Wastewater Network plus Enhancement

Dŵr Cymru Welsh Water

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PR19: Wastewater Network+ Enhancement

September 2018

Wastewater Network plus Enhancement

Dŵr Cymru Welsh Water

Contents

Executive summary

Driver for investment

We collect wastewater from 1.3 million properties, serving 3.2 million people and businesses. Our wastewater collection system comprises circa 36,260km of sewers and rising mains and 2,402 sewage pumping stations (SPSs). These figures include the legacy public sewers and the formerly private sewers that have transferred to us.

Our business has general duties to provide, improve and extend the public sewerage system, as imposed by Section 94 of the Water Industry Act 1991. Furthermore, our customers expect us to protect them in the long-term and ensure we develop and maintain a resilient sewerage network.

We face unprecedented future challenges, with a complex interaction of factors requiring multifaceted responses to achieve our aims. Climate change is being realised through changes to rainfall characteristics, leading to increasing risk of uncontrolled discharges from the network. An increasing population not only increases demand on our network, but increases the consequence of failure in the rare event of our systems not operating correctly. Our customers are also increasingly aware of society's impact on the environment around us, with social media raising expectations around performance and immediately highlighting where these expectations are not being met. These were all strong themes identified through our PR19 engagement with our customers and have strongly influenced our prioritisation of investment within this Investment Case.

The expenditure proposed in this Investment Case, builds upon investment identified in the Wastewater Network and Wastewater Treatment Maintenance Investment Cases and includes investment to implement solutions and develop strategies to help address our customers' and stakeholders expectations of a step change in our performance. In order to deliver greatest value for our customers, we need to look forward to understand where our greatest needs for investment are, identifying key future trends likely to impact on our performance and prioritising these needs appropriately.

In AMP7, the UK Government and our stakeholders expect a step-change in wastewater planning, with the production of Drainage and Wastewater Management Plans (DWMPs). The DWMPs will support our objective to have an industry-leading wastewater planning capability supporting our Welsh Water 2050 goal – '*to become a truly world class, resilient and sustainable water service for the benefit of future generations*'. These DWMPs will build on investment made in AMPs 5 and 6 on our Sustainable Drainage Plans, and will ensure we deliver sustainable and holistic solutions across our wastewater assets that meet the expectations of our customers and stakeholders.

The investment proposed in our Wastewater Network+ Enhancement Investment Case will enable us to achieve our stretching performance targets, in order to assure our customers, stakeholders and regulators that we are truly delivering 21st century sewerage.

The investment

We propose to invest £115.23m (pre-efficiency) during AMP7 to improve our sewer flooding and pollution performance, develop our long-term wastewater planning capability and secure the resilience of our critical assets. A breakdown of the investment is shown in Figure 1.

The investment will be delivered in five key areas, either building on existing enhancement strategies or through implementation of new programmes of work, and include:

Flood Risk Reduction

- Mitigating internal flooding due to hydraulic overload, by addressing and avoiding 'new' additions to our list of 'Worst-Served Customers' i.e. those suffering repeat problems;
- Focusing expenditure on external flooding due to hydraulic overload.

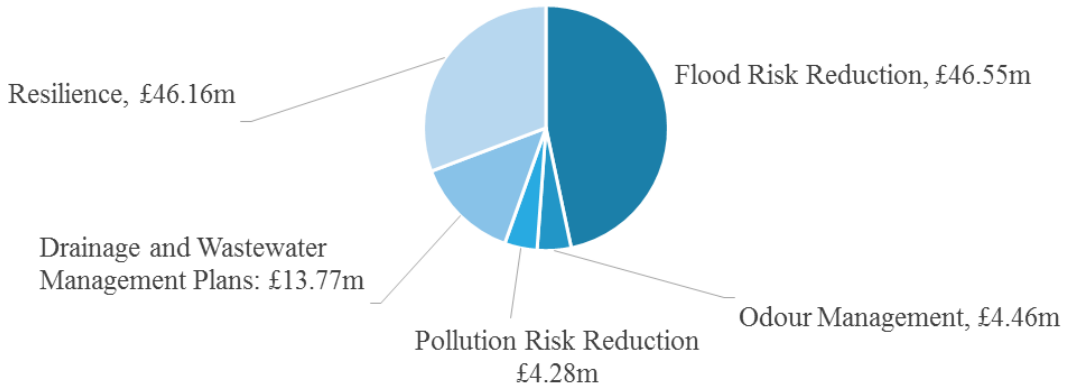


Figure 1: Summary of proposed investment

Resilience

- Delivering resilience improvements to include power resilience at our critical WwTWs and SPS;
- Undertaking condition surveys and temporary works plans at our critical sewer locations;
- Completing a key sewer resilience scheme in Newport, South Wales;
- Improving security of our assets and systems.

Drainage and Wastewater Management Planning

- Implementing a new DWMP Framework and management structure;
- Updating existing SDPs to meet DWMP criteria.

Odour Management

- Addressing confirmed odour-related complaints we receive that are attributed to wastewater assets;
- Investing in odour mapping surveys and odour monitoring equipment;

Pollution Risk

- Development and implementation of an AMP7 Pollution Reduction Strategy to include initiatives and public awareness campaigns to reduce the risk of blockages in our sewers.

We have identified £9.54 million of efficiencies in the delivery of this Investment Case through improved efficiencies in scheme delivery and the implementation of innovative solutions by our Capital Alliance partners, together with initiatives to improve operational processes and reduce capital maintenance expenditure.

Our proposed expenditure was identified following robust challenge and scrutiny of potential scenarios by our Executive team.

Delivering for our customers

Our proposed investment will meet the following of our customer promises:

Safeguard our environment for future generations: We will invest in long-term DWMPs across our wastewater catchments. We will improve the resilience of our critical wastewater assets to reduce the risk of sewer spills and flooding events.

Put things right if they go wrong: We will reduce the number of properties suffering with external flooding and address internal flooding incidents; particularly targeting our worst-served customers. We will continue to offset increases in odour complaints, focussing on addressing the repeat offending assets. Improving resilience will meet our customers' expectations and reduce the risk of service failure.

A better future for all our communities: We will reduce sewer flooding and pollution incidents, ensuring our performance is in the top quarter of the industry. We will continue to focus on long-term resilience, reducing the risk of future issues for our communities.

Delivering for the future

In our long-term strategy document Welsh Water 2050, we identified future trends. Our proposed investment will help us address the following trends:

Climate change: Climate change will result in more extreme rainfall and drought events, which could lead to an increased risk of flooding, pollution and odour. We will develop our DWMP approach to improve our understanding of long-term challenges and help us address the impacts of climate change on our wastewater assets. Our proposed investment will help us address the increased risk of sewer flooding and pollution due to hydraulic overload.

Demographic change: Our DWMPs will identify pinch points and long-term investment requirements to address increased service demand.

Change in customer expectations: Our worst-served wastewater customers, i.e. those suffering repeat flooding problems, will no longer pay for a below-standard service. Meanwhile customers will have more channels to contact us to raise concerns.

Protecting essential infrastructure: Our aging assets (and those of our energy providers) present significant issues with reliability and resilience. We will protect more of our assets from energy failure, gain further insight in to our sewerage assets, and proactively plan for failure to reduce disruption when failure occurs.

Protecting public health: We have a role to play in promoting healthier and more sustainable lifestyles for our customers. Minimising the risk of odour, flooding or pollution impacting upon public and private spaces will support this.

Delivering our Strategic Responses

In our strategic planning document Welsh Water 2050, we set out to deliver 18 Strategic Responses. The proposed investment will contribute to the following:

Strategic Response 17: Protecting our critical wastewater assets: We will improve the resilience of our critical wastewater assets that have the highest environmental and customer impacts in the event of failure.

Strategic Response 10: Addressing our 'worst served' customers: Undertaking interventions to reduce flooding will improve the minimum service standards for customers. In addition, investing in customers who are impacted by odour fits with a wider understanding of poorly-served customers.

Strategic Response 13: Smart water system management: Increasing the use of technology in the form of monitoring will enable us to provide a better, immediate and a more proactive service to customers. Our AMP7 Pollution Reduction Strategy will identify opportunities for technological advances including remote sensing, data analysis and automation to enable us to address flooding and pollution risks before incidents occur.

Strategic Response 16: Cleaner rivers and beaches: Addressing the risk of hydraulic overload from our sewers will protect our rivers and beaches from potential pollution. Investing in our DWMPs, including improvements to our hydraulic modelling use and interpretation, will enable us to identify our biggest pollution risks to help prioritise investment. In addition, the AMP7 Pollution Reduction Strategy will develop opportunities to reduce pollution of our rivers, lakes and coastal waters.

Strategic Response 18: Promoting a circular economy and combatting climate change: The development of our DWMPs will ensure the holistic and sustainable management of our wastewater catchments in the long-term. The identification and development of RainScape and infiltration reduction opportunities through DWMPs will reduce pumping costs.

Strategic Response 15: Using nature to reduce flood risk and pollution: Twenty percent of our AMP7 RainScape target is expected to be achieved by investment proposed in this investment case. Our DWMPs will provide strategic data for sustainable climate change adaptation to 2050.

Achieving our measures of success

Over AMP7, we will measure our performance based on Measures of Success (MoS). The investment proposed in this Investment Case will contribute to achieving the following MoS:

Measure of Success	End of AMP6 Position	End of AMP7 Position
Rt1: Internal sewer flooding - The number of internal flooding incidents per year	300	273
En3: Number of pollution incidents from wastewater per year	107	90
Rt6: Worst-served customers for wastewater service (no.)	368	359

Rt2: External Sewer flooding - The number of external flooding incidents per year within property curtilage	4121	3800
Rt4: Household written and telephone complaints (no./ 10,000 customers)	76	60
Ft2: Risk of sewer flooding in a severe storm	3.63% (2017-18)	5% reduction from baseline performance
Ft4: Surface water removed from sewers (property equivalent)	25,000	47,000
Ft8: Asset Resilience (waste network + above ground)	77.7%	80.0%
Ft9: Asset Resilience (waste network + below ground)	28.3%	45.0%

1. Delivering our customer outcomes

Need for investment

Our business has general duties to provide, improve and extend the public sewerage system, as imposed by Section 94 of the Water Industry Act 1991. Furthermore, our customers expect us to protect them in the long-term and ensure we develop and maintain a resilient sewerage network.

The expenditure of £115.23m proposed in this investment case builds upon investment identified in the Wastewater Network Maintenance Investment Case. It includes investment to implement solutions and develop strategies to help address our customers' and stakeholders expectations of a step change in our performance, particularly around:

Internal Flooding - Ofwat expect all water companies to target industry upper quartile performance over AMP7. We have made significant investment over AMPs 3 - 6 to reduce the risk of internal flooding for our customers, which has shown measurable benefits. However, the most cost-beneficial schemes have been completed, which means that we will have to tackle more challenging schemes to achieve further improvements.

External Flooding - Current analysis reveals we are in the bottom quartile for external flooding performance compared to other Water and Sewerage Companies (WaSCs). However, we have increased our investment over AMP6 to address external sewer flooding incidents in high risk locations.

Pollution – Ofwat expect all WaSCs to target industry upper quartile performance during AMP7. Over the last decade, we have made great strides in pollution reduction, moving us from the bottom end of the industry league table to upper quartile.

Odour – Included in our Annual Performance Report, our objective will be to offset increasing number of complaints from household customers.

Asset Resilience - In recent years there has been an increased focus on resilience by Regulators and the Government, and consequently there are greater expectations on critical service providers. As an operator of critical national infrastructure, we will ensure that we have a robust approach towards resilience and that the service our critical wastewater assets (and systems) provide is resilient.

Long term, strategic planning - In AMP7, the Welsh and UK Governments and our wider stakeholders expect a step-change in wastewater planning with the production of a company-level Drainage and Wastewater Management Plan (DWMP). The company-level DWMP will be founded on regional DWMPs, which will support an integrated approach to long-term wastewater infrastructure and non-infrastructure planning. The DWMP will identify opportunities to improve service and to increase collaboration with external stakeholders.

Views of our customers and stakeholders

We have engaged with our customers and stakeholders throughout AMP6 to understand their expectations and preferences*[i], including consultations on the use of customer dividend money in AMP6 and the PR19 business plan (Our 'customer dividend' is the re-investment of our profits made possible through our unique business model. In determining where this re-investment is directed, we have not only listened to over 12,000 customers as part of the Have Your Say consultation, but also to comments made by colleagues through our annual Employee Engagement Survey and at Employee Roadshows).

Our Welsh Water 2050 strategy consultation, held in the summer of 2017, engaged with almost 20,000 customers. We have also utilised wider industry-level research and assessed its implications for our region, our stakeholders and our future plans.

We will continue to act on feedback throughout AMP6 and AMP7 by working with the Customer Challenge Group and listening to focus groups. These groups may concentrate on understanding the requirements of customers who have flooded, business customers and vulnerable customers, amongst others.

We have wide-ranging methods of engaging with our customers, to ensure that our feedback is representative of our entire customer base. We have made particular effort to account for the views of customers who are traditionally hard to reach.

Internal Sewer Flooding

Reducing internal flooding is consistently a high priority for customers, and is universally accepted by all stakeholders as our worst service failure. Results from our "Willingness to Pay" (WtP) research, undertaken through our customer engagement activities, identified high support for a reduction in sewer flooding.

External Sewer Flooding

Our customer research indicated that whilst external flooding is not seen as being as important as internal sewer flooding, both are recognised as having emotional, practical and health implications. Results from our WtP research, indicate that customers support a reduction in external flooding.

Pollution

Our customers want us to have a strong environmental conscience and to demonstrate that we are future-focussed. As such, pollution is seen as an important issue to address. The idea of sewage pollution in rivers is upsetting for many and detrimental to business, and customers fear it could have health and lifestyle impacts. There is strong support for improvements in this area from Natural Resources Wales, Environment Agency, environmental Non-Governmental Organisations and the Welsh Government.

There is particular support by our customers of the need to prevent pollution at source, as this is better for nature and wildlife. Natural solutions are favoured as they are considered to be more sustainable than high-tech solutions.

To support capital investment and achieve improved performance (with respect to internal and external flooding and pollution), our customers recommend that we also undertake further education opportunities, exert more pressure on manufacturers of 'flushables' to promote more responsible disposal and encourage the use of sustainable drainage on new developments. Behavioural change is seen as important to success.

Resilience, Planning and Strategy

Our customers support plans to protect service for future generations and are eager that we are thinking and planning ahead; but not paying in advance.

Resilient wastewater assets are seen as a key driver to avoid interruption to wastewater services and protect the environment. During our consultation for our strategic planning document "Welsh Water 2050", our customers interpreted this to cover interventions, such as building defences around sites to reduce the risk of flooding thereby preventing damage to assets and equipment. They were also adamant that wastewater discharges resulting from flooding should not in any way affect clean water supplies.

When considering resilience, there was a customer consensus that flooding in particular, as well as pollution, shouldn't happen in the first place, and we should focus on preventing this through increased resilience of our assets and improved forward planning. There was also a general consensus that we should plan for between "once a generation" extreme flood to once in 200 years. However, we need to ensure that current issues continue to be prioritised.

There is an increasing level of expectation from stakeholders for the wastewater industry to produce long-term wastewater plans and to improve their long-term planning capability. This led to the Water UK 21st Century Drainage (21st CD) project. This project evolved from an initial UK Government challenge to the UK water industry to:

- Further monitor the performance of sewerage networks;
- Determine whether this data was signalling a lack of capacity in the system;
- Improve understanding of the links between drainage planning and the environment.

Our proposed DWMPs will support our response to this challenge.

Odour Nuisance

Our customer research identified odour nuisance to be a particular concern.

In our first phase of engagement, customers identified odour from wastewater assets to be a key priority and a specific area for focus; ranking 11th from 94 potential areas of service. In the second phase, customers expressed an unwillingness for service deterioration and a WtP to achieve the first level of improvement from the service level options they were presented with. However, in terms of importance/ value, odour ranked seventh out of the nine wastewater measures assessed by our customers in our PR19 WtP research.

We also undertook research to hear first-hand from customers who had been subject to odour nuisance from our wastewater assets to enable us to understand the issue from the customers' perspective. It was clear from the feedback that the impacts of odour nuisance are wide-ranging and impact both personal and professional lives.

Affordability of bills

Through our customer engagement initiatives, our customers and wider stakeholders have expressed a significant interest in the issues of resilience, sewer flooding and pollution. There is a particular drive from across our customer base for us to improve flooding performance in a cost-effective manner and reduce pollution incidents to protect our rivers and coastal waters.

We have engaged with our customers to better understand their WtP for improvements. Table 1 provides a summary of what our customers would be WtP per affected property. This demonstrates that our customers consider flooding to be the most important area for investment.

Customer Feedback Measure	Willingness to Pay per Property
Major flooding inside property	£22,470
Minor flooding inside property	£13,024
Sewer flooding outside property	£3,090
Sewer flooding in a public area	£1,979
Significant pollution incident	£2,128
Minor pollution incident	£805
Odour from sewage works (frequent)	£713
Odour from sewage works (infrequent)	£712

Table 1: Summary of stakeholder feedback and proposed WtP

Benefits for our customers

Reduced flood risk

We aim to improve our internal and external flooding performance and reduce the number of worst-served customers.

Sewer flooding is broadly classified into two categories:

- Other Cause (OC) is caused by a temporary problem i.e. blockages, collapses or equipment failures, and can be resolved through operational intervention e.g. sewer cleansing, sewer rehabilitation, improving pumping station and rising main resilience;

- Hydraulic overload (HO) is caused by a permanent problem (hydraulic incapacity) as a result of a flat gradient or a small diameter, for example, and requires capital intervention to resolve.

Sewerage systems include the legacy public sewers and the formerly private sewers that have transferred to us.

AMP	Year	Source	Internal Floods	External Floods
AMP 6	2015-16	Retrospective	299	5639
	2016-17	Retrospective	300	4313
	2017-18	Actual	297	3929
	2018-19	Forecast	300	4121
	2019-20	Forecast	300	4121
AMP 7	2020-21	Forecast	295	4057
	2021-22	Forecast	289	3993
	2022-23	Forecast	284	3928
	2023-24	Forecast	278	3864
	2024-25	Forecast	273	3800

Table 2: Actual and forecast incidents per year based on the AMP7 definition

Our performance targets for internal and external flooding, caused by HO and OC, are included in Table 2.

The expenditure proposed in this investment case will focus on reducing internal and external flooding due to hydraulic overload over AMP7. OC flooding will be addressed through investment in our Wastewater Network Maintenance Investment Case.

Improved Strategic Planning

Our proposed DWMPs will support our integrated approach to long-term wastewater infrastructure and non-infrastructure planning. The DWMPs will identify opportunities to reduce flood and pollution risk, working with external stakeholders, and will enable us to better understand and proactively manage risks in the future.

The DWMPs will therefore provide our long-term planning tool to meet external expectations. In particular, they will:

- Support the new Ofwat PR19 wastewater resilience measure, (Ft2) 'Percentage of population at risk of sewer flooding in a 1-in-50 year storm';
- Highlight our most pressing resilience requirements for investment or mitigation;
- Identify opportunities to reduce flood and pollution risk in a cost-effective manner and to work with partners to improve service;
- Improve our longer-term understanding of the challenges and opportunities related to our wastewater assets and hence will be a fundamental tool to support our investment planning for AMP8;
- Identify opportunities for the development of more sustainable management of surface water, in particular the promotion of RainScape[1] solutions.

Further information on DWMPs is included in Appendix 1.

Increased Resilience

Our proposed investment will contribute to our plans to deliver a high quality and resilient wastewater service to which all our customers can place their trust; as outlined within our long-term strategy, Welsh Water 2050.

Our DWMPs will enable us to better understand and hence improve the resilience of our wastewater assets and proactively manage risks in the future.

Climate change will impact upon our wastewater assets through increased rainfall intensity leading to increased flood risk in our sewerage systems. We will manage increased risks of flooding and pollution to our customers through the use of sustainable drainage systems where feasible, in

[1] RainScape promotes solutions which mitigate flooding and pollution risks whilst increasing resilience and providing additional community and environmental benefits).

particular through RainScape based solutions. These form part of our long-term plan to make our sewerage network more resilient to environmental changes e.g. climate change and will focus on removing surface water from or reducing rates of surface water flow into our sewerage systems, as well as reducing infiltration. Further information on Rainscape is included in Appendix B.

We will increase the resilience of our critical assets by improving power resilience at our critical WwTWs and SPSs. We will also undertake condition surveys and produce temporary works plans at our critical sewer locations;

Our proposed investment for Newport Tunnel, will improve the resilience of this asset by addressing current flood and pollution issues and managing the impacts of climate change and increasing flood risk. Further information regarding Newport Tunnel is included in Appendix C.

Investment will also be included to improve security of our assets and also to protect against cyber security. Improvements to systems supporting the operation of our wastewater assets will be included.

Addressing Odour Nuisance

Our investment over AMP7 will enable us to manage increasing customer concerns regarding odour nuisance from our wastewater assets. This will be achieved through a programme of odour mitigation schemes and proactive identification and management of potential odour issues through improved monitoring and improved data analyses.

We will provide a better quality of customer care to those customers who do experience odour-related issues from our wastewater assets.

2. Investing for now and the long-term

There is a great deal of uncertainty around the future environment within which we will be operating, but there are several foreseeable future trends that are likely to have a significant impact on our service provision. It is essential that we consider the challenges and opportunities presented by these trends.

In our Welsh Water 2050 strategy document, we have set out our long-term vision and our approach to achieving this, so that we can demonstrate how we will continue to meet our customer needs into the future. It considers both the direction for our own business and outlines the impact we want to have on the people, economy and natural environment of our operating area in Wales and England in the long-term.

Future challenges

Our Welsh Water 2050 strategy identifies significant trends (external factors) over the next 30 years and how these will impact on us and our customers. Trends impacting on wastewater management are included in Figure 2.

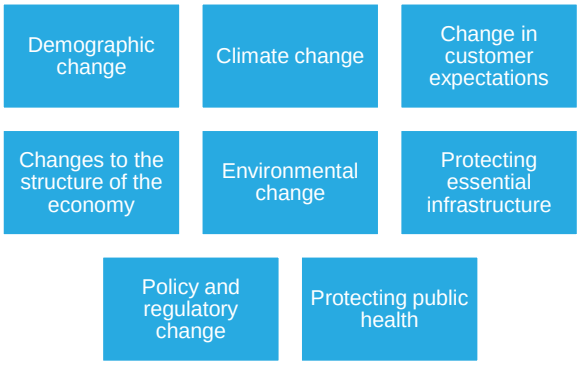


Figure 2: Trends impacting on wastewater management

Further details on trends with significant impacts on proposals in this investment case are as follows.

Demographic Change: Growth

Growth, (i.e. additional population and industrial discharges) increases flows in the sewerage network. Once development has planning permission, then unless appropriate planning agreements or conditions are in place, developers can discharge foul sewage and surface water from new developments into our sewerage network. This can increase the risk of flooding and pollution incidents. In addition, population increases may result in significant encroachment on the lands around WWTW and SPS, which were originally built on remote sites isolated from communities. Cardiff is predicted to be the fastest growing major city in the UK outside London to 2035.

Although short-term growth over AMP7 is anticipated to continue broadly at the same rate as experienced in AMP6, it remains an unknown element that requires a pro-active approach. We will therefore continue to identify and address potential impacts through our DWMPs and our Developer Services team who, through effective liaison with developers and local authorities, aim to only allow foul connections to the sewerage network, with surface water flows from new developments being controlled and discharged elsewhere.

We will promote the use of RainScape techniques, in particular, sustainable drainage systems in new development. Where a potential detriment is identified, our modelling team will undertake a detailed analysis, utilising hydraulic modelling tools to ensure that there is no detriment to the existing/proposed sewerage network, including developing appropriate solutions to mitigate the potential impacts.

Demographic Change: Urban Creep

Urban creep is the loss of permeable surfaces within urban areas e.g. domestic and commercial property owners could extend their premises or hard-surface areas.

Urban creep means that, irrespective of new developments, the impermeable area draining to our combined and surface water sewerage networks will grow over time, steadily increasing the flows in the network. This increases the risk of sewer flooding and pollution due to hydraulic overload for lower intensity rainfall events and increases the pressure on our ageing infrastructure, designed to take lower peak flows.

Whilst our industry-leading approach to RainScape mitigates this risk in identified locations, the rate and extent (beyond the scope of our RainScape initiatives) of urban creep remains a significant concern. We will continue to monitor flows and flood risk over AMP7 and through the use of DWMPs, identify potential concerns / risks and solutions.

Climate change

In 2009 the Met Office published definitive projections describing the likelihood of changes to the UK climate for the rest of this century along with a review of how our climate has already changed between 1961 and 2006. Key conclusions were that weather will become more variable, rainfall events more intense and that spring, autumn and winter rainfall have already increased significantly in Wales over the last 45 years. There is predicted to be a change in seasonal rainfall and a rise in temperature.

Our network is designed to maintain levels of service at events with return periods of up to 1 in 30 years and as such increasing rainfall intensity means that the worst rainfall event we design for now will become more commonplace in the future.

Drier, hotter summers are also projected, which will reduce the flows in our networks whilst warmer temperatures will cause an increase in septicity and the formation of odour-causing compounds. We have used our investment planning climate change toolkit to identify the climate variables that are likely to have a significant impact upon odour from our wastewater operations. For example, predicted temperature rise could lead to an increase in odour-forming compounds in sewage at our WwTW, SPS and within the network. The risk of subsequent odour complaints may be compounded by warmer weather encouraging customers to spend more time outside or opening windows.

We currently use the UK Climate Projections 2009, known as UKCP09, which will be replaced by UKCP18 in November 2018. UKCP18 will update projections over UK land areas and sea-level rise, giving greater regional detail, further analysis of the risks we face, both nationally and globally, and provide more information on potential extremes and impacts of climate change.

Whilst our customers do not prioritise our response to climate change as a short-term issue, our assets are designed for the long-term requirements of our customers. Where possible within our regulatory powers, we will work collaboratively with stakeholders to reduce the impact of the future risks associated with climate change through planned adaptive pathways in addition to implementing our RainScape approach.

We will have regard to the impacts of climate change in our schemes and initiatives and where possible, we will aim to mitigate the effects of climate change as an added benefit to our work. We will also take the long-term view of decreasing our reliance on piped systems for surface water management, increasing our resilience to extreme conditions.

Changes in customer expectations

It is expected that our customers will become increasingly intolerant of failure in the future. We may be required to ensure that all customers receive a minimum universal service standard. However, this is occurring at the same time as the increasing expectation that sewers can be used to dispense of unsuitable items e.g. by flushing disposable nappies and wet wipes down toilets, which is resulting in an ever growing threat of blockages to our sewers.

We will take all opportunities to inform and educate our customers to reduce their impacts on flooding and pollution. Our education programme within schools will be an important tool in explaining the impact of an individual's actions on our sewerage networks.

Changes in the structure of the economy

One of the key challenges to the future economy may be the impacts of energy costs through

increased demand and resource constraints. There is an expectation that there will be considerable volatility in the energy market in the future, with electricity potentially becoming more expensive and less secure up to 2050. Our proposals for increased resilience through the further provision of alternative/back up supplies will ensure we minimise interruptions to our services.

Protecting essential infrastructure

With a large proportion of our assets reaching the end of their design life, there is a greater risk of asset failure. This, in conjunction with a reliance on ageing infrastructure from other utilities (for example, energy and transport), may affect the reliability of our services and consequently increase flooding and pollution incidents. Our plans will prioritise those critical wastewater assets that are most at risk of failure to reduce and minimise the impacts of interruptions to our sewerage services.

Our plans will also address the increasing risks associated with cyber security and the hence the integrity of the services we provide.

Planning for the future

Long-term planning

Expenditure proposed in this Investment Case will from part of our Business Plan for AMP7, which will support the delivery of our long-term strategy outlined in Welsh Water 2050.

Expenditure will contribute to our long term aspirations related to flooding, pollution and resilience. In particular our proposals to develop our DWMPs, will contribute to our long-term strategy to improve the reliability and sustainability of our wastewater network and treatment assets.

Building on progress

Our proposals for AMP7 are not the start of our journey. We have had significant success over AMPs 5 and 6 to reduce the risk of flooding to our customers and pollution to the environment. We have also produced our Sustainable Drainage Plans, which will inform to our DWMP Programme.

During AMP6 we have embedded our PR14 resilience scorecard approach, improving our understanding of resilience and improving the resilience of our critical wastewater assets.

We have also continued to develop and implement RainScape initiatives, which is our preferred approach to managing surface water and has been used since 2010. RainScape seeks to reduce surface water runoff from entering our network and finding other ways to manage flows without causing detriment elsewhere in the catchment. This is a more sustainable way of dealing with surface water issues and can provide a wide range of additional social, environmental and economic benefits compared to traditional methods. Our approach has been supported by the Welsh Government, Natural Resources Wales, Environment Agency, Ofwat, customers, NGOs and others. It includes tried and tested techniques including Sustainable Drainage Systems and Water Sensitive Urban Design.

Further information on performance is included below.

Management of Internal Flood Risk

Internal flooding can be caused by the hydraulic overloading (HO) of our sewerage system or by ‘other causes’ (OC). The latter includes blockages or collapses of sewers and flooding due to equipment failures, e.g. at sewage pumping stations.

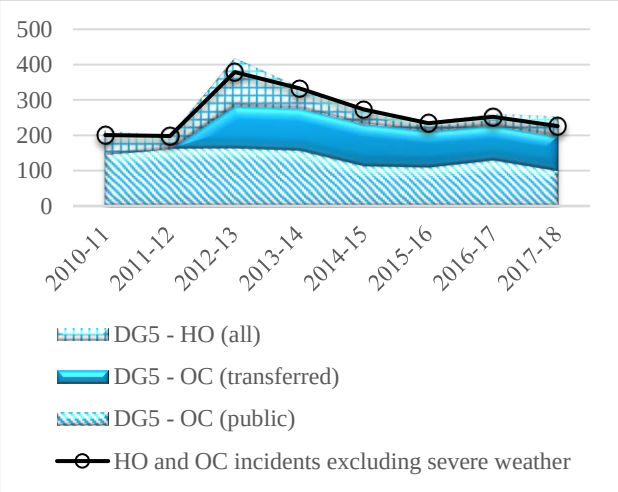


Figure 3: Internal flooding incidents split by sewer type and primary cause of flooding (using AMP6 definition of internal flooding)

The internal flooding (DG5) incidents that have occurred due to HO and OC are identified in Figure 3. In 2011-12, we accepted responsibility for additional assets through private sewer transfer, which effectively doubled the length of our sewerage system and transferred the responsibility for mitigating flood risk on what were previously-private sewers to us. The 2012-13 performance in Figure 3 reflects the contribution from these assets with a high of 417 internal floods in the year.

There has been a downward trend in overall flooding incidents due to all causes since this peak. The impact of hydraulic overload on the total number of flooding incidents is now greatly reduced through our historical investment and to date, there have been no hydraulic overload flooding issues on transferred assets.

Performance improvements were supported by the implementation of our 25-year Flooding Reduction Strategy and associated initiatives over AMP6, including:

- **Improved customer communications:** We implemented customer initiatives such as "Let's Stop the Block", which focussed on reducing sewer abuse by our customers e.g. flushing disposable nappies and wet wipes down toilets
- **Improved data mining and innovation:** We developed our predictive capability to improve targeting for proactive blockage inspection.
- **Increased operational efficiency:** We reduced our cost-to-serve by targeting individual sewerage operator productivity and customer service performance
- **Improved resilience:** We primarily focussed on improving SPS resilience and developing emergency response procedures for regular active flood locations.

Figure 3 also indicates the number of sewer flooding incidents that are due to severe weather. This shows that there has been no major impact since 2010 and only a limited impact over a wet year such as 2012-13. However, this does not mean we are not susceptible to severe weather impacts. In 2001, during significant rainfall events, 882 internal flooding incidents occurred across our operating area (with an additional 715 external flooding incidents). We therefore remain aware that severe weather events would significantly impact upon the total number of floods that occur.

Internal HO Flooding

Our investment on internal HO flooding over recent AMPs is detailed in Figure 4.

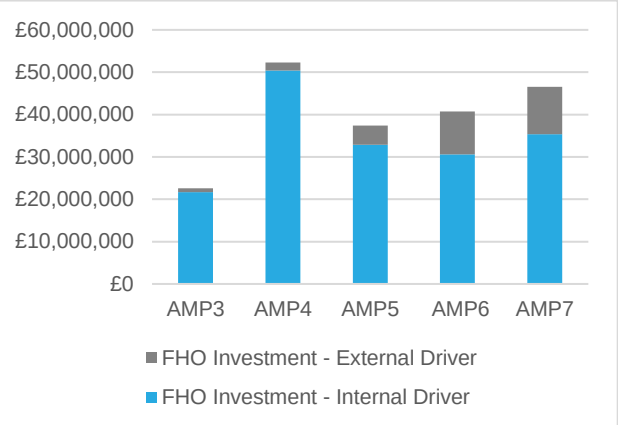


Figure 4: Internal and external flooding investment in AMP3, AMP4, AMP5 and AMP6, for comparison with AMP7 proposed investment (post efficiency)

Our focus on addressing internal HO flooding has led to a decrease in the number of cost-beneficial schemes still available to complete. The average cost of mitigating internal flooding/property is forecast at £170,000 per property in AMP6, up

from £140,000 per property in AMP5 as shown in Figure 5.

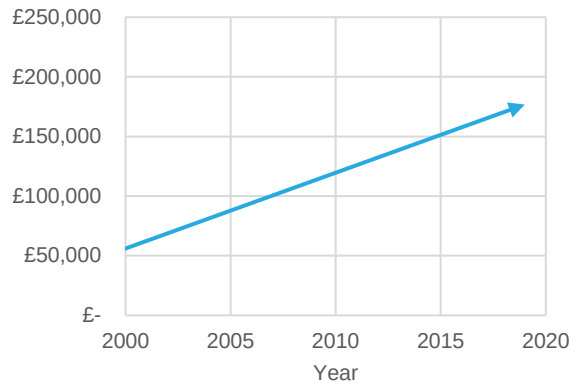


Figure 5: Average expenditure on internal flooding / property. Many internal flooding schemes will also reduce the risk of external flooding for neighbouring customers.

Management of External Flood Risk

The total external flooding incidents over time (based on the AMP6 MoS definition) is shown in Figure 6.

2012-13 was a particularly wet year, shown by an increase in flooding due to hydraulic overload, whereas each year since has seen average rainfall (external flooding performance being highly susceptible to wet weather events). The increase in events in 2015-16 reflects the first year flooding from transferred sewers was reported.

There are no AMP6 MoS relating to external sewer flooding, however we recognised that tackling this is a key element of customer-led success.

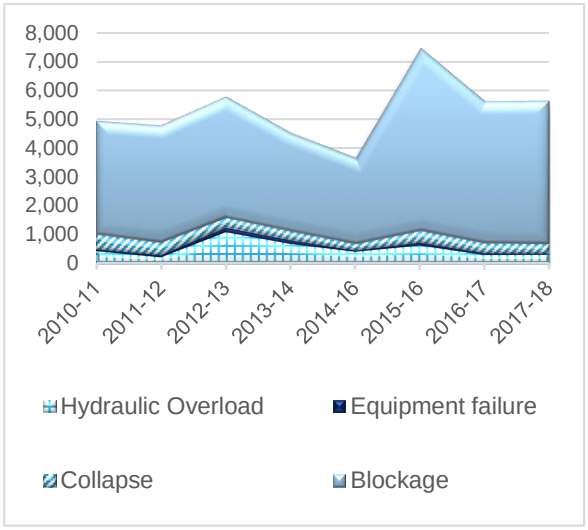


Figure 6: Number of external flood incidents split by primary cause. Flooding from transferred sewers is included from 2015-16

In AMP6, we have targeted funding at investigations and interventions for our worst external flooding locations due to hydraulic overload.

At-risk / Worst Served Customers

Since AMP3, we have targeted an overall reduction in the number of properties on our “At-Risk” Register (ARR), which is a register of the properties at highest risk of flooding. The number has fallen from 573 to 175 (see Figure 7), by addressing new flooding issues and repeat flooded properties.

Our AMP6 ‘At-risk customers’ MoS will be replaced with a wider definition of ‘Worst-served customers’ over AMP7.

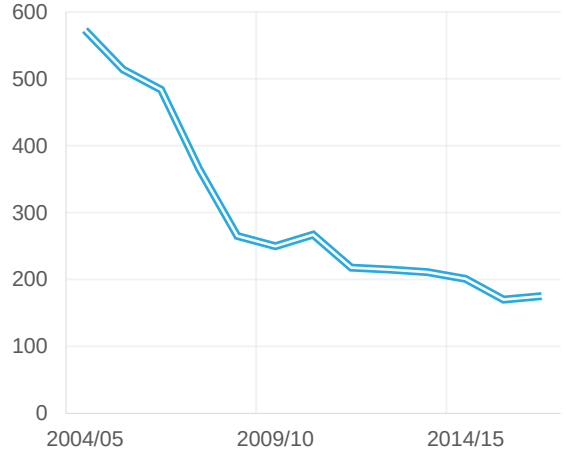
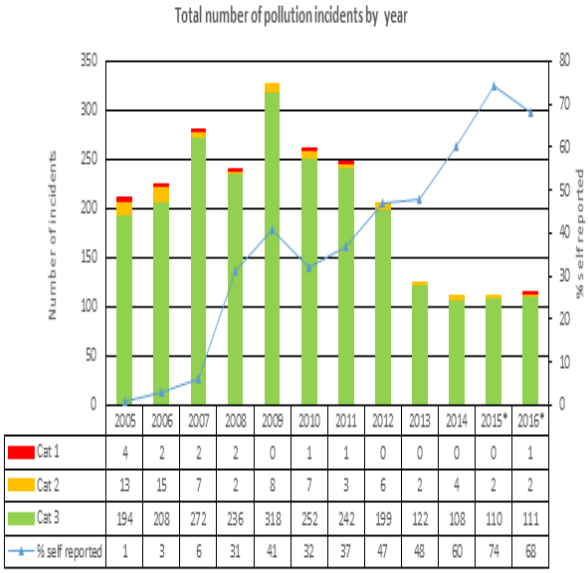


Figure 7: Number of properties on the At-Risk Register showing that investment over AMP4, 5 and 6 made significant improvements to the number of properties on the register.

Figure 8: External flooding in Porthmadog that received flooding investment in AMP6.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2016*
Cat 1	4	2	2	2	0	1	1	0	0	0	0	1
Cat 2	13	15	7	2	8	7	3	6	2	4	2	2
Cat 3	194	208	272	236	318	252	242	199	122	108	110	111
% self reported	1	3	6	31	41	32	37	47	48	60	74	68

Figure 9: Historical reported pollution incidents (*includes incidents from transferred sewers)

Pollution Reduction

We have made great progress in pollution reduction as shown in Figure 9 moving from the bottom end of the industry league table to upper quartile, whilst increasing the percentage of pollution incidents that we self-report.

Our AMP6 Pollution Reduction Strategy contributed to performance improvements, with investment focused on the themes of Asset Understanding, People and Data and Systems. To date, the greatest reduction in incidents occurred as a result of remedial works undertaken following extensive surveys to identify potentially polluting assets, together with an increased focus on proactive maintenance and increased asset telemetry coverage developed through the Strategy. As part of the Strategy, we have also employed pollution prevention field staff, who have underpinned the improvement in our self-reporting rate.

We aim for zero serious pollution incidents. All serious incidents are followed up by a Serious Incident Review, the purpose of which is to gather information that in turn may reduce the potential for future incidents. Since the implementation of these actions, we have seen a downward trend in serious incidents.

Sustainable Drainage Plans (SDPs)

SDPs have been developed over AMP5 and AMP6 and provide a greater understanding of the medium to long-term future challenges we can expect on our sewerage systems and to performance; having regard to growth, urban creep and climate change. The SDPs provide hydraulic models of the catchment and utilising the experience of and feedback from local operators, identify root cause of performance issues. The outputs identify opportunities for targeted investment within the catchment to improve the long-term and short-term performance for the benefit of our customers. By the end of 2020 we will have produced 133 SDPs covering 79% of our population (2.4m Population Equivalent).

The DWMPs will utilise the learning from and enhance the outputs of SDPs over AMP7.

Resilience

During AMP6, our focus has centred on embedding our resilience process within our business.

We have developed the resilience scorecard over the last five years as a way of measuring and improving the resilience of our assets. This is in terms of how well protected they are against extreme weather events, other short-term

challenges, and their ability to recover from service failures arising from those events.

Our current level of critical wastewater asset resilience has been achieved by indirect historical expenditure driven by enhancement (Quality, Growth) investment. This indirect investment has led to varying levels of resilience (when assessed against our criteria) across our critical wastewater assets.

During AMP6, we commissioned independent site investigations at 30 critical WwTW sites, based on the outputs of scorecards. These investigations were designed to review and confirm the current power resilience score and determine the scope required to improve each site's power resilience to achieve 100% score against our criteria. These investigations have supported the scope for our AMP7 proposals and informed the annual scoring assessment.

Over AMP6 we have also invested in our cyber security to ensure our systems and processes are protected from increasing threat of cyber-attack.

Odour Management

We operate 835 WwTWs, 2402 SPS and circa 36,260km of wastewater network. Due to their function of conveying or treating wastewater, they all have the potential to cause odour.

It is accepted that odour nuisance has increased in recent years, and this is reflected in the increased number of odour-related customer complaints since 2010-11, as identified in Figure 10. These complaints numbers identify the total number of complaints received in any format during the year relating to odour from sewerage service assets (not just household written and telephone complaints). Our current performance is relatively stable due to increased focus on odour issues over AMP6.

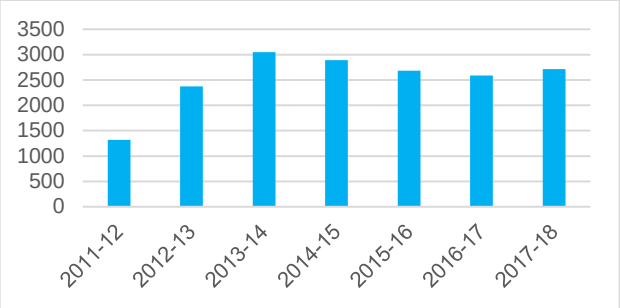


Figure 10: Odour complaints since 2011

Reflecting our ever-growing understanding of odour issues, the number of odour related risks we are exposed to and recorded on our Investment Manager (IM) System has risen over recent years as indicated in Figure 11. (Investment Manager is the central repository for all our asset risks and interventions and is also a support tool for investment planning).

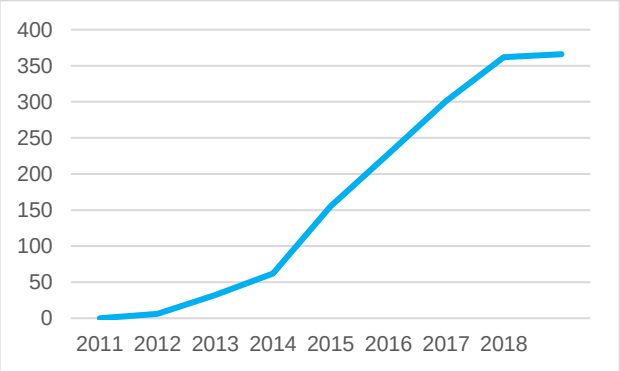


Figure 11: Increase in odour related risks

Our analyses of our odour complaint data shows that on average in 2015-16, 2016-17 and 2017-18, single odour complaints in unique postcodes made up 76% of all odour complaints. Of these, only 13% on average complained of a repeat nuisance in the following year. As such, odour nuisance is difficult to predict and our evidence from investigations has identified that the majority do not require capital interventions to address.

The reasons for the overall increase in complaints are complex, but include:

- Encroachment around our wastewater assets due to population increase and the resultant extension of urban areas to land adjacent to our assets

- The public expectation of a better environment has increased
- Tighter treatment standards over the past two decades has led to small Wastewater Treatment Works (WwTW) being abandoned and the flows pumped to another, often larger, more capable WwTW. This takes flows over a greater distance with longer residence time in the network and pumping stations which can result in anaerobic conditions which increases the likelihood of septicity and odour formation.
- More robust processes for capturing and recording complaints relating to odour.
- Wider lines of communication with our customers have both enabled them to be more informed whilst providing them with more instant means of raising their concerns.

In response to confirmed and persistent odour complaints, substantial capital investments have been made to mitigate the problem at source through the provision of odour mitigation equipment. For example, during AMP6 we invested £0.2m at Barry West SPS to mitigate odour and noise issues through the provision of new odour mitigation equipment (Figure 12).

Figure 12: New glass reinforced plastic covers and passive filters at Barry West SPS (2016)

We have also carried out a number of odour mapping survey during AMP6 in response to odour-related issues.

3. Options for AMP7

Background

In reviewing options for investment over AMP7, we have had regard to links between expenditure and performance. Our expenditure and associated performance over the past five years provides us with an assessment of likely expenditure requirements to meet performance targets over the short-term.

High-Level Options Appraisal

Three high-level options were considered in the development of this investment case.

Option 1: Maintain Stable Performance

This option aims to maintain the current levels of service for all measures. Investment would be required to react to service failures, address predicted service failures, and offset asset deterioration, however investment for these would be included in the Wastewater Network Maintenance Investment Case. Enhancement expenditure would only be made to offset detriment to the current performance e.g. investment for new mitigation equipment to ensure no increase in odour complaints.

Investment in resilience improvements would not take place, which would include the Newport Tunnel scheme.

No investment would be made for the development of future strategies and plans and no objective for any overall improvement in service levels. We would as a minimum delay the production of DWMPs and resilience improvements until AMP8.

The proposal would therefore not enable us to meet our current obligations to stakeholders and governments with respect to the development of DWMPs and to support and implement the recommendations of the Water UK 21st Century Drainage project.

Through our customer engagement activities, we identified that our customers showed strong support for investment which contributed to 'Cleaner rivers and beaches', 'Working with nature for cleaner water' and 'Better water quality for all' – topping the list for all demographic groups. They also demonstrated strong support for reducing internal and external flooding incidents and that as a minimum we should maintain the current service with respect to flooding and pollution.

As this option would not result in any improvements with respect to flooding and pollution incidents, then it is not considered tenable as it is contrary to our customers` expectations of improved performance through AMP7.

Option 2: Enhance performance

In this option we plan to invest to contribute to improvements to service levels with respect to internal and external flooding and pollution incidents. This supports our customers` expectations.

This option will include investment in the DWMP process to contribute to our aspirations in Welsh Water 2050. The outputs from the DWMP will also contribute to medium to long term reductions of flooding and pollution risks and number of incidents and support us in assessing maintenance needs over AMP7 and AMP8.

Investment would enable additional odour control equipment to be provided to offset the predicted increase in complaints over AMP7.

We would also develop a targeted, multi-AMP approach to resilience investment that proactively increases the resilience performance of our critical wastewater assets, provides increased security and protects our systems and processes from cyber-attack.

This is our preferred option and reflects our customer and stakeholder sentiments for reduced flooding and pollution incidents, reduced odour complaints and increased resilience of our critical wastewater assets over AMP7.

Option 3: Frontier performance – flooding and pollution

This is based on the objective of achieving industry-leading ("frontier") performance, in particular focusing on our MoS related to internal flooding, external flooding and pollution.

We commissioned an independent consultant to help us understand what frontier performance would look like, how we would achieve this and the expected costs associated with this target.

To achieve frontier performance, it was identified that we would need an additional £284m expenditure in AMP7. 94% of this expenditure (= £266.5m) would be required to address OC issues, to reduce the number of blockages, collapses and equipment failures. An estimated £17.5m would be required to address HO issues. It was however highlighted that due to timescales related to delivery of improvements, we would not achieve frontier performance within one AMP cycle (i.e. over just AMP7).

We also considered the option to achieve 100% resilience score for all critical wastewater assets by the end of AMP7. This option reflects our ultimate aspiration for our critical wastewater assets. However, we consider the scale (deliverability) of such an option would not be feasible over one AMP.

DWMP investment would ensure we contribute to our aspirations in Welsh Water 2050.

Due to the scale of works that would be required to deliver frontier performance, this option is not considered feasible over AMP7. Costs and affordability of proposals by our customers over AMP7 is also a concern.

4 Preferred option

Investment Programme	Expenditure	Contribution made to MoS								
		Internal flooding	External flooding	Worst served customers	Pollution	Risk of sewer flooding in severe storm	Surface water removed	Written and telephone complaints	Asset Resilience – above	Asset Resilience – below
		Rt1	Rt2	Rt6	En3	Ft2	Ft4	Rt4	Ft8	Ft9
Flood Risk Reduction	£46.55 m	✓	✓	✓			✓	✓		
Drainage and Wastewater Management Plans	£13.77 m	✓		✓	✓	✓	✓			
Pollution Reduction Strategy	£4.28 m				✓					
Increased Resilience	£46.16 m	✓	✓		✓	✓			✓	✓
Odour Management	£4.47 m							✓		
MoS Target - end of AMP6		300	4121	368	107	3.63%	25,000	76	77.7%	28.3%
MoS Target – end of AMP7		273	3800	359	90	5%	47,000	60	80%	45%

Table 3: Breakdown of our proposed expenditure and associated MoS contribution

Preferred option

Our preferred option is to make steady improvements across the range of our MoS relevant to this case*[ii].

In reviewing options for expenditure, regard was given to proposed AMP7 performance measures to be achieved, proposed capital and operational expenditure in other wastewater related investment cases, customer expectations and WtP and affordability.

Investment proposals were developed around 5 key areas of investment as identified in Table 3. This table also identifies which MoS the investment contributes to.

Table 4 identifies that the proposed expenditure for the identified key areas of investment provides some base maintenance benefits, and hence not all expenditure is identified as enhancement. It also identifies the resilience expenditure allocated for the Newport Tunnel resilience scheme.

Key Areas of Investment	Enhancement Expenditure	Maintenance Expenditure
Flood Risk Reduction	£46.55m	£0m
Drainage and Wastewater Management Plans	£13.77m	£0m
Pollution Reduction Strategy	£4.28 m	£0 m
Resilience improvements	£25.24m	£0m
Resilience scheme: Newport Tunnel urgent priorities	£10.46m	£10.46 m
Odour Management	£3.49m	£0.97m
Sub-total	**£104.77m**	**£10.46m**
Total Programme	**£115.23m**	

Table 4: Summary of proposed AMP7 expenditure

The following provides further detail of the proposed expenditure.

Flood Risk Reduction

This investment will reduce the risk of flooding to our customers and a breakdown of expenditure is identified in Table 5.

Flood Intervention Programme	Expenditure
Address internal flooding due to hydraulic overload	£19.70 m
Address external flooding due to hydraulic overload	£11.19 m
Priority Mitigations	£1.07 m
Reduce number of worst-served customers due to flood risk	£14.59 m
Flood Risk Reduction Programme total	**£46.55 m**

Table 5: Breakdown of investment related to flood risk

Proposals include the investigation and mitigation of new internal flooding incidents. Schemes to address flooding already recorded but not addressed will not be targeted as the cost benefit of these could not justify expenditure.

We have utilised our predicted flooding data, alongside historical trends, to estimate the likely rate of new flooding. Combined with our knowledge on intervention costs from previous AMPs, we have a strong cost base, backed with evidence of the associated performance trend to how our investment will achieve our targets.

The investment will utilise results of external flooding investigations undertaken over AMP6, to identify and prioritise the most cost beneficial schemes to be undertaken over AMP7.

Investment to reduce the number of our worst-served customers will address both internal and external flooding and will complement with the investment made in the Wastewater Network Maintenance Investment Case. We predict a significant deterioration of this measure under a reactive-only profile.

The priority mitigation investment is included to incorporate temporary measures to mitigate flooding, including the use of non-return valves.

Production of DWMPs

An investment of £13.77m is proposed to develop our DWMPs over AMP7. The required investment was informed from our experiences of applying the Drainage Strategy Framework in developing our SDPs over AMPs 5 and 6, and a review of the ongoing outputs from the Water UK 21st Century Drainage project 'Developing a Framework for DWMPs'. We have recognised the potential for a significant amount of additional stakeholder engagement and its management once we begin the production of our DWMP.

Table 6 provides a breakdown of expenditure.

DWMP Programme	Expenditure
New DWMPs	£4.63 m
Update of existing 'SDPs' to meet DWMP criteria	£4.30 m
SEA, stakeholder engagement, live catchment pilot, initial development of Tier 2 DWMPs, development of Tier 1 DWMP	£3.63 m
DWMP Framework and Management Structure	£1.21 m
DWMP Programme total	**£13.77 m**

Table 6: Breakdown of investment for the DWMP Programme

The DWMP investment will include updating and extending the remit of existing SDPs completed in AMP5 and AMP6, in addition to developing new DWMPs. The assessments will incorporate all the new tools and frameworks that have been developed from the Water UK 21st CD project and others (e.g. Ofwat resilience metric, severe weather inclusion in sewer flooding).

Over AMP7 we will focus on high risk WwTW catchments as determined by the DWMP Framework approach. Further information on DWMPs is included in Appendix 1.

AMP7 Pollution Reduction Strategy

Over AMPs 5 and 6 we have tackled the highest priority pollutions through increased monitoring of our sewerage system, together with a targeted pumping station and sewer overflow maintenance programme. Pollution numbers have significantly reduced (refer to Figure 3) and to further reduce these figures over AMP7 will be challenging.

However, we aim to reduce our number of pollution incidents over AMP7 from a rate of 2.97 to 2.49 incidents per 1,000km sewerage network per annum (Ofwat MoS definition) i.e. from 107 to 90 pollution incidents per annum. This will be achieved through capital investment proposed in our wastewater related maintenance investment cases (in particular our Wastewater Network Maintenance Investment Case) together with our proposed £4.28m expenditure in this Investment Case to support the delivery of our Pollution Reduction Strategy.

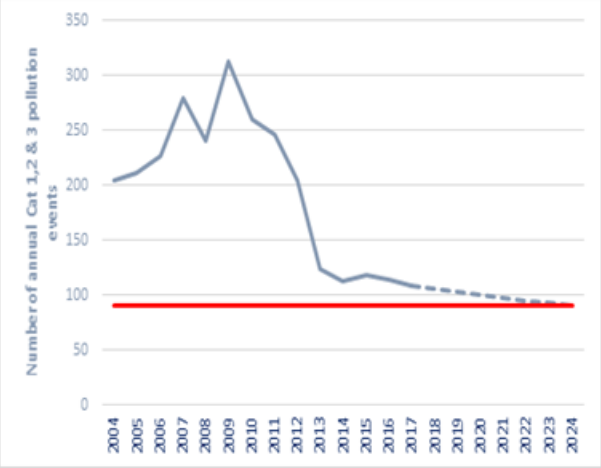


Figure 13: Category 1, 2 and 3 pollution incidents

A breakdown of the expenditure for the AMP7 Pollution Reduction Strategy is included in

Table 7. The Strategy will focus on enhancing our proactive approach to reducing pollution incidents through:

- Continued investment on our customer education programmes, such as Let's Stop the Block, to tackle sewer abuse. This will include a four-pronged approach designed to reach members of the general public through widespread advertising and publicity, educational visits by school children and interested customers, specifically-designed targeted blockage hotspot campaigns and individual training for repeat offenders;

- Continuing to lobby manufacturers, governments and retailers to correctly label wipes as 'non flushable' and to change the composition of wipes;

- Identifying and supporting innovative prediction and detection capabilities for potential pollution (and flooding) incidents. In particular we will;
  - Work with industry to provide more cost-effective and reliable sensors that can be deployed at greater density to provide the improved visibility of our wastewater network required to significantly reduce network incidents;
  - Support the development of our Smart Wastewater Networks to improve visibility and understanding of the operational performance of our sewerage network and identify potential risks (pollution and flooding).
  - Further develop our understanding of our rising main risks and improve the pumping station/rising main performance to reduce the risk of future pollution events and asset damage.

Due to the extent of the network coverage required, costs of implementation of the Smart networks will be undertaken over a number of AMPs, with a review of initiatives and costs over AMP7 being used to develop future programmes.

AMP7 Pollution Reduction Strategy Programme	Expenditure
Customer Education Programmes	£1m
Lobbying to reduce risk from non-flushables	£0.25m
Improved prediction capabilities to locate and prevent pollution due to blockages	£1.03m
Development of Smart Wastewater Networks	£2m
Pollution Reduction Strategy total	**£4.28 m**

Table 7: Breakdown of AMP7 Pollution Reduction Strategy investment

Increased Resilience

We will develop our resilience plans to maintain the effectiveness and operation of our critical assets, increase security and improve our systems, in particular to protect against cyber-attack. A breakdown of proposed expenditure is included in Table 8.

Resilience Schemes	Expenditure
Newport Tunnel urgent priorities	£20.92m
Power resilience at critical WwTW	£4.88m
Power resilience at critical SPS	£0.83m
Temporary Works resilience at critical sewers	£1.52m
Condition survey resilience at critical sewers	£2.50m
System improvements and cyber-attack protection	£14.79m
Increased security	£0.73m
Resilience Total	**£46.16m**

Table 8: Breakdown of Resilience investment

The proposed investment includes our resilience driven project at Newport. Flooding in Newport was recorded in 2009, 2010, 2013 and 2016. Initial investigations identified that the principal root cause is the high flow entering the sewerage catchment and subsequently the Newport Tunnel sewer during severe storm events. This flooding is exacerbated at high tide as the water level in the River Usk is at a higher level than the sewer network adjacent to the river and combined sewer overflows (CSOs) are unable to operate. The impacts of climate change with rising sea levels, and increased frequency of storms and rainfall will increase the risks of flooding. The proposed scheme will ensure the long-term resilience of Newport Tunnel is secured to protect the low lying urban areas of Newport. The scheme will mitigate the risks of increased flooding due to climate change and enable existing CSOs and their problematic river outfalls to be decommissioned and replaced with a new CSO and SPS. The estimated cost of the scheme is based on figures from an initial feasibility report.

Further information supplied in Appendix C.

We have used the latest scores and supporting information from our AMP6 resilience assessment to inform our thinking ahead of AMP7. We have undertaken internal stakeholder engagement to inform our preferred approach for AMP7, which included consideration of the following:

- The current resilience scores;
- Identifying those areas of the scorecard where improvement was seen as a priority for our business;
- The likely costs of intervention;
- Any logical order to the progression of interventions;
- Customer preference.

Our resilience plans for AMP7 include ensuring that:

- All of our critical WwTWs and SPS sites have 100% power resilience against our criteria by having two discrete reliable sources of power;
- All of our critical sewers score 100% against our temporary works resilience criteria. To achieve this, each critical sewer will have a specific plan in place with equipment and spares available to deploy within 2 hours;
- All of our critical sewers have had a condition survey. There are currently significant constraints to surveying our critical sewer assets and we are working to identify innovative means of understanding the condition of these critical assets.

Outline costs for the above have been generated specifically for the identified priority schemes for power resilience investment.

Temporary works and condition survey resilience costs are based on a unit cost per length of critical sewer against the classification of criticality (and thus works required/survey frequency).

An example of a proposed AMP7 power resilience intervention:

'Site 3': resident population 26,000.

The site is supplied by a single 11kV High Voltage (HV) feeder which terminates in a Distribution Network Operator's (DNO) incomer building. On failure of the mains supply, the design philosophy of the site is to switch over to a standby generator to provide the power for the works. However, the whole site processes cannot be maintained when mains power is lost on the original generator supply. This would result in major pollution to the river until power is returned. Consequently, this site scores 60% against our power resilience criteria. Our AMP7 proposal for this site is to achieve 100% by replacing the existing generator set with a new generator set of greater capacity. The facility for automated changeover on failure of the mains supply will also be installed, along with the necessary infrastructure to support the whole site treatment process on the back-up power.

Investment is also included for:

- Increased security at our assets;
- Improvements to our IT systems to support the management of our wastewater assets and improved protection of these systems against cyber-attack. Investment requirements were assessed based on expenditure made and outputs delivered over AMP6 and the need for increased protection against increasing cyber-attacks.

Odour Management

A breakdown of proposed expenditure is included in Table 9 and includes investment for odour investigations and the provision of additional odour mitigation equipment to address significant and persistent odour nuisance.

Investment is based on AMP6 expenditure and will enable a stable service for odour complaints to be achieved over AMP7. In identifying proposed expenditure, we also had regard to our analysis of risks on our Investment Manager system, as identified in Figure 14. This identified our total expenditure of £4.13m (= £3.16m plus £0.97m) would address circa 90% of recorded risks; which as identified by the black triangle, is also the point at which any further risk mitigation is not cost beneficial.

Odour Complaints programme	Expenditure
Odour mitigation schemes	£3.16m
Odour mapping surveys	£0.21m
Odour monitoring equipment and software	£0.12m
Refurbishment of existing odour equipment	£0.97m
Total	**£4.47 m**

Table 9: Breakdown of investment for odour nuisance

The majority of odour-related expenditure over the last decade has been targeted at removing odour through schemes at our WwTW and SPS. We expect this to continue in AMP7, where known issues at specific sites are addressed through best practicable means, using a variety of approaches including; chemical dosing, ventilation, covers with extraction and treatment. The methodology for resolving odour nuisance involves the complete assessment of all contributory factors, including failure modes that cause or contribute to the problems.

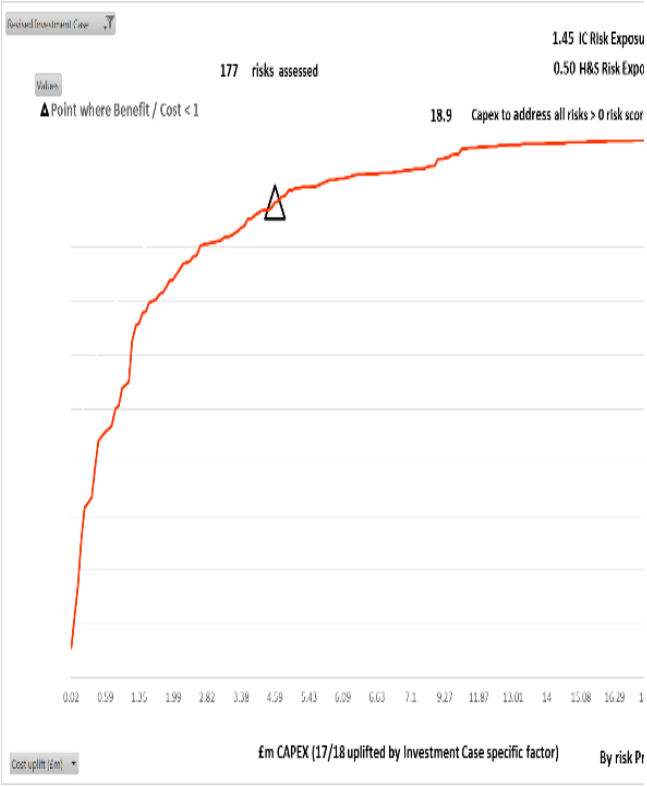


Figure 14: Analysis of odour risks on IM system

5 Cost efficiency and innovation

Cost efficiency

To help ensure that our bills remain affordable, we have identified a range of efficiency savings within the proposed investment programme. These efficiencies will allow us to deliver the improvements that we know are important to customers, but at a lower overall cost.

We propose to deliver £9.53m of cost efficiencies as part of this investment programme, as shown in Table 10 below.

We will deliver these savings by challenging our Alliance partners and our internal business to improve efficiency, and by maximising opportunities to innovate. One example is through the batching and timing of our investment programmes. We will work closely with our Alliance partners to optimise our delivery.

Key Areas of Investment	Pre-efficiency	Post efficiency
Flood Risk Reduction	£46.55m	£42.34 m
Drainage and Wastewater Management Plans	£13.77m	£13.62 m
Pollution Reduction Strategy	£4.28 m	£4.24 m
WW Resilience improvements	£9.73m	£8.85 m
Security, system improvements and cyber-attack protection	£15.52m	£15.30m
Resilience scheme: Newport Tunnel urgent priorities	£20.92m	£17.26 m
Odour Management	£4.47m	£4.09 m
Total	**£115.23m**	**£105.7m**

Table 10: Pre-efficiency and post efficiency expenditures

Innovation

We hold monthly innovation forums to identify and develop opportunities for innovation within the business. The forums are an opportunity for colleagues to share innovative ideas that will help us meet the challenges of our 2050 visions.

The DWMP approach is innovative, and as with our SDPs, these will continue to be a method to identify best practice from across the industry.

In spring 2018, we held our first Wastewater Hackathon. A Hackathon is an event where people collaborate as a group to design a solution to a problem or challenge. A two-day workshop gathered colleagues from across the business to focus on innovative solutions to three pressing problems, including blockage reduction, and at-risk odour customers. The outputs from the Hackathon are being actively investigated to stretch our thinking, whilst ensuring that the solutions are viable and have real business value.

We currently have 92 innovation projects either completed, live or approved and awaiting start, with many more options for future innovation. Further information on innovation projects are included in Appendix D.

Partnering and co-creation

Partnership working and third-party collaboration has been part of our delivery strategy during AMP6. These stakeholder relationships not only help us to develop schemes that directly improve the services we offer to our customers, but also provide schemes consistent with the wider aspirations of Wales, contributing to the national policy agenda, such as the goals from the Well-being of Future Generations (Wales) Act 2015.

Further information is included in Appendix D

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 considered the costs and benefits of different approaches to make sure that the investment represents long-term value to our customers.

As outlined in the previous section of this document, we will also seek to ensure value for money by promoting innovation throughout delivery, by learning lessons from the work we have delivered to date, and by working closely with our partners to encourage best practice and incentivise efficiency.

For example, whilst our customers show support for investment in programmes such as Stop the Block, it is difficult to establish the benefits to the overall flooding, pollution and odour complaints figures. To ensure value for money, we will continue to work with our data science team to review statistical results from targeted 'Stop the Block' and other campaigns to understand the more subtle influences of behavioural change activities. This will help us to understand if these campaigns are worth investing in, the time scale of their influence and which methods produce the best results.

The critical sewer programme and the power resilience interventions will be developed so that they are delivered in conjunction with each other and, where feasible, along with other programmes of work delivered through other investment streams. For example, the provision of back-up power supplies at our WwTW and SPS will be assessed in terms of local plans for energy management and energy generation, in order to optimise the efficiency of the site and provide assets and equipment that have wider benefits.

Through the development of more sustainable drainage systems, in particular RainScape, we will reduce the flows within our sewerage systems, hence reducing operating costs associated with the overall cost of transporting, pumping, and treating wastewater.

The development of DWMPs will increase the likelihood of identifying mutually-beneficial partnership working opportunities, which will provide increased efficiency across our operating area.

7 Delivery

Procurement

The various projects will be managed by our Wastewater 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

We will produce an AMP7 Delivery Plan. Delivery of programmes of work e.g. schemes, investigations and projects, will be risk based and prioritised having regard to cost benefit analysis. All our programmes will be managed and reviewed to reflect changing circumstances, which may result in the reprioritisation of schemes e.g. in response to new flooding, pollution or odour incidents, changed scope, increased costs, performance changes and the on-going identification of opportunistic interventions.

Risk mitigation and customer protection

For flooding and pollution, we will target a reduction in the time between a first incident and investigation. This reduces the risk of a repeat incident impacting the same customer. Our approach to flooding due to hydraulic overload has been developed over three AMPs and is streamlined and efficient.

Where we have less certainty about mechanisms, we will deliver our programme in a phased approach so that we can learn from and build upon experiences of delivering interventions.

We anticipate that a minority of critical asset condition surveys may highlight that some of our critical sewers are in a poorer structural condition than expected. To manage this uncertainty we will prioritise our condition survey programme whilst maintaining flexibility in our wider network maintenance programme to accommodate intervention where immediate risks to service are identified. Where less immediate structural risks are identified, we will capture these on our GIS sewer records and the Investment Manager decision support tool (which caters for our investment planning requirements) for future prioritisation.

Due to the transient nature of odour complaints, we will embed annual reviews and re-prioritisation into our AMP7 programme to ensure that we are targeting the most beneficial programme. This can be particularly important to proactively manage the risk of abatement notices and costly and intensive schemes.

8 Assurance

Governance

Proposals in this Investment Case have undergone the scrutiny and support of key internal stakeholders up to and including Board, whilst the outcome of broader expenditure and performance scenarios have been shared and influenced externally by our customers during our customer research. Our Board will carry out a final review of this investment in detail prior to the submission of the business plan.

Proposals are supported by our Steering Groups for Pollution, Flooding, Odour, 21st Century Drainage and Resilience. The groups report to the Company executive via the Director of Wastewater. These groups will also report to our independent Quality and Environment Committee as and when regarding the progress of their strategies, performance and the delivery of significant schemes.

Our performance is regularly reviewed and shared internally, to ensure that emerging trends and problem areas are targeted quickly, and our annual performance is reported externally.

All capital projects must pass through a gateway approval process to ensure there is sufficient scrutiny and challenge from senior management. Our Capital Programme Board has the delegated authority to approve projects through the gateways. The approach provides strong governance for approving investment decisions and is transparent and fully auditable.

We will continue to apply these effective governance systems for our proposed AMP7 investment programme.

Cost assurance

The flooding scopes are created using our Unit Cost Database (UCD) models. The models are updated annually and externally benchmarked every five years to make sure that the costs remain current.

The basis of assessment of proposed investment is indicated in Table 11.

Customer consultation assurance

Our customers have indicated that investment to reduce flooding, pollution and improve the resilience of our network are all priority investments. Our investment will also help us meet the increasing customer expectations that our service provision can withstand or recover from ‘shocks’ or ‘stresses’ by being resilient to future trends and challenges.

Our customers have indicated that they are supportive of investments to address odour issues. Customers have also been consulted on bill acceptability, which indicates the majority of customers consider the level of current bills affordable.

Measures of Success

The MoS to which this Investment Case contributes to, as identified in Table 3, will be monitored to track our performance. All our MoS are externally audited.

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.

Investment Case Programme	Investment Case Programmes	Method of Evaluating Performance and Expenditure
Flood Risk Reduction	Internal flooding (HO)	Named scheme solutions with bottom-up cost estimates using UCD, for which we have high levels of assurance. External flooding schemes developed in AMP7 will have a significant pool of schemes to choose from prior to the commencement of AMP7, allowing the most cost-beneficial schemes to be taken forward Predictions of new additions rate, with unit cost of addressing new additions based on historical analysis
	External flooding (HO)	
	Temporary flood mitigation measures	Unit cost of £100k/internal and £50k/external derived from historical costs
	Worst-served customers	Historical analysis of new additions rate and unit costs of addressing worst-served customers
Pollution Reduction Strategy	Pollution Reduction Strategy	Bottom-up costed strategy
DWMP	DWMP	Historical analysis of SDPs and new requirements to inform expenditure on DWMP
Resilience of critical wastewater assets	Newport Tunnel	Named scheme with cost estimate from Feasibility Report
	Power resilience improvements	Bottom-up costed schemes using UCD and site visits from independent consultants
	Critical sewer resilience condition surveys	Based on bespoke example scopes from AMP6 applied to our dataset
	Temporary works resilience improvements	Indicative cost for developing a site specific plan
Odour Management		Historical analysis

Table 11: Summary of main performance and expenditure method for determining investment decision

References

*[i] PR19 Supporting document 1.1 - Customer Engagement, and

PR19 Supporting document 1.2 - Stakeholder Engagement Welsh Water

PR19 Supporting Document 1.4 - Welsh Water 2050

*[ii] PR19 Supporting documents 1.1B and 1.1F - Performance Targets - PR19 Customer Engagement: Performance targets qualitative research

PR19 Supporting Document 5.2 - Performance commitments/MOSs - PR19 Performance commitments

PR19 Supporting Document 5.3 - Performance commitment definitions - PR19 Performance commitments definitions

Appendix 1: Drainage and Wastewater Management Plans

In AMP7, Welsh and UK Governments, as well as our wider stakeholders expect a step-change in wastewater planning through the production of a company-level Drainage and Wastewater Management Plan (DWMP).

To date, we together with other Water and Sewerage Companies, have developed our own approach to long-term wastewater planning, based on what works best for customers and the conditions that apply in our operating areas. This makes it difficult for those outside of our respective businesses to compare and consider plans from across the UK. Due to these different approaches, the industry, Government and regulators were conscious of a lack of transparency and a clear 'line of sight' in the industry's planning for resilient drainage and wastewater services for customers and the environment. The DWMP concept was developed through the Water UK 21st Century Drainage Project to address these concerns and represents a significant step change in our wastewater long-term planning.

DWMPs are therefore new long-term planning studies that will identify our sewerage and wastewater treatment needs over the next 25 years. They will provide a platform for key stakeholders such as Welsh Government, Natural Resources Wales, Environment Agency and Local Authorities to influence and collaborate with us on our long-term plans. Drainage within a DWMP is defined as "*the total water company network served by a wastewater treatment works (WwTW), and interaction points with non-water company drainage systems. Drainage also includes water company surface water assets not draining to a WwTW*".

We currently undertake long-term planning of our wastewater services through our Sustainable Drainage Plans (SDPs) and growth and demand assessments. SDPs focus on our sewerage networks and provide assessments (at the level of individual wastewater treatment works catchments) on how we need to manage these over the next 25 years to deal with current and future sewer flooding risk, reduce our impact on the environment, cope with climate change, provide capacity for growth, assess the impacts of network deterioration and ensure our assets and service are resilient.

The DWMPs will consider sewerage networks (foul, combined and surface) together with interconnecting drainage systems, wastewater treatment works and impacts on receiving watercourses, estuarial and coastal waters. The DWMP framework will consist of the Levels 1, 2 and 3 as identified in Figure 15:

- Level 1 - A consolidation of levels 2 and 3 in a published strategic report for our whole operational area, setting out our plan of how we will address the challenges we have identified and achieve our long-term wastewater and drainage aims;
- Level 2 - Set at the 13 WFD River Basin District (RBD) levels (within our operating area). This is where we amalgamate the significant elements from Level 3 plans within a RBD and develop a collaborative approach. Through consultation we will identify and develop opportunities that integrate the wider needs of stakeholders and seek mutually beneficial solutions, along with those of our own from level 3;
- Level 3 - At this level we undertake a detailed assessment of risks and opportunities at the sewerage catchment level areas (or sub-catchment areas for larger sewerage areas) and set out a long-term catchment plan of intervention to achieve both the aims specific to the local catchment and those of our strategic plans. Regard will be given to local planning / development proposals and needs as identified as Level 4 in Figure 15.

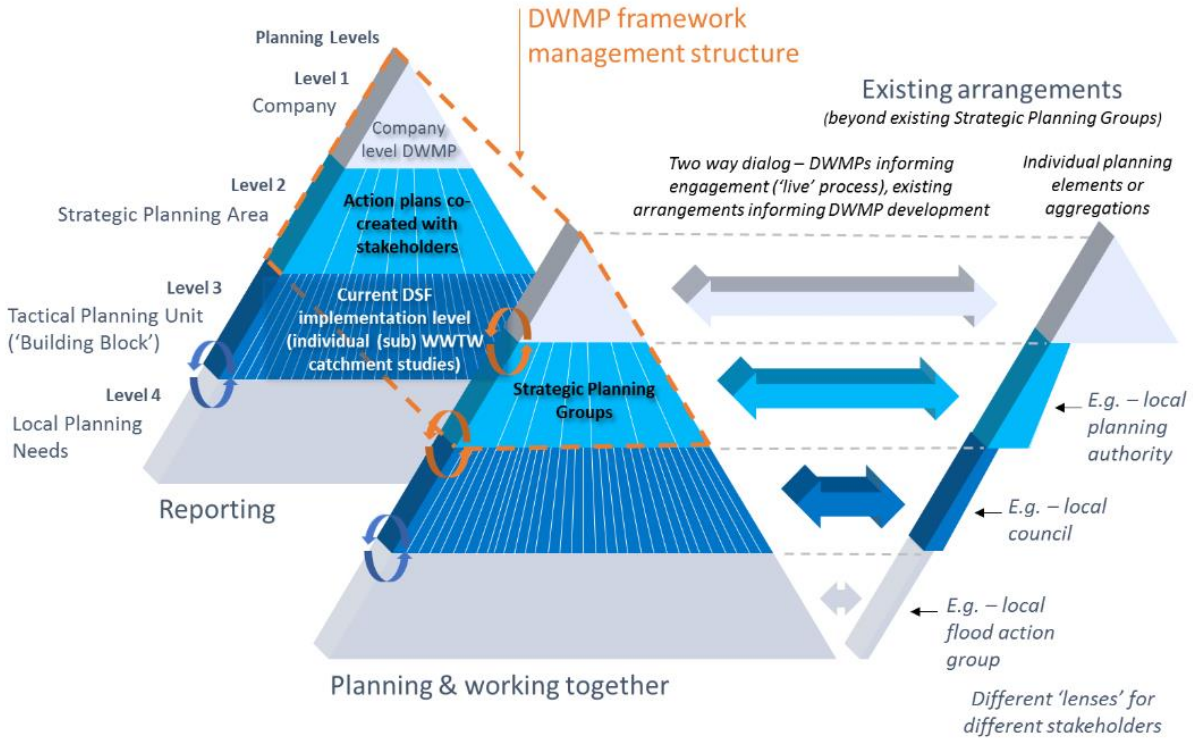


Figure 15 – DWMP management structure

To produce our DWMP, we will build on and develop the structure of the current SDP programme, with the incorporation of the additional requirements for DWMPs. The first iteration of studies will be complete by the end of 2022 to form the basis of our AMP8 (2025-2030) and beyond drainage and wastewater investment plans.

We have recognised the potential for a significant amount of additional stakeholder engagement and its management once we begin the production of the three levels of our DWMP and will continue to support the positive working relationships that we already have established with our key stakeholders. This gives us an effective starting point as we move into the evolutionary world of DWMPs to help support the delivery of our outcomes and those set by Welsh Government e.g. in the Well Being and Future Generations (Wales) Act 2015.

Appendix 2: RainScape

There are growing pressures on our sewerage systems due to increased flows resulting from climate change, growth and increased infiltration. These can increase the risk of internal and external flooding to our customers, as well as increasing pollution risks, unless mitigation works are undertaken.

Such works can include the upsizing of our sewer pipes, however this is not always practical nor is it sustainable in the long term. Hence where cost beneficial and having regard to community and environmental benefits from such schemes, we aim to resolve sewer flooding and pollution challenges through sustainable drainage initiatives. Such initiatives include what we identify as RainScape solutions, which reduce the volume and/ or rate of surface water discharging into our sewers. The volume of surface water removed from a system is measured as “roof equivalent”.

Over AMP6 and AMP7 we have an overall target, within our Measures of Success (MoS), to remove 47,000 roof equivalents of surface water from our sewerage systems through RainScape solutions, of which we expect to deliver 25,000 over AMP6 and 22,000 over AMP7. Expenditure within this Investment Case to address internal and external flooding will include Rainscape solutions and hence will contribute to the AMP7 target. This will be supported by Rainscape solutions to address challenges in other wastewater investment cases. Estimates of the Rainscape contributions to the AMP7 MoS are indicated in Table 12.

Challenges	Contribution to MoS over AMP7
Network Enhancement (Flooding)	5000
EDM	9000
NEP Bathing Waters	2350
NEP Shellfish Waters	4650
Growth	1000
Total	**22,000**

Table 12: Estimated contribution to MoS

The primary risks to the delivery of RainScape initiatives are:

- **Costs:** Assessed RainScape costs are at present higher than other more conventional solutions. Innovative solutions to reduce costs will be sought leading up to and over AMP7;
- **Identification of Schemes:** To meet targets then schemes which can remove significant volumes of surface water will need to be identified and developed prior to or in the early stages of AMP7;
- **Time-scales:** Larger RainScape solutions can take a number of years to implement due to the time taken to develop partnerships and undertake consultation with local communities. Opportunities to develop partnerships and schemes more efficiently and effectively will be implemented over AMP7.

The Sustainable Drainage Plans produced over AMP6 and the proposed DWMPs to be produced over AMP7, will identify opportunities for RainScape schemes and the development of partnerships.

Appendix C: Newport Tunnel Resilience

The wastewater catchment in Newport is predominantly a combined system which ultimately enters the Nash WwTW for treatment. The Newport sewerage system is effectively divided into two catchments. To the east of the River Usk is the Liswerry catchment which discharges into Liswerry Pumping Station (PS) and to the west is the Orb catchment, which includes the Newport Tunnel, which discharges to the Orb SPS.

Flooding issues have been identified within the catchment of the Orb SPS, which are particularly related to the performance of the Newport Tunnel and critical combined sewer overflows (CSOs) located in the northern and central areas of the Tunnel. Spills from these CSOs discharge into the River Usk, which has the highest tidal range of any city in the world with an 11.63m difference for a mean spring tide between high and low water.

Figure 16 gives a general overview of the catchment. Flows from Liswerry PS and Orb PS discharge into a gravity trunk sewer which runs to Nash WwTW where flows are pumped into the inlet works for preliminary treatment.

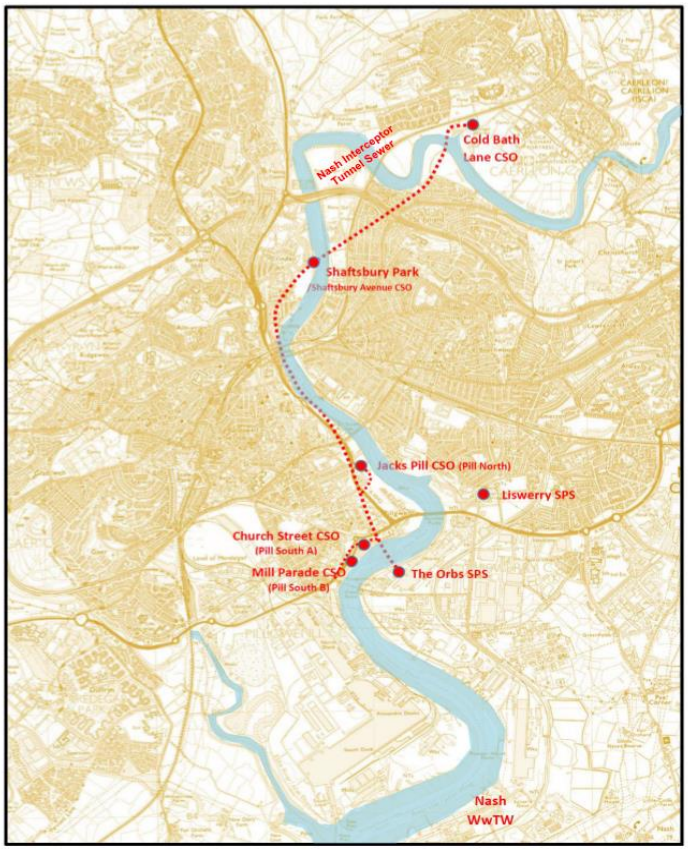


Figure 16: Newport Study Area

Flooding from Newport Tunnel was recorded in 2009, 2010, 2013 and 2016. Initial investigations identified that the cause of flooding is a combination of a number of factors including:

- High flows in storm conditions exacerbated by catchment growth and climate change;
- Limited pumping capacity at the Orb SPS,;
- Restrictions to free discharge of flow at the combined sewer overflows (CSOs) due to tide locking and blinding of screens.

- The impacts of climate change with rising sea levels and increased storminess and rainfall will increase the risk of flooding.

As identified flows from the tunnel are pumped via the Orb SPS to the Nash WwTW. In the event of a failure of this SPS the current CSOs would not be able to provide effective overflow capacity for sewage flows, with consequent flood risk to properties. We have assessed that there are 240 at risk properties.

The risk of flooding will increase in the future with climate change impacts of increased storminess and sewer flows as well as rising sea levels. The resilience of the sewerage system in Newport is therefore one of our primary concerns and to support our customer expectations we propose to mitigate flood risk.

We have worked with local customers to provide limited flood risk reduction. In the short-term, we have agreed annual cleansing of the sewers immediately adjacent to the flooding locations, plus we have installed a number of flood doors to reduce the risk of internal flooding.

We have undertaken feasibility studies for a resilience / mitigation scheme to make Newport City more resilient to major flooding incidents in the event of severe flood flows and/or a failure of the Orb SPS. Mitigation options ranged from immediate relief to the properties that have flooded to date (sewer cleansing and flood gates), to the longer-term resilience schemes to protect against high-impact/ low probability widespread flooding across Newport; having regard to the potential impacts of climate change.

Our proposed investment of £20.92m (pre-efficiency) will deliver our “preferred” scheme to improve the resilience of the Newport Tunnel and mitigate the risks of flooding of all “At Risk” properties in the low-lying areas of Newport.

The existing CSOs and their problematic river outfalls would be decommissioned and a new CSO and associated pumping station constructed at the site of the existing Orb SPS. The new outfall would be located downstream of the City Centre and the existing CSOs and with the new SPS would provide increase protection to Newport during severe storm conditions and in the event of a failure of the Orb SPS.

Appendix D: Innovation and Partnerships

Innovation

We will be trialling, installing or developing during the latter parts of AMP6 and during AMP7, numerous innovation projects. Initiatives relevant to this Investment Case include the following:

- Use of data to inform investment decisions:
  - Real time analysis of telemetry, rainfall data and risk to predict flooding, pollution and odour events;
  - Rainfall prediction software that would allow us to maximise capacities across our systems prior to high rainfall events;
  - Artificial Intelligence learning from our data to predict flooding and pollution.
  - Odour measurement and management techniques.

- Asset Reliability:
  - Passive gate device that will allow self-cleansing to clear regular blockages from screens and sewers. Its design provides an instantaneous opening and closing that delivers a flushing wave of wastewater to cleanse the downstream sewer effectively, removing solids deposited due to low velocities;
  - Reducing odour by design (For example, we are trialling an innovative sludge pre-treatment solution prior to dewatering wastewater sludge, from which one of the benefits will be a reduction in odour compared to the current process. The trial is in conjunction with academia);
  - Optimisation of odour dosing systems.

- Surveying:
  - New surveying techniques of sewers, tanks, flows, and pollutants that can be completed quicker, with less reliance on man-entry and greater accuracy; including electro scan, radar flow survey and sonar. These will allow us to develop suitable methods to inspect our often difficult to access sewers and provide us with a picture of the risk they present.

- Innovative customer engagement methods to further educate our customers to reduce the risk of sewer abuse.

We will look to exploit the opportunities presented by these projects throughout our AMP7 delivery.

There are also a range of other innovative approaches that we will consider during AMP7, including:

- Battery storage – to bolster our power options and reduce our reliance on traditional supplies that are becoming more vulnerable.
- *Development of more cost-effective methods of pipe replacement including new reinstatement technologies (including ‘no dig’ techniques), new more efficient materials, ecological assessments, and jointing methods;

We will also improve our understanding of the effects of climate change and its impacts on our business now and into the future. Planning for climate change will enable us to develop truly resilient solutions.

Partnering and co-creation

Partnership working and third-party collaboration has been part of our delivery strategy during AMP6. These stakeholder relationships not only help us to develop schemes that directly improve the services we offer to our customers, but also provide schemes consistent with the wider aspirations of Wales,

contributing to the national policy agenda, such as the goals from the Well-being of Future Generations (Wales) Act 2015.

We will therefore focus on developing partnership working over AMP7. This will be critical in developing more effective operational activities, making further efficiency savings and ensuring we meet the aspirations of our customers. For example, we will actively collaborate with partners and stakeholders to better understand our understanding of risk in developing and implementing solutions to increase resilience of our activities. Partners will include:

- Power (gas and electricity) providers;
- Network Rail;
- Local Authorities and Highways Agencies;
- Natural Resources Wales and the Environment Agency.

We will also build partnerships and undertake public engagement in developing our Rainscape schemes, enabling such initiatives to be developed and implemented more quickly. Our DWMPs will facilitate such partnerships. An example of effective partnership working is the delivery of the highly successful Greener Grangetown project, which provides far greater benefits than the three partners (Cardiff Council, Natural Resources Wales and ourselves) could have achieved alone.

We have also launched a community flooding fund in AMP6 to support initiatives which provide wider benefits to the community. We will review the success of the community flood fund and consider its continuation into AMP7, working with our customers (including our Customer Challenge Group), local communities and partners.