Dŵr Cymru
Welsh Water

Ref 3.3

PR19 Innovation strategy

September 2018

Dŵr Cymru Welsh Water

Contents

1. Introduction

1.1. Our vision

Our Vision is '*to earn the trust of our customers every day*'. We will do this by delivering high quality, essential services that protect our customers' health, our communities and the environment around us.

1.2. Our values

Our values in support of our Vision are: to be **Proud** to put customers first; **Trusted** to do the right thing; **Excellence** in everything we do; **Honest** with everyone; **Safe** at all times; and being **Open to new ideas**.

Critical to being trusted by our customers, is how we are '**open to new ideas'** and use innovation to drive our costs down; provide ever more resilient services; reduce our environmental footprint further; and how we put customers first in our decision making.

1.3. Our innovation strategy

Our innovation strategy is driven by three key elements:

- **Setting out an ambitious, clear long-term set of outcomes through Welsh Water 2050:** We need to ensure that we can both deliver affordably for customers over the long-term and move the business to a more sustainable footing. This means delivering significant efficiencies, both through disruptive innovation - such as the introduction of step change technologies – and more iterative innovations where we refine and improve our processes.
- **Growing our knowledge and capability through collaborative partnerships:** We will continue to collaborate with other organisations (e.g. through our strategic Memorandum of Understanding with the Natural Environment Research Council (NERC)) on both national and international levels, including through events such as our annual Innovation Conference.
- **Undertaking targeted and effective research to shape our investments, processes and thinking**: We will ensure that our investment decisions are based on sound evidence; and will use the evidence and knowledge to develop new catchment / nature based regulatory and other processes, for treating water and wastewater in line with the circular economy.

1.4. How we will deliver innovation

We define innovation as '*the creation of customer value through the application of knowledge*'. For a Company owned for and on behalf of its customers, innovation is intrinsic to our business and an essential component of driving the changes and efficiencies needed to deliver what our customers need and expect.

We see the innovation approach as being unique in the water Industry. Rather than have a central 'Innovation Team', innovation is embedded throughout the business, with Heads of Service being accountable for the innovation required within their teams to deliver their element of Welsh Water 2050. Our Heads of Service are supported by 'Innovation Champions' and other team members to ensure we target innovations where they are

needed at the local level. Each Head of Service designs and implements annual innovation plans at the business unit level each year, to meet the bespoke needs and challenges for their part of the business. These are managed through the performance management system just like any other key deliverable in the business. In this way innovation is embedded into our culture and systems, process and people, and thus is focused at delivering prioritised results for our customers and the environment.

Most water companies have a core team of their very best process and other scientists and technologists to lead and undertake innovation work. To avoid any silo thinking and to improve on the model we see in other companies, we have made innovation integral to every part of the business. Our strategy is to embed our innovation champions (expert scientists and technologists) in those parts of the business where they can inspire others to innovate, and act as champions for innovation themselves. A small central team helps to prioritise projects, manage specific external relationships, and run our innovation business processes. Our Innovation champions act as our technical leaders and support our Heads of Service who sit around the iLab table (see below) and its associated forums.

The innovation process in governance terms is Director-led, through our 'ideas laboratory' or iLab for short. The iLab manages cross-functional aspects of innovation such as awarding overseas study awards, the organization of our annual Innovation Conference etc. and monitors progress to report it to the Board and external stakeholders alike.

The rapid pace of technological change holds out the prospect of providing services more efficiently and reliably in the future. Moreover, new methods of working together, including co-creation between water companies, their customers and others, could enable society to deliver its goals more efficiently. Such changes may require policy changes in areas such as land use management, which we are supporting and know Welsh Government are already working on.

2. Welsh Water 2050 and innovation

In AMP6 the Glas Cymru board adopted a new mission statement in our long-term strategy document – Welsh Water 2050 – *'to become a truly world class, resilient and sustainable water service for the benefit of future generations'.* This is closely aligned with Welsh Government's Wellbeing of Future Generations and the Environment (Wales) Act. Welsh Water 2050 sets out how we will shape and prioritise our long-term innovation needs and specifically our science and research agendas to ensure that the considerable investments that we make remain focused and efficiently targeted on the issues that will matter most to our customers in the long-term.

We need to be prepared to make the right 'no regrets' decisions for urgent actions, whilst prioritising our research and innovation to build our understanding of significant future trends. The size of some of the challenges and the inter-generational nature of some of the required responses means that doing nothing in the face of uncertainty is not an option. It is clear from Welsh Water 2050, that significant efficiencies will be required over the course of the next 30 years if we are to meet the expectations of our customers and mitigate the challenges we face ahead, whilst keeping bills at an affordable level.

Welsh Water 2050 includes 18 Strategic Responses to the long-term challenges and trends that we face, each of which has an innovation 'journey plan', an example of which is given below in Figure 1:

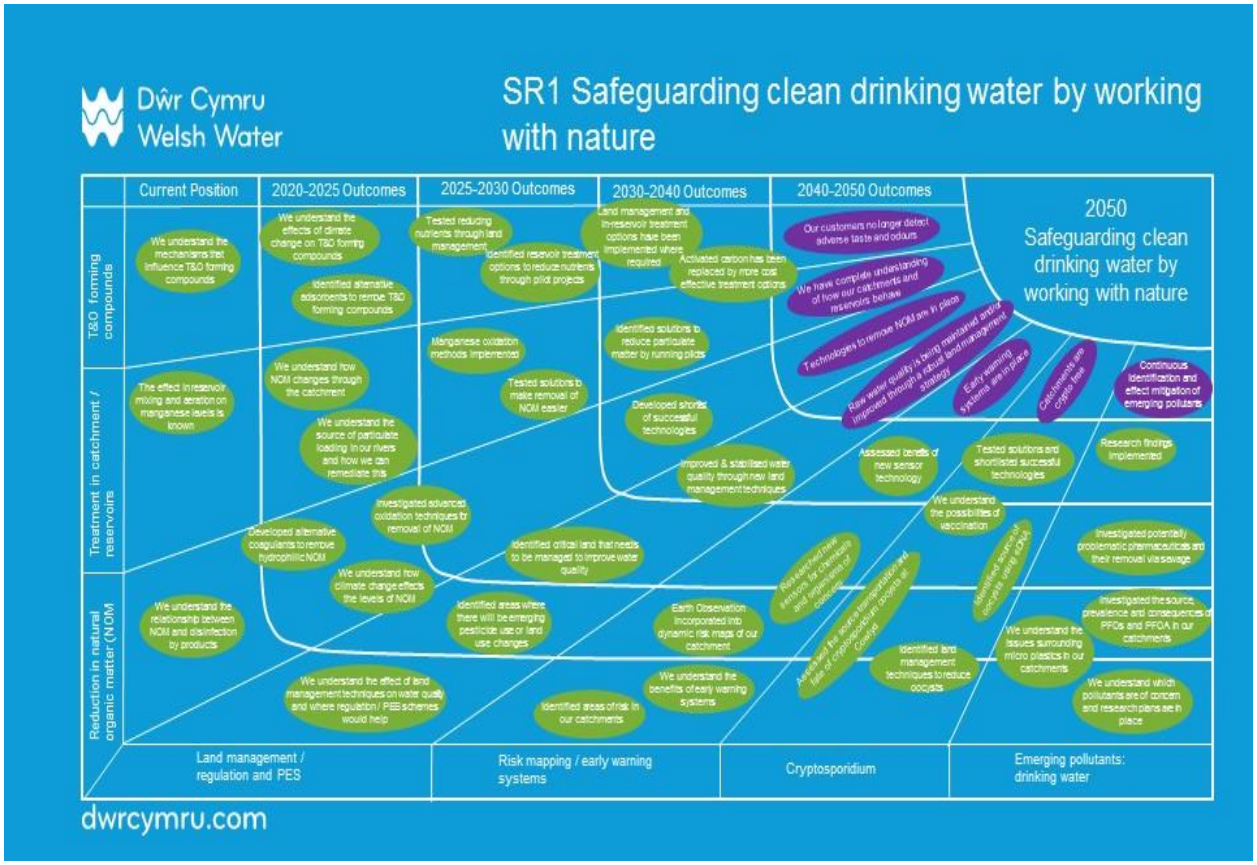


Figure 1: Example of a Welsh Water 2050 innovation 'journey plan'

The journey plans define the key innovation outcomes which must be achieved, and/or the research topics understood, to enable the particular Strategic Response to be delivered by 2050. Our innovation plans for AMP7, therefore, are based on the innovation outcomes set out in each journey plan for the 2020-25 period.

3. Customer views

3.1. Research on customer views of innovation

Our customer consultation work for PR19 confirms that customers generally think that investing in research and development helps essential services. They feel water companies should collaborate on this and look towards research to progress services, but not if it meant that service standards would slip elsewhere.

Examples of feedback are included below (source: Welsh Water Environment Research 2017):

- "I think it probably should [invest in innovation] but I think it should be careful on how far it wants to extend itself". (Large business customer)
- "I think that they have to put some money in research and development. Where that actually stands is a quite difficult thing to answer but research and development should help the standard services…you can't have one without the other." (Domestic customer, Cardiff).
- "They might be able to find a more renewable source of energy for water and other ways about it then be able to turn more of a profit to put back into it, to be a better service." (Domestic customer, Bangor).

Customers were supportive of our Welsh Water 2050 plan. Interestingly, customers felt that the long-term plan conveys us as more active in forward planning than customers had realised. Specifically, customers expected to see innovations in relation to, for example, grey water, water capture and new ways to increase efficiencies. This was perhaps influenced by the various announcements in England relating to the pressures the South East region is under in water resource terms.

We anticipate that our AMP7 plans will, once complete and publicised, help customers see the value and importance of our innovation work, how and why we have prioritised our efforts, and the value the work will bring them in due course.

4. Our approach to innovation

4.1. Our innovation strategy

Our innovation must deliver efficiencies and/or improved performance, through an accelerating innovation cycle which can rapidly ingest new ideas, is focused on operational needs now and into the future, and has access to a wide range of external expertise and resources to leverage our own growing capability.

In essence our innovation mantra is: '*Think big, start small, and scale fast to drive value*.'

4.2. Embedding innovation

The iLab is the company forum which co-ordinates, reports on, and measures progress on innovation priorities, and supports our innovation agenda more generally. It is Director led, and includes four other Directors and Heads of Service who make up its membership.

The iLab's responsibilities extend from encouraging and embedding a culture of innovation throughout the business so as to encourage ideas generation through to supporting and delivering the outcomes of those ideas to drive measurable value. The activities and the value driven through the iLab are reviewed annually by our Board. The iLab also sets up regular Innovation Days (to engage and celebrate our innovation work) and an annual Innovation Conference. The Innovation Days have included 'collision spaces' for ideas, full blown Hackathons, and supplier show case events. These have all led to a number of ideas being taken up and pursued by the business.

Our AMP7 approach to innovation is to ensure that the considerable innovation investment that we are and will continue to make, is focused and efficiently applied to the issues that will matter most to our customers in the long-term. In order to deliver both our Strategic Responses as set out in Welsh Water 2050, and also to shape the regulatory and policy environment in which we work, our innovation agenda must continue to be 'evidence led' and we must move to being a 'data smart' business in all that we do, harnessing new advances in technology, data and science. We must do this both through our own innovation programme, where we will need to be at the vanguard on selected developments, but also through the rapid adoption of emerging best practice from other utilities, sectors and countries.

To that end we have and continue to evolve our iLab processes, with new overseas research/study visits this year, expanding our 'first line of defence' and SMNR catchment work in AMP7, right through to the significant evidence gathering we have completed in AMP6 in the marine environment. This investment has demonstrated that there is no need for any further significant National Environment Programme (NEP) investment at coastal assets in AMP7, which ensures a much better outcome for customers than the application of a precautionary principle approach to investment which is sometimes adopted in the absence of any robust scientific evidence.

4.3. Creating a culture of innovation

A key part of innovation is the fostering of ideas and the development of an environment in which employees are encouraged to take risks and test their ideas. The iLab is the focus for this, with simple business processes which enable ideas to be captured, tested for alignment

with our Welsh Water 2050 outcomes and business priorities and then driven, tracked and measured through the business. Since 2015 over 300 ideas have been reviewed by the iLab process.

We continue to take a leading role in UKWIR projects such as those for the development of

- Natural Capital Accounting;
- to support the 21st Century Drainage programme (which we lead);
- to develop our understanding of the presence and fate of plastics in our processes;
- and in the development of our graduates through the trialling of novel ideas creation processes.

We have also developed and hold each year an Innovation Leadership course through the Business School at Cardiff University to equip our managers, engineers and scientists with tools to think differently and so innovate. We also support and sponsor qualifications such as MSc's and other courses through universities.

Our colleagues, both internally and externally, can share ideas through our innovation web portal, and through our internal innovation forums, both of which encourage our colleagues to come together to discuss new ideas, technologies and products. Managed by our Heads of Service, they act as a catalyst to bring innovation into the business. Each project considered by the forums must contribute towards meeting the challenges set out in our 2050 Vision or it does not proceed.

The value of these initiatives are borne out in the staff survey results for 2017, with some 90% of colleagues now feeling they are empowered to make improvements and drive change within their roles; and 77% believing that their manager encourages them to come up with new ideas.

4.4. Incentivising innovation

Key to the success of our approach to innovation are incentives to fuel the process. We have therefore put in place the following:

- A communication strategy for innovation which ensures we see innovation as a solution to the challenges we face by capturing and communicating the value of our work
- A policy of returning the HM Treasury rebate on National Insurance contributions for research (so far over £2m in AMP6) to enhance innovation budgets and drive further value.
- We set objectives and targets through our Performance Management system to incentivise innovation, as linked to variable pay schemes.
- We proactively take up external leadership positions of influence e.g. with Research Councils and research funding / university water institute boards.
- We have created overseas study awards and other opportunities to gather and bring back the best ideas and the results of international research.
- We celebrate our success and enjoy the value we create, for example through our CEO Recognition scheme which includes awards for innovation
- We publicise successful iLab projects internally and externally

- We enter successful innovations for awards such as Institute of Water Officers (IWO)
- We fund and support public speaking opportunities for staff on innovation.

4.5. Communications

The aim of our innovation communications plan is to build trust by helping to create a culture of purposeful innovation within our organisation – a culture that delivers real customer and environmental benefits and business efficiencies. Our communications objectives are to:

- Help the company deliver an increasing number of real-world innovations targeted at delivering our 2050 Strategic Responses
- Raise awareness of the importance of innovation within the company, reinforcing internal perceptions of us as an organisation that's 'open to new ideas'
- Build our internal culture so that we remain a sector-leading innovative organisation
- Boost perceptions of the company as a leading innovator within our sector externally
- Provide the iLab with customer insight to ensure our investments remain aligned to customer priorities

4.6. Partnership and collaboration

Wales now has a single environmental regulator, and our relationships with environmental organisations, the Welsh Government and NRW are strong, not least through their involvement in our Independent Environmental Advisory Panel (IEAP). The work of the IEAP is explained further in our Stakeholder Engagement supporting document 1.2.

Wales also has legislation which places new sustainability and biodiversity duties on us as a company. The Welsh Government, in particular, works closely with us on innovation. Its 2011 'Science for Wales' strategy[i] sets a broad goal of supporting the creation of a centre of excellence for water and environmental research in South East Wales. This has been at least in part fulfilled through the creation of the Cardiff University Water Research Institute (URI).

We are represented on the board of the Cardiff University Water Research Institute as well as a number of other university doctorate schools which provide us with expertise in aquatic ecological research, data science, environmental engineering, evidence gathering and knowledge development.

We are the only company to have a strategic Memorandum of Understanding with NERC, who have supported a number of secondments of academics to be undertaken with us on catchment studies, as well as ensure NERC research calls are well focused on our needs and the needs of the sector.

Working with academia, both in Wales and elsewhere, is key to our success. We currently work closely with a number of universities in the UK, who support our research directly, offer some of our rising stars further MSc type education and leadership training opportunities, and work actively for government to shape the future of policy (such as in land use management). We use these relationships to both support our research and technology development needs, to leverage skills, resources and funds onto our research agenda, and to maximize the opportunities to shape the future. We do this by actively supporting university research projects and funding bids such as the £2 million Cardiff

University NERC-funded 'FRESH' doctorate school – now driving 12 PhDs each year to better understand the freshwater aquatic environment. This is key to the future drivers our wastewater treatment works investments.

Our strategy includes leveraging in funding and resources from such parties, and the use of our innovation work to build strategic relationships with universities and other members of our independent environmental advisory panel (IEAP).

To help build and maintain connections with key stakeholders, we host an annual Innovation Conference to share innovations that can help us to achieve our vision. This forum brings the latest technologies, innovations and products into the business from across the globe. Our 2018 Conference involved more than 400 colleagues plus government representatives, and regulators.

To date in AMP6 we have worked with over 130 companies to trial, modify and adapt their products to help us to improve our services. Just one example is the use of drones and underwater remotely operated vehicles to inspect the condition of assets that are usually expensive and hazardous to reach.

4.7. Measuring and reporting on innovation

The iLab process tracks and reports on the following measures:

- Effort expended: costs dedicated to researching, discovering, prototyping, and testing ideas/proposals
- The size of the pipeline of new ideas (number and value of projects)
- Patents filed
- Key external leadership positions obtained (e.g. chairs at Universities, NERC funding committees)
- UKWIR and Academic/Research Council engagement and value derived
- Earnings received from royalties etc.
- The focus of our work relative to our 2050 Strategic Responses
- Leveraged funding from 3rd parties (e.g. NERC and Doctorate schools)
- Employee engagement with innovation (2 measures)
- Innovation awards submitted and won

5. Our record of innovation

5.1. AMP6 innovation investment

We are investing some £39m (circa 1% of our turnover) across our innovation portfolio in AMP6, the largest single element of which were our coastal investigations at circa £9m. These have enabled us to renew all our coastal water quality models, and use these to assess further investments requirements for AMP7.

This investment has now been aligned with our 18 Welsh Water 2050 Strategic Responses.

5.2. Progress in AMP6 (to July 2018)

We have made good progress across our innovation portfolio in AMP6, indicators of which are detailed below.

- Investment remains on track to deliver well in excess £39 million of value over AMP6.
- We have over 100 projects in the iLab process at any one time.
- 1 group of patents filed for our sewer recovery tools.
- 4 Research Council Boards supported directly with Board membership (FRESH, WISE, RISE, TWENTY65).
- 330 projects assessed by our innovation forums.
- Worked with 130 partner organisations on innovation projects.
- 85 projects completed in AMP6 so far.
- 12 awards collected for innovation projects.
- Employee engagement at 90% and 77% for our two measures.

5.3. AMP6 innovation outcomes

The key innovation outcomes/objectives for AMP6 delivered so far are:

- Secured a culture of innovation throughout the business - as measured by our internal staff survey at 80% by 2020 (scored 90% in our staff survey in 2017).
- Set out a prioritised, Welsh Water 2050 focused AMP7 innovation investment program for PR19 by July 2018.
- Set out a clear well leveraged research portfolio for AMP7 by July 2018 (see Journey Plans for 2050).
- Set out the evidence and regulatory changes needed to secure more sustainable ways of working (e.g. to facilitate catchment solutions and new SUDs ownership arrangements through the implementation of Schedule 3 under the Flood and Water Management Act (2010).

We continue to innovate and work towards the delivery of our PR14 performance commitments on cost, carbon, customer service, and compliance.

6. Our plans for AMP7

Traditionally much of the innovation effort made by us and indeed the industry as a whole has been focused on the development and application of new technologies and treatment processes. This has led to steady, incremental improvements, which over the last 25 years have dramatically changed the way our services are delivered.

However, in AMP7 we are planning to accelerate our innovation programme and seek more transformational changes in the way we work with partners, with nature, and with new technologies. As part of this we will more than double our innovation investment, from £39 million in AMP6 to £86 million in AMP7, which will include developing a number 'disruptive' technologies for application in either AMP7 or AMP8. But perhaps more significantly, we will trial and implement new ways of joint working with government and other stakeholders, to co-design and co-deliver truly sustainable solutions that work with nature and communities. These radical changes will require new regulatory frameworks to be developed and applied, and the open sharing of resources, knowledge and ideas – matters we are already developing with the Welsh Government.

6.1. Targeted outcomes for AMP7

The main innovation outcome targeted for AMP7 is to make substantive steps to delivering the innovation outcomes detailed in the Welsh Water 2050 Strategic Responses. Each of these is set out in a 'Journey Plan' for each Strategic Response (see Figure 1 above).

Our innovation objectives can be summarised as follows:

- All future Welsh government and regulatory policy development in relation to water should as far as possible be well evidenced, and on that basis - affordable, fair, proportionate, and aligned with the needs and views of our customers.
- All our future investment is well evidenced – and specifically the 'precautionary principle' is not in the absence of sound scientific evidence, resulting in poor value investment e.g. further tightening of phosphate or exotic substance (e.g. pharmaceuticals) at Wastewater Treatment Works permits.
- Costs and energy use is reduced to meet our AMP7 targets.
- Services to customers are improved in line with ODI targets.
- The environmental / carbon footprint of the Company is reduced in line with targets
- Nature and Communities based (Market based Ecosystem Services - MES) investment processes are developed in partnership with Welsh Government and its regulators so as to deliver more sustainable catchment based outcomes for AMP8
- Our 'Trusted' Brand and the trust we have with regulators, governments, stakeholders and customers alike is enhanced.
- Our core value of being 'open to new ideas' is further improved as tracked through our staff survey with both staff survey indices internally targeting 90% by 2025.
- Our Health and Safety performance is further improved through innovative new processes as we journey to zero accidents.

6.2. Development of our plans

Our innovation approach or framework, centres around three pillars of people; finance and governance; and research and technology, in alignment with the themes in Welsh Water 2050 and Ofwat's PR19 methodology and 'Driving innovation in water' report.

These are set out in Figure 2 below and are further explained in Welsh Water PR19 Innovation Peer Review (Arup, 2018 – available on request).

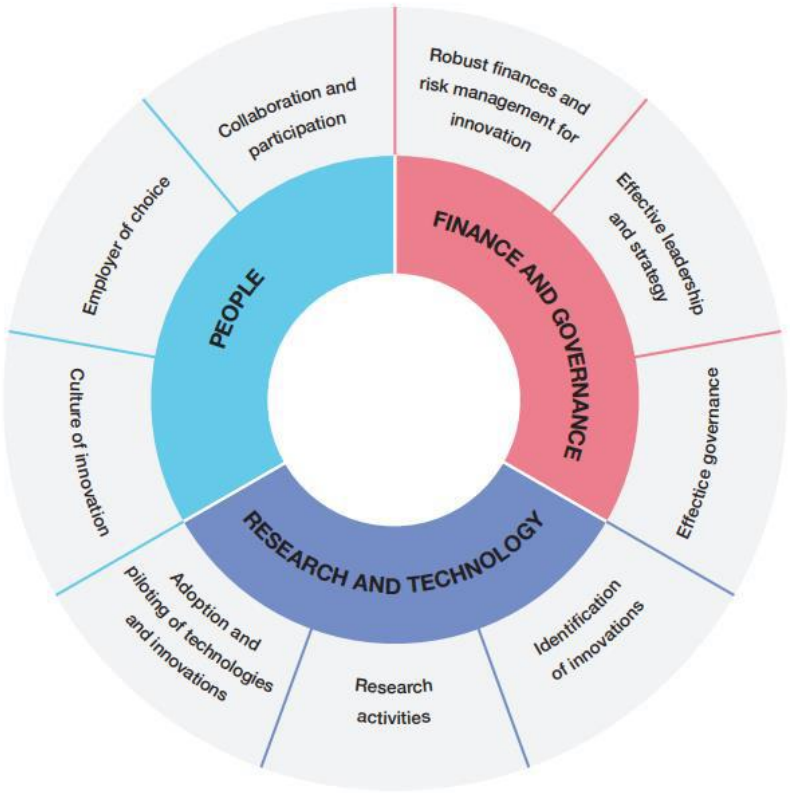


Figure 2: Welsh Water's Innovation Framework: pillars and goals.

Ofwat's 'Driving innovation in water' report outlines three components which are essential in delivering innovation in the water sector:

1. Culture: systems, processes and people which enable innovation to succeed.
2. Collaboration: within the organisation, with customers and our supply chain, and outside of our sector.
3. Technology: to improve understanding of the systems and networks, and efficiency of services delivered.

We are supporting people both inside our organisation, and in our supply chain and through our academic partnerships, to build innovation into our day to day ways of working. This means empowering colleagues to challenge and improve the way things are done, and ensure that effective solutions are diffused across the organisation. It also involves having a collaborative organisation culture. For us, this means encouraging cross-discipline internal

collaboration, maintaining strong relationships with academic partners, and reaching out beyond traditional research partners and engaging start-ups, small and medium sized businesses, other water and sewerage utilities across the globe, (notably in Denmark, New York, and The Netherlands) and government agencies together with their supply chains.

Secondly, we have effective internal governance processes which encourage and support innovation, provide appropriate funding, and capture learning. We see finance and governance as essential for allowing innovation to come to fruition and become embedded in our work.

Finally, we engage extensively in researching and gathering evidence on how our assets affect the environment. These insights help make informed decisions about the long-term options for the business, in terms of investment on behalf of customers. This monitoring and investigation work also provides the evidence base for helping government draft new more sustainable water and land use policy – essential if we are to be able to explore and develop new catchment based solutions to our challenges.

To help us meet our customer promises, there has already been significant investment in new technologies. Technology can aid better decisions by providing the right information at the right time and reduce costs and improve efficiency of existing processes. These contribute to driving down costs for customers, decreasing the carbon footprint and making the business a safer place to work for all colleagues.

Figure 3 below illustrates how the pillars and goals from our Innovation Framework are linked to our Welsh Water 2050 Visioning document. This in turn sets out our 18 Strategic Responses and the associated innovation 'Journey Plans' which are the basis for our day to day thinking on innovation.

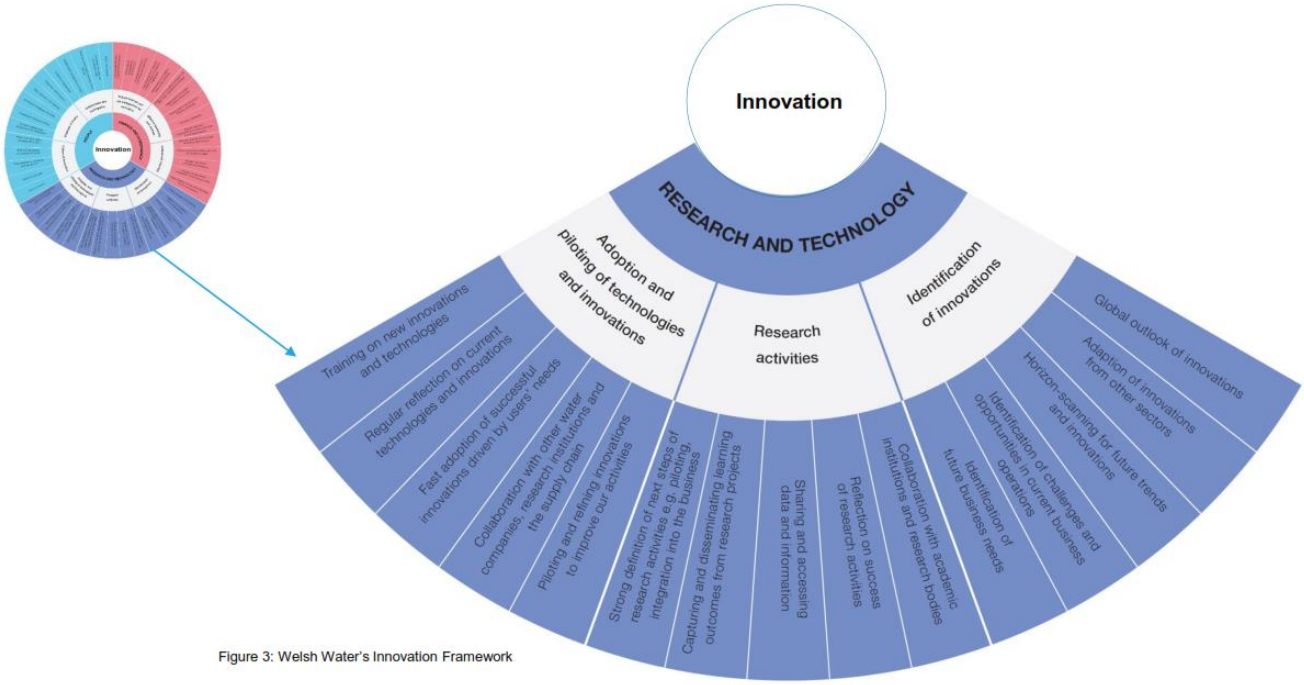


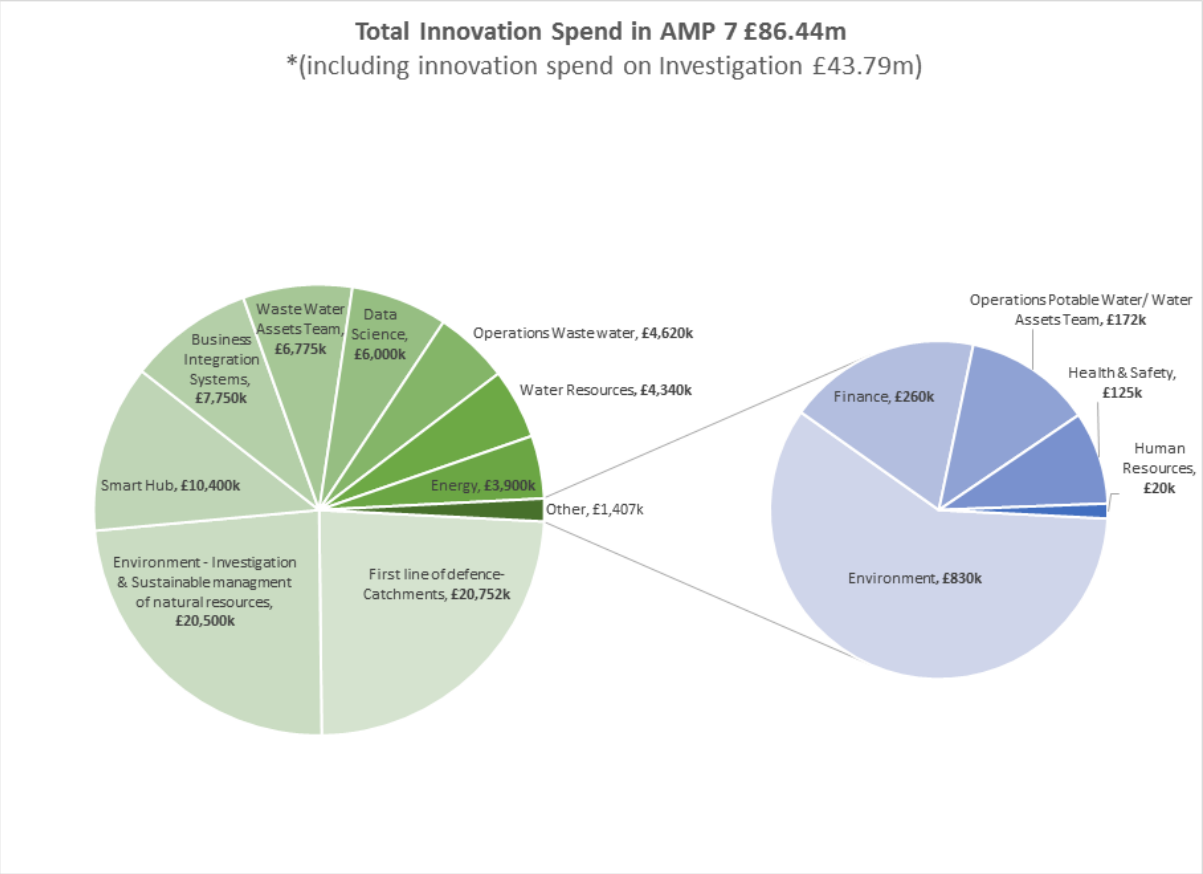
Figure 3: Welsh Water's Innovation Framework

6.3. Our AMP7 innovation proposals

By 2020 have invested some £39 million in innovation across the business as a whole during AMP6, including circa £23 million on NEP environmental investigations to directly shape the size of our AMP7 quality programme and/or shape emergent regulatory risks and policy development. We are looking to increase this investment in innovation significantly in AMP7.

Working through the iLab processes and specifically through the Heads of Service in the Innovation Forums, we have now collated a list of some £86 million of innovation related projects which have been prioritised and included in the business plan. These include a range of proposals to drive value, to improve services and to drive further efficiencies, including developing new business processes, technologies and data models.

Our proposed AMP7 innovation investments which represent an amalgamation of all the innovation related investments in our PR19 business plan - are summarised below by service area to illustrate the broad nature of our portfolio and how well innovation is now embedded into the business. Examples of these are also outlined in narrative detail in Section 6.4 and in Annex A.



Investigations

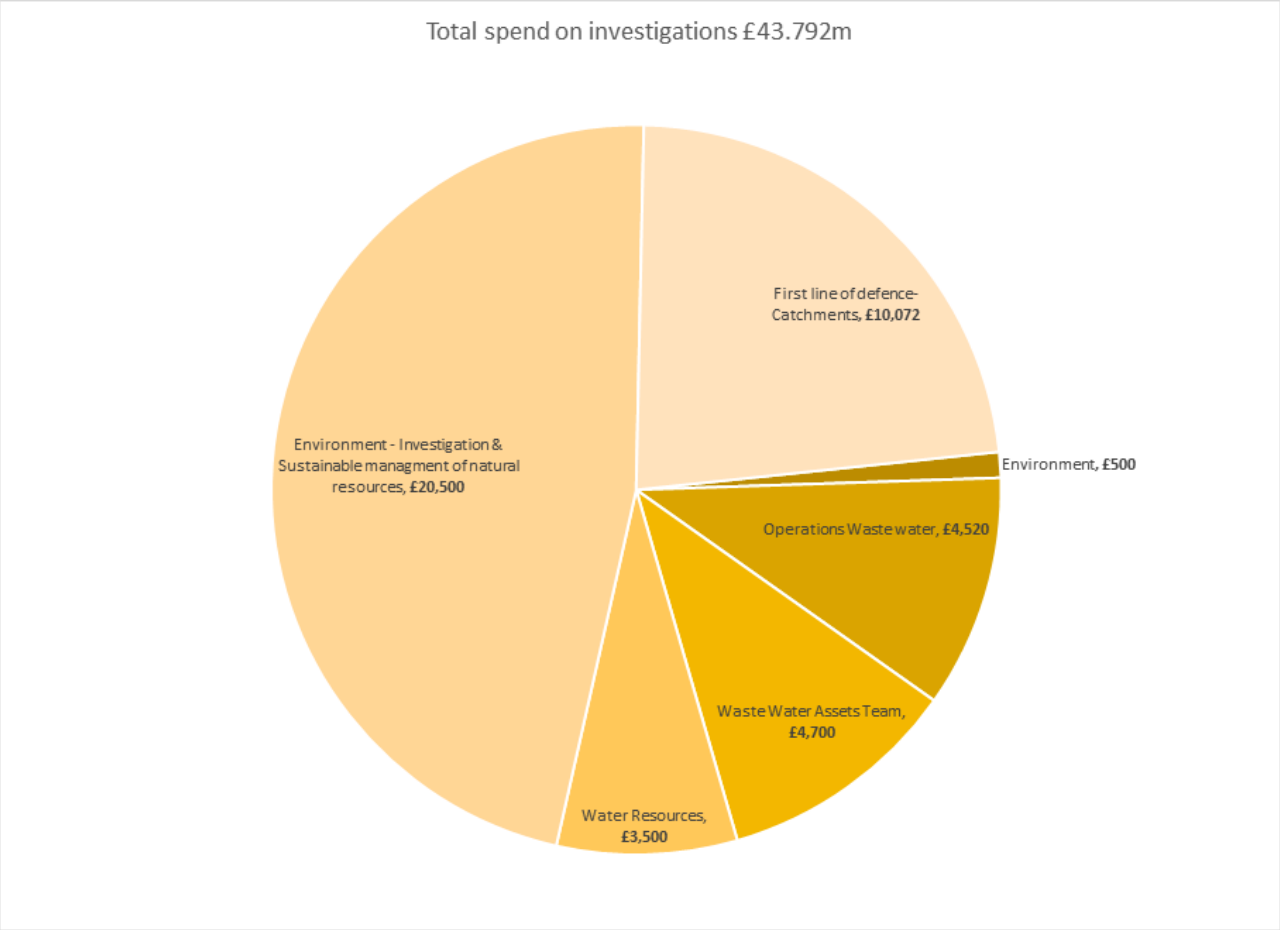
Our AMP7 innovation proposals include circa £44 million of catchment and other investigations linked to the NEP (Wales) and WINEP (England), or elsewhere in our business plans. These investigations can be split into three areas. The first is to support the development and implementation of nature based solutions to protect raw water quality for drinking water use, such as the Brecon Beacons Mega Catchment studies.

The second area of investigations will explore how to progress Sustainable Management of Natural Resources (SMNR) approaches to our wastewater challenges such as nutrient trading.

The third area will target potential AMP8 environmental improvements such as the further tightening of nutrient conditions in waste water treatment works permits. All three investigation areas will help structure and prioritise investment in AMP8 and beyond, and hopefully identify new and more cost-effective nature-based or catchment-based ways of working.

All of these investigations also aim to mitigate or eliminate AMP8/9 investment risks in relation to existing or emerging environmental regulatory standards. We recognise that in the absence of good evidence, regulators may take a precautionary approach to the application of new standards. Our investigations therefore will help regulators to make better informed decisions - which are in the interests of our customers.

Our investigations also seek to inform government and regulatory policy, again with a view to reducing long-term investment risks by deferring or eliminating what we see as poor value investment, or creating new regulatory frameworks in which to operate and co-deliver innovative more cost effective and sustainable solutions.



Research

Our AMP7 research investment at circa £4 million (and then leveraged to some £16 million – see below) is targeted at developing new processes, technologies and regulatory approaches, to reduce costs and improve performance. These will include the following research projects:

- The development of catalysis processes with Cardiff University to invent more cost-effective and efficient ways to treat water, and specifically to deal with the taste and odour compounds that are formed from elements of dissolved organic carbon we have in many of our upland raw water sources.
- Trialling new anaerobic processes for sewage treatment, which could be significantly more efficient in energy use than conventional aerobic sewage treatment processes. If successful, this process could eventually replace many of our wastewater treatment works.
- Refining our understanding of nutrients in the environment (and so explore the implementation of alternative approaches to reducing their levels in the environment).
- Exploring how best to deal with pharmaceuticals in our effluents, and how best to encourage our customers not to put plastics in our sewers.

Each of the 18 Strategic Responses have research requirements that we have identified and prioritised into three bands. The estimated costs of these are £9.9 million (high priority), £4.5 million (medium priority) and £2.1 million (low priority) – a total of £16.5 million. Some £4 million has been included in our AMP7 business plans; the remainder will need to be delivered by leveraging our research funding at UKWIR, and by securing NERC and university funding plus using all our National Insurance rebates for research.

Our research proposals have been reviewed by our Independent Environment Advisory Panel (IEAP), which includes NRW, Welsh Government, and a number of other academic colleagues who contributed ideas of their own. The Customer Challenge Group (CCG), which includes three IEAP members, has also been supportive of our approach.

The AMP7 research portfolio has been shared with the Water Research Institute at Cardiff University, and the GW4 alliance (Cardiff, Bath, Bristol and Exeter Universities) amongst others. We are working on scoping early projects to influence all of the UK Research Council members such as NERC while exploring other leveraged funding opportunities.

Technology and processes

Traditionally much of the innovation effort made by us and indeed the industry as a whole has been focused on the development and application of new technologies and treatment processes. This has led to steady, incremental improvements which over the last 25 years have dramatically changed the way our services are delivered. In AMP6 but particularly AMP7, as targeted by our 18 Journey Plans, there are a number of technologies which will need to be developed and applied, some of which will be disruptive by their nature and trigger the replacement of existing out of date treatment units.

6.4. Key examples of innovation in AMP7 plans

Examples of current and future innovations are found throughout our PR19 plan documents. Here we provide a selection of a few of the 'highlights' as an illustration of what is included elsewhere. Further examples are provided as Annex 1.

Catchment Management - Brecon Beacons Mega Catchment. Catchment management is our 'first line of defence' in ensuring that the raw water entering our water treatment works is of an expected, consistent and manageable quality. Our Brecon Beacons catchment supplies the majority of customers in our most populous South East Wales region (approximately 1.5 million people). A collaborative approach to secure the sustainable management of water and to ensure the long-term protection of the area is required to build resilience and ensure we can adapt and respond to future challenges.

During AMP6, we developed the *WaterSource* approach to catchment management (the collective term we use to describe all the work we need to do to better protect and improve the quality of raw water we abstract from the environment to make drinking water). This included the development of both 'Paid for Ecosystem Service' initiatives such as 'weed-wiper' - where we incentivised the use of different herbicide use by farmers – substituting chemicals with those that are far easier to treat in our drinking water processes; developing and implementing new processes in impounding reservoirs to oxidise manganese and so make the water easier the treat, and we developed the evidence base and associated policies with Welsh Government to enable nature based solutions at the landscape level to be pursued in AMP7.

Our AMP7 Brecon Beacons Mega Catchment proposals will build on work in AMP6 and trial the planning and delivery of catchment management at the landscape level, (i.e. covering a number of different river catchments which flow from the Brecon Beacons). These proposals will research, trial and gather evidence to evaluate new and different ways of managing land use so as to improve and protect water quality (while also improving the land's ability to retain water). In so doing we will improve ecosystems resilience and biodiversity and protect the potable supply for the majority of our South East Wales - 1.5 million domestic customers.

This approach will require new policies to be developed and implemented by the Welsh Government, setting and enforcing a regulatory floor to control diffuse pollution. Similarly it will need new incentive mechanisms to be developed and applied – as is being consulted on by Welsh Government.[ii] This approach is in many ways modelled on the successful approach used to protect water supplies for New York in the United States following a successful exchange of best practice between us, the Catskills Watershed Corporation and the New York Water Department at our WaterSource conference in 2018. It will be the first trial applied at this scale in the UK.

Our ambitious AMP7 plans have already gained significant support and interest from our partners, regulators and other interested parties and have the potential to redefine traditional catchment management thinking and inform new ways of collaborative working through co-creation and co-delivery with the third sector.

Sustainable Management of Natural Resources (SMNR) catchment projects. 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 three projects, on the Clwyd, Afan, and Teifi catchments (with a potential fourth under consideration) will set out entirely new ways of working to establish the optimum solution for a given river catchment, with regards to nutrient pollution for example. These solutions would then be co-delivered through some form of market-based ecosystem service (MES), such as providing incentives for farmers to reduce nutrient loadings from their land (in a manner which enhances biodiversity and ecosystem resilience) rather than further treat sewage effluents at significant costs to customers.

New treatment processes for disinfection by-products (DBP). The Water Supply (Water Quality) Regulations 2010 stipulate that water companies must keep disinfection by-products as low as possible without compromising the effectiveness of the disinfection in the water treatment process. In AMP6 we have taken part in two UKWIR projects identifying DBPs of concern and identifying treatment options. In addition we have been conducting trials in Anglesey using ion exchange to remove dissolved organic carbon in our raw water which lead to harmful disinfection by products. Moving into AMP7 we will move to apply treatment techniques along with catchment techniques to reduce DBPs, which will also help to meet our AMP7 targets for taste and odour.

Leakage – 'Project Cartref'. In AMP6 we have investigated a number of ways to identify leakage including taking part in the Stopwatch leakage detection trial to detect customer-side leakage. Moving into AMP7 we will develop new improved techniques for identifying leakage which will enable less skilled operators to pin point the location of leaks and the quantity that is leaking. Innovation will be key if we are to cost effectively deliver a 15% reduction in leakage. We also plan to be the first in the industry to offer leakage repairs and plumbing work within customer premises through Project Cartref ('Home'), which is reliant on the new 'stopwatch' technology that can detect background levels of leakage from customers` appliances. This background leakage is at too low a flow to be picked up by conventional meters. We will also be developing innovative new ways to engage with customers on reducing per capita consumption through behavioural change techniques and water efficiency devices.

Capital Alliance innovation. The Capital Alliance is and will remain involved with numerous innovations throughout AMP7. It will introduce new technologies and seek improvements to how projects are delivered in AMP7. A few examples are as follows:

- **Synchro Pro 4D** - this 3D visualisation tool pilot is being tested on at the new Prioress Mill Pumping Station and will be developed and used further for our AMP7 investments. It allows the construction sequences to be visualised in three dimensions reducing costs, time and health and safety risks. As well as providing visibility of future progress over time, construction activities can be sequenced to minimise local impacts and improve stockpile management to minimise double handling and emissions from site. Based on this pilot, we will review its use and roll out in other major projects for AMP7.
- **In Sewer Temperature Sensing -** The Capital Alliance are piloting the use of fibre optics in sewers to detect infiltration – one of the largest challenges we face, one driving significant investment at WWTWs in AMP7 and projected also for AMP8. The pilot consists of laying of a fibre optic cable temporarily in a sewer around 5

kilometres in length. Over several weeks, lasers are fired down the fibre optic cable with the monitoring returning echoes. The precise temperature can be ascertained every 3 metres and the temperature changes can be associated with infiltration or incoming laterals. This provides for precise repair locating, offering less disruption to customers and reducing costs.

- **Elios Remote Operated Vehicles (ROV) -** Using ROVs / drones for various external applications is becoming frequent. The Alliance are taking this further by using the Elios ROV internally for the visual inspection of a reservoir valve tower and tunnel. This removes the need for man entry to confined space and dangerous working conditions. The Elios ROV is small with a protective cage and gyroscopic correcting mechanism allowing it to 'bounce off' walls and other objects. Other applications in AMP7 could be tanks and other confined spaces.
- **Llanelli Waste Management Hub -** Construction projects usually involve either the disposal or import of 'fill' material. The Alliance are trialling the use of a common Waste storage site to be sited in West Wales. This involves using a site at Llanelli to divert hazardous and non-hazardous waste spoil to and from sites. This will improve the cost and carbon efficiency of the Alliance.
- **Decentralised Water Filtration -** Working closely with the Operations team, the Alliance are piloting the installation of a new type of small cartridge filter system to protect customers from discoloured water. Long mains often have sediment, deposition or corrosion products which are picked up at high flow events. The cartridge filters positioned at the end of these mains will remove particulate matter before the water reaches the customer, saving the cost and carbon of replacing the assets before the end of their life.

7. Continual strengthening of innovation

7.1. External assessment

We commissioned Arup, an independent consultancy to comment on and prioritise our proposals for AMP7 in light of a global best practice review. These have been supplemented by the views of colleagues.

These align well with our own findings and recommendations for refinements to our innovation proposals as detailed in 7.2 below.

In this way we can be confident that the AMP7 innovation and research portfolio represents a targeted and focused list of research priorities, that it is aligned with Welsh Water 2050, our resilience needs, and benchmarked and reviewed against global best practice.

7.2. Strengthening innovation further in the business

We understand that making significant advances in innovation will be essential if we are to become a truly world-class, resilient and sustainable water service by 2050. To help achieve this we will continue to adapt and refine our approach to innovation in the business. Highlighted below are a number of areas already identified through internal review to enhance our current iLab processes which we will drive in AMP7.

- **Traction in the business** – we will improve our ability to measure the value of innovation as it lands in the business;
- **Communications** – we will improve the effectiveness of communications activities to strengthen our culture of being open to new ideas, improve our ability to develop and implement new technologies, and communicate the value of our work to colleagues, regulators and customers alike
- **Regulatory risk sharing**. Develop further approaches with our regulators to share the regulatory risks we face when innovating e.g. on new catchment approaches
- **Alliance alignment**. Improve alignment between the company's and our Capital Alliance's innovation strategies to allow us to leverage our respective resources more effectively.
- **Trans-sector best practice**. We will do more to review international innovation best practice from outside the water sector.
- **Resource leveraging**. We will seek new opportunities to conduct and fund research jointly with our Capital Alliance partners, academia, other companies, and research councils.
- **Co-delivery at scale**. Establishing further co-delivery and collaboration approaches with other organisations at the catchment scale e.g. to progress the Brecon Beacons Mega Catchment proposal
- **Evidence gathering**. Develop further improved processes to understand the operation of our assets and our environment footprint better to arrive at optimum solutions for our customers
- **Data management and application**. Improve how we manage data, knowledge and information so as to arrive at more efficient and effective solutions and business processes.

7.3. Beyond AMP7

The 'Journey Plans' for the 18 Strategic Responses, as described above, will form the basis of our research and innovation agendas in AMPs 7, 8 and 9. The Journey Plans will be reviewed and updated every year, and formally reviewed with stakeholders as part of future periodic reviews.

References

[i] See https://gov.wales/topics/science-and-technology/science/?lang=en
[ii] See https://beta.gov.wales/sites/default/files/consultations/2018-07/brexit-and-our-land-consultation-document_0.pdf

Appendix A – Further innovation examples for AMP7

Public health improvements - In AMP6 we have been working on a number of projects to ensure the safety of our drinking water. These include understanding the sources, transport and fate of cryptosporidium oocysts in our catchments, advances in water quality analysers in our distribution network and advances in bacteriological analysis, both online and at the laboratory. In AMP7 we will continue to investigate innovative ways with universities such as Cardiff and Sheffield of understanding water quality in our networks and other projects/technologies such as the development of Catalysis and other chemical free treatment options.

Acceptability of water - In AMP6 we have been working with academia, such as Sheffield University and collating industry best practice so that we have now understand how to condition our water mains and treat our water to prevent dis-colouration. We have been working with Cardiff University to understand how Taste and Odour forming compounds are formed in our catchment and how we can best prevent their formation. In AMP7 we will continue to combat taste and odour forming compounds, investigate new mains cleansing methods and be involved in research into in-pipe robotics and understanding how these robots can be used to assess the condition of our mains. We will also support research in Catalysis processes to destroy taste and odour compounds, and hope to be able to leverage significant funds from other bodies in this regard.

Dam safety - In AMP6 we have developed a remote operation vehicle to perform duties in underwater pipes, which would have otherwise required divers to work in highly challenging conditions. In AMP7 we will develop remote sensing techniques to assess movement in our dams and to assess any structural issues arising. We will also use innovation such as ROVs, novel construction and safety techniques not normally used in water industry to achieve all the outcomes at affordable prices.

New sewage treatment processes. The drive for lower Phosphate levels in our discharges will mean we will continue to have to deliver and in time invent new treatment processes, we have piloted Blue Pro but other techniques at lower costs will be required and are currently in development. We will also need to develop different ways of catchment working to reduce Phosphate such as nutrient trading – these will require a completely new regulatory framework, supported by evidence and trails - which we will need to develop with NRW and a broad range of other environmental stakeholders in our IEAP.

Surface water removal – whilst Rainscape in Llanelli and elsewhere has been clearly cheaper than the conventional storage approaches we need to work with customers on lower cost ways of delivering surface water removal. We will need to work with customers to enable and empower them to take steps on their own properties through grants and incentives. We will also need to develop new processes to enable further local community engagement to leverage local resources in the same way we have done on our local community funded projects in AMP6.

Working in partnership with academia (NERC placements) – Building on our unique (for the water industry) Memorandum of Understanding with the National Environmental Research Council, we have and will continue to host placements for leading academics and NERC staff, to jointly work on developing our understanding of the root causes of the challenges we face. To date we have had 2 NERC placements:

- Dr Rupert Perkins, Cardiff University (2016-17) Integrated Catchment and Reservoir Systems Management – helped us further our understanding of the triggers of taste and odour, establish a

UK Working Group for Taste and Odour and we have published 1 paper with further papers to follow.

- Vanessa Banks, BGS (2016-17) - Embedding an expectation of geological and hydrogeological understanding to complement water resource catchment studies, helping us to develop our own risk mapping and modelling approach for catchments.

We will also work closely with NERC to leverage their funding towards our research priorities for AMP7.

Rhondda Fach customer engagement - Working alongside our £23m AMP6 investment programme to improve the water network in the area, the Rhondda Fach Water Resilient Community Project aims to work with the local community to ensure that our presence in area brings maximum benefits to one of Wales's most deprived areas. This place-based project is targeting activity to help meet the three key objectives of the local Wellbeing Assessment – to improve the health, wealth and assets of the area. From increasing the number of people receiving support through our social tariffs and priority services register, to education and behavioural change; from water efficiency to supporting local projects through our community fund; by working with the community to maximise the impact of our work, we hope to leave a substantial legacy in the area. We will be learning from this innovative pilot and roll-out the approach in other areas over AMP7.

Customer sentiment dashboard (next generation) - Our Customer Sentiment Dashboard has been developed by our in-house Data science team to improve our customer insight by tracking customer sentiment across our operating area using a range of data sources. The Dashboard visually represents sentiment on a map in real time of our area down to postcode level and by business unit or regional team. The dashboard also indicates the cause of the sentiment and alerts us of areas of concern where sentiment is falling. In AMP7 we plan to create a tool that also includes social media comments to help identify areas of focus for us to respond to, thereby improving our services to customers further.

Customer engagement tools (e.g. chatbot) - During AMP6 we have trialled a number of new innovative engagement techniques, including online focus groups, an online community and Facebook Messenger 'Chatbots' for engaging with customers. We are now looking at how we can develop our engagement tools further in AMP7, but making greater use (potentially in real-time) of our online community as well as the use of Facebook Live as part of our community engagement activities together with the potential use of virtual assistants (such as Siri, Alexa etc.) during incidents – all to create an innovative package of tools to better understand the short, medium and long term needs of our customers.

Data science innovation. Our Data science team has been recognised as one of the top 50 data science organisations in the UK. We will continue to develop a range of new innovative tools and statistical predictive models such as the Service Reservoir Bacteria Dashboard, the Treatment Performance Forecasting model (for Wastewater Treatment Works Compliance risk), and the Discolouration Predictive Model, and the Propensity to Pay model, used by the Retail Services team to better identify customers who may require assistance paying their bills. We will continue to operationalise their outputs into a tools that our data science team can use to manage risk in the business better, including:

- **Machine learning and artificial intelligence**. During AMP7 we will be looking to make use of the latest advancements in machine learning and artificial intelligence. This includes the use of artificial intelligence and deep learning that will provide better performing predictive models that can better aid decision making across the organisation. We will also be able to start utilising new

sources of data, particularly unstructured types such as images and audio, given that deep learning models are capable of working with such data. We will also look to progress to a space where our models become more 'prescriptive' rather than 'predictive', a situation where our models are able to prescribe the most optimal course of action required to meet a particular problem.

- **Operational research**. We will also build on the operational research based projects we have delivered in AMP6, such as the Sludge Logistics Simulation model. An advanced mathematical technique, discrete event simulation, was used to model our Sludge Treatment Centres, enabling the 'simulation' of individual components of the asset. This means we can evaluate how certain scenarios will impact our asset at no real-life cost or disruption, allowing us to understand how certain components of the process could be optimised to improve compliance and reduce cost. In AMP7 we will look to extend our use of operational research by applying simulation and optimisation principles to other domains. This may include, for example, the simulation (and later optimisation) of typical processes associated with the organisation, such as the Call Centre or water tanker locations.

- **Automation**. We will also continue to drive numerous automation projects, where manual and time consuming processes are replaced by efficient solutions that are fast and require little human intervention such as in our Regulation 27 Project. This provided an automated solution to replace the monthly reporting process previously progressed by over 10 colleagues within the Production team, taking over 200 hours to complete. The automated process can now be started by one individual and takes less than an hour to run each month. Several applications developed for the Smart Hub – including the eLibrary application – have again replaced previously manual tasks with automated processes, improving efficiency and accuracy, whilst also freeing up Smart Hub staff to deal with operational events when they occur. In AMP7 we will work closely with our colleagues in Business Information Services (BIS) to define and implement a viable infrastructure that supports the undertaking of advanced analytics. This includes utilising components that will allow us to obtain data more efficiently, such as Application Programming Interfaces (APIs), which will mean further projects can be automated. The capability offered by cloud computing services to develop and provide web applications for the organisation will also allow us to better collect and present data, enabling further analysis and reporting opportunities.

- **WISER**. In AMP7 we will also support the development of WISER (Welsh Water Information Strategy Enterprise Roadmap) data strategy. The strategy is a comprehensive vision and actionable foundation for the business to harness data-related or data-dependent capability. WISER also represents the umbrella for all domain-specific strategies such as business intelligence, data management and data architecture to determine a single view of all our data and thereby strengthen our ability to deliver the data components of Welsh Waters 2050 vision.