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PR19: Leakage Strategy

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Executive summary

Driver for investment

Our customers expect a high level of reliability in relation to their supply of water. We know from our customer research that leakage is an emotive topic with views divided between those customers who recognise the significant financial aspects associated with finding and repairing leaking pipes and those who feel strongly that leakage is unacceptable and we shouldn't be wasting any water at all.

Our challenge over the next AMPs is to realise customer and stakeholder expectations and ensure we are able to provide a resilient water supply system, reducing leakage and the associated level of water to be treated. This, in turn, will reduce our operating costs as a result of needing to store, treat and distribute less water.

The investment

We propose to invest £71.0 million during AMP7 to meet the sustainable economic level of leakage (SELL). This is equivalent to a reduction of 26 Ml/d from our end of AMP6 forecast leakage rate of 169 Ml/d to a value of 143 Ml/d by the end of the AMP7 period. The SELL assessment should be seen as a range, due to the level of uncertainty in the analysis.

Our analysis shows that the economic level of leakage lies 15% to 20% below the level we aim to achieve by the end of AMP6. We consider that a 15% reduction over the course of AMP7 is the appropriate level we should aim for due to the need to make significant changes to working methods and technology. We will use AMP7 to improve confidence in our cost – benefit analyses with a view to making further reductions in future. Our plan will include a greater focus than ever before on customer side losses tackling leaking pipes and appliances within households through our Project Cartref programme.

A summary of our planned programme for delivery in AMP7 by the main investment types is shown in Table 1 below with the associated investment required.

AMP7 Leakage Programme	Total by Investment Area
Upstream Losses	£1.53m
Distribution Losses	£60.96m
Customer side Losses	£3.66m
Lead Supply Replacement	£4.86m*
Total programme (pre-efficiency)	**£71.0m**
Total programme (post-efficiency)	**£70.3m**

Table 1: Summary of proposed leakage investment for AMP7

* A further £10m investment for replacement of lead supply pipes is included within our Water Quality investment case which will also contribute to reduction of leakage levels

Delivering for our customers

This work will meet the following of our customer promises:

Clean, safe water for all: Reduce the amount of clean water wasted and improve stability of mains pressures across our networks

Put things right when they go wrong: Reduce the number and repair times for burst mains and leaks by improving our monitoring and operational practice, through SMART networks.

A better future for all our communities: Reducing wasted resource to make sure expensive treated water is not wasted and that pressures in the network are maintained

Delivering for the future

In Welsh Water 2050, we identified future trends. The requirement for this investment is driven by the following trends:

Climate change: More extreme temperatures will increase the likelihood of burst pipes in the future.

Changes in customer expectations: Changing customer and societal expectations may require us to ensure that all customers have a minimum universal service standard.

Changes to the structure of the economy: By protecting our treated water pipelines we can reduce the amount of that we have to treat

Delivering our Strategic Responses

In Welsh Water 2050, we set out to deliver 18 Strategic Responses. This investment will contribute to the following:

Protecting our critical water supply assets: Provide greater reliability to water supply systems.

Addressing our worst served customers: Undertaking interventions to enable minimum service standards to be delivered to all customers.

Enough water for all: Making sure that as much of the water that enters our pipelines reaches out customer's taps

Towards a lead free Wales: Replacing leaking service pipes that are made from lead to protect the health of our customers

Smart Water Systems management : Making the most of the latest leakage detection technology to manage our networks and identify leakage sooner

Achieving our measures of success

For PR19, we will measure our performance based on measures of success (MoS). This investment will contribute to achieving the following MoS:

Measure of Success	End of AMP6 Position	End of AMP 7 Position
Leakage in mega litres per day (Ml/d)	169	143
Three year rolling average	171	148.2

1 Delivering our customer outcomes

Need for investment

Welsh Government expects companies to forecast a reduction in leakage over the planning period and Ofwat have also set an expectation that water companies will significantly leakage of the order of 15% during the AMP7 period.

Reducing leakage will reduce the volume of water that we need to treat and our operating costs as a result of needing to store, treat and distribute less water.

Our current strategy is based upon achieving what is known in the water industry as a 'sustainable economic level of leakage' (SELL). This measure is based on the principle that the cost of reducing leakage rises significantly as the level of leakage reduces and that there comes a point at which the production of water is cheaper than the additional effort and cost needed to reduce leakage further. In other words, it becomes much more costly to our customers to go below the sustainable economic leakage level.

Regulatory Requirements

There is a regulatory requirement for every water company to provide an assessment of its sustainable economic level of leakage (SELL). This is required to inform companies' Water Resources Management Plans (WRMP) as part of the business planning process and has hitherto been used to provide leakage targets for operational leakage management.

We have prepared an initial SELL assessment for the draft WRMP19 and this Business Plan. However recent regulatory guidance includes both changes in leakage reporting procedures and a challenge for water companies to aim for more ambitious reductions in leakage.

The approach used in 2017 to generate our initial SELL assessment for the draft WRMP19 is consistent with the methodology developed and utilised at PR14. The regulatory review of our approach at PR14 found it to be compliant with available technical guidance, industry best practice, and PR14 regulatory guidance, and there were indications that the methodology was at the leading edge of UK Water Companies' SELL assessment approaches. A summary of technical guidance documents that underpinned the SELL assessment at PR14 is provided in Appendix 1 and also subsequent technical guidance that has informed development of the draft SELL assessment during 2017.

Views of our customers and stakeholders

We have undertaken extensive consultation with customers through our PR19 preparation programme, including our Welsh Water 2050 strategy consultation held in the summer of 2017, which engaged with 19,980 of our customers.

During our consultation for Welsh Water 2050, providing enough water for all was amongst the most important aspects of our future plans, followed by providing reliability of supply and water quality[1,2]. Customers have stressed that they want stable water quality and reliability of supply, including resilience to extreme events.

We discussed leakage with our customers in our research relating to the Water Resources Management Plan. It is a highly emotive topic with customers seeing it as wasteful and inefficient. The impact on the environment of over abstraction is also raised. However, most customers understand the concept that there is an economic level of leakage.

The performance targets research gave a similar response, with a comment that something must be done to protect this precious natural resource. The investment options voting was different between the different groups, highlighting the polarisation of views on this emotive topic.

Overall 53% of respondents voted for no change in the current performance on leakage and 31% voted for the largest reduction we showed them, which was about 6%. The research took place before

1 WW2050 Qualitative Debrief, 2017- engaging with 108 customers

[2] Summer Consultation, Welsh Water 2050,2017

Ofwat had published their draft PR19 methodology so we didn't discuss the option of a 15% reduction with customers.

Benefit for our customers

Reliability of supply

Our proposals are expected to improve the reliability of our water supply to customers. By reducing leakage we will ensure there is more water in the system to manage water availability in times of peak demand.

Environmental

By reducing leakage we will be able to reduce the volume of water abstracted from rivers and hence reduce the environmental impacts of our water supply.

Wider benefits for Customers

We have reviewed the data we hold on customer supply pipe leakage repairs and have concluded that some of the transition to a lower leakage level can be achieved economically by replacing a proportion of supply pipes rather than repairing them. By focussing on lead supply pipes we gain an additional benefit in terms of the quality of water customers are receiving.

Similarly, the tools we will put in place to monitor and reduce leakage will support early warning of burst mains and therefore give us greater opportunity to reduce interruptions to supply.

2 Investing for now and in the long-term

Future challenges

Our Welsh Water 2050 strategy identifies significant trends over the next 30 years and how these will impact on us and our customers. The most significant trends in terms of leakage are set out below.

Climate change

We expect climate change to have an influence on our distribution network. There will be increases in peak demands as well as larger variability of ground movement after freezing and dry weather periods. This will result in increased numbers of pipeline failures, resulting in low pressure and interruptions to supply for our customers. The recent cold weather event in March 2018 is an example of the impact of climate on our network and the knock on effect to our customers.

Protecting essential infrastructure

Industrialisation and urbanisation in parts of our region led to the rapid construction of water supply infrastructure in the late 19th and early 20th century. A growing number of physical assets constructed during this period are expected to reach or exceed their design life within the next 30 years.

Our ageing iron water mains for example are increasingly at risk of failure. As well as their age and condition, climate change and increasing volumes of traffic where pipelines cross roads, dual carriageways and motorways are all contributing to the increased likelihood of mains failure and loss of water through leaks.

Regulatory Requirements / Changes

Ofwat proposed in its second consultation a new approach to leakage target-setting which comprises significant challenges to the water industry in England and Wales to encourage more stretching performance commitments for leakage reduction:

"Companies should set stretching leakage performance commitment levels to:

- Achieve forecast upper quartile performance (in relation to leakage per property per day and leakage per km of main per day) where this is not being achieved – or justify why this is not appropriate;
- Achieve ambitious leakage reductions. Companies will need to achieve the following minimum reductions or justify why not:
  - at least a 15% reduction (one percentage point more than largest reduction commitment at PR14); and
  - largest actual percentage reduction achieved by a company since PR14;
- Justify their performance commitments relative to the minimum level of leakage achievable."

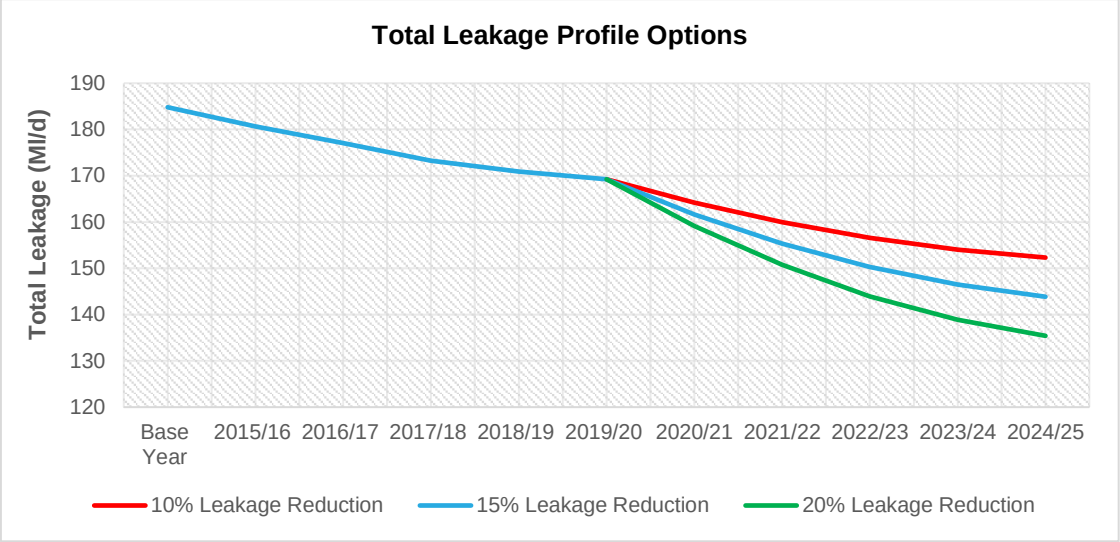

Figure 1 Predicted Leakage profiles for various scenarios

Using existing techniques and technology we consider that we are operating close to the economic level of leakage. These proposed changes will require a step-change in our approach in order to realise future leakage targets and further leakage reduction over the next AMP period.

Making a step change in leakage reduction will take us below previously achieved levels and therefore there will inevitably be some uncertainty in the forecast costs and choice of techniques.

Given the results of pilot projects and information gained from other companies we consider that a 15% reduction in leakage is achievable over the course of AMP7.

Planning for the future

Over the last 25 years the volume of water we supply to our customers has reduced from an average of circa 1040 Ml/d to circa 800 Ml/d, with about half of this reduction being down to reduced leakage.

Since its peak of 413 Ml/D in 1996-97, leakage has been reduced by some 243 Ml/D to the current year estimated out turn of 171 Ml/D. Since the introduction of mandatory targets in 1998-99 leakage has been reduced by 58%.

The following figure charts the long term performance in leakage management that has contributed to the reduction in demand. The rate of leakage reduction has slowed over the past 10 to 15 years despite the continued level of activity of active leakage control and pressure management.

We do not consider that increasing the level of expenditure on current activities will lead to the reduction in leakage that is targeted. New approaches are required to meet the forward challenge. A summary of current initiatives to explore and investigate new approaches is provided in Appendix 2.

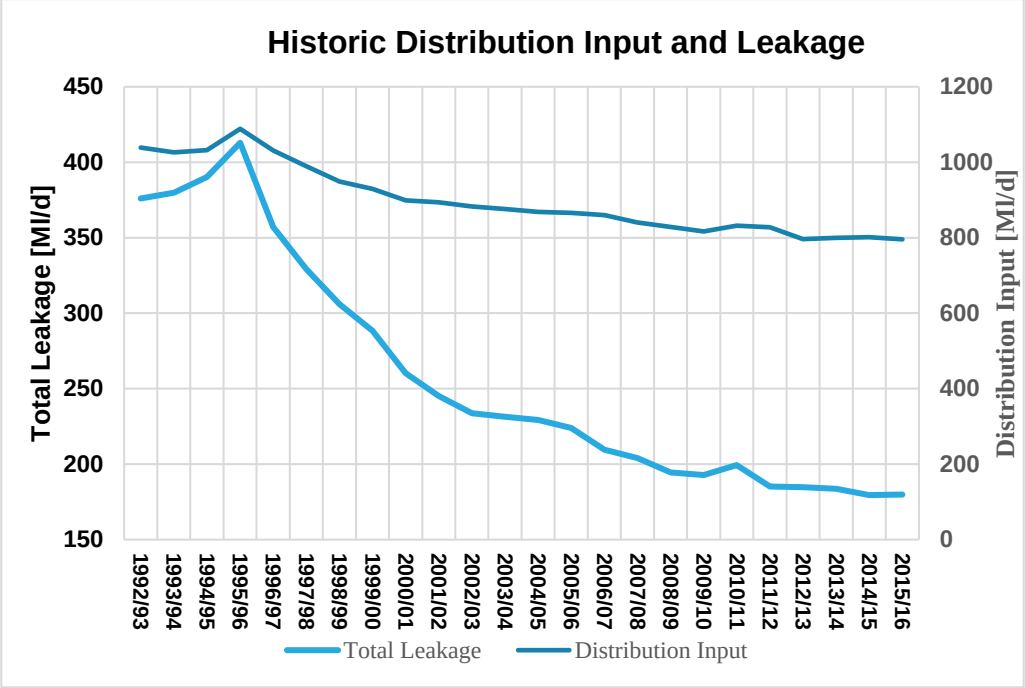

Figure 2 Historic Distribution Input and Leakage

AMP6 Progress

We have developed and started implementation of a long term strategy to guide our improvements in this area. During AMP6 we have undertaken a number of projects aimed at improving the water balance and our understanding of the current leakage position. Despite some challenging weather conditions we have managed to meet our leakage targets through this AMP.

We have embarked on a project to coordinate water efficiency, and customer side leakage operations on an area by area basis. This project, known as Cartref (the Welsh word for home) is in progress at present, focussed on some district meter areas (DMAs) in Swansea. The aim is to continually review the methods and outputs to develop a cost effective BAU (business as usual) process to be applied across the region.

Long-term planning

This programme links with our Water Resources Management Plan (WRMP) and our long-term strategy to improve the reliability of drinking water supply systems, protecting our critical water supply assets and achieving acceptable water quality for our customers.

The overall principle will remain in that leakage reductions will still be targeted based on an economic assessment, reductions only being made in areas where it is cost effective to do so, and using techniques that have been subject to a thorough cost – benefit analysis.

Long term goals are based around our Water 2050 ambition of 10% total leakage. This is taken to be 10% of the total amount of water we currently put into supply, our current Distribution input (DI) (rather than forecast future levels), and would take us down to a leakage level of 80 Ml/d.

3 Options

Background

Total reported leakage has 3 components;

- Upstream (trunk mains and service reservoirs),
- Local distribution systems (mains and communication pipes in district meter areas (DMAs) and
- Customers' underground supply pipes.

Position at the end of AMP6	Ml/d
Upstream Losses	33
Local Distribution Losses	103
Customer Supply Pipe Losses	33
Total Reported Leakage	169
Internal Plumbing Loss (this is part of consumption and not leakage)	31

Historically the focus has been on pro-active "find and fix" activity in the distribution system, as this was seen as the biggest component contributing to the high volumes of leakage present. Our investigations during AMP6 have identified that the level of leakage beyond the customer boundary box, comprising external underground supply pipe leakage (part of the leakage target) and internal plumbing loss (part of the water efficiency target) is far higher than previously recognised.

If we continue to focus on local distribution system leakage (mains and communication pipes) we would have to achieve a component reduction of about 27% in order to reduce total leakage by 15%. We consider that to be unachievable, and therefore we must alter our approach and also make reductions in upstream leakage and customer side leakage.

The customer side leakage is not evenly spread; our findings suggest that only about 5% of properties in Wales have some form of continuous flow which is worth tackling to impact overall leakage and water consumption.

Lead pipe replacement

With our intention of adding greater focus to reducing customer side leakage, we have considered options that provide additional benefit to customers and which work towards the strategic objectives in our 2050 vision.

We have reviewed the data we hold on customer supply pipe leakage repairs and have concluded that some of the transition to a lower leakage level can be achieved economically by replacing a proportion of supply pipes rather than repairing them. We have a water quality objective to realise a "lead free Wales" replacing lead supply pipes. Through appropriate targeting in locations with known high night-time flows we will gain a leakage as well as a water quality benefit.

We have estimated an average saving of 70 l/hr from each replacement. This value is relatively low in comparison to our current average repair, because it is based on replacing pipes where it has not been possible to locate the leak either because it is not making sufficient noise or because it has not been possible to locate it by other means (such as Ferret).

High-level options appraisal

In order to assess intervention options to reduce levels of leakage we have undertaken an optioneering exercise to identify our preferred approach. Our focus for optioneering considered the optimal pace of investment, accounting for deliverability constraints. The following options were considered;

- **Option 1**: Do nothing;
- **Option 2**: Maintain current trend in line with SELL targets, approx. 3% (5 Ml/d) reduction
- **Option 3**: Improve leakage reduction to 15% (25 Ml/d)
- **Option 4** : Improve leakage reduction to 20% (34 Ml/d), and
- **Option 5** : Improve leakage reduction to 25% (42 Ml/d)

Further detail on these options is provided below, whilst supporting cost curves and background

analysis is included in Appendix 3.

Option 1 - Do nothing: do nothing in AMP7 and defer any interventions until AMP8 or later. Without intervention leakage levels would rise back to previous levels requiring an increase in operational cost and deployable output. As such this option has not been progressed further.

Option 2 - Maintain the current level of service: We estimate this would require £56.2m capital investment. This approach would align with customer feedback where 53% of respondents voted for no change in the current performance on leakage.

Option 3 – Enhance performance to provide 15% leakage reduction: We have investigated three sub-options in varying the reduction of the identified component elements as follows. This investment will achieve a 10% (16.9 Ml/d) reduction in leakage;

- **Option 3a**: £66.7m. Is based on a mix of trunk mains and distribution leakage reductions but with a larger focus on the distribution side and no additional investment in reducing customer supply pipe losses.
- **Option 3b**: £67.5m based on a mix of trunk mains and customer/private side leakage reductions but with a larger focus on the customer side. This option has a risk with a greater reliance on new technology and approaches being as effective.
- **Option 3c**: £66.1m splits all of the leakage components equally; upstream losses, private leakage and distribution leakage. This option reduces our risk in targeting more than one component whilst allowing new technologies to be explored

Option 4 – Enhance performance to provide 20% leakage reduction: £71.9m. This is the maximum possible economically viable option, with a positive NPV. This option relies on the early adoption of new technology and realising its potential with a high level of effectiveness.

Option 5 – Enhance performance to provide 25% leakage reduction: >£90m. This option is not economically viable and has not been investigated further.

In addition to the above, for all Options, we have identified £4.8m of investment to replace lead supply pipes, which is directly attributable to leakage reduction. This will be delivered alongside a separate £10m water quality investment to replace lead supply pipes where leakage reduction will be a secondary benefit. This intervention in total will achieve a 5% (8.5 Ml/d) reduction in leakage.

Assessment

Reducing leakage by either 15% or 20% can be shown to be economically justifiable.

However, we consider that aiming for a 20% reduction over the course of one AMP is too great a technical / operational challenge, particularly when we have to introduce new technology and new processes, and there is a degree of uncertainty around the costs and benefits based on our pilot studies.

Our selected strategy is to aim for a 15% reduction in total leakage by the end of AMP7 and then review costs and benefits with a view to making further reductions towards our 2050 vision.

The preferred option is Option 3c, which is a balanced approach, in which we have forecast a 10% reduction in each of the three components of total leakage and a 5% reduction in overall levels from the replacement of lead supply pipes. There is some uncertainty around the results of the modelling, and because we are basing our estimates on limited pilots, we consider this to be the most appropriate option, which spreads the risk. In practice, as we learn more about the costs and savings derived from the work to reduce each component, and as technology and understanding improves, the balance of work between the components may change.

4 Preferred option

Option 3c splits all of the leakage components equally; upstream losses, private leakage and distribution leakage. This option reduces our risk in targeting more than one component whilst allowing new technologies to be explored.

Selecting Option 3c leads to a slight increase in total costs, due to the additional work that will be carried out on customer side leakage and upstream losses. This option, however, reduces the risk of delivering all of the leakage savings through distribution leakage. In practice, the balance between the percentage savings on the three elements of the network may change as processes and costs become better known and technology improves.

The cost differences between distribution and private side leakage are fairly minor. Project Cartref will help us to better understand these differences as well as the natural rate of rise element that could be attributed to each. This uncertainty gives further backing to selecting an option that provides an adaptive option at least cost.

Selecting this option also allows us to maintain our customer engagement, allowing for improved customer relations while, ensuring we are doing what is right for our customers.

The selected solution is summarised in the table below.

	AMP6 outturn (Ml/d)	Proposed Capex (PR19)	Benefit (Ml/d reduction)
Upstream Losses	32.6	£1.53m	3.3
Distribution Losses	103.0	£60.96m	10.3
Customer side Losses	33.4	£3.66m	3.4
Lead Supply Replacement	n/a	£4.86m*	8.5
Total	**169**	**£71m**	**25.5**

Table 2 Proposed leakage investment breakdown by component

* A further £10m investment for replacement of lead supply pipes is included within our Water Quality investment case which will also contribute to reduction of leakage levels

Upstream Losses

Building on our work to estimate the level of real loss in zones and “tiles” in the upstream network, we have identified sections where there appears to be leakage to find. Utilising new technology such as trunk main leak noise correlators, satellites, drones, mobile survey systems and fixed monitoring systems we will put greater emphasis into locating leaks, and we will increase staff resources accordingly. As part of our customer minutes lost programme we will be installing additional monitors on trunk mains, which will support in identifying leaks.

We have also commenced a programme of monitoring service reservoirs for overflows and losses through the structure and on-site pipework.

Our pilots have shown that it is possible to locate leaks in this way, as well as unaccounted for consumption. The forecast saving of 3.3 Ml/d over the AMP is based on our experience to date from our trunk mains team, which was established in 2015.

The configuration of our trunk main network makes isolating some sections of main difficult in order to effect repairs. We are planning to develop enabling measures for repairs alongside our increased detection focus.

Distribution Losses

We propose to improve the efficiency of our leakage detection activity in DMAs in order to free up staff to focus on upstream and customer side leakage. A key part of our strategy is to utilise fixed monitoring systems in areas with high natural rate of rise (NRR), including acoustic logging, but also other emerging technologies. We will pilot the use of digital twins. We also propose to systemise leak detection surveys by using new hand-held devices that make use of noise and vibration analysis algorithms rather than relying on the human ear.

These systems will include facilities to performance manage our detection staff by providing data on activities undertaken on site.

We are introducing a new leakage management system, Waternet, which will include new ALC targeting procedures, and provide information to better understand the balance between leakage and customer consumption.

Customer Side Losses

A key element of our AMP7 leakage plan is to increase focus on customer side losses, both external underground supply pipe losses to meet our leakage target, and internal plumbing losses through our water efficiency programme.

Our pilots have shown that the level of leakage beyond the customer boundary box may be higher than previously reported. Our Cartref project will determine the costs and practicality of identifying those properties with leaks, and then engaging with the customer to make the repairs. Detection will be aided by the use of new technology such as Stop Watch, and repairs by the use of new no dig techniques such as Aquapea.

The forecast savings of 3.4 Ml/d are based on the results from our pilot projects in 20 of our per capita consumption (PCC) areas, and the Cartref project, using a projected cost curve for detection and repair.

5 Cost efficiency and innovation

To meet our delivery target we are proposing to adopt innovative processes utilising new technology to reduce leakage on all components of the water distribution network. We recognise that to achieve a 15% reduction in leakage requires new approaches.

Opportunities for Innovation

Project Cartref

We are planning to establish a private leakage repair strategy, in which supporting policies will allow for work to be undertaken on the private side for all domestic properties regardless of the ownership status and our Private Leakage policy has been amended to incorporate this.

We have been working collaboratively with Invenio Systems over the past 18 months, so that we now have the capability to monitor customer usage and customer side leakage without installing a physical water meter. This work, and collaborative studies with other UK Water companies has the support of Water UK and OFWAT and also allows for a more structured approach to proactively identifying customers with private leaks or continual usage.

Through engaging with our customers we propose an enhanced customer service offering which takes into account Leakage, Water Regulations and Water Efficiency.

The project will also have links with, and open opportunities with other corporate strategies such as Metering, Social Tariffs and Stop the Block.

Using data from the pilot studies outlined we estimate a potential saving of c.17 Ml/d in customer side leakage could be achieved economically i.e. two thirds of the 15% reduction target. However, until we have undertaken sufficient work to confirm the costs and savings of the approach we plan a more conservative target for AMP7.

In undertaking this work on customer side leakage, we will review whether there are synergies available to other functions, namely Water Regulations and Water Efficiency. We will look to improve water efficiency as part of the initiative to educate and save water for the customer with medium to long term benefits. This has the potential of reaching vulnerable customers proactively.

Permanent monitoring of local distribution networks

In terms of the distribution network, our future strategy will involve a greater degree of permanent monitoring of the network using emerging technologies. We will invest in equipment and systems to improve the efficiency of 'find and fix' operations by better localisation of leaks in order to reduce the level of human resource employed on this activity. The approach will allow resources to be freed up to tackle leakage on trunk mains and beyond the customer boundary.

The permanent monitoring will be targeted towards those DMAs that have a high rate of rise of leakage.

Systemising leak detection

We propose to introduce new working methods utilising new technology to systemise the routine ALC processes for detecting leaks on mains and communication pipes. We are working with equipment suppliers to trial innovative solutions.

Leakage estimation and targeting

We are introducing a new leakage management system in conjunction with projects aimed at compliance with new Water UK guidance on leakage estimation. We will take the opportunity to review area specific consumption allowances and seasonal variations in order to provide more accurate leakage estimates for each DMA. We have introduced a new method of targeting DMAs for ALC survey using a measure called EVI (economic volume index), which will provide a link between our operations procedures and our SELL analysis. We anticipate that this will lead to efficiencies.

Trunk mains monitoring and surveys

We propose to build on the work undertaken in the pilot projects to provide a greater focus on trunk mains leakage. This will involve the use of permanent monitoring and mobile survey equipment to locate hidden leaks.

Leakage Repairs

Through our new R&M alliance contract (to be awarded in 2018) we propose to introduce innovative ways of undertaking leakage repairs to provide cost efficiencies and to reduce the time between detection and repair. We are also trialling the Aquapea system for supply pipe repairs; a non-invasive technology which avoids the need for excavation.

Aerial systems

We will build on pilot projects using drone and satellite technology to identify and locate high volume leaks in remote areas in a reduced timescale.

Smart metering

We will continue to trial the deployment of digital smart meters in our deficit or marginal water resource zones and continue to collaborate with CCWater and Welsh Government on metering research and the implications for our future metering policy.

6 Value for money and affordability

Impact on customer bills

We understand the importance of balancing the need for investment with the affordability of our bills. We believe the investment will help to deliver the level of service our customers and regulators expect, and represents an optimal approach for sustained long term improvement.

Value for money

We recognise the need to demonstrate value for money in everything that we do. In arriving at the proposed investment, we have closely considered the costs and benefits of different approaches to make sure that the investment represents long term value to our customers.

Uncertainties and Risk Management

A degree of risk and uncertainty has been discussed with regards to data and effects on planning results. However, a greater uncertainty, will come from operating at levels of leakage far below those achieved previously and how technologies like permanent network monitoring and pilot projects such as Cartref will help to better understand leakage, improve data and help drive further productivity changes.

Full sensitivity analysis has taken place within the SELL assessment where a range of values and techniques have been considered for the future delivery of AMP6 targets. The most economic approach has been derived through adherence to the planning guidance for identifying the least cost technically feasible plan

The graph below shows the potential uncertainty around the programme of leakage reduction and their potential impact to the total cost of delivery.

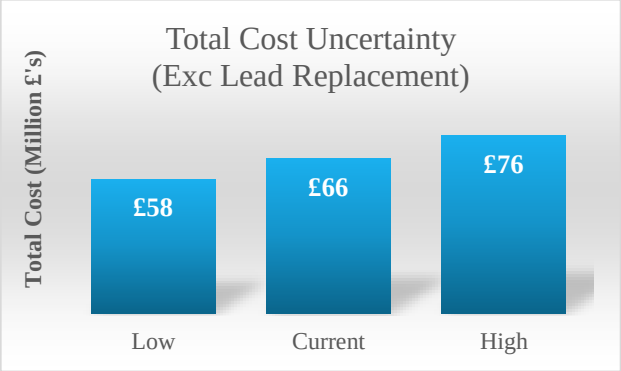

Figure 3 Cost for delivering the 15% leakage target and associated uncertainty (*this figure does not include £4.8m for lead pipe replacements)

The “Current” value is that for our preferred option (excluding the sum for supply pipe replacement). The “High” cost is to achieve the same 15% reduction in leakage, but with activities being 10% less efficient. The “Low” value is with activities being 10% more efficient than this assumed, when we have already build efficiency savings into the “Current” estimate.

As well as the uncertainty around the cost efficiencies, there are uncertainties resulting from external factors such as weather and market rates.

Managing uncertainty and external factors

The method for evaluating leakage targets depends on a number of key input parameters, variations in the values of which will give rise to different costs and intervention methods. Uncertainty in input parameters may arise either because estimation of the parameter necessitates the use of one or more assumptions, or because the value of the parameter may be expected to vary over time with changes in operational, environmental, or other external circumstances.

During the assessment exercise for PR19, a series of sensitivity tests will be undertaken in order to examine the impact on delivery through variation in key input parameters.

- Marginal cost of water
- Background leakage

- Natural rate of rise in leakage (climate change)
- Cost Curves (efficiency improvements and alternative methods)
- Exclusion of leakage and leakage-related externalities

The sensitivity tests will take account of the results from ongoing pilot projects and data reviews.

Interaction with other investment cases

As previous mentioned, within our Water Quality investment case; as part of our commitment to a Lead free Wales, we have also allocated approximately £15m investment (£4.8m Lead Pipe replacements; £10m targeted supply pipe replacements).

In line with our focus on customer side leakage, we anticipate that this investment will also provide a benefit to the reported levels of leakage.

7 Delivery

Procurement

The various projects will be managed by our Water Assets team throughout AMP7 with scope and programme adjustments being made to meet current operational and other issues. We will monitor performance month by month so that we can respond quickly to emerging signs if we are not getting the benefits we have projected.

Programme

A programme of work will be developed following completion of the analysis being carried out by RPS.

8 Assurance

Governance

Our current investment programme has been agreed with the Managing Director for Water Services and approved by the Dŵr Cymru Executive. This helps to ensure that the full focus of the business is directed at this investment.

Performance is also targeted in the monthly Water Quality meetings chaired by the Head of Distribution. These meetings are attended by key stakeholders including the Water Services Science team and Water Assets team.

On a daily basis our current performance is shared internally to ensure that emerging trends and problem areas are targeted quickly. There is also strong awareness of our commitment to improve our CML performance following the recent cold weather events and regular updates during our company-wide monthly team brief.

We will continue to apply these effective governance systems for our proposed AMP7 investment programme. The board will carry out a final review of this investment in detail prior to the submission of the business plan in September.

Cost assurance

We have undertaken high-level feasibility studies for three service reservoirs and larger pipeline schemes to enable the high-level scope of work and cost of the options to be assessed. However, further detailed feasibility will be required to define the final scope and cost of each project. We have utilised our unit cost database to provide cost estimates of the schemes we have identified.

Measures of Success

We are continuing with our measure of success (MOS) to monitor the benefits that our Leakage investment. Our target for improvement to this MOS over AMP7 as a result of our proposed investment is shown in the table below.

Measure of Success	End of AMP6 Position	End of AMP7 Position
Leakage in mega litres per day (Ml/d)	169	143
Three year rolling average	171	148.2

Table 3 Leakage MOS improvement

Future assurance

We have strong governance procedures for the planning and delivery of our capital investment. Our Board will continue to provide the high level overview and governance to ensure that we deliver these much-needed improvements in the interests of our customers.

References

Performance targets qualitative, Welsh Water consultation, June 2017

WTP Qualitative research, Welsh Water consultation, August 2016

Welsh Water 2050 Qualitative Debrief, 2017

Welsh Water 2050, Summer Consultation 2017

Appendix 1 – PR14 and PR19 SELL Assessment Guidance

Table 4 provides a list of technical guidance documents that underpinned the SELL assessment at PR14 and also subsequent technical guidance that has informed development of the draft SELL assessment during 2017.

Reference No.	Document Title	Publication reference	Year of publication
	Guidance at PR14		
1	Future approaches to leakage target setting for water companies in England and Wales	Defra, Ofwat and the Environment Agency	2002
2	The economics of balancing supply and demand (Guidelines)	Environment Agency and UKWIR	2002
3	Natural rates of rise in leakage	UKWIR 05/WM/08/33	2005
4	Leakage in trunk mains and service reservoirs	UKWIR 08/WM/08/38	2008
5	Providing best practice guidance on the inclusion of externalities in the ELL calculation	Ofwat	2008
6	Factors affecting NRR	UKWIR 09/WM/08/40	2009
7	Best practice for the derivation of cost curves in ELL analysis	UKWIR 11/WM/08/46	2011
8	Managing Leakage 2011	UKWIR 10/WM/08/42	2011
9	BAG user guide and worked example	Environment Agency	2011
10	Factors affecting Background leakage	UKWIR	2012
11	Water Resources Planning Guidelines	Environment Agency	June 2012
12	Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning	Environment Agency, Ofwat and Defra (SMC)	October 2012
	Additional guidance available for draft SELL assessment during 2017		
13	Leakage upstream of District Meters	UKWIR 15/WM/08/55	Feb 2015
14	Economics of Supply Pipe Leakage	UKWIR 15/WM/08/56	May 2015
15	Factors Affecting Minimum Achieved Leakage	UKWIR 16/WM/08/58	May 2016
16	Final Water Resources Planning Guideline	Environment Agency and Natural Resources Wales	May 2016
17	Assessing the impact of burst-driven mains renewal on leakage control effort	UKWIR	In press

Table 4: Technical guidance documents supporting 2017 draft SELL assessment

Technical and data quality refinements since PR14

Key methodology and/or data quality refinements included in the draft WRMP19 SELL submission are as follows:

Industry benchmarked background leakage assessment

Background leakage levels at PR14 were derived from direct application of the Minimum Achievable Leakage (MAbL) function, whereas background leakage levels for the draft WRMP19 SELL submission are defined by calibrating the equation for Minimum Achieved Leakage (MAL) to percentile values derived from

a nationally representative UKWIR dataset (Table 1, reference 15). The coefficients consistent with the 35th MAL percentile calibrated most closely with the background leakage values calculated at PR14 and for consistency these coefficients were applied in the draft WRMP19 SELL analysis.

Improved quality of Active Leakage Control cost relationships

Improvements in data collection processes since PR14 have enabled greater accuracy in and allocation of DMA-level cost data: this has eliminated the need to smooth DMA-level costs by DMA-level property numbers. In addition, a closer alignment of working practices by outsourced and in-house ALC resources has enabled the inclusion of both sets of cost data in the cost-curve estimation (rather than just outsourced resources being included, as was the case at PR14).

Improved pressure management data quality

There are a significant number of Pressure Management Areas (PMAs) across the region which are currently monitored and maintained in-house. PMA data contained within our PRV Database has recently undergone a detailed review, leading to significant data quality improvements which are reflected in more robust estimates of pressure management cost-savings relationships within the RPS economic appraisal model SALT (Strategic Analysis of Leakage Targets).

Improved reliability of marginal cost of water assessment

At PR14, zone-level costs were allocated to specific assets within the zone using a variety of apportioning methods. For the draft WRMP19 SELL analysis, improvements in data collection processes and the establishment of specific asset-level cost centres enabled all costs, including sludge collection and disposal, to be directly linked to their associated asset.

Method for allocating TM leakage volumes to specific pipe sections

The method for deriving zonal cost relationships for trunk mains (TM) leak repair and renewal has been modified and refined: for PR14 leakage volumes were allocated to pipe sections of different material types using a high-level predictive model. For the draft WRMP19 SELL assessment, zone-level TM leakage volumes were apportioned to different pipe sections using empirical evidence on the incidence and size of leaks identified during extensive TM leak detection surveys undertaken by us during AMP6. This approach gave rise to fewer numbers of leak hotspot TM sections, and resulted in an increase in predicted leakage savings for specific TM leakage schemes.

Breadth of deficit zone leakage schemes for least cost planning

At PR14, deficit-zone leakage reduction policy options presented to the Water Resources team for consideration within the least cost planning exercise comprised the following:

- Additional ALC (based on the current policy)
- Pressure management
- Asset renewal - distribution network
- Trunk mains detection and repair
- Trunk mains renewal

Since the PR14 SELL analysis, policy trialling in pilot areas within our area has generated sufficient specific data with which to robustly model costs and leakage savings for the following additional three deficit-zone policy options:

- Enhanced ALC (based on 'policy minimum' team work)
- Enhanced ALC (based on installation of permanent correlating noise loggers)
- Customer smart metering

Improved understanding of leakage components

Since PR14 we have also undertaken a number of projects to better understand the true level of leakage and where in the network it is occurring. These include:

- Stopwatch surveys of district meter areas and consumption monitor areas
- Smart metering pilot projects
- Fast logging of consumption monitor areas
- Review of night consumption and PCC
- Data analysis to estimate zonal balances on the trunk mains system
- Review of meter under registration
- Review of non-household use
- Review of seasonal use profiles
- Meter verification

Water 2020 and Guiding Principles for Water Resources Planning

In April 2016 the English and Welsh Governments set out a series of guiding principles for water resources planning[3]. At the same time, Ofwat set out its decisions on the future regulatory framework for the water and wastewater industry in England and Wales[4]. In both cases, resilience and sustainability were emphasised as key priorities, driven by customer-led benefits assessment and cost-minimising innovation. In relation to leakage reduction, the guiding principles particularly called on the need for WRMPs to demonstrate how water companies will innovate and develop expertise in preventing, identifying and repairing leakage more effectively.

In November 2016, the Environment Agency (England) reinforced the Governments' guiding principles by indicating its expectation that water companies should innovate to reduce leakage beyond the current levels[5]. Our alignment with the WRMP19 guiding principles are indicated in Table 2.

Guiding principle	Our alignment

[3] The Welsh Government Guiding Principles for Developing Water Resources Management Plans for 2020. April 2016
[4] Water 2020: Our regulatory approach for water and wastewater services in England and Wales. May 2016
[5] Leakage in WRMP19. Environment Agency, November 2016

The downward trend for leakage should continue throughout the planning period. If a water company is unable to reduce leakage further during the planning period, it must clearly justify its position and set out the reasons why this cannot be achieved	The downward trend in leakage is sustained over the 5-year WRMP period to the short run target. Subsequent leakage reductions in deficit zones may be selected in the least cost plan as optimal over the remainder of the 30-year planning period. The optimality of ongoing leakage reductions are reappraised at each successive AMP/WRMP on the basis of updated leakage management cost information. We have consistently sustained ongoing reductions in its short run leakage targets over the past four WRMP periods.
All companies should take action to ensure total leakage (Ml/d) does not rise at any point in the planning period. If a water company cannot achieve this, it should provide the reasons for this and what it will do to reverse the trend	Fully aligned.
Water companies must fully consider and appraise leakage management as an option to balance supply and demand alongside other options.	Options considered include additional ALC (based on the current policy) pressure management asset renewal - distribution network trunk mains detection and repair trunk mains renewal enhanced ALC (based on 'policy minimum' team work) enhanced ALC (based on installation of permanent correlating noise loggers) customer smart metering The robustness of developed leakage-cost relationships for all policies were validated and verified across the relevant parts of the Business. Further options are being considered for the final WRMP
All companies should compare their planned leakage forecast with other water companies and with suppliers in other similar countries, to demonstrate that its leakage forecast is appropriate and ambitious	In process. Water companies are currently in the process of responding to the most recent regulatory guidance and expectations regarding greater innovation and ambition with respect to leakage target-setting. Meaningful comparisons should become possible over the next few months.
Challenging leakage objectives should be informed by customers' views on leakage and also take account of the potential for future innovation.	In process. We are currently considering a range of potentially innovative approaches to reducing leakage that are affordable, in terms of customers' willingness to pay, and aligned to their preferences.

Table 5: Our alignment with WRMP19 guiding principles

The Environment Agency (England) also indicated that WRMP19 would be the 'final time that a leakage figure is derived by SELL', a decision underpinned by the findings of the SMC report[6] that:

- SELL tends to maintain the status quo, being based on data that relates to the current knowledge of leakage components and leakage management costs;

[6] Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning, Environment Agency, Ofwat and Defra (SMC), October 2012

- SELL does not incentivise efficiency or innovation: if companies' current active leakage control is inefficient, it will lead to a higher SELL and a less stretching target. This does not incentivise inefficient companies to become more efficient. It also does not drive innovation;
- Companies are risk adverse, and are reluctant to plan for lower levels of leakage for the long-term, resulting in inertia.

For PR19 we have also taken account of other recommendations from the SMC report as follows:

- Future SELL assessments should consider Minimum Achievable Levels of Leakage (MAbL) rather than, or as well as, historical minimum achieved values.
- An assessment of the economic values for trunk mains and service reservoir losses should be included rather than accepting that the current level of losses cannot be changed.
- Supply pipe leakage should be assessed and an economic assessment developed.
- Pressure management should be fully integrated and appraised, particularly aligned with operational practice, but also taking an holistic view to optimise pressure management and ALC.
- That the SELL should be presented in a transparent way demonstrating the total costs and options for operating at different level of leakage
- A range of recommendations to ensure pressure management is considered on a fair like-for-like basis with active leakage control.
- Mains renewal should be considered as a targeted option for leakage reduction.
- The impact of metering should be considered within the SELL assessment.
- An holistic approach to leakage management should be used that also considers a wide range of interventions including strategic options.

Where SELL is used for WRMP19 the Environment Agency indicated the need – in accordance with the recommendations of the SMC report - to evidence the SELL outcome as set out in Table 6.

Evidence requirement	Our alignment
SELL is fully integrated with its WRMP and is not simply an input to the process	Our short run SELL is by necessity an input into the baseline demand forecast. The long run SELL (and a wide range of leakage management options) is fully integrated within the WRMP optioneering outcome.
Minimum achievable levels of leakage as well as historical minimum achieved levels of leakage are included in the assessment of SELL	Cost-relationship asymptotes are set as the midpoint between historical minimum achieved and estimated minimum achievable leakage, both of which are determined using best practice industry guidance.
An appraisal of the full range and scale of leakage management options has been undertaken, such as pressure management, asset renewal and/or Active Leakage Control (ALC) as an integrated part of water resource planning options appraisal	Options considered include additional ALC (based on the current policy) pressure management asset renewal - distribution network trunk mains detection and repair trunk mains renewal

	enhanced ALC (based on 'policy minimum' team work) enhanced ALC (based on installation of permanent correlating noise loggers) customer smart metering The robustness of developed leakage-cost relationships for all policies were validated and verified across the relevant parts of the Business. Further options are being considered for the final WRMP
The full benefits of reducing leakage are considered both in the short- and long-term when assessing the SELL	All relevant and significant environmental, social and carbon costs and benefits are included in leakage management policy cost relationships, in accordance with industry best practice and regulatory guidance
All strategic options for reducing leakage are considered that encourage innovation and aspirations to achieve lower levels of leakage	In process. In the light of the emerging evidence surrounding increased levels of supply side leakage a number of innovative options are being considered along with existing and additional leakage detection policies
Pressure management is fully integrated and appraised in line with operational practice. Water companies should take a comprehensive approach to optimise pressure management and ALC.	Fully aligned

Table 6: Our alignment with regulatory evidence requirements for SELL

We have commissioned RPS to deliver an industry best practice Sustainable Economic Level of Leakage (SELL) determination to help monitor and drive improvements in operational efficiency and minimise the costs of meeting or exceeding targets relating to business plan commitments. We expect to receive the RPS results in early October. In the meantime, we have based our analysis on data we have shared with RPS and our own econometric model.

Convergence measurement

Ofwat require UK water companies to report leakage in compliance with the 2017 UK Water Industry Research (UKWIR) report on Consistency of Reporting Measures. Initial shadow reporting alongside existing methodologies is being implemented in reporting year 2018-19 with adoption of the new standard by April 2020.

The report identifies a series of operational and data improvements which water companies must achieve in order to meet minimum compliance with the new standards. The Impact of adhering to these standards has been assessed and compliance will result in a significant increase to reported leakage levels of between 17 million litres of water per day (Ml/d) and 26 Ml/d unless other projects are undertaken to improve our understanding of the balance between leakage and consumption in the water balance and night flow analyses.

A programme of water balance improvement projects is currently in progress and due to complete by December 2019 with the objectives of delivering compliance with the standards and additionally mitigating the impact on reported leakage volumes.

Leakage mitigation will predominantly focus on two key points:

- Data improvements and updates to key components such as allowance estimates, upstream estimate improvements,
- On the ground leakage reductions delivered through a mixture of upstream, distribution and customer side leakage options.

We consider that the impact of these water balance improvements will mitigate completely the impact of the increase in reported leakage due to compliance with the Water UK guidelines. Therefore, we expect to outturn at 169 Ml/d total leakage at the end of AMP6 using the new methods of leakage estimation.

Appendix 2 – Performance initiatives and New Approaches

Current performance

This investment case is targeted at delivering a reliable supply of water to customers and in maintaining compliance with abstraction licenses through a reduction in demand.

The current level of service is a Water Resource Zone aggregated SELL measured in Million Litres per Day (ML/D). For AMP6 the company level SELL outturn was calculated as 169.2 ML/D.

Total leakage during AMP6 to date has reduced from 184.8 ML/D to 172.8 ML/D. This is forecast to reduce to the SELL target of 169.2 ML/D by the end of AMP6 (AR20).

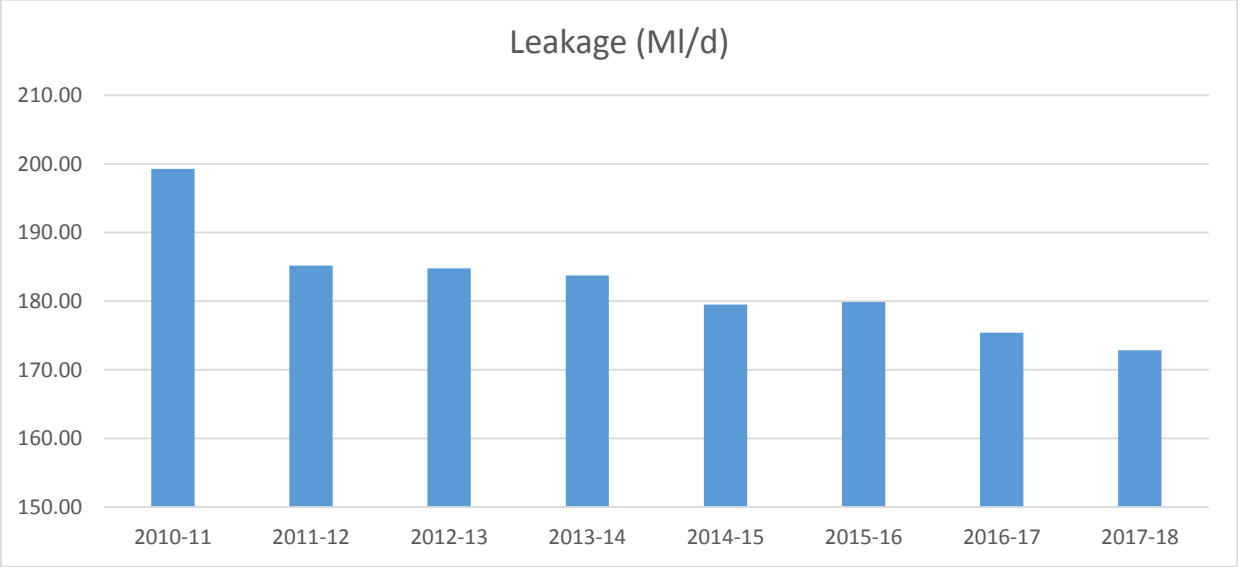

Figure 4 Reported Leakage Levels (AMP5 to AR18)

Current progress against target is as per plan, and subject to no extenuating circumstances such as harsh winters the year 4 (AR19) and 5 (AR20) targets are expected to be achieved.

The water balance position remains strong with performance within the maximum permissible 5% balance gap set by the regulator for implementation of bottom up leakage reporting. Confidence levels for the water balance components used for the AR18 MLE calculation are unchanged from AR17, but as the water balance gap is over 2% the overall confidence grade and that for DI is B2.

Component	Units	CI (+/-)	Initial Estimate		CI Range		% of Total CI Range		Adjust. Volume		Revised Estimate	
Water Balance Assets												
Distribution Input		2%	822.81	822.81	16.46	16.46	25.94%	[25.83%]	7.61	[6.10]	815.20	[816.71]
Distribution Input	Ml/d		822.81	822.81							815.20	[816.71]
Total WB Assets	Ml/d		822.81	822.81	16.46	16.46	25.94%	[25.83%]	7.61	[6.10]	815.20	[816.71]
Water Balance Liabilites												
Trunk Main and SR Losses		15%	32.61	32.61	4.89	4.89	7.71%	[7.68%]	2.26	[1.81]	34.87	[34.42]
DMA Distribution Main Losses		5%	134.86	[157.05]	6.74	[7.85]	10.63%	[12.32%]	3.12	[2.91]	137.97	[159.96]
Total Bottom Up Leakage	Ml/d		167.47	[189.66]	11.63	[12.74]	18.34%	[20.00%]	5.38	[4.72]	172.85	[194.38]
Total Top Down Leakage	Ml/d		196.81	[213.27]							Not Applied	[Not Applied]
Unmeasured Household		5%	306.45	[290.06]	15.32	[14.50]	24.15%	[22.76%]	7.09	[5.37]	313.54	[295.43]
Unmeasured Non-Household		25%	4.85	[4.79]	1.21	1.20	1.91%	[1.88%]	0.56	[0.44]	5.41	[5.23]
Measured Household		3%	128.29	128.29	3.85	3.85	6.07%	[6.04%]	1.78	[1.43]	130.07	[129.72]
Measured Non-household		3%	166.45	166.45	4.99	4.99	7.87%	[7.84%]	2.31	[1.85]	168.76	[168.30]
Water Taken Unbilled (Legally + Illegally)		50%	9.82	9.82	4.91	4.91	7.74%	[7.70%]	2.27	[1.82]	12.09	[11.64]
Distribution System Operational Use		50%	10.14	10.14	5.07	5.07	7.99%	[7.96%]	2.34	[1.88]	12.48	[12.02]
Total Demand	Ml/d		626.00	[609.54]	35.36	[34.52]	55.73%	[54.17%]	16.35	[12.79]	642.35	[622.33]
Total WB Liabilities	Ml/d		793.46	[799.20]	46.99	[47.26]	74.06%	[74.17%]	21.73	[17.51]	815.20	[816.71]
Water Balance Gap												
Imbalance	Ml/d		29.35	[23.61]	63.45	[63.72]	100%	[100%]	29.35	[23.61]	0.00	[0.00]
	%		3.57	[2.87]							0.00	[0.00]
Intergrated Flow Leakage	**Ml/d**		196.81	[213.27]							**172.85**	[194.38]

Figure 5 Regional Water Balance and MLE application (exc. Supply Pipe Leakage)

AMP6 Water Balance Initiatives

During the course of AMP6 we have undertaken a number of projects aimed at improving the water balance and our understanding of the current leakage position. The water balance improvement projects are:

Stopwatch surveys of district meter areas and consumption monitor areas

The objective of this project was threefold;

- Investigate the volume and distribution of household night use within leakage reporting areas,
- Increase our understanding on the proportion of supply pipe leakage and plumbing loss occurring on the customer side,
- Provide evidence and data to better inform the estimation of intermittent night use and overlapping intermittent use

Smart metering pilot projects

Installation of 234 SMART meters on household customers within the Grangetown area of Cardiff and the establishment of a fixed radio network for communication of demand data.

The data from this project is being used to inform understanding of customer side losses and additionally to aid in cost benefit assessment of demand side options for integration into the WRMP and future leakage policy options.

Fast logging of our consumption monitor areas

Installation of over 130 enhanced data loggers on the Per Capita Consumption (PCC) Small Area Monitor (SAM) to record flow data at exceptional high frequencies and resolutions.

Data analysis to estimate zonal balances on the trunk mains system

Establishment of 266 flow balances for improved monitoring of losses upstream of DMA on over 5000km of trunk main.

Review of meter under registration

Removal and testing of 1100 household meters (15mm) to aid and inform assessment and application of meter under registration within the water balance.

Review of non-household use

Installation of over 1000 data loggers across the non-household customer base to increase base data and update allowance assessments of DMA leakage.

Review of seasonal use profiles

Application of multiple datasets, information and assessments to aid in the establishment of seasonal use patterns within the leakage reporting estate.

Improvements to the assessment of PCC

Enhancement and expansion of the existing SAM to ensure estimates of PCC are robust, accurate and in compliance with published guidance.

Meter Verification

Annual verification and assessment of 171 distribution input (DI) meters to ensure accuracy of data for DI and the water balance.

R&D and Pilot Projects

During AMP6 we have also undertaken a number of pilot projects aimed at exploring new ways of working to achieve lower levels of leakage and gain efficiency improvements. These include:

Trunk main surveys monitoring:

From the work on trunk mains balances we have identified a number of zones where there appears from the meter data to be a continuous imbalance that could be due to leakage. We have used specialist sub-contractors to locate several leaks using leak noise correlators, in pipe technology and above ground monitors. From these pilots we have determined that there is scope to reduce trunk mains leakage with further investment.

Customer side leakage:

We have an Innovation Framework agreement with Invenio Systems Ltd to utilise their Stop Watch system to account for water passing the customer boundary stop tap, whether or not a meter is fitted. We have undertaken expensive surveys to determine the level of plumbing loss, and to locate small leaks that are not detectable by other means.

We have also introduced the use of Ferret for locating customer supply pipe leaks, and we are currently trialling the Aquapea system for making leak repairs.

Acoustic logging:

We have piloted the use of permanently installed and lift and shift acoustic logging systems, and have recently increased the use of this technology during the summer of 2018.

Mobile systems:

We have piloted the use of mobile systems that systemise leak detection by recording leak noise, or other vibration / acoustic signals, from stop taps, and mains fittings. These systems reduce the skill level required for routine leak detection and increase the certainty of leak reporting.

Aerial systems:

We have undertaken small scale pilots using drones, aerial photography and thermal imaging, and satellite systems. These systems have their place in locating leaks in rural areas, but we do not anticipate large reductions in leakage from them for AMP7.

We have also reached out to the rest of the water industry; the water companies, their supply chains, through attending conferences and exhibitions, and taking part in industry research projects to ensure we are aware of emerging technologies and techniques.

Enhancement of SELL Policy Options

Within the new regulatory context of 15% leakage reduction in AMP 7 it is apparent that our SELL assessment for PR19 will comprise only one element of its target-setting strategy. However, given the regulatory focus on setting and meeting more ambitious leakage targets through innovation and improved cost efficiency, the challenge for companies will be to demonstrate the deliverability of their leakage plans using a robust least cost modelling framework.

In order to do this we propose to integrate current policy options with more innovative and intensive leakage reduction policies like those developed for use in deficit zones, which are likely to be technically necessary to achieve more ambitious leakage reductions in the coming years.

We have therefore engaged with RPS to develop SALT++ (economic optimisation tool) in 2 ways

- To broaden the range of leakage reduction policies that are available as options to consider a full range of policy alternatives, not just those utilised historically, but including options based on lessons learned from the initiatives outlined above.

- To enable exploration of scenario modelling to determine the least cost solution to obtain alternative leakage targets which may lie below the current SELL assessment.

This increased range of policies includes:

- Enhanced Active Leakage Control
- Permanent acoustic monitoring
- 'Lift and shift' acoustic monitoring
- Smart metering
- Trunk Mains detection and repair
- Customer supply pipe detection and repair

Appendix 3 – Cost curves and Option Appraisal component analysis

The method for evaluating leakage targets depends on a number of key input parameters, variations in the values of which will give rise to different costs and intervention methods. Uncertainty in input parameters may arise either because estimation of the parameter necessitates the use of one or more assumptions, or because the value of the parameter may be expected to vary over time with changes in operational, environmental, or other external circumstances over time. We have taken account of the following principle variables in our econometric modelling; key assumptions are set out in the following paragraphs:

Natural rate of rise of leakage (NRR)

An example of the impact of environmental factors on leakage can be seen through the natural rate of rise (NRR) in leakage as shown by the graph below.

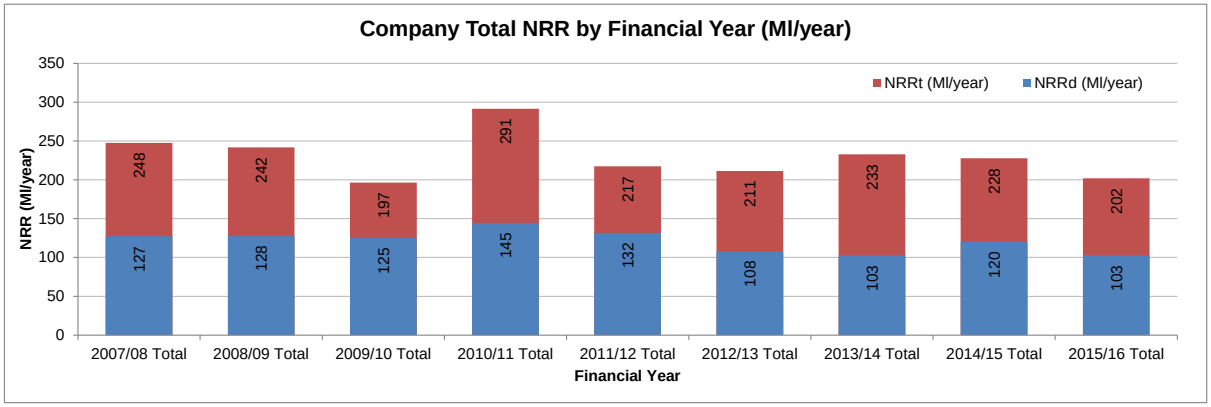

Figure 6 Observed changes in NRR (detected and total)

Extreme changes in temperature such as those that occurred in 2010-11 can lead to increase in leak breakout. As we move to lower targeted levels of leakage, leakage detection and repair will become more expensive. Any fluctuations in parameters such as NRR will lead to further increase in leak detection costs. It is therefore important to understand these factors and their cost implications. The graph below shows the potential uncertainty in cost due to variations across input parameters, some will have a greater impact than others.

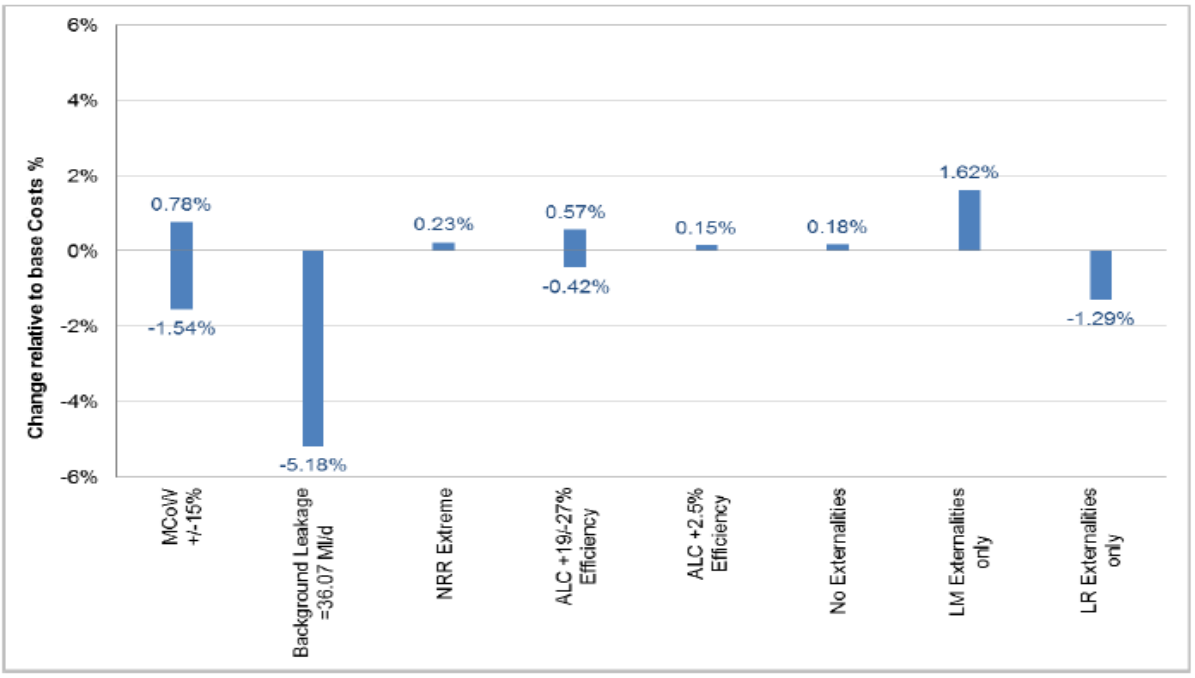

Figure 7 Key Input Parameters affected by operational, Environmental and External Factors

Our SELL calculations are based on a 5 year average of NRR, which when forecast forwards takes account of the aging of the network.

Background leakage

A key element of the SELL calculation is the level of background leakage, which is the major component of the asymptote on all leakage reduction costs curves. The level of background leakage at PR14 was set between the minimum achieved leakage (MAL) level (totalling the historic minima in all DMAs, and the minimum achievable level (MAbL) which is theoretical level based on industry research.

The graph below shows the number of MAL's found in each year, showing that over 250 DMA's achieved their MAL in 2015-2016, an increase from 170 at 2011-12. The MAL can be variable over time but will only reduce as new lower levels are achieved across the DMA estate by finding and fixing new hidden leaks or accounting for previously unaccounted for consumption.

There is always potential uncertainty around the MAL/ background leakage. For the PR19 plan we have assumed a level of background leakage below the aggregate sum of the MALs in each area. Where the observed MAL is below the estimated MAbL level we have taken the lower value. We have then taken the 30th percentile value over a 5 year period for the remaining areas. As with NRR, the background leakage in the SELL model takes account of an aging network.

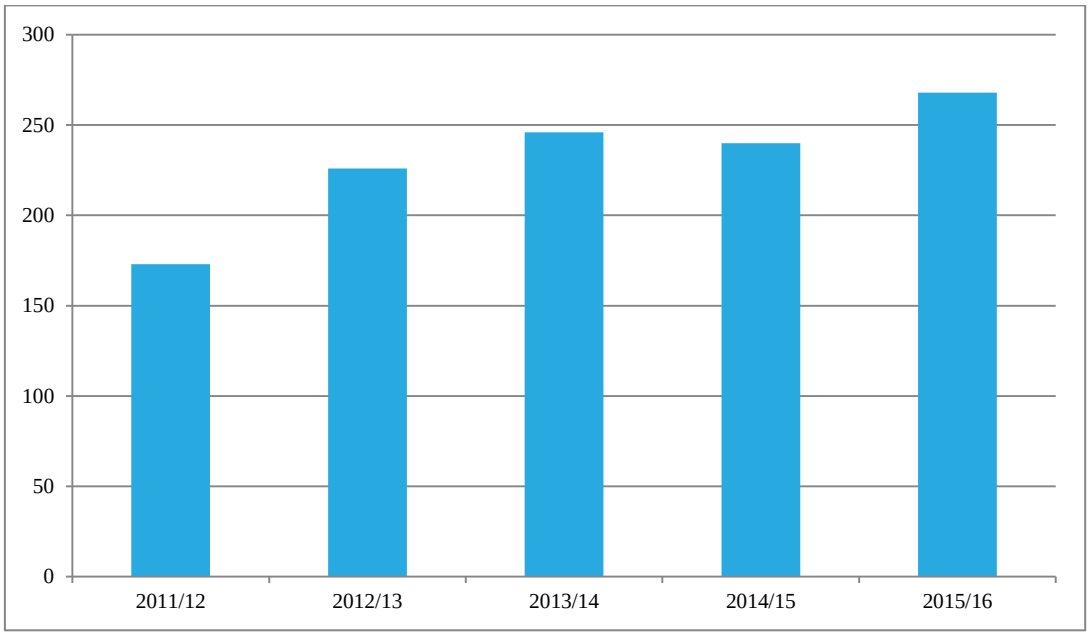

Figure 8 MALs from each year

Our analysis shows that the MAL is 72.15 Ml/d in DMAs. The Estimated MAbL level is 41.45. The background leakage level used in our econometric model is 51.56 Ml/d, although this is likely to increase to c. 58 Ml/d after the convergence on leakage estimation is completed. Adding the 32.6 Ml/d for upstream losses gives an asymptote to our total cost curves of c. 90 Ml/d.

Marginal Cost of Water

The graph below shows the potential variation in the Marginal cost of Water due to fluctuations in power costs over time. The general trend is that the powers costs are increasing but some years (like 2016-2017) may fluctuate more than usual.

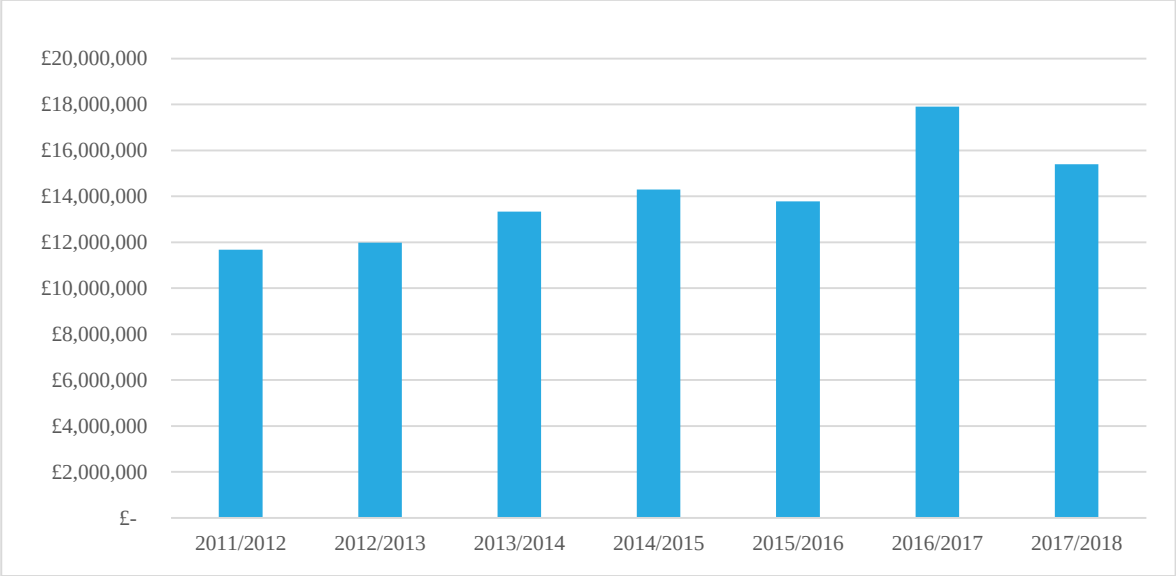

Figure 9 MCOW Power Costs

Higher MCoW will lead to a lower SELL on a like for like basis as reductions in leakage are part paid by reduced operating costs in power and chemicals. For PR19 we have updated the MCoWs for each zone in the SELL model.

The average value of MCoW used in the SELL is £72.24 / Ml.

Marginal Cost of active leakage control

The cost curves used in the SELL calculation are based on current performance within DMA's at various levels of leakage, DMA size, property counts, main materials etc this method can then be used to estimate required performance and resources as leakage levels are reduced down to target.

The graph below is an example ALC costs curve for a single water resource zone (WRZ), showing how costs increase as leakage levels reduce down to background leakage. Costs can be converted to detection hours/ FTE's as well as repair numbers for resource planning purposes.

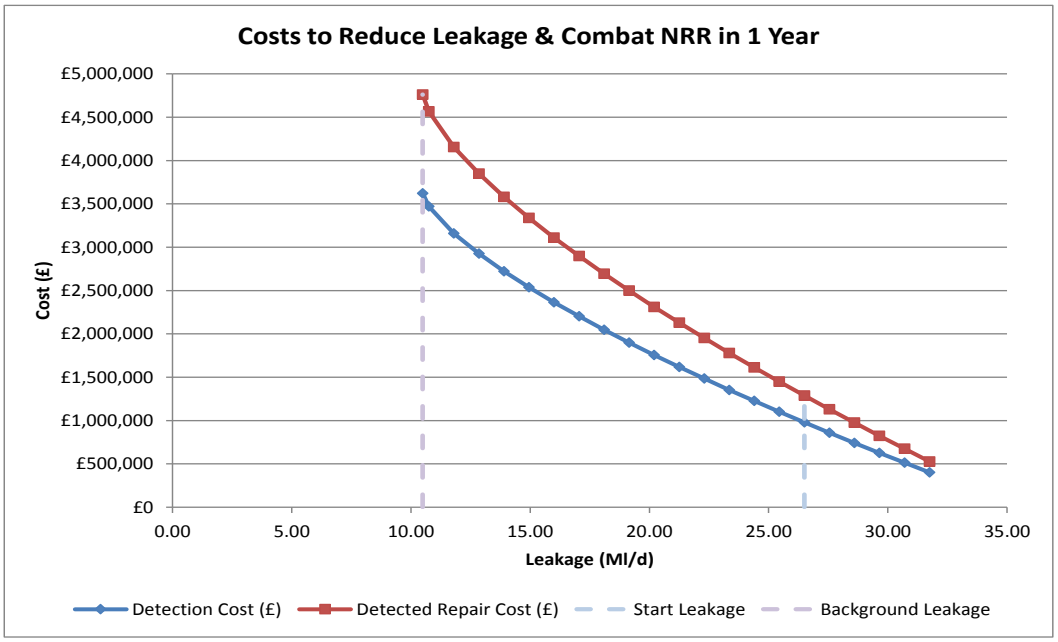

Figure 10 WRZ ALC Detection and Repair Cost Curve

System Pressure

Changes to system pressure can only be made over a long period of time. We have updated the information we hold on pressures and the opportunities for pressure management in the SELL modelling process.

Over the course of AMP6 we have made significant changes to our pressure management arrangements. We have brought the pressure management team in house from an external contractor. We have reviewed and improved our arrangements for PRV servicing to reduce the risk and criticality of valve failure and to improve the cost benefit. We have established new processes for new pressure management schemes and have set targets for the number of new schemes to be installed. We have undertaken a programme of training and established processes for stakeholder management within the business to ensure viable schemes are delivered.

Predicted Performance

Current performance against the target is monitored against the 5 year AMP leakage SELL glide path. Company leakage is calculated on a daily basis and summarised into weekly, monthly and yearly values to enable an assessment of performance to be made and interventions to be implemented if required.

Our SELL analysis at AMP6 was based on the same approach used in previous AMPs. We estimated a level of background leakage in the DMAs of each zone, we calculated the economic level of leakage above this background, and we then added on the current level of trunk mains and service reservoir (TM&SR) leakage.

It is clear from the current components of total leakage that a new approach is needed. If we continue to focus on local distribution system leakage (mains and communication pipes) we would have to achieve a component reduction of about 27% in order to reduce total leakage by 15%. We consider that to be unachievable, and therefore we must also make reductions in TM&SR leakage and customer side leakage.

Our SELL approach for AMP7 is different in that we have modelled TM&SR leakage, and customer side separately, considering the potential costs and savings resulting from pilot projects undertaken in AMP6. Some uncertainty in the results arises from this change of approach as well as the change of input parameters.

Total Cost Curves

We have reviewed the shape of the total cost curve for maintaining the reduced level of leakage from our AMP7 SELL model. This shows that the shape of the curve around the SELL is relatively flat, and therefore maintaining leakage at the lower end of the economic range is only marginally more expensive than maintaining it at SELL.

The graph also shows that reducing leakage by 15% (to c. 144 Ml/d) leads to a relatively small increase in total costs, and that reductions of 20% (to c. 135 Ml/d) and 25% (to c. 127 Ml/d) may be justifiable on economic grounds alone. We have not considered reductions greater than 25% for the next AMP.

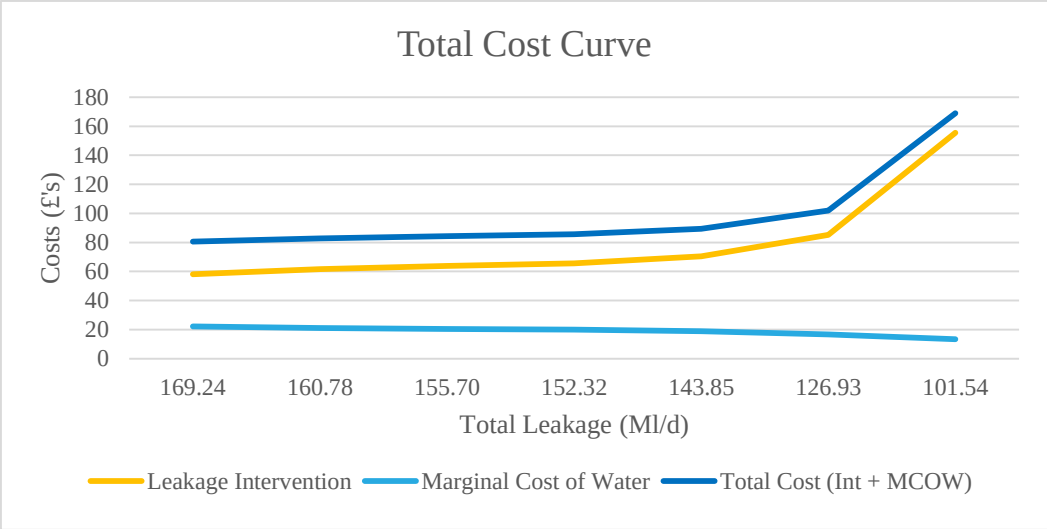

Figure 11 WRZ ALC Detection and Repair Cost Curve

Our model takes account of maintenance costs and transition costs. We have considered these separately for this plan, in order to clearly present our selected approach. The following graph shows maintenance costs alone to counteract the NRR at different levels of leakage.

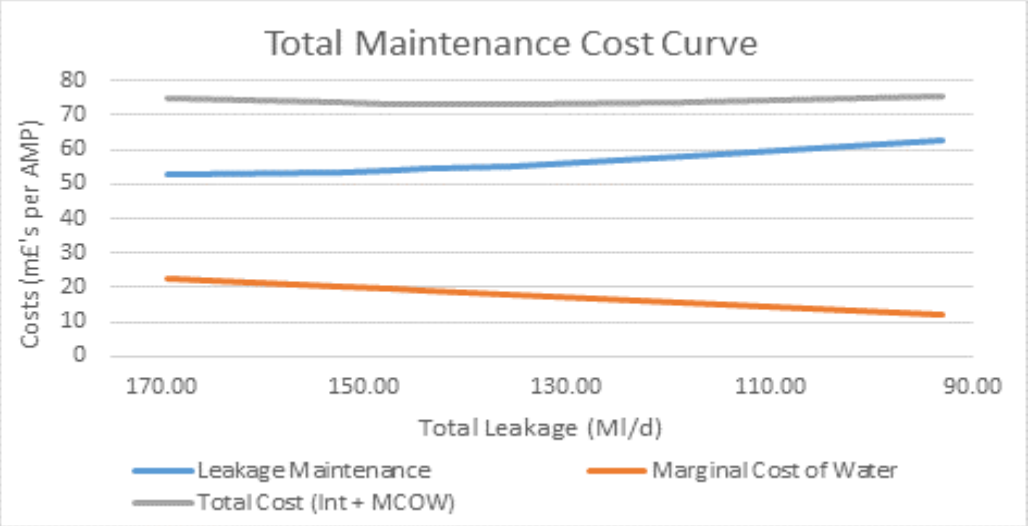

Figure 12 Total Leakage Investment Cost Curve

This shows that the total cost curve (leakage maintenance plus cost of water) is flat around the minimum point. The minimum maintenance cost occurs at c. 135 Ml/d at £73.2m over AMP7. At 126 Ml/d and 144 Ml/d the total cost is only £0.1m higher. Therefore, we have considered the cost of transition down to this range of leakage which represents a 15% and 20% reduction from the level of 169 Ml/d at the end of AMP6.

We have considered the economics of the transition costs for a 15%, 20% and 25% reduction in leakage. In each case we have taken the transition cost, and the leakage saving over 25 years. We have used a discount rate of 3.6% p.a. for the benefit, and also for the investment cost over the 5 years of the AMP. We have estimated a 5% p.a. increase in MCoW. The results are as follows:

- For a 15% reduction (= 25.3 Ml/d) we have included £11.2m for leak detection and pressure management, and 50% of the £14.8m for leakage driven supply pipe replacement (Section 4.1). The NPV of this investment cost is £17.3m (equivalent to £683k / Ml/d). The NPV of the savings in water is £17.6m. So this is deemed to be economic.
- For a 20% reduction (= 33.8 Ml/d) we have included we have included £17.5m for leak detection and pressure management, and 50% of the £14.8m for leakage driven supply pipe replacement (Section 4.1). The NPV of this investment cost is £23.2m (equivalent to £686k / Ml/d). The NPV of the savings in water is £23.6m. So this is deemed to be economic.
- For a 25% reduction (= 42.2 Ml/d) we have included £29.5m for detection and pressure management, and 50% of the £14.8m for leakage driven supply pipe replacement (Section 4.1). The NPV of this investment cost is £34.3m (equivalent to £813k / Ml/d). The NPV of the savings in water is £29.4m. So this option is deemed to be uneconomic.

The following graph shows the cost of making the transition. This shows three rates of cost, up to 25 Ml/d, from 25 to 43 Ml/d and from 35 to 68 Ml/d.

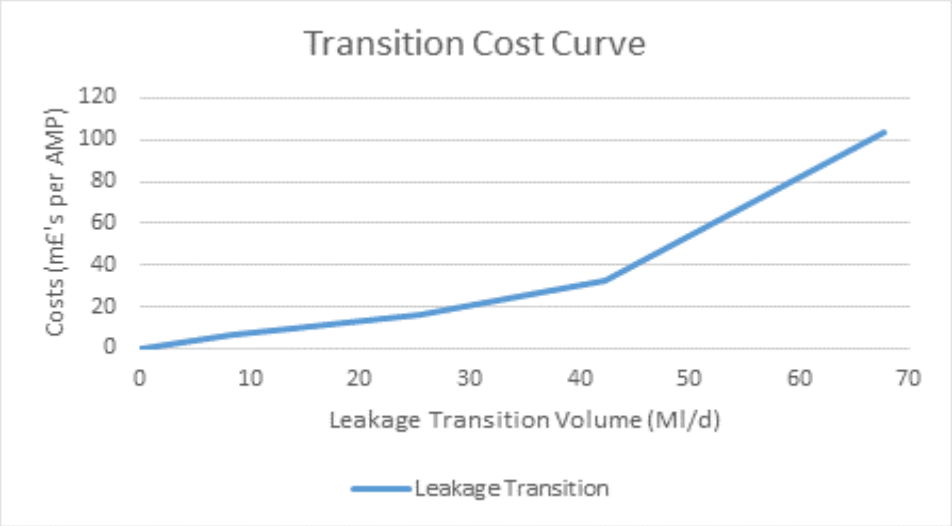

Figure 13- Transition cost curve for leakage investment