosphate dosing would no longer be required. This approach will also prevent the need for installation of dosing which may otherwise have been necessary in the future. Where we have a WTW which is the single source of supply to an area, and supplies that area only, we can disengage phosphate dosing once the risk from lead pipes is removed. In AMP7 we have already begun this work in discrete water quality supply zones. There are a small number of WTW sites with no phosphate dosing, as no requirement was identified during AMP2 or AMP3. Should any lead pipes be identified in these areas in the future, we will prioritise their replacement rather than install new dosing plants.

Our AMP7 Phosphate disengagement programme (referred to as 'Rural supplies' in PR19) aims to deliver full lead service pipe replacement for 415 properties in this category.

### 2.3.3 Hot spots

Hot-spot replacement has been carried out in previous AMPs in targeted District Metered Areas (DMA), though historically focused largely on communication pipe replacement, leaving behind a risk from the customer's supply pipe. Lead pipes can be found throughout our geographical area but 'hot spots' are generally found where properties were built before 1970. To mitigate the risk of lead in drinking water at the tap, our current programme targets replacing our lead communication pipes and the customer's lead supply pipes inside their home. The success of replacement therefore requires individual property owner's consent. In 2020/21, we focused on developing our delivery strategy, including setting up the commercial framework, and on implementing the model for delivering and reporting on our lead enhancement commitments. Although, we we're able to commence our lead replacement work in 2021, concerns regarding the COVID-19 pandemic were still high and impacted access to customers property. Therefore, it wasn't until January 2022 that we were able to move forward as planned, undertaking internal and external replacement. We are gaining a greater acceptance from customers to work on their property, and as the pace of replacement has accelerated, we remain confident that we will meet our lead enhancement targets by 31 March 2025.

We have developed an integrated statistical model to identify and target areas with a high proportion of properties with lead pipes. The model is updated on an annual basis. The model analyses multiple variables which may influence the level of lead at the customer tap and calculates an overall weighted risk score to determine properties at greatest risk. These variables include property characteristics (including age and service pipe length) and selected water quality parameters (including pH, sulphate and chloride levels) that are known to have a strong correlation to levels of lead. The model assigns a lead risk score to each property we serve and calculates a high, medium or low probability for the presence of lead. Results can be aggregated to multiple levels (e.g. postcode, DMA) to identify lead hotspots and inform the prioritisation of our lead programme. Figure 3 below shows an example of the model output and a specific housing estate that has been identified as a lead hot-spot, indicated by the red shading.

FIGURE 3: EXAMPLE OUTPUT FROM OUR LEAD RISK MODEL


## 2.4. LINK TO LONG TERM STRATEGY

This investment is needed as part of the 'miscellaneous' investment area under our Long-Term Strategy (LTS) core pathway.

In March 2023 we updated our NWG Lead Service Pipe Strategy. The strategy sets out our approach to managing lead pipes and reducing customer exposure to lead in 2020-30 within the context of our vision to work towards the potential Water UK long-term ambition to be 'lead free' by 2050. This aspirational target – informed by customer preferences – is instrumental in driving our strategic thinking and our desire to deliver a step-change in replacement rates in 2025-30, in line with customer feedback and DWI expectation.

We have set ourselves a long-term target to:

- Remove all of our customers' lead supply pipes by 2050.

We consider this is low / no regret investment because:

- Our customers consider removal of lead as a priority investment area – see 2.1.2.
- The government supports action by industry to trial approaches to reducing exposure of lead to customers from drinking water, from a public health perspective as set out in '**February 2022: The government's strategic priorities for Ofwat**'.
- The DWI supports the replacement of lead customer side supply pipes - the DWI has set out an intention to reduce the lead standard for high-risk zones from 10µg/l down to 5µg/l within the next 10 years.

- Replacement of lead supply pipes permanently reduces the risk to human health and so there is no possibility of this being stranded investment.

We considered what the most appropriate long-term profile for investments in lead pipe replacements should be in our LTS. For example, under some scenarios, this is among the investments we list for possible delay or deferment. However, customers support higher investment in lead replacement now, even in the context of higher investment needs in other areas – and so increasing bills (see 2.1.2). The Water Forum noted that this could become a higher priority for customers, government and media in the future (NES47)

We considered customer views in the context of the DWI support for a "medium" option, and potential concerns about deliverability of our enhancement programme in 2025-30. We concluded that we should deliver a step-change in 2025-30, though would limit this to the "medium" option. The investment option set out in this case ("medium option") is therefore aligned to our LTS and supported by the DWI.

We therefore consider this investment is necessary in 2025-30 to deliver our LTS.

We expect investment in lead replacement to increase in future periods if customers continue to support this and regulators support a step change to achieve "lead free" by 2050. This was not included in all our long-term scenarios for the **draft LTS** that we consulted on in May 2023, with the "affordability focus" scenario delaying this investment to keep bills lower in the short term (this scenario was removed as customers supported investment now). We will review the investment profile for the removal of lead as we update our LTS for PR29, so that we can carry out the customer and stakeholder engagement to understand if there is appetite to increase this further at PR29.

## 2.5. THE NEED IN AMP8

The DWI has set out an intention to reduce the lead standard for high-risk zones from 10µg/l down to 5µg/l within the next 10 years and we have committed to achieving the Water UK ambition for total removal of all lead pipes by 2050. At our AMP7 rate of lead pipe replacement, estimates suggest it will take over 100 years for us to remove our lead communication pipes (we have over 500,000 pipes in total). However, this still leaves a risk from the customer lead supply pipe. This means in the future we must increase our rate of lead pipe replacement and also include customer supply pipes in order to achieve the new lead standard and the 2050 commitment.

# 3. BEST OPTION FOR CUSTOMERS

## 3.1. OPTIONEERING

To address lead in the potable water network, we need to replace the lead pipework which is the root cause of customer concern over risks to health. While we can and do mitigate risk through Phosphate dosing, this is unsustainable and contributes to environmental risk and operational costs of Phosphate removal at our WwTWs. Through replacement of lead pipes, we not only remove the health risk, but also enable a sustainable reduction in chemical dosing.

Because the type of intervention required is well defined and methods well established, our optioneering process has focused on a range of AMP8 investment scenarios for lead pipe replacement: Low, Medium and High. These were developed following a review of current progress against the long-term targets and changing regulatory standards. Similar to our AMP7 programme, each option is a blend of activities targeted to address our three key priorities described in the previous section: 'hot spots', vulnerable customers and Phosphate disengagement in rural/remote communities. The three scenarios reflect differing levels of investment and therefore vary in their contribution toward the 2050 target, and the rationale for each is described in the section below.

We have considered the DWI long term guidance on lead[2]. As the typical asset life for lined lead pipes can be much lower than replacement MDPE pipes, we concluded that we would be revisiting assets within the timeframe of still working to achieve lead free by 2050. Therefore, we have not pursued the lining of lead pipes as a sustainable option.

## 3.2. OPTIONS SUMMARY

Table 2 below shows an overview of the three scenarios (options) considered for our AMP8 programme. All options deliver the same level of Phosphate disengagement replacement. The figure of 986 is the estimated number of replacements necessary to address remaining un-blended water zones (areas where water is supplied from a single WTW) where it is possible to realise sustainable reductions in Orthophosphoric dosing. Lead replacement in areas where water is blended from multiple WTWs will be driven by the hot-spot programme across multiple AMPs. Vulnerable and hot-spot aspects of the programme vary in each option, reflecting a different glide-path to achieving our aspiration of a lead-free network.

[2] DWI Long Term Guidance on water Quality, section 7.4.11

TABLE 2: AMP8 LEAD PROGRAMME OPTIONS

| Option | Description | Phosphate disengagement | Vulnerable customers | Lead hot spot | Total |
|---|---|---|---|---|---|
| 1 | Low – Continue at AMP7 replacement rates | 986 | 223 | 2,521 | 3,730 |
| 2 | Medium – Accelerated programme | 986 | 1,814 | 8,471 | 11,271 |
| 3 | High – Lead free by 2050 run-rate | 986 | 1,670 | 20,744 | 23,400 |

The rationale behind the numbers of properties in each category for each of our three investment scenarios is outlined below:

**Option 1 Low – Continue at AMP7 replacement rates**

The overall total of 3,730 pipes to be replaced is consistent with our AMP7 programme, though the number of pipes for each priority area differs from AMP7 due largely to increased phosphate disengagement investment to target remaining un-blended zones as described in 3.1. For AMP8, we plan to extend the rural supply replacement strategy to different supply zones, including a primary focus in Rothbury to allow termination of phosphate dosing at Tosson WTW and a phosphate reduction at Rothbury WWTW. To achieve this, we believe 986 properties may require full pipe replacement.

The 'hot spot' programme will also increase slightly to deliver a consistent level of lead replacements to AMP7 overall. However, continuing the AMP7 rate of investment for AMP8 and beyond does not deliver our ambition of a lead-free network within the next 100 years.

**Option 2 Medium – Accelerated programme**

This option represents a step-change in replacement rates from our AMP7 programme. It also allows us to complete replacements for both Phosphate disengagement and Vulnerable customers in AMP8, leaving only remaining Hot-spot replacements to be addressed beyond AMP8. The medium option targets a total of 11,271 replacements and is comprised of the following components:

- Phosphate disengagement (986) - The phosphate disengagement focus remains the same for all 3 options due to the limited number of properties that require this intervention and our aim to deliver benefits through dosing reduction in AMP8.
- Vulnerable Customers (1,814) - Our vulnerable customers programme increases over the Low option to ensure a continued focus on managing health risks for our most vulnerable customers. Following customer consultation and

feedback, we increased the vulnerable customers programme to 1,814 which reflects the remaining estimated number of vulnerable customers on our risk register. This will allow us to complete lead pipe replacement for our vulnerable customers in AMP8.

- Hot-spot (8,471) - The most material change in this option is the significant ramp-up of our 'hot spot' programme, which is required to drive a step-change to target a lead-free network.

It should be noted that while this option represents a step-change, it still does not achieve a run-rate that will deliver the benefit of a lead-free network by 2050, and a further increase of replacement rates will be required in future AMP periods.

**Option 3 High – Lead free by 2050**

This option reflects the same level of Phosphate disengagement and Vulnerable replacements as the medium option, but the level of hot-spot replacement is uplifted to approaching the trajectory required to deliver the 2050 target. This is based on a simple calculation of the number of hot-spot lead pipes still present in the network divided by the remaining years until 2050 and assumes a similar level of lead replacement in each AMP between now and 2050.

## 3.3. DELIVERABILITY

We have carried out a review to assess the deliverability of our PR24 programme from an internal organisational perspective as well as looking at the impact on the supply chain. This review evaluated our structure and capability across all components of the delivery framework in the context of the scale of programme required in AMP8 to deliver key investment themes including WRMP Supply Options, Metering and WINEP. The scope of the review and our subsequent action plan to address gaps identified is outlined in A6 – Deliverability (NES07).

In addition, given the specific nature of the lead replacement programme, we have evaluated the deliverability risks associated with the 3 lead investment options outlined above and concluded the following:

- Option 1 – we have shown that we can deliver a run rate similar to our AMP7 programme. Despite a slow start to the current AMP, caused by access restrictions to customers property and supply chain issues associated with Covid-19, we are on track to deliver our PR19 commitments.
- Option 2 – based on our assessment of in-house and supply chain capability required to plan, project manage and deliver the increased rate of lead replacements reflected by the medium option (delivering a step-change from our AMP7 programme), we believe the option is achievable and sustainable.
- Option 3 - Although supported by customers on the basis of health concerns associated with lead pipes in the network, there is significant uncertainty whether delivering this level of programme uplift is realistic in AMP8 given it reflects a >6-fold increase in scale of programme from AMP7.

## 3.4. BEST VALUE

### 3.4.1 Benefit Scoring

Our Value Framework[3] is embedded into our portfolio optimisation tool, Copperleaf, and contains a wide range of benefits which reflect measures that relate to performance commitments or other social and environmental values. First, we score the impact of continuing current levels of action or mitigation (business as usual) and then we score the difference in benefit delivered by each available option. Benefits are scored over a 30-year horizon beginning from the start of AMP8. This scoring considers the certainty of benefits being realised for different types of options.

Table 3 shows the range of benefits (value measures), including their quantification and monetisation values, we have used for the assessment of the shortlisted options. These include water quality implications and carbon emissions. As expected, our value models have been able to demonstrate that benefits to water quality will increase as more lead pipe is replaced, and the amount of carbon emitted to do this will also increase. Therefore, Option 3 (High) will deliver the greatest benefit to customers through reducing the number of properties impacted by lead in their drinking water from customer pipes (using Water Quality Compliance), and the frequency of lead water quality events per year (using CRI Score). However, this will come at the cost of carbon emission as Option 3 will result in the greatest amount of embedded carbon emissions (6,432 $tCO_2e$), compared to Option 1 (1,071 $tCO_2e$) and Option 2 (2,536 $tCO_2e$).

**TABLE 3: RANGE OF BENEFITS IDENTIFIED FOR LEAD REPLACEMENT**

| Value measures | Description | Unit | Value |
|---|---|---|---|
| CRI Score | Reduction of instances of Drinking Water Inspectorate (DWI) noncompliance | CRI Score | Non-monetised |
| Water Quality Compliance | Number of water quality non-compliance events | £/Non-compliance event | £228.41[4] |
| Embedded Emissions | t/CO2e / year | tCO2e | £256.20[5] |

Note, we have not monetised CRI here because these benefits are already captured under water quality compliance events.

[3] Copperleaf Technologies Inc., 2002, Northumbrian Water Limited Value Framework Definition Document, v1.6.
[4] £ value for Water Quality Network Compliance, value dependent on water quality parameter and scale of impact. Lead - Illness due to the water supply (Chemical) in the Network with 0-1000 customers affected.
[5] £ value per tonne of $CO_2e$ in 2025/26, annual increase (varying rate) reaching £378.6/t CO2e in 2054/55.

### 3.4.2 Cost benefit appraisal to select preferred option

For each of the technically feasible options we have undertaken a cost benefit appraisal within our portfolio optimisation tool to select the preferred option. This calculates an NPV over 30 years in accordance with the PR24 Guidance and cost to benefit ratio for each option. The ratio is calculated by dividing the present value of the profile of benefits by the present value of the profile of costs over the appraisal period of 30 years.

Costs and benefits have been adjusted to 2022-23 prices using the CPIH Index financial year average. The impact of financing is included in the benefit to cost ratio calculation. Capital expenditure has been converted to a stream of annual costs, where the annual cost is made up of depreciation/RCV run-off costs and allowed returns over the life of the assets. Depreciation (or run-off) costs are calculated using the straight-line depreciation over the appraisal period. To discount the benefits and costs over time, we have used the social time preference rate as set out in 'The Green Book'.

Table 4 presents the NPV and value calculated against the Carbon and Water Quality Compliance value models for each of the 3 Lead Replacement options.

**TABLE 4: NPV AND VALUE MODEL OUTPUTS FOR LEAD REPLACEMENT OPTIONS**

| Option | Net Present Value (30 years) (£) | Carbon tCO2e Cost (£) | Water Quality Compliance Value (£) |
|---|---|---|---|
| Low – Continue at AMP7 rates | -13,977,334 | -247,667 | 6,577 |
| Medium – Accelerated programme | -38,798,049 | -586,276 | 9,383 |
| High – Lead free by 2050 run-rate | -78,875,078 | -1,486,752 | 16,144 |

It should be noted that the only value models relevant to this investment in our Copperleaf tool are Carbon, CRI impact and Water Quality Compliance. Carbon calculates an addition cost (carbon impact), the CRI measure is not monetised, but the private and societal costs are captured in the Water Quality Compliance model, which calculates a very small benefit. This is because it is based on the anticipated reduction in current levels of lead-related customer tap failures as a result of lead-replacement activity. We have few such events, and they score very low values under the CRI methodology, which results in a very low benefit calculation in Copperleaf.

As Table 4 shows, the option cost is the material factor in driving the NPV, and therefore the lowest cost solution (Low – Continue at AMP7 rates) has the most favourable NPV.

### 3.4.3 Preferred Option Selection

In addition to the consideration given to cost benefit assessment outlined above, and in line with the material factors driving the need for this investment (detailed in Section 2), we have considered a number of other factors in selecting our preferred option. We have selected the medium option taking into account the following:

- Step change in AMP7 programme - greater ambition, in line with DWI expectations (see Section 2.1.1).
- Responding to Water Forum feedback by increasing the number of replacements to address all remaining vulnerable customer connections in AMP8 (see Section 3.5).
- Responding to customer feedback, increasing replacement rates to address concerns related to health impacts.
- Targeting phosphate disengagement benefits in AMP8 (see Section 2.3.2).
- Ambitious but deliverable. Uncertainty associated with the high option due to scale of programme and supply chain capacity.

The Water Forum noted that this could become a major issue in future, and it would be sensible to be as ambitious as possible now, particularly given customer support for this issue and their concern about public health.

## 3.5. CUSTOMERS VIEWS INFORMING OPTION SELECTION

We know from our previous customer engagement that customers see lead replacement as a high priority – particularly where they are concerned about public health. For PR24, we asked customers about the three options in Section 3.2 above, to understand their preferences.

As set out in Section 2.1.2, customers were surprised that there were still lead pipes and most customers felt that these should be prioritised. When presented with the three options directly in qualitative focus groups and People Panels, customers chose the “high” option.

Customers supported a higher level of investment and are willing to pay for this. While there is no change to the statutory lead standard, there is clear regulatory guidance to inform company lead ambitions in AMP8. We are able to continue meeting the 10µg/l standard that is still the official guidance, and the DWI long-term strategy reduction paper suggests a reduction to 5µg/l by 2035 or 2040 and no detectable lead by somewhere between 2055 and 2070.

This suggests that some step-change in lead replacement is needed to meet the likely future changes in standards, but there is no regulatory or statutory expectation that we should increase to our “high” rate. DWI has supported our medium option.

We have considered this carefully, and we believe our regulators would not support a “high” option – even if customers prefer this. Customers were concerned about health risks, and perhaps it has been difficult to explain the effectiveness of

plumbosolvency control. This concern does align with the DWI assessment of benefits and risk, and the Inspectorate would support a higher level of investment. However, we were not convinced that the 'high' option could be delivered in practice from 2025, as the supply chain for domestic pipework would not be sufficient to deliver this work (and would take more time to increase).

We discussed this with the Water Forum, who challenged us to do more – as customers supported a higher option. In response, we increased our "medium" option to include tackling more vulnerable customers so that all of these customers would be lead-free by 2030 (according to our estimates – there are likely to still be some isolated cases we can't find). This does not provide activity as much as the "high" option, which would have meant tackling lead in more "hot spot" local areas, but it means that our lead programme is several times larger than in 2020-25.

Our **line-of-sight document** summarises our customer evidence and decision making on our lead programme (NES45).

# 4. COST EFFICIENCY

## 4.1. UNIT RATES AND COST METHODOLOGY

Our PR19 unit rate for lead replacement was calculated at £2,754 and derived from our PR19 programme budget of £10,270,741, which planned to deliver replacements to address 3,730 properties. Applying CPIH inflation to adjust the cost from 2018/19 price base (£12,288,208) results in an adjusted unit cost rate of £3,294, which **includes indirect costs** (overheads and risk).

It should be noted that the above PR19 unit costs included an allowance for communication pipe replacement. However, we have found that our PR19 costs were underestimated. Therefore, we have focused our AMP7 programme on areas where only supply pipe replacement is required. Our AMP8 unit rates reflects learning from AMP7 and includes both communication and service pipe replacement costs.

Our cost consultants calculated AMP8 unit rates based on cost modelling carried out on 248 hotspot replacement activities from our AMP7 programme. The costs were calculated based on analysis of property and activity variables for each of the 248 replacements, including reinstatement surface type, internal and external pipe lengths.

Because the available data was for replacement activities carried out at properties in areas where we previously carried out communication pipe replacement, we have added the communication pipe cost. These costs were based on an average communication pipe length of 6m (to cover both long and short services), connection to the main, blanking off the old connection and connection to the new supply pipe. As shown in Table 5, the analysis calculated a unit rate of £3,095, uplifted to 22/23 price index and **exclusive of indirect costs**.

**TABLE 5: CALCULATED LEAD REPLACEMENT UNIT RATE (DIRECT COSTS ONLY)**

| Activity type | No of replacements assessed (properties) | Average cost per replacement |
|---|---|---|
| Hot spot replacements | 248 | £3,095 |

## 4.2. BENCHMARKING

### 4.2.1 Direct costs

Mott MacDonald has benchmarked our £3,095 unit cost rate for direct costs against two other water and wastewater companies of comparable size, assessing unit rate per property against equivalent data for lead replacement interventions (NES63). Cost comparisons have been calculated using the most recent company iMOD cost curves and adjusted for

inflation using CPIH to a price base of Q2 2022. Table 6 below shows the output of our benchmarking, with our unit rate calculated as 6% more efficient than the benchmark.

**TABLE 6: BENCHMARK SUMMARY (DIRECT COSTS)**

| Activity type | Northumbrian | Benchmark | Delta (£) | Delta (%) |
|---|---|---|---|---|
| Lead pipe replacement unit cost | £3,095 | £3,291 | -£196 | -6% |

### 4.2.2 Indirect costs

Indirect costs of delivering our lead replacement programme are not included in our unit cost rate of £3,095 (for example, investigations, surveys and trial holes that result in no lead connections found, impact of access restrictions at vulnerable properties such as schools, and other abortive costs). Therefore, we have calculated indirect costs required to support delivery of our AMP8 options. For Contract and Project overheads, we have done this by reviewing the output generated by our iMOD cost modelling and discounting all aspects of overhead that do not specifically apply to the lead replacement programme (for example, allowances for security and access that are usually included in Contract overheads, and external project management and feasibility costs that are often included in Project overheads). Risk allowance has been reduced to 10% on the basis that use of a unit cost rate and AMP7 experience provides a greater level of cost certainty.

Direct and indirect costs are shown in the following section for each of the options described in 3.2.

## 4.3. COST SUMMARY

Table 7 shows the benchmark unit rate (£3,095) and our calculated indirect costs applied to the 3 investment options described in Section 3.2.

The total cost including indirect costs for our preferred 'Medium' option is £46.823m, which reflects a total unit-rate including indirect costs, of £4,154.

**TABLE 7: COST SUMMARY FOR LEAD REPLACEMENT OPTIONS**

| Option | Total Properties | Direct cost (£m) | Indirect cost (£m) | Total cost including OH & Risk (£m) |
|---|---|---|---|---|
| Low – Similar to AMP7 | 3,730 | £11.544 | £5.284 | £16.828 |
| Medium – Accelerated programme | 11,271 | £34.884 | £11.939 | £46.823 |
| High – Lead-free by 2050 | 23,400 | £72.423 | £22.417 | £94.840 |

The cost split between our Northumbrian and Essex & Suffolk Water regions shown in Table 8 has been calculated on the following basis:

- Phosphate disengagement – all 986 activities are in our Northumbrian Water area
- Vulnerable Customers – the 1,814 activities have been split based on individual property location data (1021 in NW, 793 in ESW)
- Hotspots – activities are split based on the relative % of Very High, High and Medium lead-risk sites in each area, derived from the latest outputs of our Lead Risk Model described in Section 2.3.3. This equates to 64% in our NW region and 36% in ESW.

**TABLE 8: PREFERRED OPTION (MEDIUM) – REGIONAL COST SPLIT**

| Region | Total Properties | Direct cost (£m) | Indirect cost (£m) | Total cost including OH & Risk (£m) |
|---|---|---|---|---|
| Northumbrian Water | 7,429 | 23.425 | 7.641 | 30.862 |
| Essex & Suffolk Water | 3,842 | 11.459 | 4.298 | 15.961 |
| **Total** | **11,271** | **£34.884** | **£11.939** | **£46.823** |

# 5. CUSTOMER PROTECTION

## 5.1. PERFORMANCE COMMITMENTS

Performance commitments (PCs) incentivise water companies to improve performance and maximise outcomes for customers and the environment. We do not expect this case to affect our performance commitments, as the benefits relate to public health and are not easily measured.

## 5.2. PRICE CONTROL DELIVERABLE

Our approach to determining Price Control Deliverables (PCD) is outlined in Section 12.3 of **A3 – Costs** (NES04). In Table 9 below, we assess our "meeting lead standards" enhancement case to test if the benefits are linked to PCs, against Ofwat's materiality of 1%, and to understand if there are outcome measures that can be used.

Our assessment shows that the outcome of this case is not covered by performance commitments.

**TABLE 9: ASSESSMENT OF BENEFITS AGAINST THE PCD CRITERIA**

| Enhancement scheme | Benefits linked to PC? | Materiality | Possible outcomes? |
|---|---|---|---|
| Meeting lead standards (NES20) | Pass – no benefits linked to PCs | Pass – 1.6% | Outcome not covered by performance commitments.<br>Outcome relates to public health and not easily measurable. |

We propose a price control deliverable (PCD) based on the number of properties moved to being lead free (that is, lead pipes replaced). This is similar to our PR19 performance commitment for "delivery of lead enhancement programme", which returns the unit costs of not delivering pipe replacements to customers (if they are not delivered in period).

We considered setting this separately for each of phosphate disengagement, vulnerable customers, and hot-spots – as these have different costs. However, this is more complex for setting a PCD. We also plan to complete all our modelled vulnerable customers, so if we did find that some of these properties were in fact lead-free, we would have to return money to customers instead of tackling more lead pipes elsewhere. We concluded that a single unit rate would be more appropriate.

This meets the Ofwat principles in the following way:

- **The benefits of this investment are not linked to or fully protected by performance commitments (PCs)**. There are no PCs which relate to lead replacement, or the wider outcome of improved public health.
- **PCDs should be used to protect customers for material enhancement investments**. This enhancement is around 1.6% of totex for 2025-30, and so is above the threshold for materiality.
- **Outcomes over outputs/inputs**. The outcomes for public health cannot be easily observed or measured, with long-term uncertainty and no direct way to measure the link between this work and health outcomes for individuals (that is,

this could only be done through long-term studies for samples across the wider population). We considered if this could be linked to phosphate disengagement as an outcome, but this is not the primary benefit and would not be reflected in performance on the vulnerable customers and lead hot spots components. The best option seems to be to continue with lead replacement delivery, as at PR19.

- **Level of aggregation**. As this is about delivery of lead pipe schemes, there aren't any other PCDs which overlap with these benefits. We have proposed other PCDs which operate in a similar way, but we think these are best kept separate rather than adding many components to a single PCD. This helps to keep this simple and supports us explaining this more clearly to customers in the event that we were unable to meet this commitment.

**TABLE 10: SUMMARY OF THE PRICE CONTROL DELIVERABLE FOR OUR WINEP PROGRAMME DELIVERY TO PROTECT CUSTOMERS**

| Description of price control deliverable | **Delivery of lead replacement programme** (as set out in NES20) |
|---|---|
| **Measurement and reporting** | We will report on the delivery of lead pipe replacement through the APR and in our PR29 business plan. |
| **Conditions on scheme** | None. |
| **Assurance** | No specific assurance required, other than our normal assurance on our performance reporting. |
| **Price control deliverable payment rate** | £4,154 per lead pipe replacement not delivered. The unit rate presented here is not adjusted for cost sharing. |
| **Impact on performance in relation to performance commitments** | None |

There are no third-party funding or delivery arrangements for this investment.