Dŵr Cymru
Welsh Water

Ref 2.3

PR19 Wastewater Network Plus Business Plan

September 2018

Contents

List of abbreviations

CCW	Consumer Council for Water
CNI	Critical national infrastructure
CML	Customer minutes lost (water supply only)
LLFAs	Lead Local Flood Authorities
MoS	Measure of Success
NERC	Natural Environment Research Council
NRV	Non-return valves
NRW	Natural Resources Wales
SCADA	Supervisory control and data acquisition
SEMD	Security and Emergency Measures Directive
Solar PV	Solar Photovoltaic
THM	Total Trihalomethanes (water supply only)
WFD	Water Framework Directive
WRc	Water Research Centre
WWTW	Wastewater treatment works
EDM	Event & Duration Monitoring
NEP	Natural Resources Wales's National Environment Programme
WINEP	Environment Agency's Water Industry National Environment Programme

Executive Summary

Introduction and purpose

This document supports our submission for PR19 for the Wastewater Networks Plus price control for AMP7. It details our plans to deliver our customer promises in AMP7 and the contribution of our AMP7 plan to meeting our Welsh Water 2050 aims.

Our focus within this document is on our wastewater business services to reflect Ofwat's requirements for price review separation. It should be noted that our customers see us as one Welsh Water and our business is highly integrated, and therefore many of the programmes we have discussed in this document will provide benefits across other business plans and activity. In particular, our management of bioresources is covered in a separate price control which includes our sludge strategy, which is critical to the operation of our wastewater networks and wastewater treatment works (WwTW) and the achievement of our Wastewater Networks Plus Measures of Success.

Customers outcomes and support

Our mission is to "earn the trust of our customers everyday". As a genuinely customer-driven business, our customers' views, preferences and priorities are the foundation of our business plans.

Our customers have told us that sewer flooding has a significant impact to their lives and are intolerant of it due to health hazards, damage to property and impact on businesses. We are therefore working to reduce the impact of flooding experienced by our customers.

Moreover, we recognise that a small number of our customers experience repeated, unacceptable service levels and there is customer support to address these long-standing issues.

Customers value the natural environment and recognise the importance of our work in this area[1]. Our customers regard rivers as essential for wildlife, health and well-being, and vital for the Welsh economy and tourism[1]. Therefore, a key area of focus for us is to reduce the impact of the discharges of our assets on the natural environment. When dealing with sources of pollution our customers have also told us that where the responsibility is shared, the responsibility to rectify these issues should also be shared. We are therefore planning to proactively work in collaboration with partners to demonstrate leadership and jointly take responsibility for flooding and pollution issues.

Our unique operating area

The unique social, political, economic and geographical circumstances of Wales pose important opportunities and unique challenges for how we operate as a business.

We operate over large, relatively sparsely populated areas where agriculture is often the dominant sector. We are fortunate to enjoy a very high-quality environment in our operating area thanks, in part, to our historical investment in our wastewater assets. However, the geographical nature of our operating area puts pressure on our base operating costs due to the relatively high number of assets per customer and remoteness of many of our sites.

We also experience a high level of rainfall relative to most other water companies in England and Wales, which when combined with our mountainous terrain significantly increases the

volumetric flow rates our sewers must be able to cope with, and hence the need for pumping and treatment. This has driven our approach of finding innovative and efficient solutions. These solutions are not only focused on capital intervention (such as adopting innovative technologies and approaches like RainScape and PFET) but also on improving our ways of operating to maintain affordability for our customers.

Welsh Water is one of only two companies that serves customers across two of the UK's administrations. Welsh legislation and policy is diverging from England, and we have committed to aligning our business with the Welsh Government's approach to conserving the enhancing the natural environment of Wales. As well as continuing to meet English requirements and ambitions in the areas of England that we serve, in Wales this includes adopting the Sustainable Management of Natural Resources (SMNR) principles for how we work with the natural environment, which will be essential if we are to continue providing affordable services for our customers. It is also an approach that our customers strongly support.

We have been very successful in contributing to improving the environment of Wales, and we are committed to continuing this in AMP7 through our largest National Environment Programme (NEP) for many AMPs. We will deliver this through the Welsh legislative framework, in collaboration with partners and stakeholders to deliver improvements in an effective and affordable manner.

Welsh Water 2050

In response to the long-term trends that we are facing, globally and locally, we have developed a strategy, Welsh Water 2050. Meaningful consultation with our customers was a key part of developing this strategy. This has helped us clarify, articulate and frame our strategy around the issues that are most important to them.

Welsh Water 2050 sets out the challenges that we expect to face over the next 30 years, and the 18 strategic responses that will be required to address them. To be responsive to the needs of both current and future customers, we intend to start delivering on this long-term commitment, and so this plan forms part of our long-term strategy. Strategic responses relevant to this business plan are:

- **Strategic Response 7: Working with customers and communities** - We will work with customers and communities to co-create solutions, share knowledge, and support initiatives which reduce water use, prevent sewer abuse, and provide wider benefits for communities and the environment**.**
- **Strategic Response 8: Ensuring affordability of services delivered to our customers** - We will ensure that we continue to provide the best service in increasingly innovative and efficient ways and pass these savings on to our customers to ensure that our services remain affordable for all customers.
- **Strategic Response 10: Addressing our 'worst served' customers** – We will address the longstanding of 'worst served' customers suffering from sewage flooding to ensure that everyone receives an acceptable level of service.
- **Strategic Response 13: Smart water system management** – With the opportunity to capitalise on technological advances, we will improve the service performance and resilience of our assets through remote sensing, data analysis and automation;

solving problems before they impact on our business, our customers, or the environment.

- **Strategic Response 14: Supporting ecosystems and biodiversity** – In the face of habitat loss and more extreme weather, we also have a statutory duty to look for ways to help nature, enhance biodiversity and promote ecosystem resilience while we carry out our water and sewerage activities.
- **Strategic Response 15: Using nature to reduce flood risk and pollution** - Confronted with urban creep due to demographic change and increased intensity of rainfall due to climate change, we are proposing to reduce the risk of sewer flooding and pollution through sustainable urban drainage systems.
- **Strategic Response 16: Cleaner river and beaches** - With increasing pressure on the natural environment from increased population, changing land use, climate change and new sources of pollution, we will improve our wastewater assets to do our part to help achieve 'good' environmental status for our rivers, lakes and coastal waters.
- **Strategic Response 17: Protecting our critical wastewater assets -** Faced with an increased risk of disruption, for example, from an increase in severe weather as result of climate change, and reduced customer acceptability of pollution events, we will improve the resilience of our critical wastewater assets, which have high environmental and customer impacts of failure.
- **Strategic Response 18: Promoting a circular economy and combatting climate change** – Faced with a changing climate and increased energy costs, we will aim to become an energy neutral business, whilst maximising resource reuse and contributing to a sustainable wider economy in Wales and parts of England which we serve.

AMP6 progress

We have made very good progress in AMP6 and exceeded our original PR14 business plan objectives in a number of important areas including flooding and pollution. We have seen our best flooding performance to date in 2017/2018 and are now one of the leaders in the UK on pollution performance. This is a considerable success after being one of the worst performing water and sewerage companies in AMP5.

By the end of AMP6, we will be the first wastewater company to monitor and report on all our combined sewer overflows (via event duration monitors – EDM) which enables us to better understand our assets, and this information is published annually for our customers to see. We have built extensive coastal models and undertaken investigations to reduce pollution and understand how we and others impact the environment. These models help us to understand ongoing pressures along our coasts and in particular our bathing and shellfish waters, ensuring we focus investigation and investment in the right areas. As a result of historical investment, Wales boasts 1/3 of the UK's Blue Flag beaches even though we only have around 15% of the coastline.

We have also undertaken an extensive programme of surface water removal, called RainScape, to remove significant quantities of surface water from our wastewater systems to reduce flooding and pollution. This is recognised by Ofwat as being a key part of a strong environmental foundation for a resilient wastewater system.

Strategic Responses and Measures of Success

Table 1 includes our AMP7 measures of success, against which we will gauge the success of our approaches.

AMP7 drivers and investments

During AMP7, we plan to invest in programmes of work that progress us towards to our 2050 vision. These are focused on our customers' priorities of addressing flooding and pollution, and build on our progress in AMP6. We plan to reduce pollution by expanding our RainScape programme, to invest in the Gwili Gwendraeth catchment as part of our largest National Environment Programme (NEP) for many AMPS, and to improve assets which have been identified as frequent polluters with a high environmental impact. We will improve the service we provide to customers who have repeat problems through our new 'worst served' customer policy. We will also improve our network forecasting, modelling and monitoring to reduce blockages and therefore reduce flooding and the risk of pollution.

We are also looking to continue to be innovative through programmes such as our new focus on Sustainable Management of Natural Resources (SMNR) a collaborative process of managing our environmental resources, which will help us to deliver the NEP more efficiently and sustainably. These investments are detailed below:

Table 1: Summary of investments

Strategic response	Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
7: Working with customers and communities	Across all investment cases	N/A	SR8 – Affordability for customers SR9 – Vulnerable customers SR10 – Worst Served Customers SR13 - Smart water business SR14- Supporting ecosystems and biodiversity SR15- Using nature to reduce flood risk and pollution	• Promoting long term community resilience in Water Resilient Communities (such as Rhondda Fach). • Continuing to connect customers and communities to their local water environment through our community and school education programmes and visitor centres. • Our SMNR, RainScape approach and community flooding will work with our customers and communities to reduce surface water run-off and improve catchments. • Working with our partners to improve rivers through our National Environment Programme.	Ft11: Visitors to recreational facilities	The number of visitors to our educational and recreational sites across Wales.	450,000	480,000	830,000	1,000,000	No dedicated spend
					Ft10: Community education	The total number of children and adults who have participated in educational activities.	62,000	67,000	75,000	85,000	
					En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water action (cumulative within AMP).	36	562	418	N/A	
					Ft2: Risk of sewer flooding in a severe storm	The percentage of population at risk of sewer flooding in a 1-in-50 year storm	3.63%	3.63%	5% less	30% less	

Strategic response	Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
8: Ensuring affordability of services delivered to our customers	Across all investment cases	Across all strategies	SR7 – Working with customers and communities SR10 – Worst Served Customers SR13 - Smart water business SR14- Supporting ecosystems and biodiversity SR15- Using nature to reduce flood risk and pollution SR16- Cleaner rivers and beaches SR17- Protecting our critical wastewater assets SR18- Promoting a circular economy and combating climate change	• Capital Delivery Alliance drives efficiency • Delivering the National Environment Programme through partnership working, avoiding expensive treatment solutions • Hackathon on blockage modelling, asset compliance and odour driving new efficient methods. • Building energy efficiency into our assets.	Bl1: Affordability	The average percentage annual increase in the average household bill over the 5-year period	<RPI	<RPI	<CPIH	=CPIH	No dedicated spend

Strategic response	Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
10. Addressing our 'worst served' customers	Wastewater Network + Enhancement	Worst-Served Customers (Waste) Policy.	SR15- Using nature to reduce flood risk and pollution SR17- Protecting our critical wastewater assets	• Implement a Worst-Served Customer Policy to reduce sewer flooding. • Not charge our customers when they receive repeated, poor quality service. • Proactive approach to blockages; increase awareness of sewer misuse, smarter systems to identify potential blockages before they occur • Invest in training and equipment to address a greater range of issues on site, on the day.	Rt6: Worst served customer for wastewater service	The number of properties at risk of repeat Internal or Serious External Flooding.	423	368	359	100	£15.8 million
					Rt2: Sewer flooding (external)	The number of external flooding incidents per year within property curtilage	3,929	4,121	3,800	2,500	
					Rt1: Sewer Flooding Internal (incidents of properties flooding)	The number of internal flooding incidents per year, including severe weather events	297	300	273	100	

Strategic response		Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
13. Smart water business		Cross-Service Maintenance	Smart Strategy	SR8- Ensuring affordability of services delivered to our customers SR15- Using nature to reduce flood risk and pollution SR16- Cleaner rivers and beaches SR17- Protecting our critical wastewater assets SR18- Promoting a circular economy and combating climate change	• Implement integrated catchment management (ICM) live to provide flood and pollution forecasting • Blockage Risk Monitoring, reporting and predictive analysis • Implement Smart Networks, using telemetry to improve network performance • Increased monitoring of discharges • Wider environmental monitoring to support SMNR and partnership initiatives	En3: Pollution incidents from wastewater	Category 1-3 pollution incidents, as reported to EA and NRW.	102	107	90	40	
						En1: Water and Wastewater Treatment works compliance	Percentage of population equivalent, served by sewage treatment works with numeric limits and water treatment works, which were compliant	96.7%	100%	100%	100%	£11.6 million
						En2: Wastewater Treatment works look-up table compliance	Percentage of sewage treatment works with numeric limits, which were compliant	99.5%	99%	100%	100%	

Strategic response		Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
14. Supporting ecosystems and biodiversity		Across all investment cases	Biodiversity Plan - 'Making time for nature'[2] SMNR Plan[3]	SR15- Using nature to reduce flood risk and pollution SR16- Cleaner rivers and beaches SR17- Protecting our critical wastewater assets SR18- Promoting a circular economy and combating climate change	• Meet our obligations under the Environment (Wales) Act and support Welsh Government's aims under the Well-being of Future Generations Act • Deliver our largest NEP programme for several AMPs • RainScape strategy • Drainage and Wastewater Management Plans (DWMP) will consider the combined impact of all our integrated drainage systems • Implement Sustainable Management of Natural Resources (SMNR]) in three target pilot catchments • Implement biodiversity champion programme • Initiatives to improve biodiversity on our sites	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water action (cumulative within AMP).	36	562	418	N/A	No dedicated spend

Strategic response		Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
15. Using nature to reduce flood risk and pollution		Wastewater Network + Enhancement	RainScape Strategy[4]. Blockage Reduction Strategy Cardiff flooding strategy	SR7 – Working with customers and communities SR8- Ensuring affordability of services delivered to our customers SR10 – Worst Served Customers SR13 - Smart water business SR14- Supporting ecosystems and biodiversity SR16- Cleaner rivers and beaches SR17- Protecting our critical wastewater assets	• Deliver our NEP programme • Community flooding co-funding initiative to encourage local authorities and local groups to develop Natural Flood Management measures and other protection for their community. • Continue to build green infrastructure as part of RainScape strategy to provide multiple benefits to the local community and environment	Ft4: Surface water removed from sewers	The cumulative volume of surface water removed measured as roof equivalents since the end of AMP5	22,000	25,000	47,000	400,000	£56.3 million

Strategic response	Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
16. Cleaner rivers and beaches	First Time Sewerage Waste NEP Wastewater Growth Wastewater Network + Enhancement Wastewater Networks Maintenance Wastewater Treatment Maintenance	Pollution Reduction Strategy[5] Final Effluent Compliance Improvement Strategy[6] Environmental Improvement Plan	SR8- Ensuring affordability of services delivered to our customers SR10 – Worst Served Customers SR13 - Smart water business SR14- Supporting ecosystems and biodiversity 15. Using nature to reduce flood risk and pollution SR17- Protecting our critical wastewater assets	• Identify frequent spillers using Event Duration Monitoring (EDM) data • Undertake Storm Overflow Assessment Framework (SOAF) investigations • Monitor flow and pass forward flow at our WwTW and other key sites • Undertake chemical investigations and modelling • Undertake maintenance of our assets that are not functioning properly (WwTW, SPS, CSO and outfalls) • Reduce network blockages • Continue work on Dry Weather Flow (DWF), reporting performance and ensuring continued compliance • New Gwili Gwendraeth WwTW • Implement Sustainable Management of Natural Resources (SMNR]) in four target pilot catchments • Undertake conservation schemes and remove fish barriers • Invest in new public sewers as part of our S101a obligations • Provide sewerage for new developments and growth	En3: Pollution incidents from wastewater	Category 1-3 pollution incidents, as reported to EA and NRW.	102	107	90	40	£348.9 million
					Rt3: Sewer Collapses	The number of collapses on sewers	255	255	0% change from 2019/20	0% change	
					En1: Water and Wastewater Treatment works compliance	Percentage of population equivalent, served by sewage treatment works with numeric limits and water treatment works, which were compliant	96.7%	100%	100%	100%	
					En2: Wastewater Treatment works look-up table compliance	Percentage of sewage treatment works with numeric limits, which were compliant	99.5%	99%	100%	100%	
					En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water's action (cumulative within AMP).	36	562	418	N/A	

Strategic response	Investment cases	Operational strategies	Cross-cutting strategic responses	Activities in AMP7	Measures of Success	Narrative	2017/2018 performance	AMP6 target	AMP7 target	2050 target	AMP7 enhancement
17. Protecting our critical wastewater assets	Cross-Service Maintenance Wastewater Network + Enhancement	Resilience Scorecards Power Resilience Plan	SR8- Ensuring affordability of services delivered to our customers SR10 – Worst Served Customers SR13 - Smart water business SR14- Supporting ecosystems and biodiversity SR18- Promoting a circular economy and combating climate change	• Improve power resilience of critical WwTW and SPS • Install temporary works at critical sites to achieve required resilience standard • Undertake condition surveys at critical sewers • Invest in the Newport Tunnel • Invest in the South East Coastal Strategy	Ft8: Wastewater network + above ground	Percentage of above ground critical assets that are resilient against a set of criteria	N/A	77.7%	80%	100%	£34.1 million
					Ft9: Wastewater network + below ground	Percentage of below ground critical assets that are resilient against a set of criteria	N/A	28.3%	45%	100%	
18. Promoting a circular economy and combating climate change	Energy	Energy Plan for AMP7[7]	SR8- Ensuring affordability of services delivered to our customers SR17- Protecting our critical wastewater assets	• Increase renewable energy generation, wind and solar photovoltaics • Increase energy efficiency of pumps and controls, lights and aeration • Improve demand side management and storage • Improve maintenance of equipment • Advanced Digestion sludge strategy	Ft3: Energy self-sufficiency	Electricity generated and gas injected to grid as a percentage of all electricity and gas consumed (gas expressed as an electricity equivalent).	20%	26%	35%	100%	£9.8 million
Additional investment not directly attributed to strategic responses									AMP7 BOTEX: **£1,031.9 million**		

1. Introduction

1.1. Wider context

The removal and treatment of wastewater is taken as a given by customers, and we need to continue to do this to a high standard to maintain their trust. Where we are responsible for waste water services, we convey and treat waste water at our wastewater treatment works before discharging it safely to the environment, with the consent of Natural Resources Wales or the Environment Agency. Other outputs of the treatment process are bioresources (sewage sludge) and energy.

Our focus within this document is on our wastewater business services excluding bioresources, to reflect Ofwat's requirements for price review separation. However our treatment processes are dependent on the efficient collection, conveyance, treatment and recycling of bioresources and, in turn, the bioresources are dependent on the efficient operation of our network and treatment processes. Our business is highly integrated and therefore many of the programmes we have discussed in this document will provide benefits across other business plans and strategic responses.

1.2. Purpose, scope and structure of document

The purpose of this document is to support our submission for PR19 with respect to the Wastewater Network Plus price control for AMP7, the period from 1 April 2020 to 31 March 2025. This document outlines the plans for our wastewater network in AMP7 and how these plans will contribute to our long-term strategy, Welsh Water 2050, and deliver improvements in service for our customers.

This document provides an outline of:

- Our customers' priorities for AMP7;
- Our **progress during AMP6** and how our AMP7 plans will build-on our work in AMP6, including both successes and lessons learnt;
- Our **plans for AMP7** and how these plans contribute to our achieving our Strategic Responses outlined in Welsh Water 2050, and deliver improvements to our customers;
- Our longer-term plans for **AMP8 and beyond**;
- The way we have used **innovative techniques and technologies** to carry out our plans; and
- How we will **assess our progress** in AMP7 using our Measures of Success.

Where a strategic response covers many price controls, we have discussed the information relevant to this business plan in this document.

This plan will help us to meet our six customer promises:

- Clean, safe drinking water for all;
- Safeguard our environment for future generations;
- Personal service that's right for you;

- Fair bills for everyone;
- Put things right if they go wrong; and
- A better future for all our communities.

1.3. Relationship to our wider PR19 business plan

This Wastewater Network Plus plan is part of a larger plan, our Welsh Water Business Plan. It contains greater detail on customer and stakeholder engagement, how we propose delivering outcomes in AMP7 and beyond, the levels of service we will provide, financing implications and impacts on customers' bills.

This business plan is supported by additional submission documents. The key supporting documents are:

Document title	Reference	Description
Past Performance Report	5.4	Description of our AMP6 performance against PR14 Measures of Success.
PR19 Performance Commitments	5.2	Description of how our Measures of Success and commitments have been developed
PR19 Bioresources Business Plan	2.4	Description of our bioresources price control plans.
Welsh Water 2050	1.4	Our long-term strategy, outlining future trends for our business, and how we will harness the opportunities and mitigate the challenges we will face up to 2050.
Investment cases		
Document title	**Reference**	
Wastewater Networks Maintenance	5.8M	
Wastewater Networks Plus Enhancement	5.8N	
Llanelli and Gowerton	5.8O	
Wastewater NEP	5.8P	
Wastewater Network Plus Growth	5.8Q	

Wastewater Treatment Maintenance	5.8R

A full list of additional documents available on request is included in Annex A.

1.4. Our business

Welsh Water is the sixth largest of the ten regulated water and sewerage companies in England and Wales in terms of customers. Our geographical operating area is the third largest. We operate 835 wastewater treatment works (WwTWs) and maintain over 30,000 km of sewers. Our greatest responsibility is to protect public health by providing an effective wastewater service to 3.1 million people in Wales and parts of England. It is crucial we look after our wastewater assets, and the essential public service they provide, today and for future generations. The physical geography of our region, operating in a largely rural environment, means that our wastewater business has a network of small assets many of which are remote, with a high number of assets per customer. We have had to invest significantly in assets, with the sewage treatment for half of our customers built after privatisation, in particular around our highly populated coastline. These have been funded through customer bills, as opposed to the inland water companies who had to invest in these assets pre-privatisation.

1.5. Working for our customers

As we are a company without shareholders, and run solely for the benefit of our customers, we have a unique position in responding to their priorities.

This AMP7 business plan integrates the pioneering long-term resilience thinking that was developed as part of our Welsh Water 2050 strategy, and shows how our investment over the AMP forms part of this vision.

As part of our plan to deliver great customer service in the next AMP, we have collated the findings of customer engagement activities with around 40,000 customers that we have carried out over the past two years. This includes:

- Welsh Water Summer Consultation (2017);
- Welsh Water 2050 “Have Your Say” Consultation (2017); and
- Welsh Water 2050 Response to long term strategy (2017).

We have continued to work closely with the independent Customer Challenge Group (CCG) who provide us with critical oversight.

This has allowed us to tailor our approach to AMP7, considering our customers specific needs, wants and desires – including those that are vulnerable, even on a temporary basis. We wanted to understand how they prefer to engage with us going forward, and how we can continue to provide great customer services given the future trends that will present significant challenges for our organisation going forward.

We have shown how we want to keep bills affordable in the long term, by investing in resilience, our people and using innovative approaches in our capital investments and operations. This will include avoiding expensive ‘end of pipe’ wastewater treatment

solutions by working in partnership and using SMNR approaches to meet our environmental obligations in an affordable manner.

As part of building our submissions for PR19, we have assessed the willingness of our customers to invest in certain measures that bring benefits now and in the future. We believe that all customers, including our 'worst served' customers and customers in vulnerable circumstances, deserve the same level of service. We are looking to collaborate and partner wider than ever before to deliver innovations that keep bills low, unlock partnership funding, achieve multiple objectives, reduce our environmental impacts, and support our communities.

1.6. Our unique operating area

Welsh Water is one of only two companies that serves customers across two of the UK's administrations, England and Wales. Most of our customers live in Wales, and we are proud of our Welsh roots and identity. The unique social, political, economic and geographical circumstances of Wales pose important opportunities and unique challenges for how we operate as a business.

The political context

The Welsh Government has primary legislative responsibility regarding the activities of the water industry in most of our operating area. We need to align ourselves to Welsh and English policies in the appropriate parts of the area we serve.

Since devolution, Welsh legislation has diverged from England in some key respects. Two important examples are Schedule 3 of the Flood and Water Management Act, which will come into force in Wales from January 2019, and The Environment (Wales) Act 2016 which place a duty on public authorities to conserve and enhance the environment and biodiversity. We also plan to align with the Well-being of Future Generations (Wales) Act 2015, the Water Strategy for Wales (2015) as well as Defra's 25-year Environment Plan.

- **Schedule 3 of the Flood and Water Management Act** will require most new developments in Wales to have integrated Sustainable Urban Drainage Systems (SuDS), which could help us mitigate long-term flow increases in our sewage network;
- **The Well-being of Future Generations Act** requires public bodies in Wales to sustainably enhance the economic, social, environmental and cultural well-being of Wales. Although we are not directly within its scope, we recognise that we have an important supporting role if the Act's far-reaching goals are to be achieved. Our long-term strategy, Welsh Water 2050, explicitly aligns each of our strategic responses with the goals of the Act;
- **The Environment Act** gives the Sustainable Management of Natural Resources (SMNR) approach legal weight in Wales. It places a strengthened statutory duty on us (and other public authorities) to maintain and enhance biodiversity and promote ecosystem resilience whilst carrying out our water and wastewater activities; and
- **The Water Strategy for Wales (2015)** sets out the Welsh Government's broad direction for water policy over the next 20 years. Its vision is to ensure that Wales

continues to have a sustainably managed water environment to support healthy communities, flourishing businesses and the environment.

The geographical and environmental context

We operate over a very large, mountainous, generally sparsely populated area in the western side of the UK where agriculture is often the dominant sector.

We experience far higher levels of average rainfall relative to the average for England, leading to higher volumetric flow rates that our combined sewers must cope with. This means we need relatively large assets, must pump large volumes of water and have many CSOs to ensure we can protect our customers from flooding.

Due to the geographical nature of the areas we serve, we have a comparatively high number of assets per customer and therefore cannot achieve the economies of scale that can be leveraged by other water companies in England and Wales. Despite this, we have been successful at innovating new ways of operating our assets to maintain affordable bills for us, including finding ways to work in partnership with stakeholders.

In Wales, we are fortunate to enjoy a very high-quality environment thanks, in part, to our historical investment in our wastewater assets. The success of that investment and of our on-going operational and maintenance regimes is evidenced by the large number of national and European environmental designations, blue flag beaches, and water bodies designated as 'good' under the Water Framework Directive (WFD) in our operating area. Around 70% of our inshore waters have been designated as protected in one form or another, and we have a significant number of SACs and SSSIs on our inland water bodies. 17% of surface water bodies in England are classified as being of 'good' status, whereas in Wales the figure is 37% (based on data from 2015[8,9]). Our discharges only have a confirmed impact on 4% of water bodies, the lowest figure in the English and Welsh water industry, although we may be impacting a further 13%.

We have and want to continue to play a significant part in ensuring the vast majority of water bodies in the area we serve achieve 'good' status by 2027. Working with others to do this will be essential, as there are only 4 water bodies (<1%) which have not achieved WFD good status and for which we are the sole cause. Collaborative working will be vital if we are to continue to supply sustainable wastewater services for our customers and is an approach they strongly support.

2. Welsh Water 2050

2.1. Purpose and context

Our PR19 Business Plan is set firmly in the context of our long-term ambition which is "to become a truly world class, resilient and sustainable water service for the benefit of future generations".

Following a major consultation exercise with customers and stakeholders, we published our 30-year strategy in 2018 - Welsh Water 2050 ('2050 strategy'). It sets out the challenges that we expect to face over the next 30 years, and the 18 strategic responses that will be required to address them. It also identified and scored areas of resilience strength and areas which require enhancement for almost all aspects of our business.

We acknowledge that it is vital for us to identify and address emerging challenges, and harness new opportunities, to ensure we don't store up problems for future generations. We have identified key future trends that are likely to have a significant impact on our service provision, particularly on our ability to deliver on our customer promises.

Our strategic responses set out how we will mitigate or harness future trends. This includes the research and innovation we will need to harness them. It includes the organisations that we will need to work with and how our activities will align with our customer promises and relevant legislation, including the Well-being of Future Generations (Wales) Act 2015.

2.2. Future trends

Significant future trends that are likely to impact on our wastewater business are:

Change in customer expectations – customer's expectations of their wastewater service, and the acceptability of any flooding and other issues, is likely to change.

Protecting essential infrastructure – ageing wastewater infrastructure, and physical and cyber security risks could limit our ability to maintain a reliable service in the future.

Demographic change – changes in population and growth in the commercial sector leads to increased service demand. More of our customers are likely to be considered vulnerable in the future.

Changes to the structure of the economy – the growth of the digital, knowledge-based economy could allow us to realise significant efficiencies in our wastewater business. Other changes to the economy could present challenges.

Policy and regulatory change – policy and regulation around wastewater could change, especially after the UK's departure from the European Union.

Climate change – more frequent and extreme weather events have the potential to adversely impact upon the rivers and catchments.

Environmental change – water quality around our coastlines and in our rivers could come under increased pressure due to land use change in our catchments.

Protecting public health – regulatory standards on wastewater discharges may tighten in the future.

2.3. Relevant strategic responses

Our strategic responses include a long-term direction of travel for how we will mitigate the challenges and harness the opportunities, which will be continually reviewed and revised over time. Relevant strategic responses for our wastewater network+ business plan are:

Strategic Response 7: Working with customers and communities - We will work with customers and communities to co-create solutions, share knowledge, and support initiatives which reduce water use, prevent sewer abuse, and provide wider benefits for communities and the environment**.**

Strategic Response 8: Ensuring affordability of services delivered to our customers - We will ensure that we continue to provide the best service in increasingly innovative and efficient ways and pass these savings on to our customers to ensure that our services remain affordable for all customers.

Strategic Response 10: Addressing our 'worst served' customers – We will address the longstanding issues of sewer flooding to ensure that everyone receives an acceptable level of service.

Strategic Response 13: Smart water system management – With the opportunity to capitalise on technological advances, we will improve the service performance and resilience of our assets through remote sensing, data analysis and automation; solving problems before they impact on our business, our customers, or the environment.

Strategic Response 14: Supporting ecosystems and biodiversity – In the face of habitat loss and more extreme weather, we will look for ways to help nature, enhance biodiversity and promote ecosystem resilience while we carry out our water and sewerage activities.

Strategic Response 15: Using nature to reduce flood risk and pollution - Confronted with urban creep due to demographic change and increased intensity of rainfall due to climate change, we are proposing to reduce the risk of sewer flooding and pollution through sustainable urban drainage systems.

Strategic Response 16: Cleaner river and beaches - With increasing pressure on the natural environment from increased population, changing land use, climate change and new sources of pollution, we will improve our wastewater assets to do our part to help achieve 'good' environmental status for our rivers, lakes and coastal waters.

Strategic Responses 17: Protecting our critical wastewater assets - Faced with an increased risk of disruption, for example, from an increase in severe weather as result of climate change, and reduced customer acceptability of pollution events, we will improve the resilience of our critical wastewater assets, which have high environmental and customer impacts of failure.

Strategic Response 18: Promoting a circular economy and combatting climate change – Faced with a changing climate and increased energy costs, we will aim to become an energy neutral business, whilst maximising resource reuse and contributing to a sustainable wider economy in Wales and parts of England which we serve.

These strategic responses form the structure for the remainder of the plan.

3. Strategic Response 7: Working with customers and communities

Figure 1: Working with our customers as part of a behavioural change campaign. © Welsh Water.

3.1. Drivers

As set out in our long-term strategy, Welsh Water 2050, we recognise the importance of working with customers and communities to co-create solutions. Working with customers to shape how our wastewater services are delivered will help to ensure community buy-in and ownership of projects, a better understanding of contributing factors to network issues and an improved public perception of us as a water company.

3.2. Customer and stakeholder priorities

Sewer blockages are one of the 'top of mind' threats for our customers[10], and they would rather we focus on behavioural change, than on expensive reactive or capital solutions (see supporting document 1.1B). Safeguarding the natural environment is also regularly highlighted as a customer and stakeholder priority, and our customers place a high value on our investment in education projects.

Several stakeholders who responded to our Welsh Water 2050 stakeholder survey have said that they are keen to work with us to achieve our mutual shared objectives including CCWater, The Campaign for the Protection of Rural Wales and the Wildlife Trust Wales. We want to work with stakeholders to improve the WFD status of water bodies in an affordable and effective manner.

3.3. Our approach

Working in partnership with customers and stakeholders is essential meeting our Customer Promises.

We have recognised the need to look beyond expensive 'end of pipe' solutions to meet our environmental obligations. Our approach is to work with a range of stakeholders to deliver affordable and effective environmental improvements whilst keeping bills low for our customers.

We are engaging households to reduce their contribution to sewer blockages, delivered through customer communication, education and behavioural change programmes. We are also working closely with our communities to realise shared objectives from our RainScape projects and are contributing to jointly-funded Community Flooding schemes. Our customer engagement activities underpin our long-term Welsh Water 2050 Strategy and have driven our approach to PR19.

Customer-driven strategies

We recognise customers are at the heart of decision-making at Welsh Water. We will continue to build on our wide range of customer engagement activities in AMP6, and work with our customers to understand what is important to them and how we should prioritise our investments. Through our Water Resilient Communities approach, we will build long-term relationships with a communities to align our approach and our investments with their specific needs.

Working with our customers and stakeholders to improve our performance

Over recent years we have been very successful at keeping customer bills below the rate of inflation and our customers tell us that affordability remains a key concern. We want to find new ways of meeting the aspirations of the Welsh Government and deliver significant environmental improvements, whilst ensuring that bills remain affordable for our customers.

Our traditional approach of investment in 'end of pipe' treatment solutions is delivering diminishing environmental benefits. This, combined with the fact that we have a very large number of assets per customer compared to other wastewater companies in England and Wales, means that if we were to continue our traditional approach we would deliver only small environmental improvements, whilst incurring high capital and operational costs. This would saddle our customers, and future generations, with higher bills and reduce our ability of deliver affordable services.

Therefore, our approach is to work with NRW and other stakeholders, including farmers, landowners, and non-governmental environmental groups to deliver significant but affordable and effective improvements using Sustainable Management of Natural Resources (SMNR) principles. SMNR is a holistic approach to environmental protection and recognises the interdependence of catchment pressures and the vital importance of partnership working. We are also working with NRW and the Welsh Government to explore the introduction of payment for ecosystems services (PES) approach, for example, through a Nutrient Offsetting Scheme. This could allow us to deliver alternative catchment-wide initiatives, to support environmental improvements and WFD compliance in an affordable manner.

Our RainScape schemes form our long-term approach to reducing flows entering our sewage network and reducing flooding. We work very closely with our communities, hosting collaborative consultation events to ensure our RainScape solutions are sensitive to the local context and maximise benefits for our communities.

We recognise that flooding events can be caused by a combination of several factors, and we cannot protect our customers be concentrating solely on our assets. We therefore contribute to community flood reduction schemes through our Community Flooding Fund (as detailed in chapter 8).

We recognise that it is crucial for us to build resilience into our catchments against pollution incidents. Our Sustainable Management of Natural Resources approach (SMNR) involves working with landowners to improve land management practices and promote natural resilience (as described in chapter 9).

Communicating the right messages to our customers at the right time in the right way is important to building strong relationships to facilitate our collaborative projects. We underpin our engagement programmes with research to improve our understanding of relevant technological innovations, the behavioural economics driving disposal in our waste water network, and appropriate communication channels. This ensures we are well placed to advise our customers and build on our reputation as a trusted service provider.

Communication and education

We aim to use our education programmes to build awareness of issues that can contribute to poor sewer performance. These programmes are delivered in collaboration with the following partners:

- CCWater;
- Waterwise;
- Energy Savings Trust;
- Local Health Boards;
- Public Service Boards;
- Local and national charities;
- Local Authorities;
- NRW;
- Keep Wales Tidy
- Cynnal Cymru
- Our Independent Environment Advisory Panel that draws its members from stakeholders and academia;
- Office of the Future Generations Commissioner; and
- Housing Associations.

Our education programmes include:

- Our four education centres;
- Our “Stop the Block” Campaign;

- Our River Schools Education Programme; and
- Our Education Plan.

Stop the Block and Your Community Works

Over half of all sewer blockages are caused by customers flushing inappropriate items (e.g. sanitary waste and wet wipes) down the toilet or pouring fats, oils and greases down the kitchen sink. 'Let's stop the block' is our community outreach and education programme, aiming to transform customers' attitude and behaviour towards sewer abuse. The project is not just a 'poster campaign' but reaches out to and interacts with customers in several innovative ways, (e.g. TV and radio ads, social media, visits to businesses, free but informed beauty sessions, school outreach and interactive activities) which are continuously updated as we gain further insights. The campaign also focusses on the regions that are most affected and specifically targets demographic groups that can contribute the most to change.

Customer awareness has been steadily increasing, shown by a steady decrease in blockages caused by sewer abuse in the areas we were active, with an estimated reduction of at least 5% to date.

Part of this collaboration includes increasing awareness and understanding of green infrastructure and the link between urban water quality and land management in our upland catchments. Through these programmes we are helping to place our customers as active participants in the water system.

3.4. AMP6 performance

Customer-driven strategies and behaviour change

In AMP 6, we have worked with our customers to understand what is important to them and how we should prioritise our investments, given the future challenges that we will experience going forward. Throughout the development of our long-term strategy, Welsh Water 2050, we have engaged with more than 40,000 customers over the past two years to build a collaborative programme of prioritised investment. This has allowed us to tailor our approach to AMP7, considering their specific needs, wants and desires.

In AMP6, we also began the trial of our first Water Resilient Communities pilot project. This takes a holistic approach to our work in communities, and alongside raising awareness of our ongoing work.

Collaboration: Rhondda Fach Water Resilient Community

Despite being one of the most economically disadvantaged communities we serve, only 96 of 10,000 households in the Rhondda Fach area are on social tariffs. The area, which faces numerous challenges both from a water utilities asset and a community point of view, is currently the focus of a new type of project: co-creating and co-delivering schemes with our customers to address these issues holistically.

This approach links water and wastewater services in the community. Since January 2018 we have been collaborating with key stakeholders from the Rhondda Fach area to align our £23 million investment in the drinking water network with the objectives of the Cwm Taf Well-being Plan. At the same time, for example, we are seeking out good RainScape opportunities to benefit the local area.

A bespoke outreach programme is underway to increase engagement with our customers. These include raising awareness of our projects in the local area, our community group support and our apprenticeship scheme.

Working with our customers and stakeholders to improve our performance

We have implemented successful RainScape schemes in the Loughor Estuary, Grangetown in Cardiff, Llanelli and other areas. As part of these, we have worked with stakeholders and communities to host extensive engagement events, allowing our customers to actively participate in the design of their streets (as detailed in chapter 8).

In AMP6 we made £1 million available through our Community Flooding Fund to help jointly contribute to community-based flooding solutions with community groups or local lead flood authorities (LLFAs).

Communication and education

Our education programmes have gone from strength to strength in AMP6. Our four education centres receive half a million visits each year, and we are planning to complete a new visitor centre in Cardiff by the end of AMP7. Through our education plan we are reaching 62,000 children a year in our Discovery Centres or schools.

We have also invested in our “stop the block” campaign, a non-flushable item customer awareness strategy (as detailed in chapter 5).

3.5. AMP7 plan

	PR19 Measures of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	Ft11: Visitors to recreational facilities	The number of visitors to our educational and recreational sites across Wales.	450,000	480,000	830,000
	Ft10: Community education	The total number of children and adults who have participated in educational activities.	62,000	67,000	75,000
	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water action (cumulative within AMP).	37	562	418
	Ft2: Risk of sewer flooding in a severe storm	The percentage of population at risk of sewer flooding in a 1-in-50 year storm	3.63%*	3.63%*	5% less
			*This figure is provisional and will be refined over the course of AMP6		

Figure 2: Our PR19 Measures of Success

Customer-driven strategies

We will continue to co-create strategies and projects with our customers, allowing them to develop a sense of stewardship for their own water use and behaviours and improving their appreciation for how this relates to the wider water environment. We will also be continuing our work alongside local communities to identify the most efficient approach to investing in our sewage network, as well as exploring other initiatives such as RainScape, support for community groups and apprenticeships.

We will also be building our long-term plan for managing wastewater, our Drainage and Wastewater Management Plans (DWMPs). These will build on our existing sustainable drainage plans but will expand the scope and ambition of our long-term planning process considerably. DWMPs will allow us to consult and collaborate with stakeholders (such as Welsh Government, Lead Local Flood Authorities (LLFAs), NRW, EA and other risk management authorities) and customers across the area we serve at many levels. We will be able to report on our plans in a way that is transparent and understandable for customers and comparable with other water and sewerage companies. They will allow us to identify areas that are at risk from climate change or where growth could present problems for the

hydraulic or biological capacity of our systems. Most importantly they will allow us to work with stakeholders to identify common objectives and opportunities for co-investment.

The framework for the DWMPs is due to be finalised soon, but we have already commenced work on the early stages of the programme in AMP6 (particularly on the strategic context and risk-based catchment screening steps), aiming to complete the programme by the end of 2022. We will commence work on the more detailed baseline risk and vulnerability assessments before the end of this AMP, building on the results of our sustainable drainage planning which are providing the detailed information for the DWMPs. We are establishing our internal team for delivering the plans and have secured consultant resources to support the team. Stakeholder engagement will begin at the Wales Water Forum on the 3rd October 2018 and we expect to invest £13.6 million developing the plans.

Working with our customers and stakeholders to reduce flooding

Our aim is to maintain affordable bills for our customers in the long-term. To deliver one of our largest ever NEPs we want to work with communities and other stakeholders to find alternative ways of meeting environmental objectives, whilst also delivering wider benefits such as biodiversity enhancements and community engagement. We are therefore implementing a new approach to environmental improvements based on SMNR principles.

Innovation: SMNR Catchment Pilot in Afon Teifi

The Teifi catchment has several water bodies that are not currently achieving WFD 'good' status. The impacts of our assets on these failures are relatively minor compared to the impact of agricultural activities, and therefore, investment in our assets alone will not deliver WFD 'good' status.

To support a healthy and compliant environment in the Afon Teifi catchment, we are proposing to work in partnership to deliver effective, affordable solutions using SMNR principles. These could include introducing a payment for ecosystems services (PES) trading scheme for nutrient abatement in the catchment, supporting the provision of advice to agriculture and encouraging the registration of septic tanks.

In AMP7 we want to continue to expand our community-centred RainScape approach to more communities and aim to remove an additional 22,000 rooftop equivalents of surface water from our sewers. In particular, we will work collaboratively with stakeholders to leverage a co-ordinated RainScape strategy for central Cardiff, to help tackle flooding and promote growth and investment (as detailed in chapter 8).

Communication and education

We will continue to build on our existing customer and community education programmes, including our visitor centres, and significantly increase the number of children and adults to visit our educational or recreational sites, or participate in educational activities. We will also continue to invest in our "stop the block" campaign to reduce inappropriate items entering

our sewage network. We intend to build on all these services in AMP7 and beyond, focussed around developing with our customer's needs.

3.6. Long-term planning: AMP8 and beyond

	Measures of Success	Narrative	2025 target	2030 target	2050 target
	Ft11: Visitors to recreational facilities	The number of visitors to our educational and recreational sites across Wales.	830,000	880,000	1,000,000
	Ft10: Community education	The total number of children and adults who have participated in educational activities.	75,000	85,000	85,000
	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water action (cumulative within AMP).	418	128	N/A
	Ft2: Risk of sewer flooding in a severe storm	The percentage of population at risk of sewer flooding in a 1-in-50 year storm	5%* less	10%* less	30%* less
				*reduction relative to AMP6 end	

Figure 3: Our long-term PR19 Measures of Success targets

Over the long-term, we are committed to making customers increasingly central in our decision-making processes. Our work with communities will help us recognise and respond to pressures on the environment through community-led projects.

Moreover, we will work internally to help our colleagues have a better understanding of our customers, and the opportunities and incentives to change behaviour around wastewater use and enhance their participation in water cycle management.

Communicating the right messages to our customers at the right time in the right way is important to building strong relationships to facilitate these collaborative projects. To support this, we will continue to horizon scan customer communication technologies, while also improving our understanding of how to influence customers to use the most appropriate channels for contact.

We will enter AMP7 as a water company with a very low contribution to WFD water quality failures, in comparison to our English counterparts. By the end of AMP7, the successful delivery of our NEP will mean that the remaining impacts would be comparatively expensive to mitigate, if delivered using traditional schemes, and would only benefit small lengths of rivers. It is therefore difficult to forecast a length of river improved on the same basis beyond AMP7. This in no way detracts from our ambition to continue to provide leadership and drive further environmental improvements. We will look to create a different method based on SMNR principles and using our DWMPs to measure and demonstrate our environmental aspirations.

4. Strategic Response 8: Ensuring affordability of services delivered to customers

Figure 4: Our customers expect and affordable service for the long term. © Welsh Water.

4.1. Drivers

Affordability is defined in Delivering Water 2020 as "the ability of a customer to pay their water bill". Currently the majority of our customers believe that Welsh Water's bills represent good value for money, however with debt and poverty on the rise in Wales,[11] we must work to ensure that our services remain affordable for all customers. We must consider both current and future needs to ensure that delayed investments do not result in unaffordable bills for future generations. As set out in Welsh Water 2050, we are committed to ensuring that we continue to provide the best service in increasingly innovative and efficient ways, and pass these savings on to our current and future customers to ensure that our service remains affordable for all.

4.2. Customer and stakeholder priorities

Affordability and the ever-changing vulnerability of our customers in Wales is recognised by Consumer Council Water as one of the key challenges the company is facing in the future.

Our customers recognise that collecting bills is a fundamental part of our operations, but nearly 5% of our customers say they cannot afford their water and waste water bill, and many more say they find affording their bill a 'stretch' (supporting document 1.1C). A key theme across our customer consultations is efficiency: we have a very large number of assets to operate and maintain relative to the number of people we serve. Our customers are keen to see us demonstrate that we are investing responsibly in delivering cost-effective service, and they are largely willing to play their part in achieving this.

4.3. Our approach

We must respond to the challenge of affordability for our customers and demonstrate to them that we are providing a cost-effective service. We will provide a cost-effective service by:

Reducing our expenditure on energy and minimising our running costs;

Implementing operational improvements;

Seeking procurement efficiencies;

Working with customers and stakeholders; and

Innovation.

Reducing our expenditure on energy and minimising our running costs

We are improving the energy efficiency of our pumping stations and WwTWs, as well as investing in on-site generation. RainScape also plays a part in reducing energy costs by keeping surface water out of our sewers so avoiding pumping and expensive treatment. Within our offices, we minimise our running costs by looking at new ways of working and adopting new technologies.

Implementing operational improvements

We always look to implement cost-effective operational solutions, for example using network controls to reduce sewerage loading, single-person jetting crews capable of dealing with much greater range of problems at their first visit to a customer or working in partnership to reduce costs and achieve shared objectives. We are implementing smart solutions, including predictive technologies that allow us to prevent incidents with operational responses and avoid or delay capital expenditure (as detailed in chapter 6). With over 800 WwTW, the majority of which are small and rural, keeping operating and maintenance visits to a minimum is key to controlling operating costs. We will continue to focus on innovative remote monitoring and effective logistics to keep this as efficient as possible.

Seeking procurement efficiencies

Our Capital Delivery Alliance brings our partners together with our in-house teams and drives value throughout the investment cycle. This is achieved by co-locating our colleagues, contractors and consultants in a single office. This allows them to work more collaboratively on innovative solutions, package work more effectively and optimise the supply chain, whilst maintaining partner-specific accountability for all aspects of construction.

Working with customers and stakeholders

We work with our customers and in partnership with other stakeholders to take advantage of better ways of working together. Our traditional approach of investment in ‘end of pipe’ treatment solutions is delivering diminishing environmental benefits. This could limit our ability to maintain affordable bills due to the long-term operating and maintenance costs associated with the type of asset needed to meet environmental quality objectives. As outlined in chapter 4, our approach is to work with customers and stakeholders to deliver affordable catchment improvements using SMNR principles through our large AMP7 NEP programme, whilst also delivering wider benefits for our communities. We will also deliver

RainScape solutions in our urban areas to reduce hydraulic loadings on our sewerage network in the most sustainable and cost-effective manner.

Our SMNR approach is a partnership with stakeholders and landowners to help improve the resilience of the natural environment to pollution in a cost-effective manner and enhance the eco-systems they provide.

Innovation

Improving affordability for our customers is a core reason for us to innovate. We harness the technical expertise of our colleagues through formal innovation forums, hosting an annual Innovation Conference, investing in the skills and expertise of our people and for the first time in 2018 hosting a *Wasteathon*, to create innovative and affordable solutions to some of our biggest challenges.

4.4. AMP6 performance

	PR14 Measure of Success	Narrative	2014/15 performance	2017/18 performance	2020 target (current forecast)
	E1 Affordable bills	The extent to which the company will continue to make bills more affordable. After 2014-15, customer bill increases will be 1% below the rate of inflation each year.	-	1% below	1% below

Table 2: Our PR14 Measures of Success

Throughout AMP6, we have committed to ensure customers' bills increase at a rate of no more than 1% below the rate of RPI inflation, which we expect to achieve against our MoS E1.

Reducing our expenditure on energy and minimising our running costs

Our investments in energy efficient technologies at our sites as well as wind, hydro and solar PV renewable generation schemes are enabling us to reduce the cost of our energy (as detailed in chapter 8).

We have improved our operational practices, through the introduction of LEAN operating principles. This is being delivered through a project which aims to significantly reduce our operating costs by retaining only those practices that add value and are core to good operations and asset management and introduce a culture of continuous improvement in everything we do.

Implementing operational improvements

In AMP6 we have piloted ICMLive, blockage risk modelling and Smart Networks, with the aim of improving the service to our customers, through affordable operational solutions where possible (as detailed in chapter 6).

Seeking procurement efficiencies

Our Capital Delivery Alliance was required to deliver savings against our core in-house benchmarking resource, our "unit cost database" (UCD) of around 2% per annum cumulative, over the course of the AMP6 period. Our commercial model includes pain/gain and KPI arrangements that ensure that partners are highly incentivised to outperform the UCD cost curves, as well as incentives to work with us to identify the least (totex) cost solutions in the first place.

Working with customers and stakeholders

We have worked with our customers and stakeholders on our RainScape schemes, to provide affordable long-term solutions to issues of sewer flooding. We have also helped to address affordability issues in a specific community through our Rhondda Fach Resilient Communities Initiative (as detailed in chapter 3).

Innovation

We have pioneered the use of Rainscape and innovative peak flow treatment methods (PFET) in the Loughor estuary catchment, using techniques refined through best practice exchanges with the wastewater industries in the USA and Denmark (Copenhagen). In sum, this has allowed us to meet new spill frequency permits arising from the EU infraction proceedings for a cost of some £130 million, massively less than the estimated £650 million which would have been required using conventional storage and trunk sewer options. This will deliver a huge savings on our customers' bills for generations to come.

4.5. AMP7 plan

	Measures of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	BI1: Affordability	The average percentage annual increase in the average household bill over the 5-year period.	<RPI*[1]	<RPI	<CPIH*[2]
			*[1]Retail Price Index		*[2]Consumer Price Index, including housing costs

Table 3: Our PR19 Measures of Success

Ensuring the efficiency of our service for all will be critical to the successful delivery of our AMP7 plan. Our plan includes an ambitious target to further reduce our operating and maintenance costs by around 10% in real terms over the period 2020-25, and overall we will reduce our total costs by around £100 million in the next period as compared to our current level of costs.

Reducing our expenditure on energy and minimising our running costs

We will reduce our expenditure on energy to make our services more cost effective. We will identify options to minimise the amount of energy we use to deliver our compliance and customer service objectives, generate an increasing proportion of the energy we use ourselves, and minimise the price of the energy we buy (as detailed in chapter 11). Our Maintenance and Reliable Support (MaRS) project seeks to further improve the efficiency of the maintenance operation of our 836 WwTW and over 2000 sewage pumping stations.

Implementing operational improvements

Building on our knowledge in AMP6, we will continue to deploy ICMLive, blockage risk modelling and Smart Networks, with the aim of improving the service to our customers, through affordable operational solutions where possible (as detailed in chapter 6). We will also look to use enhanced data analytics to continue to improve how we use data to realise affordable operational solutions. We will continue to find ways of operating our large estate of assets more efficiently and using the knowledge we will build up jointly with stakeholders and partners through SMNR principles and Drainage and Wastewater Management Plans (DWMPs). We will make the case for moving away from point to catchment based discharge permitting and focus on catchment-based outcomes.

Seeking procurement efficiencies

We will continue to work with our Capital Delivery Alliance of leading engineering and design companies to harness worldwide best practice to find the optimal scheme solution, while maximising efficiency through a stable supply chain and a defined forward programme of work.

Working with customers and stakeholders

Our traditional approach of investment in ‘end of pipe’ treatment solutions is delivering diminishing returns and would not deliver long-term affordability for our customers. In AMP7 we intend to deliver the biggest environmental improvement programme seen in our service area for many AMP periods, and therefore we will be targeting a new sustainable approach, working with our customers and other stakeholders including land owners. An example of how this approach will be applied is given in chapter 3, our SMNR Catchment Pilot in Afon Teifi.

Moreover, we will continue to work with our communities to deploy RainScape schemes, including in Cardiff Central, to promote affordable long-term flood resilience. We plan to expand our Water Resilient Communities Project to other communities, especially those that are economically disadvantaged and would most benefit from this customer-led approach, allowing us to further understand and respond to issues of affordability.

Innovation

Building on the success of our ‘Wasteathon’, we will continue to host Hackathons with our colleagues and external partners to identify affordable solutions to the challenges we face.

4.6. Long-term planning: AMP8 and beyond

	Measures of Success	Narrative	AMP8 target	2050 Target
	Bl1: Affordability	The average percentage annual increase in the average household bill over the 5-year period.	=CPIH*	=CPIH*
			*Consumer Price Index, including housing costs	

Table 4: Our long-term PR19 Measures of Success targets

As evidenced throughout our long-term strategy Welsh Water 2050, we are committed to continued delivery of wastewater services that are affordable for households and businesses in the long term. We will build on our approach in AMP7 and expand our projects and trials that bring real innovation in promoting affordability for our customers.

5. Strategic Response 10: Addressing our 'worst served' customers

Figure 5: An external wastewater flood event. © Welsh Water.

5.1. Drivers

Looking to 2050, climate change will increase extreme weather events. The 2017 Climate Change Committee's report on the risks posed by climate change for Wales[12] indicates that short duration intense rainfall events are likely to be 10-20% greater and it is expected that as UKCP18 becomes available over the course of 2018 and 2019 these projections are likely to increase. Extreme rainfall events will increase the flows in our networks which can cause an increase in frequency and scale of sewer flooding events. Our combined sewers rely on overflows to surface water drains and river systems, and climate change will impact the ability of these integrated systems to operate effectively.

Climate change will also put pressure on our WwTW, networks and systems. Prolonged dry weather with higher temperatures will lead to increased anaerobic conditions which can promote development of volatile odorous compounds. This could increase odour issues for our communities[13,14].

We may also be impacted by future pressures like demographic change and urban creep. For example, expansions of developments in new areas increases impermeable surfaces leading to increased flows into our sewers, again increasing the risk of sewer flooding. Developments may also encroach on current odour paths, which will require us to invest to ensure people are not impacted by our service. When increases an impermeable area draining to our network are combined with more intense rainfall events the effect on our networks is even greater.

We recognise the issues faced by our worst served customers can go unresolved over long periods due to our focus on prioritising investment that benefits the most customers. In

future, we will also target investment on improving the service we provide to 'worst served' customers - those that experience repeated internal or serious external sewer flooding.

5.2. Customer and stakeholder priorities

Our customers have told us that sewer flooding has the greatest impact on their lives, followed by sewage odour[15]. Our customers are intolerant of internal sewer flooding due to damage to property, health hazards and impact on businesses[16]. It is of the greatest concern if you are a customer who is affected (supporting document 1.1B). It is a highly emotive issue[17] for those who have been impacted by sewer flooding and is of critical importance for them personally.

Targeted service improvements for those customers suffering from repeat service failure ranked third in priority out of the six options given[18]. Many of our customers strongly support the idea that all our customers should receive the same level of service (see supporting document 1.1D).

Our customers have also told us that sewage odour causes significant impacts for customer affected by this problem. We therefore aim to improve our customers' experience of serious odour problems.

The Consumer Council for Water support our focus on Worst Served Customers. Improving our service to these customers is a key priority for the next five to 10 years.

5.3. Our approach

Over the course of AMP6 we have been very successful in reducing the number of customers at risk of internal flooding even during the wettest winter on record of 2015/16. Our target for internal flooding in 2017/18 from any cause (excluding severe weather) was 292, but we have been able to beat this target by over 24% this year and limit the number of properties affected to 221 down from 242 in 2016/17. We delivered this reduction through a combination of investment in our network, front line crews and our analysis of where risks are most likely to occur. However, following consultation with our customers, we concluded that it is also important to target external flooding resulting from hydraulic overload that can affect some customers repeatedly, a group we have classified as being amongst our "worst-served" customers. These problems tend to be expensive to deal with by their very nature and have tended to miss out on investment in previous years. However, because of our Customer Dividend programme we have been able to commit an additional £12 million in AMP6 to deliver an extra 25 projects to protect 100 customers from repeated flooding, with the first of these recently completed at Gaerwen on Anglesey.

We recognise that both internal and external sewer flooding, regardless of the cause, is increasingly unacceptable to our customers. Our approach to managing our Worst-Served Customer Register and reducing the number of our customers on this register is outlined in our Worst-Served Customers (Waste) Policy.

Sewer flooding can be from Hydraulic Overload (HO), which we consider a permanent issue requiring an increased capacity or reduced flows to resolve. Flooding can also result from blockages, collapses and equipment failure, which we consider temporary issues (or 'other causes'). The sub definitions of 'worst-served' are:

- Properties recorded as being at active risk of flooding internally due to HO in the highest risk category (2:10, meaning a risk of flooding twice or more in 10 years);
- Properties recorded as being at active risk of serious external flooding due to HO in the highest risk category (2:10);
- Properties which have flooded internally more than once in the last ten years due to 'other causes' (2:10); or
- Properties which have suffered, on average, more than one serious external flooding due to 'other causes' every year for the last three years (3:3 rolling years).

Currently there are 425 properties affected by repeat sewer flooding issues. Solutions which are not cost-efficient for our wider customer base are rarely undertaken. This can affect individual, often rural, customers. However, we believe that everyone should receive an acceptable level of service and those that do not receive this level of service should not be charged.

Our long-term approach to reducing the impact of odour on our customers is outlined in our Odour Nuisance Reduction Strategy[19], which focuses on both innovation and investment in this area. Our key overarching aim is to ensure that our customers are not adversely impacted by our service. We will actively monitor this impact using customer complaints and unwanted customer contacts.

5.4. AMP6 performance

	PR14 Measure of Success	Narrative	2014/15 performance	2017/18 performance	2020 target (current forecast)
	D3: Sewer flooding (internal)	No. of properties subjected to internal sewer flooding	265	221	223

Table 5: Our PR14 Measures of Success

Sewer Flooding

During AMP6 we focused on 'at risk' customers, those that suffered repeat issues with our service with a focus on internal flooding caused by HO. We aimed to achieve a 20% reduction in sewer flooding, which we achieved in reducing internal sewer flooding from 54 (in 2013/2014) to 35 (in 2016/17). Our focus on 'worst served' customers is new for AMP7 and therefore we do not currently report on this. In AMP6 and previous AMPs we have only focused on reducing the number of properties on the internal flooding register, as this reflected the biggest flooding risks. We have made progress for all our 'worst served' customers in AMP6.

Properties recorded as being at active risk of flooding internally due to HO in the highest risk category have reduced year on year over AMP6 due to extensive capital investment. We believe this is a significant achievement given that period included some of the wettest winters on record. Those that are left in this category are either new additions, which we will continue to focus on dealing with, or problems that are difficult and expensive to fix. In

AMP6 we have worked to solve the issues of these 'worst served' customers including through property level protection and improved network management. In addition, our RainScape strategy has been instrumental in helping us achieve our AMP6 goals. RainScape is discussed in detail in chapter 8 below.

RainScape at Cambrian North

In central Llanelli the sewer systems are typically combined and highly integrated with highway drainage and land drainage infrastructure. They were at critical capacity in terms of flood risk, causing regular damage and disruption for the local community.

In Cambrian North we collated and analysed the combined effect and flood risk from each component and developed an inclusive resilient solution. At the heart of the approach was RainScape. The highway and roof runoff from the 2ha catchment was diverted into a new 2600m^3 bio-retention basin. The basin controls rainwater runoff and slowly releases it to a combination of the natural environment, local land drainage and the combined sewers. The result is local flood alleviation, a reduction in local CSO spills to meet Shellfish water drivers, and a new green community asset which the local population have widely approved. The site was previously disused and now it links footpath and cycleways, provides a beautiful site for recreation and supports a more diverse ecosystem.

We have begun to consider how we can target investment more effectively for customers affected by external flooding. In AMP6 we have actively focused on solution investigation in this area to protect 100 customers, and developed schemes to implement in AMP7. We want to utilise our RainScape strategy as the solution for these types of issue in the long term, with the key focus of delivering a downward trend in external flooding.

Properties which have flooded internally more than once in the last ten years due to 'other causes' will require a range of solutions that are dependent on the specific cause of the issue. The number of properties on this list has increased in AMP6 in large part due to the private sewer transfer process. Our AMP6 interventions include hotspot identification of repeat issues, surveys, sewer rehabilitation, operational improvements and customer education. We have invested in our "stop the block" campaign, a non-flushable item customer awareness strategy, working with "flushable" product manufacturers and enhanced modelling techniques to predict and prevent blockages before they impact on customers or our environment.

Our industry leading Sustainable Drainage Plans (SDP) help us to identify customers at risk of flooding now and over the next 25 years due to growth, urban creep and climate change. As we move into AMP7 these will be incorporated and enhanced through new Drainage and Wastewater Management Plans (DWMP). If we do nothing, the number of 'at risk' customers will increase by an additional 130 in AMP7. This rate will continue to increase with climate change if it is not addressed.

Sub definitions	Number of properties impacted	
	2013/2014	2017/2018
Properties recorded as being at active risk of flooding internally due to hydraulic overload in the highest risk category (2:10 or risk of flooding twice or more in 10 years).	54	46
Properties recorded as being at active risk of serious external flooding due to hydraulic overload in the highest risk category (2:10).	221	202
Properties which have flooded internally more than once in the last ten years due to 'other causes'.	169	175
Properties which have suffered, on average, more than one serious external flooding due to 'other causes' every year in the last three years.	10	2

Table 6: Worst served customer subcategories and the number of properties which experience this level of service in 2018

We are currently developing a suite of minimum service standards for all customers irrespective of cost-benefit constraints of the solution to be implemented in AMP7 which will be incorporated into a new policy governing our 'worst served' customer register.

Odour control

In AMP6 we have continued to adhere to the odour control requirements which focus on how we manage all our wastewater facilities and networks. Fundamental to this is considerate planning and designing best practice on all new and retro-fit asset investment.

The main objective was to better understand which customers are experiencing odour problems and target 'at risk' customers i.e. customers who have contacted us at least once in each of the three preceding years regarding odour issues. Our aim in AMP6 was to halve our number of "at risk" customers; we are making good progress towards this, as our current total is 18 (as of June 2018). An important strand in this work is to manage our 122 potential 'at risk' customers, who have contacted us at least once in each of the preceding two years regarding odour issues, to ensure that we have, where possible, resolved the source of the odour problem permanently. Another area of focus is to ensure we understand the source of the odour. For this we have a trial underway at one of our odour 'hotspots' that will allow us to track a complaint back to its origin.

To reduce the number of 'at risk' customers, we have developed an operational management strategy with a number of improvement approaches. We have improved the way we handle complaints and engage complainants, developed odour dispersal maps and management plans for odour 'hotspots', reviewed odour risks at our assets and targeted small investment sums at network problems that are often missed during investment at larger sites. We also reviewed complaint data to identify 'hotspot' areas and frequently occurring postcodes in which 'at risk' customers are linked to an asset.

We have proactively enhanced our works when new developments have encroached on odour paths. We complete several Odour Impact Assessments every year, which include dispersion modelling to understand the odour emission and how this impacts nearby customers and members of the public. For example, we invested in the maintenance of our odour control systems at Swansea WwTW to improve performance in line with planning requirements; this has helped prevent the new Swansea University Campus to the east being impacted by odour from our asset. We have also undertaken similar studies for Chester WwTW and Treborth WwTW. After these assessments, we created an Odour Management Plan to ensure that the assets or site is being managed with the best practical approach to odour nuisance. We improved odour serviceability, implementing mitigation at high risk sites and optimising odour related chemical usage. For new and retro-fit sites, we aim to engineer our systems to prevent the source of odour in the first instance, rather than treat / mitigate the impact after it occurs.

Reducing odour complaints was also one of the themes at our recent 'Wasteathon' where we focused on predicting odour risk to help us manage potential high risk activities for odour generation, developing a simple mobile phone app for improving our odour source data, and identified improvements to be included in our new Genesys customer management system. An additional benefit for our customers is that they can have greater certainty that we do not invest when we are not the primary cause.

5.5. AMP7 plan

	Measures of Success (MoS)	Narrative	2017/18 performance	2019/20 target	2024/25 target
	Rt6: Worst served customers for wastewater service	The number of properties at risk of repeat internal or serious external flooding.	-	368	359
	Rt2: Sewer flooding (external)	The number of external flooding incidents per year within property curtilage.	3,929	4,121	3,800
	Rt1: Sewer Flooding Internal (incidents of properties flooding)	The number of internal flooding incidents per year, including severe weather events.	297	300	273

Table 7: Our PR19 Measures of Success

In AMP7, we will deliver significant improvements for customers in this area. We will drive improvements on today's worst served figures whilst also offsetting annual new additions to our register.

'Worst Served' customers: WaterFair

In AMP7, we will introduce our new WaterFair scheme and will not charge for our wastewater service to those 'worst-served' customers who have suffered repeated sewer flooding, until the issue is resolved.

Sewer flooding

In AMP7 we are committing to suspend sewerage charges in the event of service quality failures for the duration that they remain at risk of sewer flooding under the relevant categories.

We will implement our 'worst-served' customer policy with the aim to reduce the number of customers that are affected and deemed to be 'worst-served'. We will record and aim to reduce the number of properties that are affected across the worse served subcategories. We will continue our work to increase our focus on properties recorded as being at active risk of serious external flooding due to hydraulic overload through implementation of the schemes identified in AMP6. Over 40% of our repeat flood issues are caused by "other cause" issues e.g. blockages; we will continue our focus to reduce this through proactive identification of blockages and customer education. We will invest in our site teams' skillsets and mobile equipment to enable us to meet this challenge; this will improve our "first time fix" capability and give us flexibility to tackle a wide range of issues across a varied and challenging geography.

In AMP7 we will focus on setting up and managing our new 'worst served' customer register with an aim to remove current customers. In addition to these, we anticipate 33 more customers being added to the register annually; this will take our start AMP7 baseline figure to 368 customers. We are directly investing £15.8 million which will build on the extra £12 million investment committed in AMP6 through our customer dividend programme to reduce the overall number of 'worst served' customers in AMP7. This provides the funding required to deal with additions to the register and achieve an overall reduction of nine customers.

'Worst-Served' Category	**Estimated Annual Net New Additions**	**Predicted AMP7 Baseline (no new additions)**	**Predicted AMP7 Baseline (with AMP6 net new additions)**
Internal (2:10) HO	15	35	65
SEF (2:10) HO	6	169	181
Internal (2:10) OC	8	96	112
SEF (3 in 3yr) OC	4	2	10
Total	33	298	368

Table 8: Estimated AMP7 Performance baseline considering 2017-2018 flooding, 'timing-out' removals and scheme delivery and including new additions within remainder of AMP6

To enable these reductions, we will continue our AMP6 work to reduce the impact on our customers. Internal flooding reduction will be achieved through the continuation of our

RainScape strategy, smarter network management, sewer rehabilitation, continued investment in better trained and equipped operations teams, and customer education. We will increase the investment we provide to deal with external sewer flooding caused by HO by investing in an implementation program of the schemes we will have identified by the end of AMP6 as most appropriate. We will work with stakeholders to seek out and actively contribute to joint investment and community flooding projects. To help facilitate this, we will be investing in Drainage and Wastewater Management Plans across Wales; by the end of AMP7, all of our customers will be represented in our higher level DWMP with the majority modelled within the most detailed level of a DWMP. This will enhance our understanding of future flooding and pollution risks that will arise as a result of climate change, growth, deterioration and urban creep.

Odour control

We will continue our AMP6 progress in AMP7. We will continue with odour mapping surveys, undertake odour mitigation and invest in odour monitoring equipment. We will continue to develop and invest in our current live and future innovations to ensure we drive down our odour complaints.

5.6. Longer-term planning: AMP8 and beyond

Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
Rt6: Worst served customer for wastewater service	The number of properties at risk of repeat Internal or Serious External Flooding.	359	270	100
Rt2: Sewer flooding (external)	The number of external flooding incidents per year within property curtilage	3,800	3,420	2,500
Rt1: Sewer Flooding Internal (incidents of properties flooding)	The number of internal flooding incidents per year, including severe weather events	273	252	100

Table 9: Our long-term PR19 Measures of Success targets

Our long-term plan for ‘worst-served’ customers in AMP8 is to aim for a 25% reduction of the number of customers on our register. Our AMP7 programme focuses on building the foundations to deal with ‘worst served’ customers and implementing our processes and policies. AMP8 will see far larger investment to build to these enabling works, and this work will continue through to 2050, when we aim to eliminate ‘worst served’ customers. We expect there to still be some residual internal sewer flooding that continues to 2050, which we cannot fully control as it caused by customer behaviours, but programmes such as ‘stop the block’ will be vital to reduce this impact.

Our odour strategy will develop and mature in AMP7, with stronger links to our at-risk customers, predictive tools to understand where and when odours are likely to arise and improved means of evidence collection and analysis.

6. Strategic Response 13: Smart wastewater system management

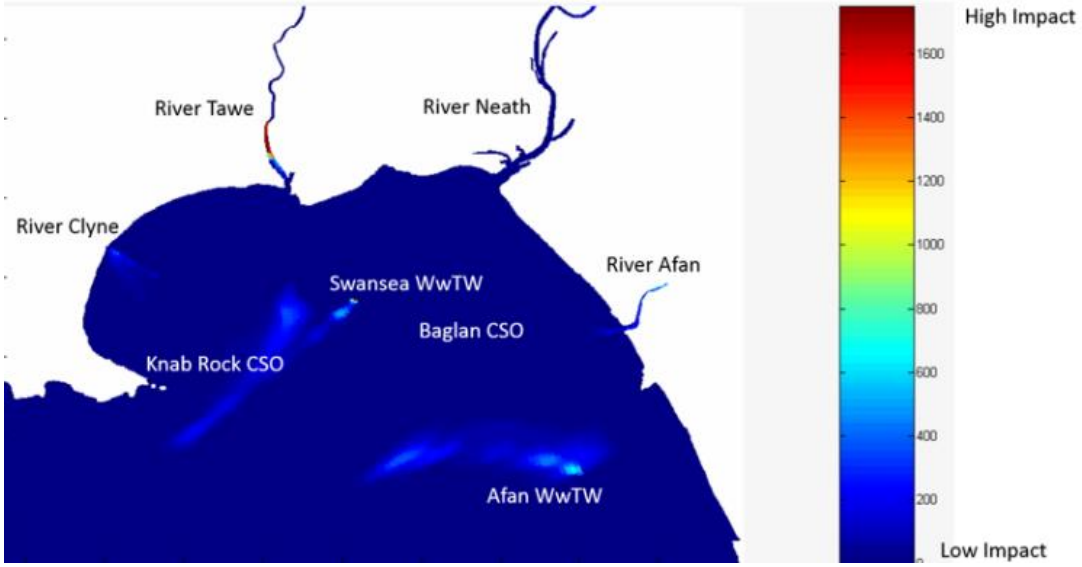


Figure 6: Our water quality impact model for Swansea Bay. © Welsh Water.

6.1. Drivers

In the coming decades, we will have to deal with complex challenges, particularly linked to flooding, pollution and environmental impacts and we will need to use innovative technology and techniques to meet these challenges.

We recognise that smart technologies and data will play a key role in supporting our 2050 strategy. Leveraging these opportunities will help improve performance decision-making, resilience and interactions with our customers and stakeholders. Now, and in the future, digital technologies will rapidly change how we provide services to our customers, as well as changing expectations that customers have concerning service. Emerging digital technologies will also change the way networks are managed, with new opportunities in the integration of networks, data sharing and predictive and early warning technologies. Digital initiatives will also increase our vulnerability to cyber threats and therefore new technologies will have to be coupled with building resilience against new threats.

The key aim of our wastewater smart plan is to reduce pollution and flooding. We recognised that the primary source of pollution and flooding is blockages in our sewer network, with blockages accounting for 80% of the incidents last year. These blockages are primarily related to sewer abuse originating from the incorrect disposal of rags and wipes, and fats, oils and grease. While we are undertaking behaviour change programmes, like our 'Let's Stop the Block' campaign, and lobbying manufacturers, government and retailers, we also recognise that technology can help us to manage this risk.

6.2. Customer and stakeholder priorities

Our customers expect that future technology will be able to eradicate service interruptions and issues[iii]. Related to this are our customers' views on sewer flooding and the quality of the water in our rivers and streams. These are both highly emotive issues which we will use smart wastewater techniques to help deliver best possible service and value in these areas.

6.3. Our approach

Technology and better use of data form a critical part of our overall approach to mitigating the diverse range of challenges we will face going forward. They will also allow us to operate our sewerage network more efficiently and provide long-term value for our customers. Specific activities will include:

- Using real-time operational forecasting to prevent incidents;
- Expanding our telemetry systems and processing data more effectively to make better decisions; and
- Implementing preventative repairs of our assets to avoid failures.

Using data and technology, we hope to improve the reliability of our assets. This will help us to reduce the need for frequent, repeat and unplanned visits. This is particularly beneficial in Wales due to the large number, dispersion and remote nature of assets. Our approach to how we will utilise smart technologies and smart data, and make smart decisions, is outlined in our Smart Strategy. This approach will help us to improve performance, make better decisions, improve our resilience and improve our customer and stakeholder interactions.

6.4. AMP6 performance

	PR14 Measure of Success	Narrative	2014/15 performance	2017/18 performance	2020 target (current forecast)
	B3: Preventing pollution - number of incidents	No. of pollution incidents (cat 3)	117	112	112

Table 10: Our PR14 Measures of Success

We are now forecasting an end-AMP6 position of 112, beating our regulatory target of 131 category 3 pollution incidents.

In PR14 we said we would target efficiency savings by implementing smart networks including remote control and automation. We have focused these innovative technologies to deal with blockages in AMP6, to reduce the incidents of pollution and flooding. We estimate that blockages and sewer collapse is the cause of 80% of our Other Cause flooding and pollution incidents. In response we increased investment by £7 million in AMP6 and undertook a comprehensive programme of initiatives including:

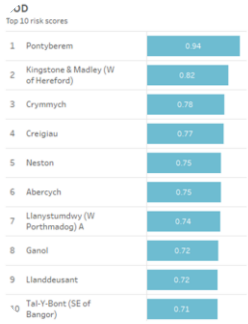
ICMLive provides us with real-time operational forecasting, and has been piloted in AMP6. Our model of Gowerton has allowed us to identify several anomalies where proactive intervention prevented incidents.

Blockage Risk Modelling provides us with a data driven decision-tree model. Our model provides blockage likelihood based on key physical and performance data, linked with historical incident information. Our model maps our high-risk blockage locations which allows us to recognise and intervene on potential issues before they impact on our customers or the environment.

The Smart Networks programme has implemented telemetry at hotspots in our network to provide monitoring in AMP6. This includes assets like CSOs, pumping stations and WwTW, and has enabled significant reduction in incidents. We have taken this further by combining telemetry data with decision support systems. This combines real-time data with self-learning software based on Artificial Neural Networks, to identify anomalies and trigger alerts from the Control Room or 'Smart Hub'. Successful trials were undertaken in AMP6 with a view to extending to AMP7. This has included investment in pilot schemes to test new flow monitor technologies which allow us to monitor large, difficult to access trunk sewers and provide reliable data across a range of gravity (free surface) and pressurised flow conditions.

Maintenance and Reliability Support (MaRS) programme focuses on condition based monitoring of all wastewater pumping stations, as equipment failure is the primary cause of flooding and pollution incidents for non-infrastructure. This will enable preventative repair or replacements of machinery components prior to the onset of failure should the consequence of failure be unacceptable. This programme delivers significant benefits in terms of data, understanding and optimal asset management to prevent incidents. This allows us to effectively and efficiently operate an extensive asset base.

Event Duration Monitoring (EDM) at all our CSOs in Wales, over 2,700 assets, will provide us with a nationwide view on all our storm sewer overflows, allowing us to understand and analyse the performance of the assets that can affect CSOs and their impact on the local environment. It helps us work collaboratively with our regulators by reporting CSO performance data to Natural Resources Wales (NRW) and the EA. We are making this available to our customers who can access key data online; this includes real-time spill alerts for a number of bathing waters and is also being trialled on the River Dee in Chester in support of triathlon events and local "wild swimmers".



Collaboration: Open data

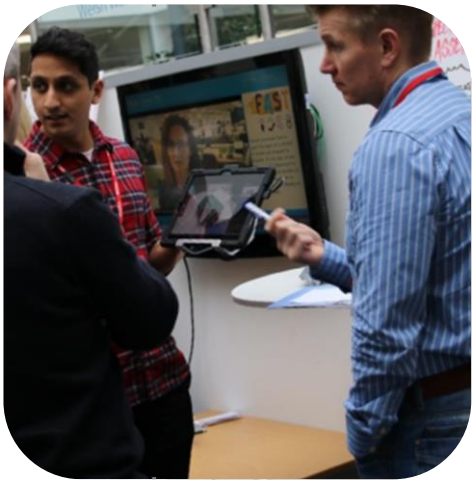
We are driving open data pilot projects, sharing data with third parties like NRW, Surfers against Sewage, Public Health Wales and other stakeholders. This is enabling improved partnership working and will be a catalyst for future collaborative projects like Sustainable Management of Natural Resources and our Drainage and Wastewater Management Plans. This is tied into our continued investment in data collection and transmission in the field.

Operator training and new tools will equip our crews with a wider range of equipment including blockage retrieval tools. Through the use of more tools, better training and single

person crews we will improve frontline service for our customers whilst meeting our cost to serve challenge.

As a result of the above, we have reduced blockages by 19% compared with the end of AMP5, during which we had 27,842 blockages. We will continue to invest in reducing blockages and we expect numbers to have reduced by nearly 24% by the end of AMP6 and plan to continue focusing on this area in AMP7. This has resulted in a significant benefit to customers including a 31% reduction in the number of customers experiencing repeat incidents since the end of AMP5 and our lowest ever number of pollution incidents from our wastewater assets.

Data science - Project WISER



Project Wiser (Welsh Water Information Strategy Roadmap) is our internal data governance programme that is working towards embedding efficient data governance in all aspects of our business. We have a centralised data science team that is implementing a unified strategy, ensuring that all relevant data is always available and consistent across our business. To facilitate this, we are also introducing new policies, smart systems and technologies for gathering and analysing increasing amounts of data. One of the goals of the project is to develop a company culture that views data as an integral and important company aspect, and change our behaviour around the definition, production and usage of data to improve our performance. With our new data governance policies, we want to ensure that for all business aspects we get the right people involved, at the right time, in the right way, to make the right decisions, leading to the right solutions.

6.5. AMP7 plan

PR19 Measures of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
Pollution incidents from wastewater	Category 1-3 pollution incidents, as reported to EA and NRW.	102	107	90
En3: Pollution incidents from wastewater	Category 1-3 pollution incidents per 10,000km.	28	29	24
En1: Water and Wastewater Treatment works compliance	Percentage of population equivalent, served by sewage treatment works with numeric limits and water treatment works, which were compliant	96.7%	100%	100%
En2: Wastewater Treatment works look-up table compliance	Percentage of sewage treatment works with numeric limits, which were compliant	99.46%	99%	100%

Table 11: Our PR19 Measures of Success

In AMP7, we will continue to improve our sensing, modelling and analytics to improve our waste network performance. Planned projects for AMP7 include:

ICMLive will continue in AMP7, and will focus on areas where the model can support dynamic catchment control in key target catchments. This will include using forecast data to predict, and subsequently influence, network performance

Blockage Risk Modelling will continue to be developed in AMP7 in collaboration with universities and other organisations with a focus on the consequences of blockages. This will provide us with the information to prioritise and target proactive maintenance. We plan to use artificial intelligence and machine learning to predict blockages.

Smart Networks programme will expand in AMP7, monitoring the wider wastewater network to improve performance and taking advantage of the additional flow monitoring to be installed under the AMP7 NEP. This will be facilitated through improved network knowledge derived from the sustainable drainage plans, hotspot analysis and pollution prediction modelling. More monitors, based on our trails above, will be sited to provide the best network visibility.

Continuing to take a leading role in 21st century drainage as we develop new Drainage and Wastewater Management Plans (DWMP) aimed at sustainable long-term planning and high quality, affordable customer, stakeholder and environmental services.

The Maintenance and Reliability Support (MaRS) principles will be embedded in our business and change operational practices going forward. Our work will therefore continue to drive preventative repair or replacements of machinery components prior to the onset of failure.

We will also improve our situational awareness by implementing new tailored visualisation tools, enabling live EDM monitoring through real-time dashboards. This will help with optimising operations as well as enabling more effective field maintenance and improving operational safety.

Enhanced data analytics will allow us to continually improve this process and crossover between issues; odour issues, for example, are often borne out of blockage issues. We will build on our blockage hackathon to further supplement this.

6.6. Longer term vision for AMP8

Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
Pollution incidents from wastewater	Category 1-3 pollution incidents, as reported to EA and NRW.	90	80	40
En1: Water and Wastewater Treatment works compliance	Percentage of population equivalent, served by sewage treatment works with numeric limits and water treatment works, which were compliant	100%	100%	100%
En2: Wastewater Treatment works look-up table compliance	Percentage of sewage treatment works with numeric limits, which were compliant	100%	100%	100%

Table 12: Our long-term PR19 Measures of Success targets

By 2050 we aim to reduce flooding and pollution events significantly, by removing predictable pollutions and blockages as well as working with customers on new ways to change behaviour.

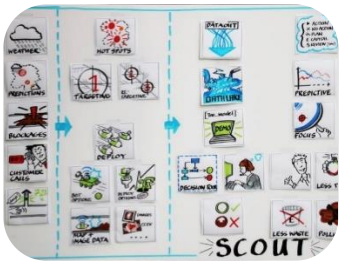
We will build on our 21st century integrated catchment management approach as well our approach to smart wastewater systems. This will include investment in smart assets and smart monitors. We expect the cost of these technologies to reduce over the next ten years.

Other work we hope to achieve is to continue to undertake research and run new pilot projects to enable the adoption of new emerging technologies. These technologies may include the adoption of AI and robotic process automation which could help develop our blockage prediction, removal and repair systems.

Furthermore, we plan to start exploring the possibilities of digital twin, programmable matter, brain-computer interfaces and quantum computing in the future.

Collaboration and innovation: #Wasteathon

We always look for innovation but last March we decided to try something new by adopting the hackathon approach used in the IT industry and hosting our first "Wasteathon" in order to go beyond our normal approach.



We focused on three areas of concern for our customers – improving compliance at our WWTWs without increasing cost, reducing the costs resulting from blockages in our sewers and detecting, responding to and preventing odours particularly for those customers who are most at risk from odour problems.

The philosophy behind the workshop was to think differently and bring in a diverse range of IT professionals to work with our own colleagues and between us develop a series of realistic ideas that were demonstrated to a "Dragons Den" style board of directors and Heads of Service. Nine "proofs of concept" ideas were developed which ranged from;

Short term developments such new mobile phone apps to give front line staff easier access to corporate data systems and help them prioritise which WWTW to visit

Medium term such as building more in "bot services" to our new Genesys customer management system

Long term ideas such as using biodegradeable nano bots than could be injected into a sewer and then map the location and condition of sewers in an area and detect blockages as they are forming.

7. Strategic Response 14: Supporting ecosystems and biodiversity

Figure 7: Zebra mussels attached to structures at Llandegfedd Reservoir. © Welsh Water.

7.1. Drivers

We aim to protect the landscape, rivers and coasts we operate in and the 40,000 hectares of land which we manage directly, aligning our activities with our biodiversity duty under the Environment (Wales) Act 2016. Changing demographics, land use changes, climate change and new sources of pollution all contribute to increasing pressure on the environment and what we receive in our drainage systems and sewers. Due to these and other factors, biodiversity faces many threats in the future, as has been set out by both environmental NGOs and Welsh Government alike. Growing population and the further industrialisation of agriculture post Brexit, can and will continue to lead to habitat loss and fragmentation. In the longer-term, changing rainfall patterns and extreme temperature fluctuations will have a negative effect on biodiversity, through for example altering river flows and temperatures impacting migration of species like salmon, reducing the dilution available to disperse pollution events and decreasing oxygen supplies to flora and fauna to name but a few. In addition, in the future we might be subject to new, more stringent environmental standards and legislation which would significantly drive our treatment costs and carbon footprint up.

Part of our mission is to work with our partners to provide a safe, resilient and sustainable environment, one we are proud to hand to future generations. Furthermore, considering our customers' priorities, and advice we have received from our Independent Environmental Advisory Panel, as well as the requirements of new Welsh Environment and Well-being of Future Generations Acts, it is clear that we must continue to enhance biodiversity and promote the resilience of ecosystems in our work as a priority.

7.2. Customer and stakeholder priorities

Our stakeholders consider protecting the environment and biodiversity is vital to the work we do. Our customers and our Independent Environmental Advisory Panel have consistently said to us that they want us to have a strong environmental conscience and reduce the impact we have on the environment[vii]. They feel the future of the natural environment is vital to their quality of life and for life itself[viii]. Our customers also think that the countryside and rivers should be protected not only for wildlife but also for their health and well-being, and tourism benefits[ix]. The support of the environment from our customers and stakeholders alike very much endorsed the inclusion of this strategic response in our 2050 plan.

7.3. Our approach

> The service we provide depends on a sustainable environment. However, a multitude of challenges threatens the integrity of our environment, and we want to mitigate this by protecting nature, enhancing biodiversity and promoting ecosystem resilience while we carry out our sewerage activities. Our Biodiversity Plan sets out our commitment to maintaining and enhancing biodiversity up to 2019. Our approach includes working with our communities and colleagues to highlight the importance of the environment, understanding any impacts we have on the environment and undertaking specific environmental enhancements, including our National Environment Programme as agreed with NRW.

The largest contribution we make to biodiversity and the natural environment is through the carrying out of every day functions in compliance with the various permits and licences we operate within. We already consider natural solutions as part of our investment options assessments, including sustainable urban drainage systems (SuDS) as part of our RainScape strategy, reed beds and wetlands.

Our approach to promoting the natural environment in the work that we do is outlined in our biodiversity plan, 'Making time for nature'[20], which includes our commitments to meet our biodiversity duty in 2019, as set out in the Environment (Wales) Act 2016. We are the only public authority to so far have published their biodiversity plan under duty set out in Environment Act (Wales).

Figure 8: Wildflowers planted at Cardiff WwTW. © Welsh Water.

7.4. AMP6 performance

In AMP6 we implemented several successful projects and initiatives, including research and trial projects, investigations, education programmes, collaborations with stakeholders and third parties and funding schemes for independent and charitable organisations. To date we have improved 37km of rivers and are on track to improve 562km by the end of AMP6 due to our combined investments across multiple price controls.

At PR14 we said that we would target environmental research and investigations in AMP6. These have included, in collaboration with Natural Resources Wales, investigations into the ecological status of 76 inland water bodies. This work has helped to shape and prioritise investment for AMP7. Within this programme we have improved the discharges at 22 WwTW including reducing the level of phosphorus released back into our surface waters. We have also undertaken a range of innovations to improve our environment.

In AMP6 we invested in better protecting the Welsh coastline. This took the form of the development of the largest investment in science in our history. New bespoke models were built to predict the movement of coastal water influenced by tides and wind and river flow, as well as being able to accurately predict how pollution is dispersed and diluted in the marine environment. These models have enabled us to target future investments for improving water quality at bathing and shellfish waters which are included in our AM7 plans and so further improve marine habitats and ecology. It has also helped us highlight pollution sources which are not wastewater related; for example in Cemaes Bay, a borderline compliant bathing water, our analysis proved the source of pollution to be from a number of small streams free of wastewater discharge; in this way we can help regulators to target the true root cause of pollution and make plans accordingly. We have made these models and data available to our regulators, which we hope will provide them with opportunities for assessing the impacts of other sectors such as agriculture, which is now the predominate industry affecting coastal water quality.

We also have several successful customer education programmes, including four visitor centres where visitors can learn about the natural environment including about biodiversity. We have several school outreach programmes and education programmes on the impact of sewer misuse.

Innovation: Bluepro trials

We have progressed Blue Pro trials at Llanberis WwTW establishing how this new technology could achieve lower levels of phosphorus in our effluent. With this new technology, we have managed to remove 90% of total phosphorus and achieved low iron levels thereby meeting the very stringent requirements of the environment at this site. This has helped us provide improvements to 1.16km^2 of a site of special scientific interest (SSSI) at Llyn Padarn and support Wales' only inland designated bathing water.

7.5. AMP7 plan

	PR19 Measure of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water action (cumulative within AMP).	36	562	418

Table 13: Our PR19 Measures of Success

We will continue this work through our whole plan and continue to work with our regulators and with our Independent Environmental Advisory Panel (IEAP) to include biodiversity and nature based solutions in our AMP7 investments. To facilitate this we have signed up to a number of shared environmental principles with the Blueprint/Wales Environment Link groups, principles which should enable us to forge even closer working relationships with eNGOs and charity organisations in particular and from there more efficient and effective solutions to our challenges.

We will undertake a National Environmental Programme (NEP) with Natural Resources Wales to improve 980 kilometres of rivers to 'good' ecological status, cumulatively by the end of AMP7. This is the result of combined investment across our price controls. We will also invest in new RainScape schemes and we will work in partnership with several stakeholders like Natural Resources Wales, the Environment Agency and the Welsh Government.

We will continue to support our Biodiversity Champion programme and also raise awareness of our biodiversity duties to contractors and encourage them to play their part. We will make funds available to support community and volunteer groups, who have projects to curb growth and spread of Invasive Non-Natural Species (INNS) and work with river trust and community groups through our WFD 3rd Sector and Biodiversity improvement grants schemes.

We will undertake extensive further investigations as part of our National Environment Programme (NEP) to gather evidence as to which of our storm flows in particular is having an impact on the environment using the newly developed 'Storm Overflow Assessment Framework (SOAF)'. This was developed in AMP6 by the 21st Century Drainage programme, which we initiated and continue to lead on behalf of the UK water sector.

We will lead new Sustainable Management of Natural Resources (SMNR) approaches in four catchments to establish different solutions to the waste water challenges we have in those catchments, and offer us choices in investment terms as to how these are dealt with. These will be the Rhyl, Afan, Alyn and Teifi river catchments.

We will pursue further research work in several areas, including developing our understanding of the presence of pharmaceuticals in our effluents and how best to deal with them.

We use our Drainage and Wastewater Management Plans (DWMPs) to deliver improvements to drainage of wastewater. The DWMP framework is due to be finalised in September 2018, with fully developed DWMPs by the end of 2022-23. As expected by DEFRA, we will set out a clear roadmap to produce DWMPs, responding to Ofwat's 2019 Price Review. The roadmap will cover the approach to risk assessment and options appraisals (with work already started on the initial risk screening process in 2018), plans for stakeholder engagement and consideration of the investment needed.

We will continue to work in partnership with Welsh Government and our IEAP on the development of environmental policy in Wales, particularly relevant as we are now responsible for less than 10% of the environmental challenges to achieve 'good status' under the WFD for our rivers and waters in Wales. In this way we can ensure that any funding available is correctly targeted at where it can benefit the ecology of our rivers and marine environments the most.

7.6. Longer term vision for AMP8

	Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water action (cumulative within AMP).	418	128	N/A

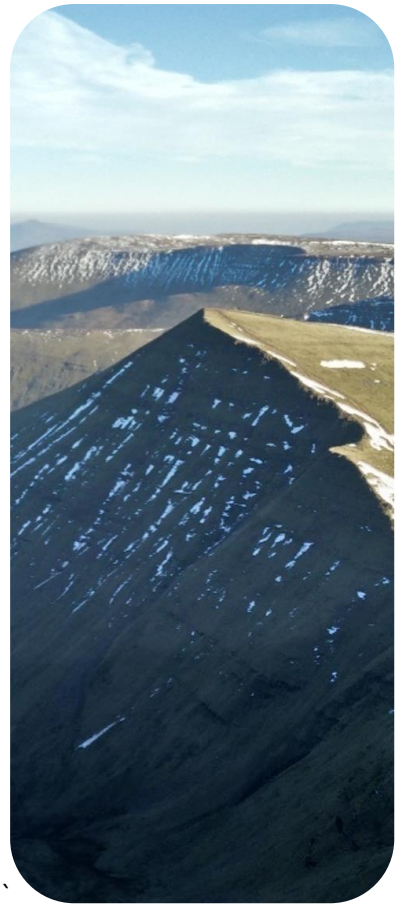
Table 14: Our long-term PR19 Measures of Success targets

We plan to continue the work we are doing in AMP7 building on this in AMP8. We anticipate completing our river improvements by the end of AMP8. We plan to include a continued focus on research into the environment, innovation in the development of new processes, the development of new national policies with respect to water and pollution, and a reduction of pollution events and loadings to the aquatic environment from our assets.

By the end of AMP7, the successful delivery of our NEP will mean that the remaining impacts would be comparatively expensive to mitigate, if delivered using traditional schemes, and would only benefit small lengths of rivers. It is therefore difficult to forecast a length of river improved on the same basis beyond AMP7. This in no way detracts from our ambition to continue to provide leadership and drive further environmental improvements. We will look to create a different method based on SMNR principles and using our DWMPs to measure and demonstrate our environmental aspirations.

During AMP7 and 8 we anticipate radical changes will be made to land management in Wales in a post Brexit environment. These may well offer a wide range of benefits to our customers, by tackling the main sources of pollution we now see in Wales – from Agriculture, Forestry, Mining and other sectors. Working in partnership with these sectors and Government to develop SMNR and other similar market based processes will enable us

to make the best possible use of our customers' funding in protecting the environment and ensuring we provide them collectively with a safe and sustainable environment, one we are proud to hand to future generations. Under our current approach and based on AMP8 planned expenditure in line with previous AMPs, our investment could benefit around 100km of river based on the diminishing returns of a traditional approach. Through SMNR and smarter approaches we want to make this investment go much further.



Innovation and Collaboration: Sustainable Management of Natural Resources (SMNR)

The Environment (Wales) Act 2016 places a duty upon Natural Resources Wales (NRW) to deliver the Sustainable Management of Natural Resources (SMNR). The objective of SMNR is to maintain and enhance the resilience of ecosystems and the benefits they provide. The Act sets the expectation that natural resources are used wisely and that the ecosystems they support should contribute to the well-being of present and future generations.

To maximise benefits for ecosystems, biodiversity and the well-being of our common customers, and future customers, Welsh Water and NRW have recognised that there is opportunity to develop a new strategic approach to integrated environmental management for AMP7.

We intend to be guided by the need for collaboration and co-operation at an appropriate spatial scale in the Clwyd, Afan, Alyn and Teifi catchments. By working with representative bodies such as the Public Service Boards in each area we will make connections between ecosystems and wellbeing and collate and gather evidence on the state of ecosystems. Participatory processes will enable all relevant stakeholders to build their understanding of problems in catchments, co-create new knowledge and to adapt practices to promote the resilience of ecosystems for the benefit of our customers.

8. Strategic Response 15: Using nature to reduce flood risk and pollution

Figure 9: Green Infrastructure in Llanelli. © Welsh Water.

8.1. Drivers

Our long-term strategy, Welsh Water 2050, highlights how trends of more frequent and intense rainfall in Wales, combined with demographic change and urban creep in our service areas, will lead to an increase in sewer flooding if we do not act to prevent it. This leads to increased flows in our foul, storm and combined networks, causing an increased risk of hydraulic overload and an increased risk of excessive Combined Sewer Overflow (CSO) operation and environmental impact. Urban creep caused by population growth is increasing the impermeable areas served by our sewers, further increasing the strain and flood risk. This additional pressure on an ageing infrastructure base increases the likelihood of assets being unable to function effectively.

We aim to significantly reduce sewer flooding, a key delivery tool within that plan is to remove storm water from the foul/combined sewer network entirely, known as RainScape™. This involves retro-fitting new surface water systems to divert flow away from foul / combined systems and direct it towards local watercourses. It can also include the provision of green infrastructure to slow, treat and return surface water to the natural environment. We have had considerable success with RainScape in AMP5 and AMP6, and plan to build on that in a sustainable, focused way to move towards our long-term vision.

8.2. Customer and Stakeholder Priorities

Our customers have clearly told us that sewer flooding is considered the worst service failure they can experience. Customers who are affected regard this as the most important issue affecting them, and it is noted as a highly emotive issue. Sewer flooding is of great

importance due to emotional, practical and health implications. Protecting rivers is important to wildlife, health and well-being and the economy, particularly tourism. Notwithstanding the better position in Wales than England, our customers are surprised how many of the rivers in our area are not currently meeting WFD 'good' status and they would like to see improvement in this area. The condition of natural resources in our region is inexorably linked to tourism, which is a crucial economic area for our customers. We recognise that though Wales currently has the best WFD status across the UK (as detailed in the introduction), there remains a great deal of work in this space to meet our vision and our customer expectations. Our customers are surprised how many of the rivers in our area are not currently meeting WFD 'good' status and they would like to see improvement in this area. The condition of natural resources in our region is inexorably linked to tourism, which is a crucial economic area for our customers.

8.3. Our approach

> We recognise that working with nature to reduce flood risk and pollution not only provides long-term resilience but can offer the best value for our customers. Our approach is to work in partnership to build RainScape features to reduce flows entering the sewerage network and improve our customers' local communities. We are also incentivising customers to remove their private drains from the sewerage system, and jointly funding projects through our Community Flooding initiative.

Our approach to maintaining and improving the performance of our sewerage networks in the face of future challenges is described in our RainScape Strategy[21]. Our broader approach to reducing blockages in our network that can contribute to flooding is outlined in our Blockage Reduction Strategy.

RainScape benefits our customers as it protects them from sewer flooding and can help reduce the operation and environmental impact of our Combined Sewer Overflows (CSO). RainScape can help maintain flows in our natural waterways whilst reducing reliance on the combined sewer network and other third-party infrastructure such as urban water courses and electricity supplies. RainScape can green the urban environment and promote biodiversity aligning with the Welsh Government Water Strategy and Well-being and Future Generations (Wales) Act 2015. Green infrastructure systems are living assets and our data shows they can retain significant volumes of rainwater/stormwater runoff (with up to 80% of the flow evaporating in the case of our swale on Queen Mary's Walk Llanelli), and return it to natural water systems at an appropriate rate. Our data also shows that performance can improve with time as vegetation establishes and new ecosystems adapt to local conditions.

In central Llanelli our RainScape strategy included new a 1,500mm diameter 1.2km long tunnel with a 3,000 l/s terminal pumping station. In total 42 ha, or 20% of the urban drainage area, has been diverted away from combined sewers and into natural watercourses via a network of new storm water pipes, storage systems and green infrastructure in the form of roadside planters, trees, larger basins and swales. Our award-winning approach is the largest retro-fit of SuDS in the UK.

RainScape is an area where we can collaborate with other stakeholders, such as local authorities, to get the best outcome for all our investments. We have already been able to demonstrate this approach in Cardiff in the jointly funded Greener Grangetown project. It

promotes a joined-up approach to understanding existing assets and risks, and how these will be owned and maintained in future.

8.4. AMP6 performance

	PR14 Measure of Success	Narrative	2015/16 performance	2017/18 performance	2020 target (current forecast)
	C1: Adapting to climate change	The volume of surface water removed from the system, expressed in number of properties equivalent (cumulative)	1,531	15,097	25,000

Table 15: Our PR14 Measures of Success

Our target for AMP6 is to use sustainable drainage schemes to protect properties from flooding and to protect the environment. In PR14 our stated aim was to remove 25,000 rooftop equivalents of surface water and we are set to achieve this target.

We have actively shared our approach and asset performance openly with our stakeholders and other interested parties. In addition, we have worked with academic organisations to help us analyse and understand the performance of our new green RainScape assets, thereby informing future forecasting and best practice development.

Loughor Estuary

In the Loughor Estuary area, we have invested £99 million in 2015-2020, in addition to £15 million in AMP5, which will enable the removal of 5,840 roof equivalents of rainwater from our sewers by the end of AMP6. The aim of the work was to reduce sewer flooding whilst delivering National Environment Programme (NEP) requirements at 14 critical assets. The strategy was founded on two key principles; investing in one of the most detailed network models in the UK and the establishment of strong local working relationships with NRW teams and Carmarthenshire and Swansea County Councils. Our model indicated that RainScape would work best in combination with other technologies. A combination of our award winning RainScape, infiltration removal, innovative smart network controls to maximise the existing storage in the sewer network and Peak Flow Effluent Treatment (PFET) was implemented. We worked with specialist technology companies in the United States to understand the potential benefits on PFET. Two technologies were chosen and pilot tested on site. Both technologies were successfully able to treat storm flows to the required standard but one demonstrated a greater level of reliability and has been adopted for delivery at two WwTWs. The technology will allow us to reduce storm tank discharges from both sites significantly at a fraction of the cost of conventional storage or further upstream network improvements.

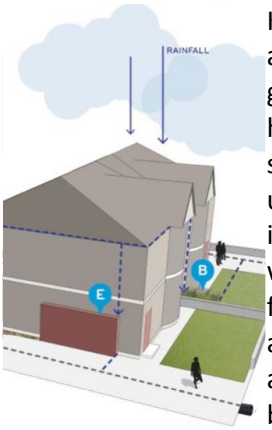
This was the first time PFET had been applied in the UK and it ensures that we meet water quality requirements. The net result is that catchment wide CSO operation has been reduced

by 80% and over 97% of all wastewater in the catchment is now treated, compared with about 78% treated when the programme commenced in 2011.

Customer Focus

Welsh Water is delivering a pilot study by investing £1.5 million in trialling three methods of encouraging customers to remove their private drainage from the sewerage system. The aim is to understand what incentivises customers and how it could feasibly be delivered across our service area. This will help inform Welsh Water's future investment. Customer service has been key to arriving at an offering that is attractive to the customer, cost effective and scalable. The customer has been at the very heart of the new delivery strategy for the pilots with designs co-created with customers and customer feedback informing the evolving delivery method and the final Welsh Water report, due for completion autumn 2018. This project was shortlisted for the Global Water Awards Smart Water category in 2017, the only UK project represented.

Innovation and collaboration: Halfway RainScape roofwater trials



Key to the Halfway trials was to understand the RainScape options available for each household out of a list of generic options such as green roofs, permeable paving, planters, swales, and rainwater harvesting. The options available varied based on site size, existing site drainage, ground conditions and space availability. Working with urban designers and our capital delivery team we developed a simple illustrated handbook to show the options available and a digital tool which allowed each household to select their home and then choose from a list of the options available to them. This allowed them to "pick and mix" the types of RainScape which suited their own home and it also provided them with an outline cost which would be reimbursed by Welsh Water. The handbook and tool was used at customer engagement sessions in the local area, both of which were well received.

Greener Grangetown

Our Greener Grangetown project is a collaboration between Welsh Water, Natural Resources Wales and Cardiff City Council. The RainScape project has been led by Cardiff Council to promote regeneration, growth and investment in the area. It maximises the use of green infrastructure to remove 483 roof equivalents of rainwater from our sewers annually and to future-proof the drainage network against climate change. It also enhances public spaces, helps regenerate the area, promotes sustainable transport and improves ecology. It was developed through extensive public consultation and engagement, with residents actively participating in the design of the streets. The ground-breaking and collaborative nature of the project led to national recognition as it was awarded Engineering Project of the year at the 2018 Water Industry Awards.

Community adoption

We want to use our RainScape work in Greener Grangetown to help us connect with our customers. We want the local community to engage with the green infrastructure and understand how important it is in terms of its primary function. Having eyes on the ground looking out for the well-being of our assets will help us ensure the planters mature, provide the best service to the community they can, and remain in a healthy condition in perpetuity.

Central Cardiff

We have invested £3 million in AMP6 into understanding the complex Cardiff catchment and specifically critical flood risk in areas of central Cardiff. This assessment determined the root cause of flooding to be a combination of high levels of impermeable area connected to the trunk sewers, catchment growth, tidal impact and the operational performance of the network and terminal pumping station. The analysis proved that RainScape alone would be cost prohibitive within a five year investment period due to the extensive 140ha of RainScape needed. A strategy was formed to secure high impact up-front investment in network and terminal asset performance, with a longer term view to subsequently develop a sustainable catchment wide RainScape strategy.

Community flooding

We have collaborated with local flood management authorities to create a community flood programme. We have made £1 million available in a community flooding fund, with a specific set of criteria, to ensure that this investment reduces flooding effectively.

In 2017 Rhyl on the north coast of Wales experienced a severe storm with a return period of 1:54 years. 18 customers experienced internal flooding when our Marine Lake pumping station failed, but our modelling has since confirmed that our network would not have been able to cope with flows generated by the storm. We also found that the impact on our customers was exacerbated by the amount of water running off local land drainage and impermeable surfaces such as highways and shopping areas, the inability of our emergency overflow to operate during high tide and problems with NRW's main flood protection asset in the area known as the "Rhyl Cut".

This event, amongst others, has shown that flooding like this tends to be caused by a complex interaction of several factors. This means that we cannot protect our customers as much we would like by concentrating solely on our assets and we need to take a more joined up approach, or systems resilience approach, to dealing with this type of flooding risk. As a result, we have launched our "Community Flooding" initiative with aims to contribute £1 million to Lead Local Flood Authorities (LLFAs) or community groups who want to invest jointly with us on projects that will improve the resilience of the communities we serve. We have already had applications for support from a number of Local Authorities (LAs) which we have been able to support and we expect to expand this approach in future with more focus

on measures that improve systems resilience of our assets. A good example of this approach is using green infrastructure on retrofitted sustainable drainage (our 'RainScape' approach). Data from our sites in Llanelli have shown that up to 80% of all the surface water from the area around Queen Mary's Walk evaporates from the retrofitted swale without entering our network, reducing our dependence on electricity supplies for pumping or urban drainage systems to cope with our CSO discharges that would otherwise have resulted.

8.5. AMP7 plan

	PR19 Measure of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	Ft4: Surface water removed from sewers	The cumulative volume of surface water removed measured as roof equivalents (cumulative in AMP)	15,097	25,000	47,000

Table 16: PR19 Measures of Success

AMP7 will see us building on our RainScape innovations in AMP6, rolling out pilots and using data collection and practical guidance to ensure continuous learning and improvement. Our aim is for RainScape to be business as usual when addressing hydraulic issues in our catchments. We will continue to use nature as a key part of our toolkit to deliver our AMP7 vision. We always benchmark RainScape solutions against conventional solutions to make sure that the applications are cost-effective throughout their whole project life cycle. We are working to develop a quantitative approach to include the socio-economic benefits to our customers in this benchmarking exercise. This aligns with our work helping Welsh Government and Local Authorities implement Schedule 3 of the Flood and Water Management Act which is expected to come into force in Wales in January 2019.

We plan to continue to invest in RainScape in AMP7 to remove 22,000 rooftop equivalents of surface water from our sewers, bringing our AMP6/7 total to 47,000 roofs. RainScape will form part of the wider solutions to the SR16 measures of success - pollution prevention, and cleaner rivers and beaches. We are engaging with developers as a key stakeholder to reduce the impact of new developments on our network. We are also continuing our work on the community flooding fund and working with Local Authorities as we develop natural flood risk management opportunities.

The Rhyl and Afan (Port Talbot) communities will see SMNR projects which aim to deliver multiple benefits including flooding resilience through wider community and stakeholder involvement.

Central Cardiff

Our initial £3 million investment in operational performance enhancement is the foundation for our longer-term vision in Cardiff. We will work collaboratively with stakeholders to leverage a co-ordinated RainScape strategy to help tackle flooding and promote growth and investment in the local community. We want these relationships to begin at inception and run through delivery, adoption and operation. We aim to promote street scene improvements through new green assets, link with other initiatives such as provision of cycleways, develop a comprehensive catalogue of green RainScape systems and facilitate measures aimed at reducing the unit cost of delivering RainScape.

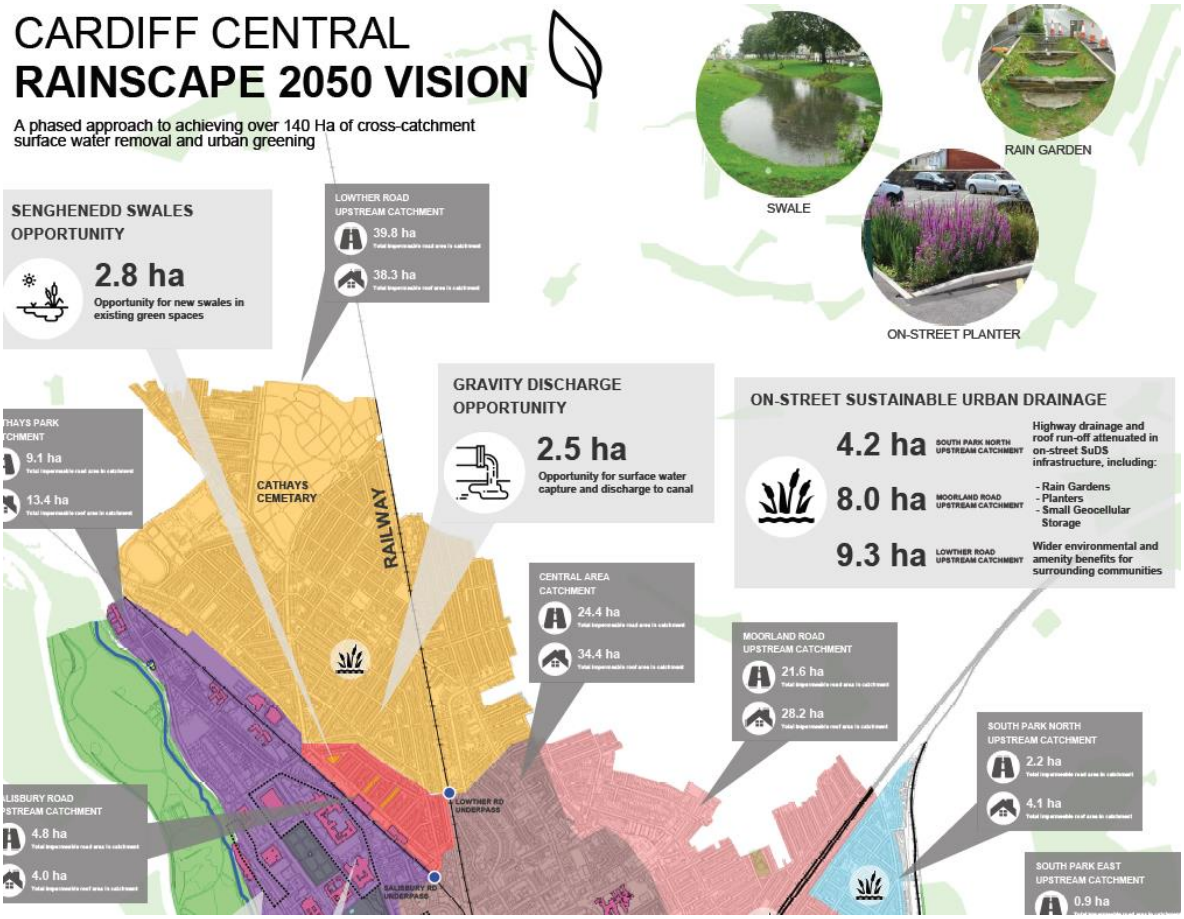


Figure 10: Cardiff Central RainScape 2050 vision.

8.6. Longer term vision for AMP8

	Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
	Ft4: Surface water removed from sewers	The cumulative volume of surface water removed measured as roof equivalents since AMP6 end	47,000	94,000	400,000

Table 17: Our long-term PR19 Measures of Success targets

Investment in RainScape will continue. Our longer-term vision is to double our AMP7 RainScape total by the end of AMP8. This figure will develop as our understanding of long term future flood risk and the relative impact of pollution sources matures. Information, data and enhanced analytics provide an increasing critical platform for key investment planning. For example, UKCP18, which is due for release late 2018 (superseding UKCP09), will provide us with greater clarity and detail on future rainfall projections.

We have started to collaborate with others to develop catchment-wide approaches, as demonstrated by our Greener Grangetown work. We will promote greater collaboration on drainage assets from understanding of performance and integration, through to feasibility

assessments, investment decisions and adoption. In this, our investment in Drainage and Wastewater Management Plans are expected to play an important role in facilitating co-investment and delivery of mutually beneficial solutions with stakeholders.

We expect this co-delivery approach to develop in AMP7 and reach maturity in AMP8. This will be facilitated through future joint Drainage and Wastewater Management Plans (DWMP) and the application of the Sustainable Management of Natural Resources (SMNR).

9. Strategic Response 16: Cleaner rivers and beaches

Figure 11: Three Cliffs Bay, The Gower, by William Pearce, Creative Commons License (CC-BY-2.0).

9.1. Drivers

Welsh Water is one of just two water companies to have two environmental regulators, Natural Resources Wales (NRW) and the Environment Agency (EA). Some 90% of our population is governed by the NRW. We work closely with NRW to achieve the best outcome for our rivers and beaches. We have worked in partnership with these vital stakeholders to develop a plan that is best for Wales, and our English customers, in synergy with environmental legislation. This will become essential as the natural environment comes under increasing pressure from trends such as population growth, urban creep, land use change and climate change in the future.

We are committed to minimising our impact on the environment and implementing improvements to our assets based on sound evidence and where we are confident of a tangible benefit to the environment. This investment is focused on working towards our aim of contributing to achieving 'good' environmental status for our rivers as defined by the Water Framework Directive (WFD). This is focused on waterbodies where we are the confirmed, probable (or suspected) cause of water quality failure. We are also committed to ensuring we contribute to good coastal waters, key to our customers' quality of life and the Welsh tourism economy.

Improving our environment is the key service the wastewater business delivers. This investment focuses on our regulatory requirements and maintenance of our assets to ensure that our service does not impact on our customers or the environment. Our AMP7 NEP investment is significantly larger than AMP5 or AMP6, and will represent 15% of our total capital expenditure.

9.2. Customer and key stakeholder priorities

Our customers see that protecting rivers is a vital part of protecting wildlife, improving health and well-being and supporting the wider economy as it is linked to tourism.

We have found that our customers are surprised by how many of the rivers in our area do not currently meeting WFD 'good' status[22], despite the high quality of our rivers relative to the operating areas of other water companies in England and Wales.

The issues with pollution in our rivers is not purely linked to our operations, with agriculture and industry linked to a significant amount of the pollution. The water industry is only solely linked to 0.5% of the waterbodies which are not achieving good status and a contributor to a further 17%.

Our customers think that if it is a wider issue the responsibility to rectify these issues should be shared by relevant partners. We are therefore planning to proactively work with partners on innovative methods like holistic catchment approaches to identifying and dealing with pollution so that the burden does not fall entirely on water customers. This approach will ensure customer money is only spent in areas which will have a beneficial effect on the local environment.

9.3. Our approach

We recognise that our activities can contribute to marine pollution and we want to contribute to cleaner rivers and beaches on our coastlines. Our approach is to use our coastal investigations programme and enhanced Event Duration Monitoring (EDM) to inform our interventions, which include investing in our WwTWs, pumping stations and sewers, implementing our National Environment Programme (NEP) and working in our catchments to improve the resilience of the natural environment to pollution.

Our approach to delivering improved long-term pollution performance is outlined in our Pollution Reduction Strategy[23]. This document captures how we will more effectively predict pollution incidents, understand the risks to the environment and our proposed investments in existing and emerging technologies to enable proactive maintenance and intervention. Our Final Effluent Compliance Improvement Strategy[24] sets out how we will consistently meet our consent permits for AMP6 and AMP7.

9.4. AMP6 performance

	PR14 Measure of Success	Narrative	2014/15 performance	2017/18 performance	2019/20 target (current forecast)
	B3: Preventing pollution - number of incidents	No. of pollution incidents (cat 3)	117	112	112
	B2: Treating used water - % compliance of WwTW	% compliance against WwTW discharge permits	99.13%	98.21%	99%

Table 18: Our PR14 Measures of Success

Our aim in AMP6 was to invest in our WwTWs, which serve 1.4 million customers, to improve compliance and reliability, and protect the quality of our rivers and beaches. We committed to reduce our pollution incidents from 237 in PR14 to 131 by the end of AMP6. We are now expecting to exceed these targets with end of AMP6 forecast being 107 incidents from wastewater assets.

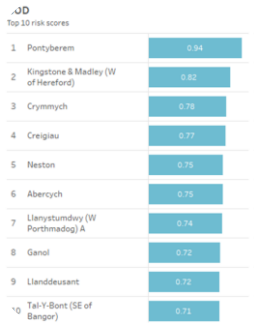
On wastewater compliance, our performance for 2017/18 was 98.21% compared to 99.47% in 2016. This was based on 10 WwTWs failing, out of a total of 559 WWTWs with numeric permits.

In AMP6 we forecast that we will have invested 10% of our total capex plan into National Environment Programme (NEP) investment which will lead to (for the water quality NEP) 150 kilometres of river being improved. By the end of AMP6 we will have completed our event duration monitoring (EDM) programme which will provide us a national picture of the performance of over 2,700 assets covering virtually all of our combined sewer overflows (CSOs). These EDM monitors provide us with key performance data; this helps us recognise potential issues in our network which allows us to direct necessary maintenance and investment. As part of this programme we are voluntarily self-reporting to NRW on our performance as well as publishing results on our website for our customers. We are providing real-time updates for sites which can affect bathing waters or amenity waters such as the River Dee.

The strong performance demonstrated in delivering and reporting EDM differentiates Welsh Water in the industry. This is a significantly higher amount of monitoring than is planned for other water companies. Our approach to install the necessary infrastructure in a timely manner, provide transparency on our results, and swiftly investigate high spill sites is fundamental in helping us achieve our strategic response of cleaner rivers and beaches.

In AMP6 we have invested £8 million in detailed coastal investigations and modelling to understand the factors affecting water quality at 49 sites (29 bathing water sites and 20 shellfish water sites). This allowed us to assess the impact of our wastewater assets and understand what further investments are required. We have worked with NRW to gather evidence and show clear justifications for any improvements undertaken using cost benefit analysis. This work identified two sites where our investment would deliver significant improvements in water quality at an affordable cost. Other sites did not require our investment due to catchment improvements which had been recently undertaken or because the sources of pollution were from diffuse third-party sources and not caused by our assets. This analysis ensures targeted improvements have the impact that matters for our customers, and aligns with our affordability strategy.

Innovation: Treatment Performance Forecasting



In AMP6 we have invested in analysing WWTW water quality performance data and we are now using the information to highlight trends and risk of compliance failure for front line operational colleagues. The work provides predictions for the month ahead for BOD, ammonia and solids using information from multiple existing corporate systems. When piloted it successfully predicted nearly 40% of sample failures before they occurred, and this performance has been refined as the tool has gone into day to day use. The tool helped us achieve our lowest ever number of regulatory sample failures in 2017/18.

9.5. AMP7 plan

	PR19 Measures of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	En3: Pollution incidents from wastewater	Category 1-3 pollution incidents, as reported to EA and NRW.	102	107	90
	Rt3: Sewer Collapses	The number of collapses on sewers	272	255	0% change from 2019/20
	En1: Water and Wastewater Treatment works compliance	Percentage of population equivalent, served by sewage treatment works with numeric limits and water treatment works, which were compliant	96.7%	100%	100%
	En2: Wastewater Treatment works look-up table compliance	Percentage of sewage treatment works with numeric limits, which were compliant	99.46%	99%	100%
	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water's action (cumulative within AMP).	36	562	418

Table 19: PR19 Measures of Success

This investment is focused on three main areas; monitoring and investigations, maintenance of existing assets, and enhancement of existing assets.

In order for us to deliver our most ambitious National Environment Programmes (NEP) for many AMPs, we will move away from traditional 'end of pipe' solutions towards a collaborative, affordable and effective approach based on SMNR principles. Our approach is to consider diffuse pollution in the catchment to fully understand the impact of improving effluent quality in each water body. Our aim for AMP7 is to improve 418 km of rivers. This will be complemented through a combination of a Drainage and Wastewater Management Plans (DWMPs) and increasingly a Sustainable Management of Natural Resources (SMNR) approach, which will be piloted in four catchments in AMP7.

Monitoring and investigations

We need to maintain monitoring of 100% of our combined sewer overflows (CSOs) to ensure that we have robust and consistent data to inform our future maintenance, long-term drainage planning and discussions with regulators and stakeholders. EDM helps us to understand, predictively model, and identify our priority schemes. This allows targeted work at CSOs and give more data on the environmental impact of these assets based on the

impact of those discharges. Using this data, we can identify assets working correctly, collaborate with our regulator and monitor the impact of our assets on local water environments.

This programme of monitoring will identify frequently spilling storm overflows as part of our Storm Overflow Assessment Framework (SOAF) requirements agreed with our regulators. We plan to undertake around 310 SOAF investigations to understand the cause of the frequent high spillers and the threat they pose to the environmental objectives of the receiving water. We will use this approach to target improvement works, providing better value and outcomes for our customers and the environment.

We are monitoring pass forward flow (PFF) conditions at 390 sites to meet our regulatory requirements, investigating the flow conditions at 36 sites and undertaking work at five sites to restore compliance with our permits. The outcomes of this monitoring and any rectification we deem to be required will be considered by our Flow Programme and Strategy group, which has representatives from the EA and NRW sitting on it.

We are undertaking chemical investigations and monitoring, in our CIP3 investigation, which includes:

- Trend monitoring;
- Using a catchment management tool in the Severn Estuary;
- Pathway control;
- Monitoring the pollutants: Hexabromocyclododecane (HBCDD) and cypermethrin; and
- Effluent monitoring for Tributyltin (TBT), Di(2-ethylhexyl)phthalate (DEHP) and Triclosan.

Innovation and collaboration: Chemical Investigations Programme (CIP)

The Chemical Investigations Programme (CIP) is the UK water industry's response to current and emerging legislation on trace substances in the water environment. It brings together the water and wastewater companies in England and Wales with the various regulators in a collaborative programme.

CIP2 (AMP6) and CIP3 (AMP7) are joint investigation programmes of England and Wales' water and wastewater companies as well as various regulators. CIP2 assessed the impact of hard to treat chemicals in effluent on the environment, where we focussed specifically on rivers and tidal waters. The programme also undertook research into potential removal technologies for specific chemical pollutants from the water system. CIP2 ran at a cost to the water industry of £200 million and looked at over 600 hundred sampling sites in England and Wales.

CIP3 will run for AMP7 and includes research into pharmaceuticals and other emerging hazardous substances in rivers, groundwater and wastewater effluent. CIP3 will also be investigating the mechanisms of removal for these substances including what products they break down into, and how they can be removed during the treatment process. The investigations are wide reaching and include a module on microplastics in the environment, potable and waste water.

Improving the performance of our assets

As we deliver more flow measurement and monitors and we improve the understanding of our assets in all weather conditions we are continually undertaking vital maintenance of our assets that are not functioning appropriately, including WwTW, sewage pumping stations (SPS) and outfalls. We also need to undertake maintenance on our sewer network and provide further training to our operators to deal with sewer blockage and understanding of the consequences. This will include investment in upgrading the resilience of the strategic Gwent SECS main. We are undertaking sewer rehabilitation after private sewer and pumping station handover where there is a risk of pollution or network blockage through creating and implementing our Blockage Reduction Strategy. We will be investing £29.7 million in improving of our assets that have breached their bathing or shellfish water trigger, following detailed investigations. This includes triggers for 5 for bathing waters and 14 for shellfish waters for the year in the NRW area. We will continue to invest in maintaining Dry Weather Flow (DWF) compliance at our WwTWs to help protect our watercourses.

Enhancements of existing assets

National Environment Programme (NEP)

We have worked extensively with NRW on the production of the National Environment Programme for Wales and with the Environment Agency on the parts of the Water Industry National environment Programme (WINEP) that apply to our operating area. There are significant outcomes we are seeking in our English area to improve the river Wye and water bodies in Cheshire and we agreed with EA early on in the process what these improvements would be and all will be delivered within AMP7. NRW took a slightly different approach and given the fact that within the large number of water bodies in Wales, there are much fewer in number environmental improvements required that are solely down to water company assets; We plan to work far more in partnership with farmers and other landowners and stakeholders to deliver multiple benefits as part of our NEP delivery. Given that some of these take longer than hard engineered end of pipe solutions we have agreed with WG and NRW that some of these will be phased over AMP8 as well as AMP7. Our AMP7 wastewater element of the NEP and WINEP delivers 294km of river improved at a cost of £288m and more detail is set out in our NEP investment case.

We are investing in enhancing our existing assets to improve water quality. One of our major investments is approximately £50 million to improve the river water quality in the Gwili and Gwendraeth rivers in Carmarthenshire, South West Wales. This will meet our formal obligations driven by the Water Framework Directive (WFD) and is included in the National Environment Programme (NEP). We have identified that we need to invest in the WwTWs in this area to deal with regional growth, as the top of this sensitive catchment is identified in the Swansea Bay regional city deal as including sites for significant business and domestic expansion. We also need to address asset conditions and the increasing running costs of many of our assets. Elsewhere we intend collaborating with stakeholders to look for opportunities to improve the water quality status along the whole water body rather than just from our point discharges. We believe this will be a much better use of our customer' money because it will deliver greater environmental benefits without building up future operating and maintenance costs. We also hope to use the information from our SMNR pilot to work with our regulators so that we can move away from fixed permits at each site. We

plan to investigate how a more flexible approach based on catchment-wide permitting can deliver greater benefit at a lower whole life cost.

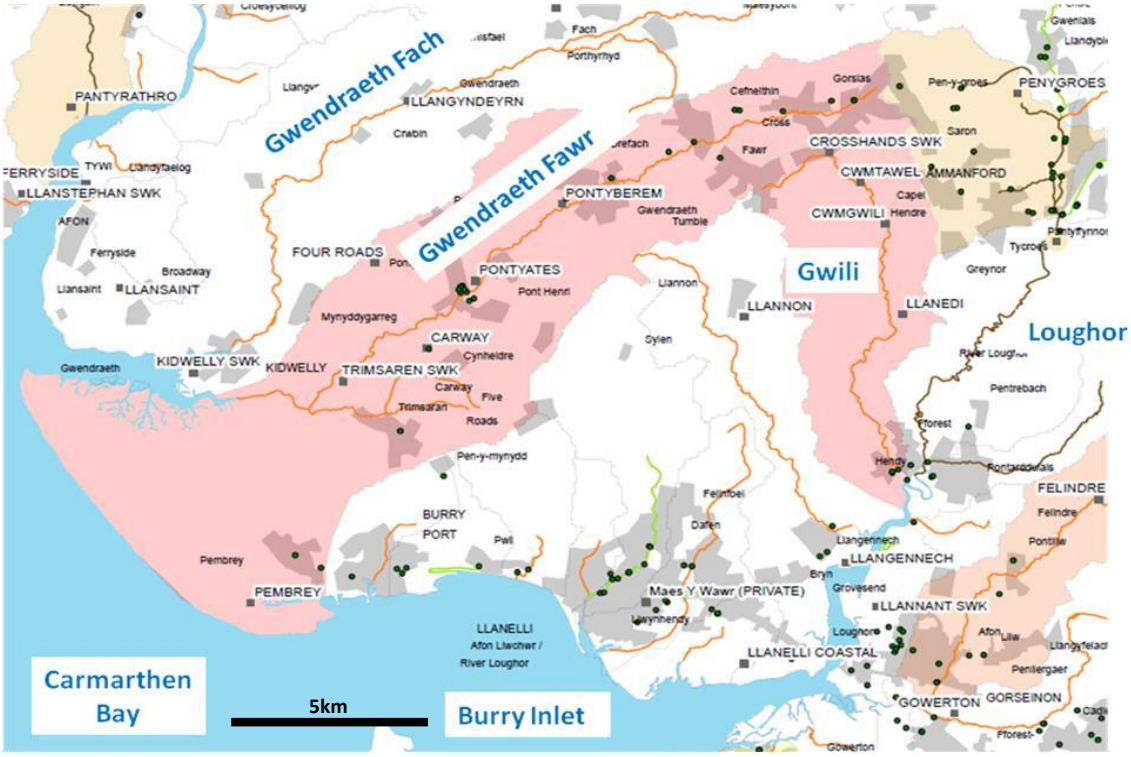


Figure 12: Map of the Gwili and Gwendraeth Region

To achieve the NEP required outcome, we have proposed to build one new Gwili Gwendraeth WwTW to replace seven of the eight ageing WwTWs discharging into the Gwili and Gwendraeth Fawr rivers. This has been chosen as our preferred option as it provides certainty of water quality and environmental compliance and help to protect our valuable natural resources. It will deliver these benefits whilst providing financial savings compared to the costs of continued maintenance and upgrades to our existing sites.

We will improve our monitoring of shellfish waters using real time notification trails as we do for Bathing Waters.

We will support the environment of our rivers by investing in removal of up to 16 barriers for fish, and undertaking conservation schemes for biodiversity, SSSI status, priority species, invasive non-native species (INNS) and benthic ecology at two of our estuaries.

Our other NEP investment includes increasing our Flow to Full Treatment (FFT) at five sites, and upgrading storm tanks at 13 of our WwTW. We are also looking at WFD improvements in this investment period including tightening of sanitary determinates like ammonia and phosphorous removal at 33 of our WwTWs. Finally, we will be improving five additional assets on Menai Straits in support of the thriving shellfish industry in the area.

We are investing in new infrastructure with new public sewers for three communities which are not connected our network currently, but are likely to cause pollution or have amenity issues like odour, as part of our S101a statutory obligation. We are also investing to provide for new developments and growth.

9.6. Longer term vision for AMP8

	Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
	En3: Pollution incidents from wastewater	Category 1-3 pollution incidents, as reported to EA and NRW.	90	80	40
	Rt3: Sewer Collapses	The number of collapses on sewers	0% change from 2019/20	0% change	0% change
	En1: Water and Wastewater Treatment works compliance	Percentage of population equivalent, served by sewage treatment works with numeric limits and water treatment works, which were compliant	100%	100%	100%
	En2: Wastewater Treatment works look-up table compliance	Percentage of sewage treatment works with numeric limits, which were compliant	100%	100%	100%
	En6: Km of rivers improved	The length (in km) of river improved because of Welsh Water's action (cumulative within AMP)	418	128	N/A

Table 20: Our long-term PR19 Measures of Success targets

We will use investigations, EDM data, and more predictive modelling (e.g. criticality of sewers, blockage reduction) from our AMP7 work to provide us with robust data to build our AMP8 plan. We aim to continue to reduce pollutions from our assets and particularly from direct operation of our assets by 2030 using smarter network operations.

Our focus in AMP8 to continuing to improve rivers and beaches in the future will be on management both of our assets and of wider areas. This is likely to include a participatory approach in collaboration with partners on offsite solutions, such as continuing with our SMNR approach, payment for ecosystem services and other catchment solutions. There is £249m of NEP deliverables allocated currently to AMP8. We are confident that by working in partnership with wider landowners and farmers and the outcomes from our SMNR catchment projects that we intend to reduce the costs to customers from this figure without reducing the environmental improvements we intend to deliver. We anticipate potential co-investment with opportunities identified from our DWMP's for example natural flood risk management techniques which may also offer water quality improvements.

We also wish to understand more about emerging pollutants. We are therefore aiming to undertake work to understand the issues surrounding micro plastics in our catchments, horizon scanning for new emerging pollutants and how regulation is going to impact sewage treatment regarding pharmaceuticals and water quality.

We will also undertake further measures for WFD, which will include predicting changes in waterbody status due to climate change, methods for smart network control, antibiotic resistance in wastewater and biosolids, and understand how best to address emerging contaminants including antibiotics and other pharmaceuticals.

10. Strategic Response 17: Protecting our critical wastewater assets

Figure 13: One of our critical assets © Welsh Water.

10.1.Drivers

This investment focuses on our need to improve the resilience of our critical assets, i.e. those with a high customer or environmental impact of failure. As a result of climate change, storms are increasing in frequency and intensity, sea level is rising (the Climate Change Committee's 2017 report highlighted significant deterioration in the degree of protection offered by existing coastal defences in the coming decades as a result) and drought more prolonged. These factors place greater strains on our sewer networks and treatment works and increase the likelihood of flooding and adverse environmental impacts. These more extremes will become more commonplace, placing a greater challenge for continued compliance performance from our assets.

We need to protect our critical assets from flooding, loss of power and asset failure and ensure that our contingency plans are up to date and tested. We need to develop our systems approach which references our asset vulnerability against the failure of other critical infrastructure such as power or telecoms. We must also consider other external factors such as the energy market and the state of and our impact on the Welsh economy.

If a site is considered 'designated' as Critical National Infrastructure (CNI) under the Security and Emergency Measures (Water and Sewerage Undertakers) Direction 1998 (SEMD) than we have a specific duty to carry out security work, install appropriate protection, and implement surveillance. This ensures we mitigate against vandalism, terrorism and sabotage

(including chemical, biological and radioactive attacks). For 'non-designated sites', we will mitigate risks based on the Water UK Security Standards[25].

10.2.Customer and key stakeholder priorities

We need to continue to provide acceptable service to our customers in the face of future challenges. There is a low tolerance of wastewater flooding events as it is perceived as a negative impact on business and a health hazard. Our customers expect us to have contingency plans in place and to rectify issues quickly to prevent impacts to businesses and homes.

10.3.Our approach

We are facing increased environmental and human risks to our assets, including emerging threats from terrorism and cyber-crime. To mitigate these, our approach is to use our resilience scorecards to prioritise our investments for improving the resilience of our critical wastewater treatment and conveyance assets. Improvements include physical and technological security measures.

10.4.AMP6 performance

	PR14 Measure of Success	Narrative	2015/6 performance	2017/18 performance	2020 target (current forecast)
	F3: Asset Resilience (wastewater only)	% critical assets that are resilient against a set of criteria	73.6%	77.5%	78%

Table 21: Our PR14 Measures of Success

Resilience scorecards

At PR14 our target was to improve the resilience of our delivery systems and reduce the risk to our assets by improving the percentage resilience of our assets by 7% over AMP6, from 71% to 78%, which is close to being achieved.

Whilst we have focussed on improving the resilience of our assets for many years, the overall resilience of critical assets itself became a driver for investment in AMP6. Welsh Water has risen to the challenge and developed a bespoke resilience scorecard process for our critical assets. These scorecards reflect the resilience of our critical assets, in terms of how well protected they are against extreme weather events and other risks. Their ability to recover from service failures, or the level of disruption caused to customers or other infrastructure arising from those events. In AMP6 we extended the approach to include key trunk sewers and sewage pumping stations the failure of which could impact bathing waters or shellfish waters. The scorecard resilience score is reported to Ofwat annually to evidence the progress made in protecting our assets.

Physical and technological measures

These improvements were mainly due to our investment in SEMD works, automation and control, as well as our preparatory investigations on power resilience for AMP7. We have

just completed an overhaul of the scorecard to expand our criteria of critical assets to ensure that assets whose failure would have a large impact on customers, the economy and the environment are included.

PR19 has seen the Asset Resilience Scorecard evolve into three distinct categories: Water resources, Water Network plus and Wastewater Network plus, to reflect new price controls. Our resilience scores for AMP7 are therefore not directly comparable to AMP6 scores. This is because we have adjusted the weighting to make a fairer comparison between the network and above ground resilience.

An example of our work on resilience is our engagement with the council to understand the coastal erosion risks at our largest WwTW as well as an in depth technical root cause analysis of the network. This includes areas which would affect our customers the most, such as road and rail crossings.

10.5.AMP7 plan

	PR19 Measures of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	Ft8: Asset resilience: wastewater network + above ground	Percentage of above ground critical assets that are resilient against a set of criteria	-	77.7%	80%
	Ft9: Asset resilience wastewater network + below ground	Percentage of below ground critical assets that are resilient against a set of criteria	-	28.3%	45%

Table 22: Our PR19 Measures of Success

Resilience scorecards

Our revamped resilience scorecards, with a stronger focus on critical assets that may impact customers and the environment, are in place for AMP7. This will allow to place greater focus on the resilience of our wastewater assets moving forward.

The resilience improvement programme was planned by understanding and verifying the root causes which are affecting our score, by technical investigation and alignment with our 'Investment Manager' system of risks. As part of our 'whole systems' review, stakeholders were identified and engaged to understand the possible mitigations available and the effects of those mitigations, before defining appropriate measures to deliver best value to our customers.

We have looked at the resilience of our assets from a customer lens. As an example we have defined 'critical' sewers as those which, if they failed, would cause significant disruption to customers, such as major road or railway crossings, or where environmental pollution would be significant. The projected resilience score on this basis for critical below ground assets in

particular is low for 2019-20. We will deliver a multi-AMP programme to improve resilience of these assets, to 45% by 2025, 60% by 2030, and 100% by 2050.

Physical and technological measures

We are planning to invest £46 million in our resilience programme. This has three main focuses of enhancement:

- Power resilience of critical WwTW and power resilience of SPS. This ensures that all these sites have two discrete sources of power which would supply 100% of their energy needs;
- Operational works at critical sewers which involves ensuring that these sewers have plans and access in an emergency; and
- Condition surveys at critical sewers.
- System improvements and cyber-attack protection

There is flood risk in Newport which significantly affects a large number of our customers in the city; we are aiming to address this during AMP6 and AMP7. The key causes are a combination of the risk of asset failure and lack of hydraulic capacity. To date we have invested in our critical infrastructure at Nash WwTW to improve emergency screening and energy provision. We have also invested in significant investigation to allow us to develop the capacity improvement strategy; as a result £17.2 million is planned in AMP7 focussed on enhancement works around the main Newport tunnel sewer.

Some of our critical assets have had pollution events linked to them including Category 2 incidents. To address one of our key risk areas in this space we have developed the £40 million South East Coastal Strategy (SECS). We are currently investigating significant stretches of our strategic pressurised mains network which have a heightened risk of burst due to unfavourable ground conditions. Concurrently we are investigating the potential reinstallation of three WwTWs and the abandonment of some of the most high risk strategic mains. The strategy will alleviate the risk of high impact environmental pollution events which could affect sensitive local wetlands, by improving strategic asset resilience for the long term.

We are investing in RainScape and green infrastructure across Wales. These natural systems provide resilience to climate change and are inherently less vulnerable to other external infrastructure failures such as power, telecoms or other urban drainage systems.

10.6.Longer term vision for AMP8

	Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
	Ft8: Wastewater network + above ground	Percentage of above ground critical assets that are resilient against a set of criteria	80%	85%	100%

Ft9: Wastewater network + below ground	Percentage of below ground critical assets that are resilient against a set of criteria	45%	60%	100%

Table 23: Our long-term PR19 Measures of Success targets

Our approach to resilience is one of continuous improvement. The work in AMP6 has provided a clear framework to achieve 100% score on our Resilience Scorecards on our most critical assets by 2050. In AMP8 we will focus on continuing to protect our critical network assets through projects such as Cardiff City Centre Network Resilience and Cardiff Wastewater Treatment Works Coastal Erosion Resilience projects. Long term investment will be informed by our customer engagement work and regular reviews of the Resilience Scorecard to provide customers with the best value solutions. We will continue to test new technology and evolve with it. This may include, for example, the provision of energy storage on critical and remote sites.

11. Strategic Response 18: Promoting a circular economy and combatting climate change

Figure 14: Swansea WwTW Wind Turbine under construction. © Welsh Water.

11.1. Drivers

Climate change will affect almost all aspects of our business, and the UK's power distribution network, resulting in more frequent failures going forward. We are committed to playing our part in mitigating climate change, as well as adapting to it. There are some natural resources used in our processes that are facing greater scarcity. In response to this, the circular economy principles support designing out waste, maintaining natural resources in a useable form and regenerating natural systems.

In response to these trends, our 2050 strategy led us to adopt a bold target – that we would become an energy neutral business by 2050, generating 100% of our own energy needs. We plan to do this by adopting the following in an affordable way:

- Minimising the amount of energy we use to deliver our compliance and customer service objectives by becoming more energy efficient;
- Generating an increasing proportion of the energy we use ourselves, renewably wherever feasible and economic to do so; and
- Minimising the price of the energy we use through our purchasing and time of use.

In 2017 we secured a new energy contract which means that all our sites are now powered by energy from named and certified renewable sources.

Our management of bioresources, which is covered in detail in a separate document, provides significant input into Strategic Response 18.

11.2.Customer and key stakeholder priorities

Our customers recognise that many organisations have commitments to reduce their overall energy consumption and to use renewable sources and understand the importance of energy generation and energy efficiency measures[26]. This is seen as an important area to invest in, and our customers would like us to continue to do so (see Supporting Document 1.1B).

11.3.Our approach

> We want to increase our resilience to power failures and reduce our long-term energy costs, recognising that our customers' want to see us increase our consumption from renewable sources. Our ambitious approach is to build self-generation capacity, reduce our demand by improving the energy efficiency of our assets and ensure we can buy external energy when it is cheapest. We want our new energy generation capacity to be renewable where economic and feasible to do so, using anaerobic digestion, hydropower, solar PV and wind turbines.

The focus of our energy policy is four main themes which are:

- Investing in energy efficiency and energy generation;
- Improve information availability, for example real time energy use and generation data;
- Maintenance and support, ensuring that our own generation and efficiency issues are dealt with promptly; and
- Purchasing and hedging energy at low cost, through a risk management-based approach, reducing the risk we face.

Our approach to investing in our energy-related systems is outlined in our Energy Plan. Our Energy Investment Case (supporting document 5.8T) outlines our approach to investment in AMP7 to bring long-term value for our customers.

11.4.AMP6 performance

	PR14 Measures of Success	Narrative	2014/15 performance	2017/18 performance	2020 target (current forecast)
	C2: Carbon footprint	Gigawatt-hours (GWh) of renewable energy generated	45.8	55.51	69.7

Table 24: Our PR14 Measures of Success

These policies have led our AMP6 investments. At PR14 we planned to increase our low carbon energy generation by 100% and reduce energy consumption by 5% over water and wastewater. Shared between water and wastewater the AMP6 energy programme allocated £26 million of investment to create savings £3.8 million per year. To date, we have gone further than this investing £32 million which has provided us with savings of £4.8 million a year, at the end of 2017.

The energy programme contains projects on solar, wind, hydro, aeration, lighting, process and network control and other schemes. Most programmes are well on their way in terms of the investments made, with the wind turbine programme now complete. These are detailed below.

Figure 15: Solar PV at Five Fords. © Welsh Water.

Renewable Energy Generation

As part of investment across the company, we have completed four energy generation projects on Wastewater sites in AMP6: two wind turbines and two solar arrays:

2.5MW wind turbine at Nash WwTW near Newport in March 2017;

900kW wind turbine at Swansea WwTW in September 2016.

500kW extension to the existing solar at Five Fords WwTW

99kW solar array at Llanina WwTW

Energy Efficiency

We have achieved improved aeration by implementing advanced blower technology which is more energy efficient. These blowers have replaced less efficient blowers at five of our larger sites. Typically, we expect these to save 25%-40% of the power required to operate.

We have improved the way our sites and networks are controlled. For example, four of our largest WwTW have multi-variate process control systems installed to optimise the plant.

We are looking to ensure that we have the most efficient pumps and we have also ensured that we have started a programme to switch to LED lights at our larger sites.

Greywater Recycling

We have worked with Liberty Steel to provide final effluent supply from Nash WwTW for them to utilise as part of their manufacturing process. This is a catchment based approach which improves water efficiency and provides significant bills savings to the customer, with real benefits to the local economy.

Five Fords Energy Park and WwTW Energy Neutrality

Five Fords Energy Park is a WWTW near Wrexham that is implementing several methods of generating renewable energy, with the goal of becoming self-sufficient as well as supplying energy to the local grid. The treatment works currently uses anaerobic digestion (which will be converted to advanced anaerobic digestion by the end of AMP6), which is linked with a combined heat and power and a gas-to-grid plant. This plant produces biomethane, which is fed into the local gas grid for domestic and commercial use. In addition, the park is building a solar park and is planning to install a wind turbine and a hydro turbine at the works outfall. Processed sludge from the anaerobic digesters is recycled to local farmers as soil conditioner.

The park has the first gas-to-grid plant in Wales, is the first UK water industry site to integrate so many technologies and will be the first Welsh WWTW to use its outfall for hydro-electric generation. In total the site currently generates enough energy for about 5000 homes.

Five Fords Energy Park is an example of future WWTWs and makes a significant contribution to our business goals of doing our part to combat climate change, contribute to circular and local economy and become carbon neutral.

11.5.AMP7 plan

	PR19 Measure of Success	Narrative	2017/18 performance	2019/20 target	2024/25 target
	Ft3: Energy self-sufficiency	Electricity generated, and gas injected to grid as a percentage of all electricity and gas consumed (gas expressed as an electricity equivalent).	20%	26%	35%

Table 25: Our PR19 Measures of Success

To meet our long-term target of becoming energy neutral, we must strive to achieve the following interim objectives for 2025:

- Achieve the revised measure of service of 35% of our energy consumption generated by our own sources. This will be achieved by both minimising the energy we use and maximising the energy generated,
- Take a step towards our long-term goal of energy neutrality by 2050, and
- Deliver value for customers through contributing to lower costs and therefore lower bills.

To achieve these targets, we will focus on three types of projects: energy efficiency, renewable energy generation and demand side management and storage. The breakdown of the invested areas for wastewater is detailed below.

Renewable Energy Generation

The amount of renewable energy generation across the whole company will be increased to 30% of electricity use by 2021 and 35% by 2025. We plan to invest £4.5 million to implement renewable generation at two sites, producing 5.5GWh and saving £571k per annum

We will gain consent and install a wind turbine at a site at Five Fords to complement the renewable energy technologies already at that site.

We will deliver a programme of micro-generation (wind and solar) on some small sites as a pilot of how to bring this technology cost effectively to such sites which have, to date, been unable to benefit from on-site generation.

Energy Efficiency

We expect our energy efficiency programme to save us 6.6GWh and £783k per annum by undertaking:

- **Pumps and Control:** This will form the largest component of the efficiency investment. Pump network control has the potential to offer efficiencies both by enabling pumps to operate at the peak points on their efficiency curves but also to optimise the time of operation. We plan to implement this in the Cardiff/Nash network where we will invest £1.6 million to save £251k per year. Five sites have been identified where pumps can be replaced with a more efficient pump and motor specification, where we will invest £146k to save £23k per year. In total, pumps and pump network control will save us 2.3GWh.
- **Lights:** We will continue to convert lights to LEDs. Some of the investments will go towards addressing smaller sites where a different delivery process is required to ensure value for money is obtained. We plan to invest £633k in lighting which will save £126k and 1GWh per year.
- **Aeration:** We propose the use of more efficient blowers on some of our smaller sites as well as revisiting the technology and business case for the larger sites that have not already been updated. It is proposed to spend £3.9m with an expected saving of £383k per year. In addition, this plan should save us 3.3GWh per year.

Demand Side Management and Storage

This area has great potential but also large uncertainty. This is due to energy costs becoming increasingly variable dependent on the time of day at which the energy is bought or sold.

There are now a variety of schemes for demand side response where we could turn our power usage up or down in response to price signals. Therefore, we will invest £825k for these types of schemes, saving £95k annually. If the technology and approach proves economically viable there will be a much greater potential that could be accessed where funding is available.

Asset Maintenance

We have been investing in renewable energy for many years and therefore there is a need for planned capital maintenance to enable us to continue to operate at full efficiency and maximise our asset life. Most of this investment will be on Water and Sludge sites but some limited maintenance will be required at our wind and solar sites. Whilst turbines and solar panels last for over 20 years and so should not need replacing until AMP9, the inverters are shorter lived and typically last only 10 years so some replacements are expected within AMP7. On wind power, alternator maintenance will be required after 5 years. A total of £200k will be invested for maintenance requirements.

Circular Economy

We will build on the examples and learning to date. Our SMNR approach will help us identity further opportunities and potential co-funding projects for the benefit of local communities. A risk to our AMP7 energy and efficiency plans is if the NEP leads to a significant number of end of pipe treatment solutions, which will see low cost, sustainable biological filter plants expanded to require complex tertiary plants to remove phosphorous. We therefore intend to work hard with NRW and other stakeholders to explore partnership projects and nutrient trading options to be able to preserve our low cost sustainable treatment works, whilst delivering multiple environmental improvements.

11.6.Longer term vision for AMP8

	Measures of Success (MoS)	Narrative	2025 target	2030 target	2050 target
	Ft3: Energy self-sufficiency	Electricity generated and gas injected to grid as a percentage of all electricity and gas consumed (gas expressed as an electricity equivalent).	35%	50%*	100%*
				*This target dependent on technological developments	

Table 26: Our long-term PR19 Measures of Success targets

Our long-term plan is to achieve our aim of becoming an energy neutral company by 2050 so for AMP8 we will continue to make progress towards this goal. We will build on what will have been completed in AMP7 to make further improvements. We consider new technologies as they become viable. Specific areas we plan to invest in is how to maximise the energy recovery from our sludge resources and low energy treatment technology e.g.

reedbeds. We will also look to expand our use of final effluent and biosolids as a resource, such as in our Liberty Steel greywater recycling example.

11.7.Innovation and efficiency

As part of our ongoing focus on looking for the new ways of reducing costs for our customers we are working with NVP Energy to carry out full scale pilot trials on an industry-leading low temperature anaerobic wastewater treatment process. If successful, the approach could allow us to meet our discharge permit requirements with a modular process that has a much lower sludge production than conventional treatment and generates biomethane for energy production directly as a by-product of the treatment process itself.

Figure 16: Our NVP Energy Pilot. © Welsh Water.

12. Summary

Our Water Network Plus Business Plan demonstrates how we will continue to meet our customer promises in the face of a diverse range of future challenges to our business. We have built this plan based on our range of recent customer engagement activities, and in alignment with our long-term Welsh Water 2050 Strategy. We have recognised that we will need to innovate and collaborate, whilst partnering with a wide range of stakeholders to achieve our shared objectives. This is especially important in areas where we have limited or no control, such as land use in our catchments.

Annex A: Additional documentation

The documents below are available on request.

Document title	Date	Comments	Strategic Response(s)
Making time for nature, Welsh Water	2016	Our plan for maintaining and enhancing biodiversity in the work that we do.	SR1,SR14,SR18
Odour Nuisance Reduction Strategy, 2015-2040	Jan-15	Our strategy to reduce the nuisance caused to our customers by odour from our wastewater assets.	SR10
Pollution Reduction Strategy	Oct-14	Our strategy for wastewater to deliver improved pollution performance.	SR16
RainScape Strategy	Aug-18	Our strategy for maintaining and improving the performance of our sewerage networks in the face of the combined pressures of climate change, urban creep and growth.	SR15

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[1] Welsh Water, Resilience customer engagement, October 2016

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[5] Welsh Water, Pollution Reduction Strategy 2015-40, October 2014

[6] Welsh Water, Wastewater Treatment Works Final Effluent Compliance Improvement Strategy 2018-2025, 2018

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