



Discover Climate Change – it's here!
How do we build in operational resilience?

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Key:

S = Stuart Moss

C = Caecilie Hougaard Pedersen

A = Andrea Gysin

ST = Steve Quarmby

K = Keith Gardner

T = Tim Baldock

C: Okay, I think that we will get started. Welcome everyone. Welcome to this eighth webinar in the Water Discovery Challenge series. Welcome to all of our regulars, but also a massive welcome to anyone who's joining us for the first time. Don't forget that if you are joining for the first time, you can watch the recordings of all of the webinars in the series on our website. Also, a massive welcome to our host today, which is Stuart Moss from Isle Utilities, and also a big welcome to all of our guests for today. Welcome to Discover Climate Change: How do we build in operational resilience? Feel free to introduce yourselves in the chat who you are, your organisation where you're joining from so that everyone can get to know each other. Before we get started, we just always cover a little bit of housekeeping, so if you have any issues doing the webinar, feel free to use the chat.

We have a team there who's ready to help you, and they're also going to be sharing lots of relevant materials and links throughout the presentation that you can use for any further research that you might want to do at the end of this webinar. At the end, we will have lots of time for a live Q&A. For this Q&A, we are using the platform Slido. The platform is live already, so you can use the QR code that you can see on the screen, or you can use link that is being posted in the chat to access the Q&A and add any questions that you might have in there. You can add questions during the presentation, or you can add your questions during the Q&A as well. We always hope to get through all of the questions. But if you do have any questions at the end of the webinar that is unanswered, you can reach out via email to us directly as well. Any questions that you might have for a particular speaker, you can add that when you ask the question, but otherwise we will open it up to the full panel. Without taking away any more time I'll get us kicked off and I will hand over to Stuart Moss.

S: Thank you Cecilia. As you heard this week, we are focusing on operational resilience across the water sector. In the previous webinars, we discussed water sources, treatment, distribution, usage, sewerage, wastewater treatment and resource recovery. Across all those areas, there are huge number of physical assets, pipes, pumps, valves, sensors, and a huge amount of human resource to make this complex and sophisticated water process operate efficiently. Therefore, this session will focus on the operational resilience of that system. Let's unpack that. In the UK there is an expectation that water will be available as we open the tap water of food grade quality and a bottomless supply of it. We also expect that the waste is taken away as we pull the plug or flush the toilet. It is 24 hours a day, seven days a week service. But there are internal and external factors that may challenge the water companies from providing the service that they want to and are regulated to do.

Some of these factors could be quickly changing temperatures from freezing temperatures to warm temperatures, which cause the pipes to contract and expand, which can cause pipe breakages and leakages. Then there's heavy rainfall and droughts. The water companies need to continue to supply through these events. There are many areas that the water companies need to be resilient in. They need spare parts, spare valves and pumps. They need energy and backup sources if the national grid goes down. They need chemicals and a store of those chemicals in case the supplier cannot supply. They need human resilience. There is an aging workforce in the sector, and we need to grab that knowledge and capture it for future generations. That's resilience. A plan B or even a plan C when plan A is sideswiped. Climate change is having a huge impact on the water sector. We are seeing an increase in weather events such as flash flooding and prolonged drought that impact water utilities.

The flood water will enter the sewer system and end up at the wastewater treatment plant, which is not designed for that high flow. There are large storm tanks to hold that storm water, which buys the utility sometimes to allow the plant to deal with the increased throughput. These storm tanks offer a preliminary treatment step. Then there is the opposite side of the coin where there is drought and no rainfall to fill up the reservoirs. Water companies need to manage those resources to keep the taps flowing. That is why we have reservoirs to store a large amount of raw water, but sometimes water needs to be tanked around the country or the water network is set up in such a way that water can be moved from one region to another region within that water company. There is also a big infrastructure scheme to move water between water companies from the northwest to the drier southeast of England. These schemes are all in place to ensure resiliency. Water companies are also working to reuse the wastewater when it has been treated as a water source, as a further line of resilience.

Unfortunately, there are still scenarios whereby customers are banned from using hose pipes or water cannot be redirected after a burst and water needs to be delivered to customers in plastic bottles. This is far from ideal, but is still a resilient stage, and that's still sometimes needs to be exercised. Let's explore some of these challenges. The asset base is aging. We have old cities and towns in the UK and the pipes are on average over 50 years old. They are being maintained and patched up, but typically

water companies do not have the investment to replace those pipes. Replacement is also very disruptive. Knowledge. Within the aging pipes is an aging workforce.

The experience and operational knowledge built up over many years is destined to be forgotten as experience operators retire from the sector. Growth. The population is growing, the increase in demand for water, and therefore water companies need to plan for not only an increasing drinking water demand, but the knock-on effect of increased wastewater production. Environmental. There is a drive to abstract less water from the ground and from rivers to protect habitats and the environment. Therefore, the water companies need to have resilient sources of water going into the future.

Chemicals and power. There are very few suppliers of chemicals in the market, and the costs can be volatile, and therefore water companies need to explore alternatives to remain resilient. There are plenty of opportunities to innovate in this area. A big growth area is around data and digital twins. Gathering data, analysing that data, and producing actionable insights. Preventative asset maintenance can be driven by data. Demand management can be driven by data. Condition assessment can be driven by data. This is an exciting area for development. That's enough from me. Let's hear from our guest speakers, Steve Quarmby, Andrea Gysin, and Isle's very own Keith Gardner. Thanks for joining us. Straight onto question one. What is your name? What do you do, and what does your role entail?

ST: My name is Steve Quarmby and I work in the innovation team at one of the UK's largest water companies, United Utilities. A big part of my role is to seek and identify interesting and novel ideas. The most exciting part of that search is to encounter unexpected and highly creative innovations. Sometimes as technology transfers from the non-water sectors, sometimes from small scale start-ups who often have very creative and thought provoking ideas, and sometimes individual entrepreneurs who approach problems with a radically different mind-set. Actually, to build on that, I'm not just looking for ideas. I'm looking for the genuinely creative people out there who have emerging, stimulating, creative, radical, transformative approaches to solving problems. My role is to be able to bring those people in the outside world with my problems in my world in a way that benefits both.

A: Hi, I'm Andrea Gysin. I lead the water strategic advisory team for WSP. WSP is a large engineering and professional services company, and for my team in particular, we focus on key themes for the sector, including net zero, innovation and digitalisation.

K: Hi, I'm Keith Gardner. I'm the managing director for the asset management and business consulting business line at Isle Utilities. Currently I look after the UK and Europe asset management business.

S: Thanks all. Great to have you join us today. Right. Straight into the second question. Tell me the biggest challenges related to building operational resilience from your perspective.

ST: That's a very far-reaching question, Stuart. Let me relate operational resilience onto a more personal level. All our customers in the northwest of England, and I'm one of them, expect to turn on their tap and receive instant limitless, fresh, clean water. Can you even imagine a world where that wasn't the norm? Operational resilience is how we work hard in the background to keep the taps flowing in the face of the many, many challenges that you all already be aware of from climate change, increasing population, leakage, micro plastic pollution, and the need for carbon reduction to reduce reliance on power and chemicals, all valid areas for attention. But there's a lesser known and ever-present problem I'd like to particularly share with you. The secret world of aging infrastructure, the inevitable decline and eventual failure of the pipes buried beneath our feet.

A: Operational resilience plays into every activity that a water company does. We often think about it in the context of assets and that is a major consideration. The asset base is aging and the service ability of those assets is in some cases declining. We need to find new ways to invest in our assets in a cost efficient way to deliver long-term performance and resilience. Our people are another factor. The workforce is aging, and with that we are losing the corporate memory of how to optimise the performance of our assets. We need to find new ways for institutionalising that corporate memory by using digital technology, for example, and finally supply chains. As water companies, there is a huge reliance on other companies to be part of the delivery of the service. That can be the people that support the design and delivery of new assets, or it can be the supply of chemicals that are required around water and wastewater treatment.

Resilience touches all of those activities and all of those aspects of the business. But for me, the single biggest challenge is climate change. Climate change is having a fundamental impact on water companies. Not only is water resource diminished as we face hotter, drier summers, but also we are facing increased severity, increased frequency of heavy rainfall events, and that's causing greater levels of flooding at an unprecedented scale.

K: For me, from an operational resilience perspective, I think one of the biggest challenges facing the sector overall strategically is the whole supply demand balance question. There's no doubt that with population growth, climate change over the next, 10, 15, 20 years we are becoming more and more water stressed and I think it's a huge challenge for us strategically particularly in the southeast where we are really struggling with having just fundamentally enough water available within the overall system to ensure that we've got enough resources that we can abstract from and make sure that we're getting enough of that water ultimately treated and then supplied to our customers in a resilient fashion over the medium to long term.

S: Yikes. Juicy challenges there. Climate change, leakage, power, chemicals, aging infrastructure, supply demand balance, corporate memory, resiliency covers most of the water cycle and sometimes plan A and plan B are not sufficient and further resiliency and redundancy and succession planning is required. The thing I love the most from those answers is around the expectation we all have that high quality water of limitless supply is available whenever we open the taps. The pressure on the water

companies to supply 24 /7. It's quite amazing, really. Onto question three. Tell me about an innovative solution you've tried, tested, reviewed to address the challenges and what were the outcomes?

ST: I'll do better than that, Stuart. I'll give you two. Underground pipes are inaccessible and hidden. We can't easily look at them to make assessments. How can we know if they are well and doing their job properly? We almost need a Fitbit to assess their health and a stethoscope to hear any problems. For the Fitbit, we've strapped strain gauges to the outside of some of our pipes to tell us the pipe's overall health. The strain gauge is actually the easy part, the complex and sophisticated analytics, if you like, the software for the Fitbit, was the true innovation that enables us to accurately predict the longevity of a pipe, a real health assessment. Now we know which pipes need intensive care to prevent problems emerging. For the stethoscope, we send a small acoustic puck about the size of a yo-yo inside the pipe, and it travels and listens for the tell-tale whistle of an unwanted leak. The emerging water makes a characteristic tiny noise, which is located by the traveling puck and tells us exactly where to dig to rectify small leaks before they become big ones. Like keyhole surgery to prevent a more major operation.

A: I've already touched on the importance of the weather on water companies' activities, and that's the example I'm going to use for a great innovation that really improved operational resilience. During my time at Thames Water, the innovation team that I looked after worked together with our operational control team to look at how we could reduce the risk associated with taking water treatment works out of service. Periodically treatment works need to be maintained, and that may reduce their capacity to produce drinking water. Now that reduction may be within normal tolerances, so there would always be some additional headroom, some capacity to produce more water than is needed. But if an outage were to coincide with a period of really hot weather where demand typically tends to increase, we could be in a situation where demand outstrips our ability to supply. This piece of work looked at taking long-term weather forecasts in order to understand when there was going to be a period of hot weather so that we could actually schedule asset outages, asset maintenance much more efficiently.

Thames Water working together with the met office were looking to understand the long-term weather forecasting, which in itself is a new area of research. But understanding that relationship to water company assets and operations. The upshot of that was we were able to use those sub seasonal forecasts to better schedule interventions on the assets so that we weren't at risk of having insufficient water to supply to customers. The really exciting thing is that same principle is now being tested to see whether we can better understand the risk of flooding so that we can schedule our interventions on wastewater assets on our sewers more efficiently. Through some funding from offload on the catalyst competition, that work is being done at the moment by Thames Water, the met office and a number of other partners to understand can we further improve our operational resilience on wastewater using sub seasonal weather forecasts?

K: Overall, when you need to understand the many, many components that make up the overall water balance in the supply demand piece, there's a number of components in there and some of the really...there're some big infrastructure options which are being assessed currently, the big strategic resource options, new reservoirs, big transfer mains. But for me, I think that we really need to make sure that we're addressing every single element across that water balance, which is a really, really complex picture. One of the things that we've done in the past in a previous role when I was in a water company that we were looking to tackle was our leakage numbers, and there's a lot of innovation and technology that can be deployed in a leakage context.

One of the things that was really successful for us was we actually looked at deploying...we trialled and deployed a new type of acoustic logger and correlator, which is around assessing the size of a leak, and then actually correlation is pinpointing exactly where that leak is. We trialled some new loggers from a Swiss company called Guttaman. That was a really, really successful trial for us. It actually was particularly effective on a particular type of main, the plastic mains, and it allowed us to identify some significant leaks that we weren't actually able to find through more traditional techniques of people going out on the ground and listening with listening sticks and what have you. We were really quite successful in reducing our leakage numbers.

At the end of the last amp which was the five year regulatory period, we were seeing the lowest level of leakage that the company had ever actually seen. Leakage is one of those huge challenges of that this sector have committed to some really, really ambitious targets and some ambitious reductions. Leakage technology, these acoustic loggers were a really successful trial for us, and ultimately, we deployed them into our workforce and to the best of my knowledge there, they're still using them today quite successfully.

S: We've heard a lot of variety there. We heard about the role of weather in resiliency using forecasts to plan maintenance. We heard about the big infrastructure options, the reservoirs, the transfer mains to build resiliency. But also leakage monitoring and reduction to manage supply levels. I love the Fitbit and stethoscope analogy. It reminds me of one of the previous webinars where we heard about keyhole surgery for repairing pipes. We're turning into water doctors here. Final question. Tell me about the key innovation opportunities within resiliency.

ST: Well, those two examples I just gave you were cultivated in our own innovation lab accelerator program. Both were small scale start-ups that agreed to work with us, and we gained their agility, creative thinking, and brilliant ideas, and they got access to our huge resources, data sets, expertise, and support. Actually, three of us benefited, our company, their companies, and the water sector as a whole. The greatest opportunity is to pool the creative talents outside the water sector with the knowledge and expertise of those in the water sector through our mutual growth and enrichment of the industry as a whole. I'm actually one of the assessors for the Water Discovery Challenge.

I'm really looking forward to the opportunity to be personally involved with some of you watching now, and I hope you've inspired to come forward with your insights and

energy. Oh, just to make it real, those two small companies as I mentioned, the Fitbit was Data Techniques based in Manchester who specialise in pipe health analysis. Stethoscope was Fido based in [unclear 0:22:13] in Oxfordshire, who innovate in acoustic miniature detection and analytics equipment. Both joined our innovation lab with prototype ideas, now they're expanding enterprises with real world products and employing staff. Look them up, Data Technics and Fido. It was a pleasure talking to you all. Thanks for those questions.

A: Operational resilience presents a huge number of opportunities for innovation. The one I'm going to call out is very broad in its own right, and that is digitalisation. The potential to digitalise our assets presents an opportunity to reduce the risk of performance outages, both in the short term and also understand our asset performance in the long-term. That's everything from different types of monitor to monitor our assets, and of course we have loads of opportunities to do that today, but often the cost of the monitoring technology is preclusive. So in part that's about the potential that digitalisation presents to have lower cost monitoring technology so that we can monitor our asset base more widely. The second part of that is the data that we have available. That's not just new data from new monitors, but also making better use of the data we've already got through data science, and there've been some brilliant examples of how this is already happening in the sector, but there is undoubtedly more and in particular where there's opportunities to layer different data sets together.

So data relating to the physical asset, the material of construction, the age of the asset, the interventions that have been undertaken, some maintenance that's been undertaken on those assets with the operational data sets. What's happening in terms of the level in a sewer or the temperature of a digester and understanding how those various different types of data interrelate and what we can learn from that. For me, digitalisation is the way we're going to drive our asset performance, both in real time but also it will help to inform asset deterioration, which will help to inform investment and I'd love to see more innovations in that space.

K: For me, I think the key innovation opportunity ultimately around the whole supply demand balance is going to be really assessing the overall system effects at a macro level, so understanding the interrelationships across all the very different elements of the water balance. I don't think it's a problem we can build our way out of. I don't think just building big new strategic resource options is ultimately going to be the answer for us. I think it needs change right across the whole system. That's supply side and demand side, customer behaviour, smart metering and all the technologies that are available for deployment across that whole system. I think the real challenge is going to be effectively adopting innovation and making sure that it's effectively implemented. I've seen lots and lots of examples of some really great sort of bespoke individual innovative technologies that we've trialled that ultimately have never actually been adopted or implemented.

I think that's the key opportunity. I think there's lots and lots of really, really good technology out there, but I don't think technology on its own is ultimately the answer. I think we're going to have to...is going to require behaviour change and understanding that whole system dynamic at a macro level. I'm talking about zooming right out,

looking at the big picture and understanding how we can achieve the ultimate efficiency and effectiveness across all the different elements that make up the water balance.

S: Thanks all. We heard about the need for a macro level view, that you cannot only build your way out of it. It's not just about the new infrastructure, it's about customer behaviour change, smart metering, digital twins, data capture, data science, combining physical asset data such as age and condition with the operating parameters. Thanks to all our speakers, Steve, Andrea, Keith, really appreciate your views and input. Thank you. To summarise, the water system is vast and complex and aging with lots of legacy systems, metal pipes, plastic pipes, hidden assets, digital assets. There are internal and external factors that can derail water companies' operations. Be that flooding, drought, population growth. There needs to be multiple layers of resiliency to allow for that 24/7 service. Operational resiliency needs to be explored at a macro level, thinking about everything as a system, the infrastructure, the people, the sensors, the data, customer behaviour change, they're all items that need to be considered when looking to be resilient.

This has been the eighth in a series of 11 webinars as we travel through the water cycle. Keep an eye out for the future sessions. We will now transition to the Q&A session. I hope you've been thinking through some questions and populating them via Slido. We invite all speakers to come off mute and I'll pass back over to Cecilia to chair the Q&A.

C: Thank you very much, Stuart. We will definitely be jumping straight into the Q&A. I have seen that the questions have been popping in during the presentation. Before we just get started on the questions, just a quick note to everybody in the audience that we've launched a little quick poll. It's five questions in total. We'd be super grateful if you just take 30 seconds just to answer that. It gives us a lot of insight as to who the audience is and how we might improve on the last few webinars in the series. Before we get kicked off with the Q&A, I just wanted to give two of our speakers today a chance to introduce themselves as they joined a little bit later and weren't part of the presentation. We will jump over to you first, Tim, if you want to come off mute, turn your camera on and just give a quick hello and introduction to our audience.

T: Hi everyone. Thanks for letting me join you today. My name's Tim Baldock. I'm a principal consultant in asset management at Binnies UK which is a multidisciplinary engineering consultancy in the water sector. I've been with Binnies for a few months and prior to that I spent 17 years working in Southern Water across various roles. That's me.

C: Great. Thank you very much. I think that we might have lost Martha as well, but if she's coming back, then we will get her to introduce herself when she comes back. We will jump straight into our questions for today. We'll ping the first one over to you, Andrea. But Tim, feel free to jump in if you have anything afterwards. The first question that came in is what's currently the bigger stressor on the water sector operations in the UK?

A: Thanks, Cecilia. I'm tempted to say climate change and the impacts that's having on the weather, but as I already talked a lot about that in my clip earlier, I'm going to go with a different one. That is we are heading for one of the biggest ever investment programs in the UK water industry. In the next regulatory cycle amp, it promises to be investing probably two to three times the amount we've invested in previous amps. What that means is we've got a real challenge on resources. That's impacting water companies, it's impacting the supply chain, and we are simply not going to meet that challenge by employing more people. The people aren't out there with the right skill sets. That really requires innovation in terms of how we drive efficiency in delivery. How can we automate? How can we reduce the relationship between outputs and people?

I think that's a real opportunity and again, it links to that digitalisation piece around how can we use technology to automate some of the things that previously were being done by people. Some great innovations coming through in terms of automated design, for example, offsite construction, all of which reduce the dependence on people. I'd go with that, but really interested to see what Tim's thoughts are as well.

T: Hi, there. Thanks, Andrea. Yeah, in the context of climate change, there's quite a number and I'm not sure exactly what everyone has covered previously, but certainly from my experience, the two main ones essentially affecting both water and wastewater networks are there's big temperature swings and they are coming more and more frequently which causes all sorts of issues. From a network perspective, the ground movement associated with three, four events causing buckling of joints on pipe works and leak, et cetera right through to effectively surface water having a significant deterioration quite often after heavy rainfall events. That puts more pressure on the processing cleaning systems, which will have been designed with a particular period of reprieve if you like, a break in between those events. Some of the attenuation capacity is potentially put to the limits.

Temperature swings also impact some of the biological treatment processes that operate on the waste water treatment side. You have a tendency for the biology to react differently to different temperatures, and particularly when it's in that transient phase, you often produce a lot more of the by-products that we term sludge from those biological processes that then the attenuation and the storage capacity and the logistics that go with dealing with that sludge are put under a lot of pressure. They're coming some of the climate impact elements of resilience, but I would call out another one, which from my networks within the operational world that has reared its head recently, has really been around the lead times on spare parts. There is a huge problem with parts that are coming from all over the world and this has been generated through Brexit and COVID amongst other external factors which have effectively resulted in weeks and weeks and weeks of lead time for critical parts for infrastructure and assets that ultimately are delivering these services to the customers.

There're two that I really want to call out and I know that some of those water companies, they're moving back to having large storage spaces and spares management systems that are built in. I think there's probably some innovation in that

area from other sectors that the water industry hasn't necessarily been doing that for a number of years could learn from.

C: That's great. Thank you both. Leaving a little moment there to see if anyone wanted to jump in. Keith, you unmuted. Is that for the next question or did you want to add anything?

K: No, no, I was waiting for the next question. [Laughing].

C: Waiting for the next one. Okay, great. 'Cause we're going to ping this one straight over to you. The next question that we're coming in is are leakage numbers similar across all of the water companies? Or do some have bigger issues than others? I think this is probably a response to some of the things that you set in the presentation around water leakage.

K: Yeah, sure. The thing with leakage, I think is there's definitely variation across the sector and some companies do have bigger challenges than others, but also you've got to recognise that the challenge is very different across the different businesses because of...that'll be geographies, that'll be population, it'll be the type of countryside they're supplying over. It may be the age of their asset base. Some companies have had quite significant means renewal programs where other companies went a slightly different direction at the beginning of our post privatisation period. There's definitely variation and variety across the sector, but what I would say is that overall, the UK, I know we beat ourselves up a lot about leakage and it's definitely an area that we need to get better at. We are not actually really a massive outlier in terms of Europe. There's countries in Europe, if you take non-revenue water, which is a slightly different calculation to leakage, but that's over water losses. Places like Bulgaria are still at 60% leakage or non-revenue water loss.

We are typically around about the 20% mark, and then you get to countries like Denmark and the Netherlands, which are below the 10% territory. There's no doubt that we can do better. I think to Andrea's earlier point, the next five year regulatory period is going to be a really challenging one for us for a number of reasons. We've got some really, really ambitious targets in terms of reducing leakage by 2030. I go to my earlier point, I don't think we can build our way out of it. It's just not viable or feasible to just replace all the pipe networks and even if you did that, you wouldn't achieve no percent leakage because of the challenges we've already discussed around, whether free store pipes will expand, they will contract and you would always have losses in the network. There's definitely lots of opportunity in there. I won't get into the whole water balance piece 'cause I see there's a later question around overall behavioural change and everything else. I think Steve was going to...maybe has a bit of a build on the leakage question as well.

ST: Yeah. Thanks a lot. Am I on?

K: You're on. Yeah.

ST: I'm on. Great stuff. Just to build on what you just said. There are definite regional variations. For instance, some areas are highly urbanised and the pipes that were put in place may have been used to horses and carts rolling over them, but when you get 30 ton juggernauts going over every single day, the ground movement, the disturbance to those pipes just stresses them beyond their natural life cycles, so you may get premature failure. Of course, those failures occur in areas where actually they're very hard to get at and cause enormous disruption in town and city centres. There's always a reluctance to actually go in there until the very last moment. What we're looking for, if we can, is non-invasive ways of getting to pipes, ways of fixing pipes from the inside out, if that's possible, and certainly keyhole surgery type approaches to excavations to minimise the social impact as much as the resilience effect it has on the water companies themselves.

You mentioned geography and such, so in areas where you've got heavy clay soils, the pipes will behave differently than ones that are in say, chalky soil because the soil returns and attracts water seasonally that causes the ground to swell and move. That gentle swelling and movement you might think it doesn't have much impact on an iron pipe or of a plastic pipe, but actually over many, many decades it does. Pipes are actually part of a dynamic system. That system is called the ground and it's not as firm and fixed as people assume it is. It actually is subjected to many, many changes including temperature changes. We've got penetrating thrust, it affects the temperature of the pipe and the content, and it can even as say, in shallow distribution pipes cause them to fracture which again, unwelcome 'cause the water expands more than the...ice as water expands more than water. Yea.

A wide-ranging variability. Generally speaking, older parts of the country or those that had industrial revolutions earlier generally are built over their older assets and struggling to rectify the leakage that arises from those deteriorating assets. Which as I said, are so fundamental to our infrastructure and basic urban landscape. It's actually very difficult to get at them now. There's also usually gas pipes and electricity pipes and communications cables above them as well. It's a whole nightmare to actually rectify what would appear to be a very simple issue of bringing pipe condition to a modern-day standard. Hence we have lots of leaks and other difficulties. That'll be my take on it.

C: Thank you so much both. I'm slightly worried that we might have a lot of leakage questions coming in after this. There's clearly a lot of knowledge on that. We'll jump into the next one. Andrea, I'll ping this on your way first, but Tim, feel free to jump in afterwards as well. But a question has come in around whether could increasing the numbers of water butts in homeowners...could the number of water butts installed by homeowners help the resilience to rainwater events and contribute to water availability through droughts?

A: Yeah. Great question. Thanks, Cecilia, the answer is yes. One of our big challenges with more frequent, more extreme rainfall events it's not necessarily even about the absolute amount of water. It's the rate at which it falls, and of course, because we have lots of paving in urban areas, lots of impermeable surfaces, that water runs off very quickly and it all ends up in the sewer system. The sewer system simply

isn't designed with the capacity to deal with those rainfall events. Being able to capture that water so that it doesn't get to the sewer, is really important. Now those of you who are listening to this and have thought, "Well, hold on a second, if a water butt is full, that doesn't really help." You're absolutely spot on. What we see is solutions called smart water butts or subs planters. These are systems designed to essentially stay empty or have alternative ways for example a mix of media soil aggregate to capture water and to capture falls and to attenuate the flow in the sewer.

It's not stopping the water getting into the sewer necessarily, it's just slowing down the rate that the water gets into the sewer. I'll post a link in the chat. Thames Water, for example, has been working on a sub planter which is a passive solution. Essentially it has two tanks, one that the homeowner can use to fill their watering cans, water their garden, the other tank, which just slowly empties. It fills up in a rainfall event then slowly empties into the sewer to attenuate that flow. Therefore, it's ideally empty when the next rainfall event comes along. You also get smart water butts, which are similar concept but there it's actually a digital solution so that the water company or whoever controls it can actually control when the water butt empties into the sewer. Yes, water butts really important part of the solution and there's just a little bit of subtlety there, which hopefully my explanation was helpful. Tim, any thoughts?

T: I think yeah. I think you covered most of the things that I was going to say. The only other element of that of course is, can it contribute to water availability during droughts? Which I think the obvious answer is yes, but obviously those sorts of smart technology water butts, there needs to be some management around that because obviously during those periods of peak water demand. Actually, a lot of the problems that are suffered during the hot summers, is not necessarily around the ability for the water sources themselves to be able to cope with demand. It's often that the actual networks that move the water around don't really have that peaking factor in their design to be able to deal with everyone wanting to run things like hosepipes. Is the thing that people traditionally point towards and obviously hosepipe bans make the news. If there is a reservoir or a water butt or something that is there that can serve the purpose and lop some of that peak off the network, then those sorts of interruptions for customers are going to reduce. Yeah, it's a good thing.

C: Excellent. Thank you so much, both of you. We'll jump straight into the next one. Keith, we'll ping this on your way first. To build resilience, is innovation mostly needed across operations, water sector asset management in that area? Or is it more looking at consumer behaviour?

K: Thanks. That's a great question, isn't it? I genuinely believe that if we are going to achieve resilience at a system, a holistic system perspective, it needs addressing throughout the whole value chain, if you like. I think there's no doubt that the companies have got to look at innovation internally and things like leakage reduction is a really, really big factor. But there's also undoubtedly the demand side question has got to have a huge influence in actually achieving that overall supply demand balance. I think it's really interesting and I don't want to be too controversial, but I think it's really interesting that the water companies are ultimately accountable for per capita consumption within the general population. Ultimately you are asking a water company

to influence people's behaviours. What we have seen actually post COVID is that people's behaviours have fundamentally changed. COVID caused us in the role I was in immediately prior to this, a whole raft of issues in terms of people's behaviours changing, people not commuting to work. There was definitely a shift from non-household to household consumption and the first lockdown, it was particularly nice and warm and sunny. Trust me, I tried, tried buying a hot tub at that point in time, it was almost impossible.

Gardening was also something that people took up as a hobby and they're still doing today. There's definitely been a shift in terms of people's behaviour. There're some really, really interesting case studies out there. If you look at the Las Vegas Valley Water Department and the Colorado River, there's some really interesting examples of how they've been able to change behaviour. But of course, they're in the desert supplying water to customers, and they've actually got legislative powers to stop people planting ornamental grass, for example. They have water cops driving around looking to see if you're using your sprinklers when you shouldn't be. We haven't really felt that level of pressure yet in the UK, but I do think planning regulations are a big area that need to be looked at. Efficiency labelling of white goods is another area which could really have an impact. But again, it is a whole system piece. You can't just target two or three elements of this because you'll need to address everything.

The other really interesting thing, I've been working with an electricity distribution business for the last year, and they've just gone through their equivalent of the five-year regulatory cycle. They call it RIIIO-ED2, which is the same as price review PR24 for us in water. Of course, what the energy companies have seen is they've seen a demand side reduction, which has happened as a result of cost, and we just don't have that cost and price incentive in water because you don't feel the effect as a consumer the same as you doing your electricity or gas bills. They've got some real challenges in terms of net zero heat pumps, photovoltaics, and connecting to the grids and grid capacity. But they've also seen customers' behaviours change as an effect of cost and pricing. We're getting to the question now of, do we undervalue water? Is water undervalued for our customers? Because the reality is a typical water bill is what? 450 pounds a year? It's not 3,000 pounds a year. Don't completely accept that that 400 pound a year for some people is a really difficult price to pay. Particularly unmetered as well, our meter penetration probably is nowhere near where it needs to be to start to drive that behavioural change.

I guess that's a really long-winded answer to the question you've asked there, but I think it needs all of the above. I think it's only going to be when we really get a holistic position. We are much better today than we were maybe five, 10 years ago. The big regional bodies, WRE, WRSE and all the others. We've had a national strategy from the environment agency, so we are getting more joined up where obviously water resource management planning previously was done in silos and individual companies did their WRMP without any consideration of the bigger picture. We're moving in the right direction, but I think there's still a long way to go.

C: Right. Thank you very much, Keith. We'll jump straight into the next one. I think this is quite a specific one. We'll ping this to you first, Andrea. One of the

audience members have popped in a question to say that they're interested in exploring, linking a real community engagement for demand alongside a subs and financing approach at a neighbourhood level, and is looking to maybe get some quick feedback.

A: Yeah. I think it's a, it's a great initiative. Building on what Keith said around customer engagement, it's such a vital part of the choices we need to make going forward. I think Bayes...well Bayes' was estimate that something like 40% of the interventions we need to drive down carbon emissions require people to make green choices, so to change their behaviours. Specifically on this one I'd point you to, and it is another example from my past I'm afraid, but in terms of water together with Exeter University based spin out called Our Rainwater and several other water company partners launched a project funded through the catalyst stream called Towards Incentivisation of Community Centric Rainwater Management, really catchy. We were going to call it How Big Is Your Butt? Which I think would've been much more fun. That project seeks to do exactly that, to look at how you can incentivise householders to engage with subs measures. So really worth reaching out to the Thames Water and our rainwater teams to understand a bit more about how they're doing, and we'll post the link to that project in the chat.

But essentially to my mind and from the experience both at Thames Water and in WSP where I am now, that community engagement piece is absolutely critically important, not just to the adoption of subs, but to the long-term stewardship. Which of course is one of the big unanswered questions that perhaps can be a barrier to adoption. Yeah, really keen to see more solutions coming forward in that space.

C: That's perfect. Thank you, Andrea. As well to the person who asked this question, if there's any follow up or if anyone is looking for really more specific feedback or any particularly detailed questions, you can definitely email them through after this webinar as well and we'll try and address them directly via email. We'll jump straight into the next one here. Steve, we'll throw this one you away first. Keith, I think probably you can jump in after. Do you think, and I think our entire panel, so anyone else, apart from Steve and Keith, feel free to jump in as well. But do you think that you can build out risk to infrastructure from the increasing risk of severe droughts and flood events, given that we can no longer trust the one in 500-year event?

ST: Yeah, that's a thought-provoking question, isn't it? It cuts the heart of the real-world challenge that we face. I'm going to summarise the answer and tell you yes, I think we can. I'm going to tell you why. If you look at the existing network, it was originally built as a passive system. It's simply in the case of sewers, it simply received whatever was presented to it. Now we think in terms of a modern approach, we'd actually build a smart network, one where there's activity, including at the very start predicting the rainfall that's likely to fall on it using met office data. We then monitor the actual flow and level of sewage in the sewers, monitoring them, level control, automated controls of pen stocks and valves and actuators and pumping to proactively shunt and slush fluids around in anticipation of other fluids coming behind it during the course of rainfall. Bringing on extra storage tanks, closing of other conduits down and such like. That's actually quite an exciting development.

We actually do have the luxury and benefit of having the opportunity to play with an existing system. The system we've inherited is a passive system. We now have the opportunity to use modern technology to enhance that and bring it up to a modern standard. What are some of the enablers for that? Well, some of the enablers for that will be sensors. Sensors traditionally in sewer systems have been placed in an aggressive environment and often failed and let us down so we don't trust them. But if we could have a large number of pervasive small low cost everywhere, then we could afford a little bit of attrition and a little bit of loss. We'd get that pervasive understanding of what's going on. If those sensors could be made to have low power requirements, batteries lasting six, seven, eight years, that puts down the maintenance requirements as well. With one, communications. Again, modern technologies like low cost, lower run and low large area networks will enable us to actually connect those networks of sensors cheaply without having to have copper cables, which was the previous requirement in the past way of looking at things. If we've got those sensors and those communication systems, then what we need is analytics that can actually bring all that data together and sieve out all the false positives and false negatives and actually give us useful and meaningful data, which we can then use to drive changes in the system, changes in the network, and actually proactively manage it and balance flaws and balance the demands and the conflicting requirements that are placed on the system at any one time. A simple example of another technology in there will be edge computing. We'd want a lot of the activity and analytics to be done actually at the point source of activity so we're not bombarding our central systems with huge amounts of data. Simple decisions are taken at the point where they're needed, even if they're using complex and really cutting-edge analytical capabilities to make those what appear to be simple decisions.

But if you cross compare our network with a biological system, what things that we take for granted, simple movements or looking around or simple activities are actually a combination of millions and millions of nerve activities that are taking place that we simply don't recognise or realise are happening, but they are necessary to make very seamless activities, look very simple in a complex and dynamic environments. I'm very optimistic that we can take the existing systems and the existing networks with all their legacy issues, but actually make them fit for purpose for a future world which has got more stresses and more demands on it using the best of modern available technology. Once again, I'm very optimistic that we can actually crack this one using the available capabilities out there.

T: Can I chip in at that point? 'Cause I...

C: Yeah. I was going to say Tim and Keith, you're more than welcome to pitch in, but if we can keep it nice and short.

T: Yeah.

C: We're very low on time.

T: I completely agree with what Steve has said. I just wanted to urge that a passive system is in itself relatively resilient because there isn't the same number of moving parts and steps in a process chain of sensing decisions, et cetera. What the water industry from my experience has suffered with, has actually been keeping those kinds of intelligence systems alive, keeping them active and not just installing them and walking away and then wondering why it doesn't work. There needs to be that support framework that goes with it. The asset management that follows needs to be different. You're dealing with a series of relatively short life assets compared to a pipe, which is a comparatively long-life asset. That needs to be given consideration. Then the service and the maintenance, the up skilling of the staff and all those things, they need to all be part of it. I think that there's some core innovations in those support areas as well as the actual digitalisation and the smart networks themselves. Yeah, that's my say.

C: Anything additional, Keith? Or are we happy to move on?

K: I suppose in the interest of time, I'll be really quick.

K: Probably gathering, I'm a big advocate for the kind of systems thinking big picture piece and I'll just give you a very, very quick story which has always resonated with me in this space. In the Cumbria floods in 2015 there was a village on an island where the bridge was washed away and they were unable to get power and water back onto that village and they ended up helicoptering in standby generation to actually get power and water back on. Now, if you'd considered that risk, a system perspective, the real resilience risk for the water and power companies wasn't their assets. It was the bridge that connected that village to the main road. But there's no mechanism currently for a water company or a power company to reinforce a piece of infrastructure that isn't within their asset base. But if you consider that at a system level, and if we could have the right conversations in a joined-up way at the right level, I think we would direct our capital investment differently if we were starting to provide true resilience at a system level. I won't even delve into nature-based solutions because that's another thing I think we really need to get heavily involved in. But we're short on time, so I'll let you move on.

C: Thanks so much all. I'm going to bump just one question up. I know we got one minute left, but someone has popped in to say that if they wanted to contact Steve directly regarding no dig, would that compromise their submission? Just to say that obviously the entire water sector is involved as part of the delivery team in the Water Discovery Challenge. United Utilities as well as multiple other water companies are providing sector reviewers who will look at the short list and provide reviews and feedback to us and to off work on the entries that have come in. You can see lots about how the assessment sector reviewer process judging at the winner's stage, you can see that entire process in the innovator handbook. Maybe Elettra, if you wouldn't mind popping that link in the chat, but just to say that no, contacting Steve and talking to United Utilities or talking to your company about a potential innovation or solution does not compromise the submission. It compromises slightly Steve's ability to obviously review that entry.

If you are in contact with them, they would obviously have a conflict of interest, so they would not be involved in reviewing that entry if it comes into the Water Discovery Challenge, but we are working with multiple water companies, so it means that your entry would be reviewed by a sector reviewer outside United Utilities. We obviously want innovators and water companies to talk and to collaborate and for you to get insights and knowledge. If there is an opportunity to talk or to get feedback, we encourage that. It just means that Steve needs to put his hand up and say, "I know these people," so he can't formally review that entry if you do submit it. We are one minute over time, so I'm aware that there's a couple of questions that we haven't covered. Anyone who still has pending questions, feel free to send us an email and we'll address them directly with you via email.

Also at the end of this webinar series, we will publish a bit of a PDF as well where we'll cover any questions that we didn't cover live, that came in in the webinars, but that we didn't cover live, we'll publish written answers to those questions as well, so anyone can go and have a look at that PDF in a couple of weeks as well. Just finally, a quick reminder to join us next week at the entry clinic, which takes place on Tuesday on the 16th. Any questions regarding assessments, sector reviewers, selection process, finalist support, all of that fun stuff, we'll cover that in the entry clinic on the 16th of March and next week we'll look at partnership approaches, the importance of partnerships in the delivery of innovation initiatives, and we'll also look at how innovators can maximise their chances of successfully scaling their innovation throughout the water sector. We'll look at those on Tuesday next week and Thursday next week. We very much hope to have you all back. Massive thank you to all of our speakers. Andrea, Tim, Steve and Keith, thank you so much for joining us today and for sharing. Thank you very much.