

Ref 5.8B

PR19 Investment Case: Reservoir Safety

September 2018



Caban Coch Reservoir

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1 Executive summary

Drivers for investment

Managing the safety of our dams is the one of the most critical roles we undertake as a water company, and is subject to strong regulation. A failure of one of these assets would lead to the disruption of water supplies to tens of thousands of people (and could in the worst scenario potentially result in loss of life). Over recent years the failure of two spillways within the company and incidents elsewhere in the world, for example, in Oroville in California, have further heightened awareness of the level of risk carried by the company and driven a change in our approach to dam safety.

There are three key drivers to invest in our reservoirs:

- Legal obligations - recent changes to regulation and good practice guidance relating to reservoir safety;
- Proactive, company-wide risk review - our improved understanding of the risks our reservoirs pose from our Portfolio Risk Assessment and the adoption of a proactive approach to addressing unacceptable risks, and
- Environmental Legislation - the environmental enhancements needed to provide compensatory flows associated with our reservoir assets.

Changes in regulation and good practice guidance

Over the past five years, regulation and good practice guidance relating to Reservoir Safety have seen significant updates. New regulations were introduced in Wales by the Welsh Government in 2016 driven by the Floods and Water Management Act 2010ⁱ.

Good practice guidance relating to the management of flood risk at reservoirs (Floods and Reservoir Safety 4th Edition, Institution of Civil Engineers, 2015ⁱⁱ) and relating to drawdown in an emergency (Guide to drawdown capacity for reservoir safety and emergency planning, Environment Agency, 2017ⁱⁱⁱ) have been introduced. These guidance documents will lead to the need to upsize spillways, raise dam crests and upgrade pipes and valves at our reservoir sites, due to the increases in expected storm intensities driven by climate change.

Adopting a proactive approach to risk management

During AMP6, Welsh Water has adopted the industry-leading Risk Assessment for Reservoir Safety (RARs) methodology^{iv}, introduced by Defra in 2013, to develop a detailed understanding of the safety of our portfolio of reservoirs. This methodology has changed our approach with our investment needs now based on a proactive quantitative assessment of risk and consequence of failure rather than simply reacting to statutory 'matters in the interest of safety' made during inspections.

We have also adopted a proactive risk management approach to our pipes and valves in dams in AMP6. This involved both a desk study using historic drawings and a site visit to confirm pipework arrangements and assess the condition and operability of pipes and valves. The benefits of this are threefold, firstly allowing us to plan work in a more proactive way, i.e. not driven by our Section 10 inspection programme, hence increasing efficiency; secondly, reducing the impacts of consequential damage costs from picking up

faults too late; and finally allowing us to assess our risk across our whole estate at once and not managing asset by asset as we have in the past.

Enhancing the environment downstream of our reservoirs

Our programme includes investment for specific sites where we have a responsibility to ensure that flows are maintained in the downstream watercourse, in accordance with the Operating Agreements we have with NRW, to manage the flow of water within the rivers to maintain the overall river ecosystem.

The investment

The drivers above lead to a need for us to provide greater than historic levels (£10m per AMP) of investment to upgrade our reservoirs. In order to achieve this in an efficient and affordable way we are proposing to invest in our reservoirs over the next three AMPs, spanning a horizon of 15 years. This will build on an already strong start; by the close of AMP6 we will have delivered our most extensive reservoir investment programme of £80m, a significant increase above our PR14 business plan of £23m. Our intention is to invest a further £347 million over the next three AMPs to build on this. This will include spending:

- £116.5 million in AMP7;
- £130 million in AMP8; and
- £100 million in AMP9.

We have developed an extensive innovation programme to support this investment, and will apply new techniques to maximise efficiency, improve outcomes for our customers, and safety for our staff. These innovations span the lifecycle of investment, from remote inspections, improved modelling, design and installation.

Need for cost adjustment

Of the £116.5 (pre-efficiency) million we are proposing for AMP7, we are requesting a cost adjustment of £86.1million (pre-efficiency). This relates to expenditure of:

- £47.5m of reservoir upgrades due to regulatory change and changes to good practice;
- £28.9m for the accelerated expenditure for reservoir upgrades related to the Portfolio Risk Assessment; and
- £9.7m of improvements to provide enhancements to compensatory flows

Once we have applied our efficiency challenge the cost adjustment claim is valued at £79m.

This investment will reduce the risk relating to the safety of our reservoirs to a level that is acceptable to our business and bring our future levels of maintenance to a sustainable level for the future.

Delivering for our customers

This work will meet the following of our customer promises:



Clean, safe drinking water for all: Work proactively to provide our customers with a long-term water supply, achieving acceptable levels of public safety risks associated with essential reservoir infrastructure.



Put things right when they go wrong: Aim to have reservoir infrastructure that is compliant with UK regulation and guidance and can be operated to respond to shock events, such as heavy rainfall.



Fair bills: The costs of this investment will be spread across three AMPs to avoid an unacceptable spike in customer bills.

Delivering for the future

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



Demographic change: With population in Wales expected to increase from 3.1 to 3.28 million people from 2014 to 2039, there may be larger populations downstream of reservoirs, which are at risk of flooding.



Climate change: More frequent and extreme weather events are predicted. We need to invest in our reservoirs to operate safe infrastructure and protect our customers from flooding.



Protecting essential infrastructure: We have an ageing asset base which is increasingly likely to fail. The average age of Welsh Water's reservoirs is 106 years. They are considered to be operating beyond their design life. A significant increase in investment is needed to mitigate the deterioration of some of our most critical assets.



Policy and regulation change: Since PR14, significant changes have occurred in best practice guidance and regulatory requirements that affects the risk management of our reservoirs. For example, since 2016, a further 45 reservoirs must comply with the Reservoirs Act.



Protecting public health: Our reservoir portfolio is exposing customers to a greater level of risk than is considered acceptable by current industry guidance. This includes the risk of death and destruction from sudden and uncontrolled release of water and the risk to public health from an inadequate supply of water.

Delivering our Strategic Responses

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



Enough water for all: Significant upgrades to spillways and internal pipework will be needed at many of our dams, so they remain safe in light of an expected increase in extreme rainfall events, and flexible enough to respond to more frequent drought periods.



Improving the reliability of drinking water supply systems: Our proactive approach will reduce the risk of failures and supply interruptions as well as reducing the likelihood of emergency drawdowns or the need to remove reservoirs from operation.



Protecting our critical water supply assets: Our change in investment approach is aligned with our 2050 strategy, to improve the resilience of critical water assets with high consequences of failure and reduce supply outages.



Ensuring affordability of services delivered to customers: We aim to have our services remain affordable, therefore we have spread our cost across three AMPs to avoid an unacceptable spike in customer bills.

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, which is defined in Supporting Document 5.8B.4:

Measure of success	End of AMP6 position	Benefit at the end of AMP7
Asset Resilience	92.2%.	95.5%

1 Delivering our customer outcomes

Need for investment for customers

The safety of our customers is a key priority for Welsh Water. We must upgrade and maintain our 131 reservoirs which provide 75% of the water supply for the 3.2 million people and businesses we serve. We must achieve this while ensuring an acceptable level of flood risk for our customers who live downstream of our reservoirs.

In AMP6, we have adopted the new Risk Assessment for Reservoir Safety (RARS) methodology to carry out a comprehensive review of our reservoir asset base. The RARS methodology is a risk framework, which looks at the risk of several failure mechanisms of the reservoir and the subsequent risk of loss of life.

Our adoption of the best practice RARS methodology represents a real change in approach. Required investment and intervention is now being identified based on a proactive quantitative assessment of the risk called the Portfolio Risk Assessment (PRA), rather than simply reacting to observations and recommendations made during statutory Section 10 and Section 12 inspections. The methodology is provided as Supporting document 5.8B.1.

The key findings of the PRA are that 81% of our reservoirs are likely to cause significant loss of life if they failed, with a median value of 13 and maximum of 102,000 lives lost if the worst did happen.

From the PRA, we have developed a multi-AMP strategy to improve our reservoir safety. At the end of AMP6 we will have completed works at ten sites to address priority issues and we have prioritised the investment required for AMP7, 8 and 9.

Over the past five years, regulation and good practice guidance relating to reservoir safety have seen significant updates.

In addition, good practice guidance relating to the management of flood risk at reservoirs (Floods and Reservoirs 4th Edition, 2015) and relating to drawdown in an emergency (Guide to drawdown capacity for reservoir safety and emergency planning, 2017) have been introduced. These

guidance documents will lead to the need to upsize spillways, raise dam crests and upgrade pipes and valves at our reservoir sites. This is necessary as the intensity of rainfall predicted during future storm events has increased significantly as a result of climate change. Our assets must be able to manage these additional flows without causing damage to the structure of the dam and risking a catastrophic failure.

If this work is not undertaken, we may be required to drawdown their reservoirs for safety reasons, following direction by the independent inspecting engineer. This would disrupt supplies to our customers.

Views of our customers and stakeholders

Our planned investment in reservoirs is aligned with a number of the Strategic Responses outlined in our long-term strategy, Welsh Water 2050. The responses represent the ways that we will address the challenges and opportunities we see in the future. Our proposed investment in our reservoir asset base will contribute to Strategic Responses such as 'enough water for all' and 'protecting our critical water supply assets'.

Our customers place great importance on the role we play in safeguarding a sufficient drinking water supply for everyone in our region. The highest importance Strategic Responses were: 'enough water for all' and 'protecting our critical water supply assets' in our 2050 consultation.

Our online '*Have Your Say*'^{vi} survey in 2017 showed that customers are highly supportive of investments in our supply systems. Improving the reliability of the drinking water supply systems was considered important to our customers^{vi}. This continuity of supply is important to all our customers, but zero interruptions to supply were most critical to vulnerable customers and business customers. Our customers have also highlighted

drought, as it is a key threat to water supply, which we should respond to^{vii}.

Benefits for our customers

Our intention is to invest £347 million in our reservoir asset base over the next three AMPs. This will include spending:

- £116.5 million in AMP7;
- £130 million in AMP8; and
- £101 million in AMP9

We believe that without this investment we would expose our customers to a greater level of long-term risk than is considered acceptable.

Specifically, there would be an increased risk of:

- Loss of life and destruction as a result of the sudden and uncontrolled release of water if our reservoirs were to fail; and
- Public health emergency if we have an inadequate supply of water caused by the requirement for an emergency drawdown or a sudden and uncontrolled release of water if our reservoir assets were to fail.

The proposed investment will help us to provide our customers with:

- **Adequate protection from reservoir failure:** We will reduce the risk of failure of our reservoirs in line with best practice guidance and protect our customers from loss of life and flooding.
- **Improved availability of water and drought resilience:** We will reduce the risk of being unable to hold adequate water stocks in an emergency.

Whilst the proposed level of investment represents a significant increase compared with historic expenditure, we have elected to undertake the required investment over a period of three AMPs in order to minimise the impact on bills for our customers.

2 Investing for now and in the long-term

Future challenges

We have created a company-wide strategy which looks to 2050 and has identified future challenges. We wish to address these challenges and become more resilient to provide the best service possible to our customers and the environment.

Policy and regulatory change

Over the past five years, legislation and good practice guidance relating to Reservoir Safety has seen significant updates. Principally, new regulations were introduced in Wales in 2016 driven by the Floods and Water Management Act 2010.

These regulations have reduced the capacity of reservoirs that are included under the Reservoirs Act 1975 from 25Ml to 10Ml of storage. As a result, the number of our reservoirs subject to this regulation has increased from 86 to 131. These 131 reservoirs will require statutory inspections in accordance with the Reservoirs Act 1975 and where these inspections identify safety concerns (Matters in the Interest of Safety), which are enforceable by Natural Resources Wales (NRW), investment will be required.

As well as change in legislation, in the past five years, we have seen changes in good practice guidance. In 2015, the Institution of Civil Engineers released an updated version of their guidance on managing the risk of flooding at reservoirs, Floods and Reservoirs Safety 4th Edition.

This introduced a higher category of flood, the Safety Check Flood that reservoirs have to be designed for. This will result in spillway upgrades and crest raising at some of our reservoir sites.

In addition, there has been the introduction of good practice guidance documents to ensure that water levels in reservoirs are maintained at a safe level or can be reduced in the event of an emergency: the Guide to drawdown capacity for

reservoir safety and emergency planning by the Environment Agency in 2017. This has resulted in the introduction of minimum drawdown requirements for reservoirs and will result in the need for pipe and valve upgrades at Welsh Water's reservoirs.

Demographic change

In our region, the population is predicted to increase from 3.1 million in 2014 to 3.28 million in 2039. This includes significant growth in key cities such as Cardiff (90,000) and Swansea (22,000).

As a result, there may be an increased population living downstream of reservoirs that are at risk of flooding in the event of a reservoir failure. In addition, the increased demand on water supply will make it more difficult to complete upgrade works at our reservoirs without disrupting supply to our customers.

Climate change

The 2017 UK Climate Change Risk Assessment identified a number of key risks for Wales, including risks to infrastructure from flooding and the risk to public water supplies from drought and low flows. These risks present challenges to our reservoir asset base.

The risk of too much water means that there is an increased risk of dam overtopping and reservoir failure. Conversely, drier summers may lead to diminished water supply from river abstractions, putting resource zones at risk of water deficit.

This underlines the importance of keeping our existing reservoir assets in service. This has been reflected in the latest update to the Flood Estimation Handbook, which is used to predict the magnitude of flood events that is used to size reservoir spillways and pipework.

Protecting essential infrastructure

The majority of our reservoirs are over 100 years old and the likelihood of failure is increasing. Historically our spend was based on only Section 10 requirements. However, during AMP6, we completed the Portfolio Risk Assessment, which is a risk management approach to reservoir safety. This has improved our understanding of the risk profile

of our reservoirs and has resulted in the development of a multi-AMP strategy to improve our reservoir safety.

Legal duties

We will continue to meet our legal requirements under the Reservoirs Act 1975 and the Habitats Directive.

3 Options

Background

We treat approximately 800 Megalitres/day (MI/d), of drinking water to supply 3.2 million people and businesses. By the creation of dams, we can store water to meet this demand and provide resilience to the resource availability. Impounding reservoirs not only provide storage to meet demand, they also provide a useful settlement stage for suspended solids plus other amenity and environmental benefits.

The storage volume within our impounding reservoir asset base accounts for 75% of this supply need. Our river and groundwater abstractions would not be able to replace the capacity of our reservoirs if they were not available.

At the end of AMP6 there will be 137 structures across 131 reservoir sites. Of these sites, 38 directly feed a water treatment works.

Legal obligation	Impounding reservoirs	Service reservoirs	Total assets
Reservoir Act 1975	79	7	86
Flood and Water Management Act 2010	90*	41	131

*we have transferred 1 reservoir to a third party since PR14.

Table 1: The legal obligations for our reservoirs

We have a statutory duty to ensure our bulk storage of water complies with legislation on health and safety under the Reservoir Act 1975^{viii}, with a requirement to carry out detailed inspections (Section 10 reports) every 10-years supported by annual statement (Section 12 reports).

Our asset base is ageing; the majority are over 100 years old and the likelihood of failure is increasing. Figure 1 provides an indication of the age and storage volume across our asset base. Our risk assessment has identified that 81% of our reservoirs are likely to cause significant loss of life if

they failed, as they are located close to population centres.

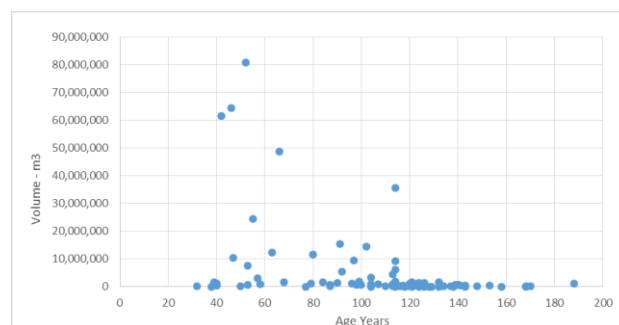


Figure 1: Graph showing age of reservoir against storage volume.

Options

We have undertaken an optioneering exercise to identify our preferred approach to meeting these challenges.

Our focus for optioneering considered the optimal pace of investment, accounting for the need for investment and deliverability constraints.

The following three options were considered:

1. Retain current levels of investment and approach;
2. Deliver increased levels of investment over AMP7 and AMP8; and
3. Deliver increased levels of investment over AMP7, AMP8 and AMP9

Option 1 – Section 10 and enhancements to meet legislative change

This approach would mean investment levels of approximately £50 million in AMP7 and implement legislative changes over a 40 year cycle. This is more in keeping with our historic approach but could lead to deferment of work that was not affordable. Investment would be on a reactive basis only, responding to the Section 10 (S10) and Section 12 (S12) inspections and observations from our engineers.

Under this option, the residual level of risk posed by our reservoir assets would increase and we would expect to see increased enforcement actions under the Reservoirs Act from NRW and any enforcement action would need to be completed over more challenging timescales than if we had acted proactively, leading to increased costs due to the loss of efficiency of pre-planning.

It would also result in reduced resilience and increased disruption to our water supply, as we will be required to carry out increasing numbers of emergency drawdowns and increasing levels of reactive maintenance.

As such we do not believe that this is a viable position for a responsible company to take.

Option 2 – Section 10 and deliver increased levels of investment over two AMPs

This approach would increase investment levels to approximately £160 million in both AMP7 and AMP8. From AMP9 onwards the level of investment would reduce to a baseline maintenance programme of £50 million.

A key advantage of this approach is that it would enable us to significantly reduce the risk of reservoir failure. It would mean that risks identified in the current AMP could be proactively addressed in a timely manner before any works are mandated by S10 inspections.

This approach would also provide greater investment plan certainty across the business. By planning to allocate sufficient expenditure to our reservoir assets based on known levels of risk, there is a reduced likelihood of investment in other areas of the business being deferred to make way for reactive works.

Despite these significant benefits, there are some challenges inherent in this approach. Firstly, the cost of additional investment would have to be raised through an increase to the bills of our customers, the impact of which would be spread across AMP7 and AMP8.

Secondly, the significant increase in the levels of investment in our reservoir assets over the next

two AMPs would require a marked increase in supply-chain engagement. This would have associated cost impacts due to the short-term investment required. It would also require a number of our identified schemes to be undertaken in parallel. Since many of these schemes will require our reservoirs to be taken out of service during works, this would put significant pressure on our supply system and represents a real delivery challenge.

Option 3 – Section 10 and deliver increased levels of investment over three AMPs

Under this approach we would increase investment levels to £116 million in AMP7, £130 million in AMP8 and £101 million in AMP9. The level of investment would then reduce to a baseline expenditure of £50 million from AMP10 onwards.

This approach shares many of the benefits offered by Option 2. It would reduce the risk of reservoir failure and would allow us to adopt a proactive approach to managing our reservoir assets that is in line with best practice.

It would also mitigate a number of challenges identified for Option 2. These principally relate to the practicality of delivering such a significant increase in the levels of maintenance and remedial work. The programme of works proposed for AMP7 will involve construction at 21 reservoirs, which supply seven water treatment works and 716,400 of Welsh Waters' customers as well as parts of the Dee Regulation. By spreading our investment over three AMPs rather than two, we can limit the number of reservoirs in construction at one time and therefore reduce the risk interruptions of supplies to our customers. It would also allow time for lessons to be learnt between the delivery of the improvements, helping us to optimise our performance.

We arrived at our preferred option by weighing up both the costs and benefits that each option would provide to our customers. Our preferred option is detailed in the following section of this document.

4 Preferred option

Preferred option

Following our appraisal of the three options, we are confident that an approach that increases investment over the course of three AMPs (Option 3) would provide the best investment profile to enable us to implement the significant increase in approach that is needed to reduce risk.

Option 3 will allow us to adopt a more proactive investment programme and to deliver it over a timescale that makes delivery more achievable and minimises the impact on customer bills.

It is unlikely that we could meet all of our legal obligations if we selected Option 1 and delivering in the timescales of Option 2 would be challenging and inefficient.

In AMP7, our preferred option will deliver investment across the following areas of our reservoir asset base.

S10 and S12 inspections

Completion of statutory inspection reports across all our reservoirs, S12 inspections are required annually for all our registered sites, whilst a S10 inspection is required once every ten years. During AMP7 we have planned to complete 655 S12 reports and 34 S10 reports. The costs of these inspections are well understood and are based on historic costs.

	AMP7				
	Year 1 2020- 2021	Year 2 2021- 2022	Year 3 2022- 2023	Year 4 2023- 2024	Year 5 2024- 2025
<i>Annual Total</i>	8	3	9	3	11
<i>AMP Total</i>	34				

Table 2: Summary of Section 10 inspections in AMP7.

*This table excludes reservoirs between 10MI and 25MI, which are awaiting designation by NRW.

Base maintenance

This is our planned investment for capital maintenance works at our large reservoir sites to address smaller items of work. These are activities identified as part of the S10 and S12 reports, such as:

- Patch repairs to stone and masonry spillways;
- Re-pointing of masonry spillways and walls to reduce the chance of stones coming loose;
- Improved access to sites with localised works;
- Provision or replacement of access steps and handrailing to reservoirs to avoid the need to walk up and down a grassed slope;
- In-situ repairs to leaking valves;
- CCTV inspections of existing drainage pipework;
- Minor health and safety works, such as improved signage; and
- Capital maintenance works at our Service Reservoir (SRV) sites to address issues where a Section 10 inspection is planned. These are expected to be small scale elements of work across the wider asset base.

Enhanced maintenance

This is our planned investment to address the outcome of our AMP6 PRA investigations where our new proactive risk-based approach has identified the need for significant capital investment, and to address changes in regulation and guidance.

The investment required to address regulatory change and changes to good practice guidance totals £44.75m and includes:

- Seven spillway replacements;
- Pipework replacements at seven reservoirs;
- Valve replacements at seven reservoirs;
- Capital maintenance at our SRV sites, which are between 10-25MI of capacity and have recently

been brought under the Reservoirs Act 1975. (In developing this investment case we have ensured that there is no overlap with the delivery of the Service Reservoirs maintenance investment case. Operational maintenance of the SRVs are accounted for separate from this investment case.)

The accelerated investment required to proactively manage our reservoir safety risk following the Portfolio Risk Assessment totals £44.25m and includes:

- Seven spillway refurbishments;
- Pipework replacements at six reservoirs;
- Valve replacements at five reservoirs;
- Tower access improvements at eight reservoirs;
- Tunnel refurbishments at two reservoirs;
- Discontinuance of one reservoir;
- Grouting at 10 reservoirs;
- Ground anchoring at two reservoirs;
- Stabilising works at one reservoir.

This is our current view of our investment programme for AMP7. This will be reviewed over years 4 and 5 of AMP6, taking into account further analysis of the PRA and the results of statutory inspections. This programme is provided in Supporting document 5.8B.2.

For each of these projects, we will challenge ourselves to deliver the outcomes efficiently. We will undertake optioneering for each project and complete a risk and value exercise to determine the most appropriate solution.

Regulation of river flows base maintenance (Section 20 Water Resources Act)

We have environmental obligation under the Habitats Directive to ensure that prescribed flows are maintained in downstream watercourses. The expenditure we have identified is in accordance with the operating agreements we have with NRW to manage the flow of water within the rivers in order to protect their ecosystems. This will require greater flexibility and control than is possible with existing assets. Some of the changes will need significant modification to include the type of flow control systems required.

Cost

Our approach will see £325 million invested in our reservoir asset base over the next three AMPs.

£116.5 million will be invested in AMP7, representing a significant increase in our expenditure levels.

	Baseline Investment (£m)	Accelerated Baseline Investment (£m)	Legislative & Good Practice Guidance Change (£m)	Compensatory Flow Enhancement (£m)
Reactive general maintenance	2.3			
Regulation of river flows base maintenance				9.7
S10 and S12 inspections	3.8			
Studies & Investigations	3.8			
service reservoirs Reservoirs Act maintenance			3.1	
Impounding reservoir base maintenance	3.7			
7 spillway replacements			36.6	
7 spillway refurbishments	4.8	5.7		
Pipework renewal at 6 reservoirs		3.2		
Pipework upgrades at 7 reservoirs			5.6	
Valve renewal at 5 sites		1.1		
Valve upgrades at 7 sites			2.2	
Tower access improvements at 8 sites	4			
Tower refurbishment at 8 sites	8			
Tunnel refurbishment at 2 sites		2.1		
Discontinuance at 1 site		3.2		
Grouting at 10 sites		8		
Ground anchoring at 2 sites		1.6		
Stabilizing works at 1 site		4		
Total	30.4	28.9	47.5	9.7
Overall reservoir safety investment total		£116.5m		

Table 3: AMP7 Costs for this investment split between capex. Legislative & Good Practice Guidance Change, Compensatory Flow Enhancement and Portfolio Risk Assessment.

Of the £116.5 million we are proposing for AMP7, we are requesting a cost adjustment of £86.1 million due to:

- Changes in best practice and regulatory change in Wales;
- Accelerated investment to enable us to take a proactive approach to reservoir safety risk management following the PRA; and
- Investment to enhance our compensatory flows in line with our operating agreements with NRW.

We believe this expenditure is outside the scope of the econometric and unit-cost modelling that has been undertaken as part of Ofwat's cost assessment. Our costing approach is set out in Supporting Document 5.8B.3.

5 Cost efficiency and innovation

Summary of innovation in this project

During the design and construction of our reservoir upgrades, we will innovate to ensure that we provide cost-effective solutions for our customers. During AMP6, we have adopted innovative approaches to provide more cost-effective and safer solutions whilst maintaining supply to our customers. Four examples of these innovations are provided in Table 4 below.

'Bus shelter', Rhymney Bridge Number 2, South Wales



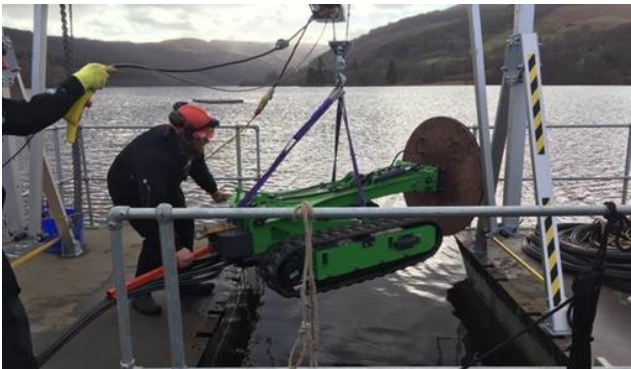
When designing the new spillway we undertook detailed physical and computational fluid dynamics (CFD) modelling to identify the location which was at risk of water leaving the structure at change of direction. Rather than increase the height of the walls along the entire length of the structure, the design included a localised 'bus shelter' arrangement to ensure that any water is returned safely into the new structure. This detailed analysis enabled this localised approach which was less expensive than the alternative of a greater length of higher concrete walls.

Labyrinth weir, Shon Sheffrey reservoir, South Wales



In 2014-15 (AMP6) the spillway was upgraded with a new labyrinth weir and tailbay. The design was informed by a 1:20 scale physical model. The use of a labyrinth type spillway resulted in a more economic solution as the alternative would have involved raising the height of the wave wall along the entire crest of the dam. This saved around £2million CAPEX.

Vulcan, Remote operated vehicle (ROV)



When replacing or enhancing our reservoir pipes we need to isolate these pipes which will often involve the use of divers. This is a high-risk task. Therefore, to improve safety of this process an innovative alternative method has been started to reduce the Health and Safety risk to our staff and sub-contract partners.

We have been working with our contract partners to design, manufacture and commission a prototype remote operated vehicle (ROV), called Vulcan. It can be operated from the surface via hydraulic control and can carry out these isolations instead of divers. This is the first of its type and was manufactured by a local Company in Cowbridge.

Caban Coch dam, Elan Valley, Mid Wales



Following a leak on a scour pipe at another of our Dam's we started our innovative 'Pipes In Dams' project, with the Dam at Caban Coch being one of the first surveyed. We were concerned about the condition and rate of deterioration of some sections of pipe inside the Dam. We identified work to replace the scour pipe valves and sections of pipework. We were initially unable to provide any means of isolation upstream to enable safe working and drawing down the reservoir was not an option as we need to maintain supply to 1.5 million people across Birmingham, Mid Wales and Herefordshire. We developed a solution to provide upstream isolation by divers using a proprietary inflatable plug and plate technique.

We were challenged by the altitude and the depth of the diving operation due to the restriction it placed on the time the divers could spend working underwater. Considerable planning was required to ensure the works could be completed safely and in 2017 we managed to replace all valves inside the Dam without the need to interrupt customer supplies.

Table 4: Innovative techniques used by Welsh Water

We will adopt some of the innovations we have developed in AMP5 and 6 to deliver our projects in AMP7, 8 and 9. In addition, we will continue to innovate. These innovations may include:

- Advanced smart monitoring of our reservoirs to reduce the need for reactive maintenance by providing timely information to operators;
- Exploration of the procurement routes that will give consistency in the delivery of our schemes. This will allow efficiencies to be accrued as we move through this significant investment programme;
- Standardisation of the specification of products across our reservoir asset base to encourage delivery efficiency; and
- Exploration of opportunities for off-site fabrication and construction techniques, minimising the down-time of our reservoirs.

Partnering and co-creation

We are working with the supply chain to develop innovative solutions to some of our challenges particularly around maintaining supply to our customers during construction. These include diving contractors and pipeline isolation specialists. There have been a number of incidents over the last couple of years associated with gates, valves

and pipework failure in dams. As a result the Construction Industry Research and Information Association (CIRIA) carried out an industry-wide survey, which highlighted the ongoing need for research into the design, selection, operation and maintenance of gates, valves and associated equipment in dams.

This has generated interest amongst a number of water utilities, the Environment Agency and other reservoir owners.

A national project is being jointly funded by Welsh Water, United Utilities, Yorkshire Water, Thames Water, Severn Trent, Scottish Water, Northern Ireland Water, Scottish and Southern Energy, Environment Agency and Natural Resources Wales. Our 'Pipes in Dams' Project has been used to guide the this project.

Of particular relevance to our proposed investments in our reservoir assets is our enduring and strong relationship with NRW. We will work closely with them to deliver this ambitious investment programme and will look to make the most of opportunities to coordinate efforts in order to minimise disruption to our system through inspections, risk designation and routine maintenance.

"Dŵr Cymru has the largest portfolio of reservoirs in Wales, storing more than 650 million m³ of water for drinking water and other supply purposes. Dŵr Cymru is therefore an important and significant customer for us in terms of managing the safety of the dams that retain these reservoirs, but also to the wider public who depend on them. Dŵr Cymru has actively engaged with us throughout the introduction of the amended legislation to ensure their assets are properly registered and compliant with the Reservoirs Act. We are aware of a full programme of inspection, supervision and maintenance works, and we meet regularly to ensure this compliance continues.

It is clear to us that reservoir safety is a priority for Dŵr Cymru, where the management has committed itself to be best in class in reservoir safety, and we commend them for this."

NRW Reservoir Safety Team, 2017

6 Value for money and affordability

Impact on customer bills

We need to make sure that our services remain affordable for all customers: both in terms of average bills and for those on social tariffs. For this reason, our decision to significantly increase investment in our reservoir assets has not been taken lightly.

The decision has been taken to reduce the risk posed to public safety and to protect some of our most critical water supply assets. We hope to balance this need for additional investment with the affordability of customer bills by proposing a delivery timeline that has been carefully considered to make sure that the bill impact will not be felt acutely by our customers.

Value for money

We understand the need to demonstrate value for money in everything that we do. In arriving at our

preferred approach to the challenges facing our reservoir assets we have closely considered the financial requirements of different approaches to make sure that any investment represents value to our customers.

We have used information from recently completed works in AMP5 and AMP6 to inform the cost estimates that underpin this investment case.

Our proposed measure of success and Outcome Delivery Incentive (ODI) will provide a regulatory assurance to ensure we realise the planned outcomes.

To support effective delivery of this ambitious investment programme we have devised a new delivery structure underpinned by a strategic delivery plan. This will allow for the effective strategic planning of the programme across our operational areas before handing over to the on-site delivery teams, and is discussed in more detail in the following section.

7 Delivery

Procurement

We have undertaken an assessment of the applicability of direct procurement for these projects. The nature of these projects is such that we consider a direct procurement approach would not be in the best interests of customers

Programme

We are currently preparing the strategic delivery plan for our identified capital investment in AMP7. This fully prioritised programme and delivery plan will be in place by March 2020. To achieve this, we will undertake detailed design for the initial schemes during years 4 and 5 of AMP6.

A dedicated Capital Delivery Team will be responsible for the investment programme. This will allow us to retain and hone specialist skills in reservoir construction, and ultimately exploit opportunities to realise delivery efficiencies throughout AMP7 and beyond.

We will draw upon experience across our supply partners to use best practice project management techniques to plan and monitor our delivery programme and where advantageous we will explore opportunities to advance the progression of schemes by working closely with both these service partners and NRW.

Risk mitigation and customer protection

To protect the interests of our customers we are proposing an ODI for resilience of impounding reservoirs.

We currently monitor the resilience of our critical reservoirs and report our performance via our annual regulatory returns. The resilience scoring is quantified using the following inputs:

- Failure risk of the reservoir (related to the PRA risk category);
- Access resilience to the reservoir - for both operational and construction purposes; and
- SEMD (Security & Emergency Measures Direction) classification.

At the start of AMP7, we believe our asset resilience score will be 92.2%. At the end of AMP7, based on the investment plan we have set out in this investment case, we anticipate that the score will improve to 95.5%. We forecast by the end of AMP8, the score will further improve to 97%.

Full details of our ODI scheme will be included within our 3rd September submission.

8 Assurance

Governance

Our annual Dam Safety report is reviewed by our Board annually and the PRA methodology was reviewed in January 2018. The findings of the PRA informed our decision to increase PR19 investment in our reservoirs.

Cost assurance

We have taken steps to ensure the accuracy of our costs for the described works. We have derived our costs from a number of sources, including:

- Costs of historic inspections;
- Costs from procurement contracts, for example for grounds maintenance;
- Costs from operating agreements, for example with NRW; and
- Costs of historic works, including costs from schemes of comparable scope, particularly the costs of AMP6 projects.

Given the nature of reservoir assets, it can be difficult to achieve high levels of cost confidence in advance of capital works. In some instances, we have instead applied a cost range to reflect the levels of uncertainty.

We have also procured Chandler KBS to complete a benchmarking exercise of the costs of the reservoir schemes to industry averages.

Customer consultation assurance

Our customers place great importance on the role we play in safeguarding a sufficient drinking water supply for everyone in our region. The highest importance placed by customers on the Strategic Responses in Welsh Water 2050 were: 'enough water for all' and 'protecting our critical water supply assets' in our 2050 consultation.

Our online 'Have Your Say'^{ix} survey in 2017 showed that customers are highly supportive of investments in our supply systems. Improving the reliability of the drinking water supply systems was considered important to our customers^x. This continuity of supply is important to all our customers, but zero interruptions to supply were most critical to vulnerable customers and business customers. Our customers have highlighted drought, as it is a key threat to water supply, which we should respond to^{xi}.

Monitoring and future assurance

We have created new MOS to monitor the success that that our investment programme will bring. The measures against which we will assess the success of the programme include:

- **Availability of water:** We will stop the deterioration of our critical reservoir assets and reduce the risk of being unable to hold adequate water stocks.
- **Drought resilience risk:** Our reservoirs are especially crucial during extreme dry weather periods. By investing to stop the deterioration of our reservoir assets we will maintain resilience of supply and maximise our flexibility to respond to these types of events.
- **Asset resilience (water resources):** Ageing assets have a higher risk of failure and associated service impacts such as catastrophic flooding. The investment will allow us to keep our reservoirs in operation and will provide us with a wider choice of available water resources.

We will report on these measures annually to customers. Alongside these MOS, we have proposed an ODI for impounding reservoirs.

9 Supporting documents

5.8B.1 - Portfolio Risk Assessment (PRA) summary

5.8B.2 - Schedule of works anticipated for AMP7

5.8B.3 – Dam Safety & Reservoirs – Cost Modelling

5.8B.4 – Definition for asset resilience performance commitment

5.8B.5 – Cost-adjustment summary form

10 References

ⁱⁱ ICE, 2015. Floods and Reservoirs Safety, 4th Edition

ⁱⁱⁱ Environment Agency & Defra, 2017. Guide to drawdown capacity for reservoir safety and emergency planning

^{iv} Environment Agency & Defra, 2013. Guide to risk assessment for reservoir safety management

^v Welsh Water 2050 Summer Consultation- 'Have your say'

^{vi} Welsh Water 2050 Summer Consultation- 'Have your say' & Customer priorities, Welsh Water Consultation, October 2016

^{vii} Performance targets Qualitative, Welsh Water consultation, June 2017

^{viii} UK Government, 1975. Reservoirs Act

^{ix} Welsh Water 2050 Summer Consultation- 'Have your say'

^x Welsh Water 2050 Summer Consultation- 'Have your say' & Customer priorities, Welsh Water Consultation, October 2016.

^{xi} Performance targets Qualitative, Welsh Water consultation, June 2017