Discover where our water comes from
Webinar Transcript
07/02/2023

Key:

C = Caecilie Hougaard Pedersen
SM = Stuart Moss
RP = Robin Price
PG = Paul Gaskin
VS = Vanessa Speight
NB = Nick Blamire-Brown

C: Welcome everyone, welcome to any newcomers and also welcome back for anyone who is returning for more information. My name is Caecilie and I am from Challenge Works, I am part of the delivery team who is delivering the Water Discovery Challenge on behalf of the Ofwat Innovation Fund. Welcome to 'Discover Where Our Water Comes From and How We Treat It'. Before we get started there is just a little bit of housekeeping. If you have any issues during the webinar, please feel free to use the chat, our team is already ready to help you and they'll also be sharing relevant materials and links throughout the presentation. At the end of the webinar we will have plenty of time for a live Q&A. For our Q&A we will be using the platform, Slido. The platform is already live and you can use the QR code on your screen or the link that's being shared in the chat to access the Q&A and to add any questions that you might have. You can add questions during the presentation or during the Q&A and we will address them on a first come first basis. We very much hope to get through all of them but if you do have questions at the end of the webinar that are still unanswered, please do feel free to email us directly. If your question is for a particular speaker, please do add that to your question, otherwise we will open the question up to the full panel. So without taking up any more time I will hand over to Stuart Moss from Isle Utilities and he will get us started.

SM: Right then, I'm going to give you a high-level overview of where our water comes from and how we treat it. So fortunately, it rains quite a lot in the UK, rainfall is captured in reservoirs, in lakes and runs into rivers and filters through the ground into underground reservoirs. Around 30% of our water comes from these underground sources, or aquifers, and the rest comes from the surface water such as reservoirs, rivers and lakes. There are 474 lakes, reservoirs and rivers and 2,259 underground sources of water that make up the raw resources that we need for our drinking water. As you can imagine this is going to be quite varied in its condition and therefore this is what the water utilities need to deal with. The water companies abstract a massive 15 billion litres each day but this is only part of the story. Across England and Wales over 50 billion litres are abstracted from these sources on a daily basis for drinking but also for agricultural, industrial purposes and energy production, this is

a huge amount. These are the traditional sources of our drinking water however as population grows and there is a drive to further protect the environment and abstract less for the environment we're looking for alternative sources of water that can contribute to what we abstract. This, for me, is where the innovation falls.

So what are our options? One of our options is desalination, this is quite an energy intensive process to remove salt from seawater which allows us to drink it. Another alternative is storm water and rainwater, typically this is treated at the sewage treatment works and then discharged back into the environment. Why don't we use that as a water source? There's probably going to be new contaminants in there that we haven't treated before so there's going to need to be a bit of innovation around looking at what those contaminants are and thinking about treatment processes to remove them. Then the final one that I can think of is final effluent re-use. So this is the effluent that is discharged from our sewage treatment plants back into the environment. Instead of sending it all back into the environment why don't we capture some of that, treat it further and use that as a drinking water source. this isn't new technology, it's being used in other parts of the world but there's a bit of a perception around the 'ickiness' of using sewage as a drinking water source. So really there's a perception in the public that it's not a very clean source of water.

So there really is a requirement for innovation around customer engagement and changing the views around the use of this as a drinking water source. In San Diego for example they refer to it as 'toilet to tap'. We're going to take your toilet water and then provide it you in the tap. But there's a slightly different tact in Singapore where they refer to it as new water. So you decide what messaging you prefer there. I know which one I prefer. That's the end of our dash through water and where it comes from, I hope that's helped you. Let's move on to the water treatment process.

What does our water treatment process look like? Well, it's quite varied really, we have over 1,000 water treatment works in the UK, all different and with slightly different compositions of source water. As the raw water is abstracted from the various sources that we talked about earlier it's usually stored in tanks or reservoirs. You can liken this to filling up your car with fuel, it's a reserve of fuel ready for when you need to drive your car. Similar to this it's a reserve of raw water ready for when you have a demand for drinking water. It's screened to remove the large objects such as branches or leaves or fishing rods or kayaks, lots can be found in those riverbank screens. The equivalent really is the sink strainer that you might have in your kitchen sink to capture little bits of debris food to stop it from blocking your kitchen drainage. Smaller particles are then removed, typically solutions like coagulants are added to the water to bring smaller particles together to form larger ones which makes them easier to remove. This is called flocculation. Let's use another analogy, when you pour your oats into your saucepan to make porridge for your breakfast in the morning, they're quite separate and loose and can move around quite easily but as you add the milk and you start to mix that and heat it up, or the water if you're Scottish, the oats clump together into larger pieces. That's a very similar process to what we find in the wastewater treatment stage.

The larger particles then settle to the bottom of the tank and a sludge is removed. This sludge can be spread to farmers' land but sometimes it includes metals that are not so good for the soil and therefore it's landfill which really has a negative environmental impact and is quite costly to the water utilities. So really there's some potential to explore the resource that can be recovered from this sludge so I think there's some innovation that can happen around that. The next stage is to filter the water. The level of filtration really depends on the source water and the contamination so it's really ideal if you can get a clean source water or

you can manage your catchment to remove any contaminants through the catchment process to minimise the amount of costly energy and chemicals that you need for the filtration stage. There are various stages including sand filtration, activated carbon filtration and sometimes more advanced processes like ion exchange, ultraviolet or ozone treatment and then you might include other additives to create advanced oxidation, and we'll hear a little bit about that later on through one of our guest speakers.

The final stage is to add a small amount of chlorine to the water. The water is then stored and pumped around the distribution network to our homes and places of work as and when we need it. There is a requirement to ensure that chlorine is still present in the water as it comes out of our taps and that's why there's that slightly swimming pool-ish smell within our drinking water, which is completely healthy and wholesome. However, some countries do not require them to have chlorine within their drinking water. This presents other challenges within the distribution network but greatly reduces the reliance on cost and chemicals and this is perhaps something that can be explored in the UK from an innovative perspective to really move away from that reliance on chemicals to a more chemical-free treatment process. Water companies are typically reliant on quite a small number of chemical suppliers to supply them with the chemicals and additives that they need for this process and therefore it's quite attractive to reduce the chemicals that are required or diversify the processes to sue natural solutions or nature-based solutions and really increase that resilience that a water utility really craves. Water quality is checked all throughout this process to ensure that the water meets very strict regulation and I'm pleased to say that we've got some of the cleanest and most wholesome water in the whole of the world which is just absolutely amazing.

That's all I'm going to touch on from a water treatment perspective. We will now move on to exploring water quality compliance. As we have established water in the UK typically comes from surface sources or ground sources, these sources get contaminated. Surface waters can get contaminated by compounds from algal growth, pesticide run-off from farmers' fields and even animals defecating in fields or directly into the rivers. Therefore, all water companies in the UK are heavily regulated to ensure that these contaminants are removed before the water is distributed in our homes and places of work. Meeting compliance costs money through the energy and chemicals that are required to meet this compliance. The amount of energy and chemicals and the sophistication of the treatment processes is directly linked to the quality of the source water. There is a great opportunity to optimise our treatment processes to reduce the energy and chemical demand but in order to do that we need to innovate, we need real-time sensors at our sources of water.

We need the ability to react fast and to switch the water resources if they are contaminated or their too expensive to treat or require expensive energy and chemical sophisticated solutions to treat that source of water. We need to create partnerships with various stakeholders to look after our catchments and understand how we can stop them from getting contaminated or reduce some of the natural contaminants that occur. We need to explore nature-based solutions to treat in the catchment before we bring it into the cleaning process to really elevate the quality of the raw, natural resources of water. There's plenty of innovation opportunity around water quality compliance from across the catchments through to the raw water itself and throughout the treatment process. So now let's hear from our guests. I am pleased to say that we have three great industry professionals joining us today to speak on the subject and answer key questions. We have Dr Robin Price from Anglian Water and Paul Gaskin from Welsh Water to give the water utility view. We then have Professor Vanessa Speight from the University of Sheffield to give the viewpoint from

academia and share some of the research in this area. We'll start of with Robin, followed by Paul and Vanessa. Can you please introduce yourselves, tell us a bit about your role and the responsibilities you have.

RP: Thank you. Hi, my name is Robin Price and I'm the Director of Quality and Environment at Anglian Water Services here in the UK. My job, I am responsible for all aspects of science within the company, for water quality and environmental regulation, quality management, sustainability, circular economy and all aspects of our overall environmental strategy.

PG: Hi, my name is Paul Gaskin and I work for Welsh Water as a Research and Innovation Manager where we look at aligning our research and innovations to meet our strategic goals which have been set out in our 2050 vision. As well as that, highlighting and developing new products that will solve particular problems that we are experiencing here and now, so things like new hydrant locking caps which stop illegal use of water.

VS: Hi, my name is Vanessa Speight and I'm Professor of Integrated Water Systems at the University of Sheffield. I work on innovation across the water cycle from water supply to water treatment to distribution and sewers and sewage treatment. I've very interested in how we can improve and be more sustainable and how we do treatment and abstractions in particular is an interesting topic to think about in more detail.

SM: Thanks Robin, thanks Paul, cheers Vanessa. So what are the biggest challenges related to water abstraction and treatment from your perspective facing the industry right now?

RP: The greatest challenge I would reckon that we face related to water abstraction and water treatment is the need to significantly reduce the amount of water we're taking from the environment in order to protect, restore and enhance some really precious habitats, for example chalk streams. In a region where we have huge pressure in terms of housing growth and climate change on top of all these environmental pressures this water has got to be found from somewhere. So the water we're not abstracting we've got to take from somewhere else and this is forcing us to look at other sources of water that we abstract and turn into drinking water. So whilst we're looking to reduce demand from water in the first place we're looking at how we can make better use of flood water, other surface water and of course we're looking at things like desalination as we have a very long coastline. All of these bring new water quality challenges which will mean that we have to continue to innovate really hard around the subject of water treatment.

PG: By far the biggest challenge relating to the abstraction and treatment is climate change and this can have many facets from not having enough water to abstract without harming the environment to changing law water quality where we're seeing an increase in colour and algal activity causing both problems with treatment from a blocking perspective but also taste and odour issues with some of the by-products that the algae gives, to extreme weather events which cause either flooding or burst mains due to ground movement with freeze/thaw events where the ground is frozen for a long time and then it thaws very quickly and the ground moves and our pipes break at the same time.

VS: One of the issues I see for the future is how climate change will impact not just the quantity of water that we're dealing with to treat and distribute for drinking water but actually the quality of that water as well. To become more sustainable and use chemicals

more sparingly you really need to have better information and early warning of water quality issues that are coming towards the treatment works so that the treatment works is prepared to deal with it accordingly. That's to me a big challenge that the industry is facing, we've been doing some research on this topic, and we've had a few successes with monitoring and looking at different ways to model river water quality but it is still an emerging area of interest.

SM: Thank you all. Interesting to see similar challenges there around resource quality and availability. I told you we need to explore alternative sources of water like effluent re-use, toilet to tap, it's the future. Okay to build on that tell me about an innovative solution tried, tested, reviewed to address the challenges described and what were the outcomes?

RP: So one of the most significant problems and challenges we face as we continue to look at alternative sources of surface water has been the issue of pesticides. So eastern England is a very agricultural area, our rivers are very slow moving as they kind of meander through a very flat landscape on their way to the sea. So they pick up an awful lot of stuff that runs off from agricultural land. A particular issue we've faced in recent years has been the pesticide metaldehyde which is a very, very tricky molecule to reduce, a very tricky substance to reduce and remove through more conventional water treatment processes. So we've had to innovate and look at very advanced observation processes, so processes which break the tricky molecules down into smaller parts and remove them. The process we've for metaldehyde has been using ultraviolet light and hydrogen peroxide to remove the pesticide, and this was extremely successful and we are now operating the world's first pesticide removal plant that uses these treatment process. Whilst being very successful this has been a very costly treatment process for us, both financially but also in terms of carbon so a lot of the work we've been doing is around kind of optimising to reduce the cost and importantly reduce the carbon impact as we seek to become a net zero industry moving forward by 2013.

PG: So one of the issues we see with climate change is increased taste and odour which is caused by compounds that are released by algae and these are Geosmin and Methyl-Isoborneol or MIB for short. One of the things we've noticed at some of our treatment works is that the ordinary sand filters Geosmin and MIB. So to understand this we've been working with Cardiff University and we've discovered that there're microbiological activity in some of these filters and basically the microbes are munching and eating the MIB and Geosmin. So we see that at some works but not at other works so to understand more we've been looking at what bacteria actually love to munch on these compounds and then how can we engineer it so that that bacteria naturally becomes present in all of our filters. The other great advantage of this when you're looking from a climate change perspective is that traditionally we use activated carbon to remove the Geosmin and MIB and that's either in a filter bed with granular activated carbon or we dose powdered activated carbon in the raw water to remove it before we go through the treatment processes. It's incredibly carbon intensive to produce this carbon and also to regenerate it afterwards if you're talking about the granular activated carbon. So to actually remove it using natural processes is much better, much cheaper and also environmentally friendly.

VS: One of our research projects which was part of the 2065 Consortium looked at monitoring total organic carbon from the top of the catchment through the catchment to understand how it changes with rainfall and seasonal changes and that's really a big issue in water treatment is removing the organic carbon and making sure the water won't promote the growth of disinfection by-products or won't use too much chlorine or treatment chemicals in the treatment of it. One way that this research found to understand the total

organic carbon was to place online total organic carbon sensors which are now commercially available and becoming possible to use in this kind of setting and to watch how those numbers are changing through the catchment over time in real time. Ultimately understanding the total organic carbon will really help water treatment operators to optimise their treatment particularly for coagulant dosing and other types of treatment chemical optimisation. We've also had some success doing research on combining some of these kinds of sensors with models of the river, as I said earlier it's really trying to use the best available knowledge and the models of the rivers are quite good at predicting the flows, so if you can add water quality on top of that then that's a way to have that information ready to go.

For example, modelling pesticides that might run off from farmers' fields, we've done some innovative modelling with Severn Trent Water to predict using the real time rainfall, how much pesticide might run off from different fields and at what time that pesticide might reach the abstraction point for the treatment works. That gives you early warning where you can either choose to not abstract the water at that time if that's a possibility or to abstract the water into an offline reservoir so that you're not having to add additional chemicals and treat the water more expensively or if you must treat that water because it's the only source you have then at least you can be prepared with the right kind of dosing to achieve the pesticide removal that would be necessary to meet the drinking water quality regulation.

SM: Again, similar challenges. Contamination happening in the catchment from algae and pesticides and the increasingly carbon-intensive treatment processes but with the potential for process optimisation. Thanks all. So more generally tell me about the key innovation opportunities that you see within your area of work.

RP: So just thinking about the key innovation opportunities for us it's really clear that we are going to be much, much more reliant on surface water rather than groundwater as a source of our drinking water. Of course, we're now aware of continuing every day a new contaminant hits the new or hits the headlines that has been found in the rivers and streams that we're going to be relying on from so-called forever chemicals based on fluorinated substances, micro-plastics, pharmaceuticals, antibiotics, personal care products and many, many more. Of course, our first course of action to deal with these and the key innovation areas is how we continue to prevent these things from finding their way into rivers in the first place. How do we drive up the quality of our rivers and streams and how do we do this through product control, very simply alternatively using less of some of these substances to enhance wastewater treatment processes but also importantly working with communities and farmers and landowners to protect catchments, to undertake catchment protection and catchment management. Ultimately, we're going to have to continue to innovate, we're going to have to think around the innovation around low cost, low carbon water treatment processes to deal with some of these very tricky substances. We're excited by the challenge and we really look forward to working with the best minds in the world, the best innovators and best minds globally to help us to solve some of these problems.

PG: I think leakage is a fairly hot topic at the moment, especially around detection on plastic pipes. Also no-dig repair methods, so Jez Heath from SES Water, the industry leakage guru, talks about us still using Roman methods to repair our pipes in that we have to dig down, take the pipe, find the leak, replace the bit which is broken and put all the soil and everything back. It's madness in this day and age. So can we get to a method where we can actually send something down the pipe inside that can repair the main but doesn't give any issues to water quality going forward. Another area would be chemical treatment, so

anything that would reduce our reliance on chemicals or even remove chemicals from the treatment process so we can produce water without having to rely on a supply chain which is ever decreasing.

VS: So there is quite a lot of innovation that's possible in this area, it's really at the early stages of thinking what might be coming down the river, what can we monitor with remote sensors. We've done some work more recently with trying to monitor for e-coli and other bacteriological contaminants as well as cryptosporidium and nitrates to understand where and when infection's going to take place. So there's a sensor development component to that, there's a modelling and understanding, the river behaviour component to that as well as a rainfall data processing component. So altogether there're several pieces that need to line up to make this innovation something that's deliverable to operators on a daily basis but there is really quite a lot of opportunity and I think this is an area that moving forward will become more and more important because we really will have quite variable water quality as the climate continues to change and continues to throw floods and droughts at us within the same very short period of time.

SM: If we jump into the final question really, it's all about innovation and where do you see the sort of main innovation opportunities within your area of work? So Robin if you can come off video and let us know where you see your main opportunities for innovation.

RP: Thanks for the opportunity to be here and take part in this webinar. The main innovation, there are so many opportunities for innovation as we've talked about, as you've heard from all three of us there are huge challenges around climate change which is driving us to think about alternative water sources and particularly how we're going to treat them. So I guess I'd start with analysis, understanding what compounds are out in the raw water, how's the raw water that we're starting with, how is that changing in composition, what emerging substances of interest are there. So a huge amount of innovation around analysis. Then once we have a greater understanding of what's in the water it's then the innovation is around firstly how are we going to remove them, what is a safe limit, what are the standards and the targets we're trying to get to. So there's a lot of kind of regulatory innovation here as well, but the solution bit in terms of how we're going to reduce some of these emerging contaminants as we search through alternative water sources is really kind of pushing us to the forefront. I guess what we need to be very, very careful of is traditionally we've relied on very carbon hungry treatment processes, ozone we've talked about, I've just talked about hydrogen peroxide, UV light, activated carbon, these things. We've got to think very carefully about how we integrate those with mainstream, how do we seek to become a carbon neutral industry.

So again, we've got to work really, really hard around that, what are the low carbon, low cost, low energy chemical free treatment process. We mentioned nature-based solutions, how do we harness nature, so this is another whole raft of innovation opportunities in terms of innovative partnerships and some thinking around catchment management. So a bit of a gabble there, Stuart, forgive me but there's innovation peppered throughout this and it's just so exciting to be just with a likeminded audience who want learn more and explore this with us, thank you Stuart.

SM: Thanks, Robin, much appreciated. Vanessa, if I can come to you and ask you just about the way you see the key innovation opportunities within the sector that would be fantastic and then we'll hand straight on to Paul as well afterwards.

VS: Sure. I think there's a lot of opportunities as I was discussing earlier in predicting the water quality early so that the treatment can be finetuned and the chemical dosage, the energy, all of those things Robin described so well can be managed but really you need early warning of what's coming to the treatment works. We've been working on some research, part of that is with the 2065 program which was looking at organic carbon as it moves through the catchment from the head to the works and there're quite a few interesting transformations that happen in organic carbon and having monitored out in the catchment to be able to see those changes happening in real time and be able to react at the treatment works could save a lot in terms of treatment. Coagulation as Stuart described uses a lot of chemicals and that's primarily the first opportunity to remove this organic carbon and so if we can see that it's coming in an undesirable form or in high quantities we can perhaps not abstract at that moment, let that flood go past of the undesirable water or change the treatment accordingly.

Similarly we've done some work with Severn Trent Water using models actually along with monitoring, but predominantly uses models, of the rivers, of the rainfall to predict when the peak of a contaminant might arrive at the works intake and again not abstract that particular flood of water that's not as easily treated, let that go past and then resume abstraction later. That's been particularly successful, we have ongoing work in that area with several of the water companies. So really the things needed to make that a success and to really bring that innovation into every operation is improvement in sensors so that we can monitor for a variety of different contaminants or their surrogates, and we're working with several sensor manufacturers on that sort of research as well as improvement in the models. We're doing lots of work on machine learning to see if machine learning can give us a quick and easy modelling solution for places where we don't necessarily have a complex river model in place. Really also automation and in the treatment work side of things to bring that information in and be able to react very quickly to it, particularly if there's not staff at a treatment site 24/7. So all of those elements are needed to bring this innovation forward but as Robin said it is a very exciting time, I think the technology is there it's just about bringing it into play and making it all work together.

SM: Thanks, Vanessa. Paul, can we continue please, it would be good to hear your views from a sort of a chemical free perspective if you're able to talk through that.

PG: So I think for myself chemical free treatment is really the Holy Grail and what we want to get to as water companies because it builds resilience that we don't have to worry about chemicals in the treatment process. I guess there are some exciting things coming along with Nano and reverse osmosis although at the moment they still use too much power but if we look at reverse osmosis moving it forward to forward osmosis using more resilient membrane such as ceramic membrane to filter the water and get rid of all the impurities then chemical free or reducing chemicals is going to be the way forward really. I guess the one caveat to that is our distribution systems are very old so actually it's going to take a bit of time before we can get something that doesn't include some sort of disinfectant which will last through to the customer's tap. But the Holy Grail really is why do we treat 150 litres of water for everybody up to drinking water standards when most of it is for washing clothes and flushing down the toilet. So can we actually do something else there and just treat what's needed and not the other bit?

SM: So I think you'll all agree there is lots of potential to innovate around chemical free, so great to see Paul talk through that, thanks again. I just want to say really thanks to all of our speakers, thank you Robin, Paul, Vanessa for getting involved and sharing your industry

insights and thanks to Caecilie who's come back online for introducing the session today, much appreciated. So just to summarise the sort of key trends that have come out from speakers today. We've heard there's not enough water, there's too much water, there's contaminants in the surface water like pesticides and algal compounds and bacteriological contaminants, but the processes are quite carbon-intensive and we see climate change being a key challenge in the future. We really want to move to this place of a sustainable use of chemicals and that seems to be the flavour terminology at the moment rather than chemical free, the sustainable use of chemicals and of course the nature-based solutions that Robin talked through. We believe that there's a better way to optimise our treatment processes with more knowledge of the raw water quality that's coming in and Vanessa talked eloquently about that and stopping perhaps those batches of contaminated water come through.

Just a reminder as well that we're running a number of these webinars as we travel through the water cycle so keep an eye out for these and if they're helping you in building your knowledge of the sector then please join us for those future sessions. We'll now transition to a Q&A session so Caecilie will pick up now and run through any questions that you have on sli-do. The sli-do link was in the chat earlier on so perhaps it can be re-posted again now. Thanks for your interest and engagement and I hope we've got some good questions to run through now. So Caecilie over to you.

C: Thank you so much, sorry for the technical glitch earlier on but it feels like we picked up nice and strong after that. We've got lots of super exciting questions that are popping in on the Q&A on sli-do, please keep them coming. I see the link has gone back out on the chat. So there was an early question that came in back at the beginning of the presentation, I think it was Robin while you were talking. There's a question around is this what many would call recycled water, this is regarding the final effluent re-use.

RP: Yeah absolutely, absolutely. So within Anglian Water we've stopped using the term wastewater 10-15 years ago and started talking about water recycling because we take water, we treat it, people drink, it comes back to us, we recycle it and put it back into the environment. I guess just one point I'd like to make about innovation in this space is we automatically jump to and quite rightly Stuart's just taken us around the world to places like Singapore where we're talking about kind of effluent re-use straight through to tap water. But again, when we look across how future demand for water particularly in somewhere like East Anglia where I'm based actually we need more water for irrigation of crops, we need more water for manufacturing. An important drive, and I've seen a question or a comment around the hydrogen economy, so we're going to need an awful lot of water for hydrogen production. So what we need to think about in innovation and innovate is okay well yes we do want to do effluent re-use, it seems a bit daft taking water from a chalk stream and then treating it and then discharging it into the North Sea kind of thing. So what can we re-use that effluent for, and it might not be we go straight to drinking water with it but how do we turn that into hydrogen, how do we turn that into water which can be used for irrigation.

So again, I don't want us to get fixated in all effluent must then be turned into drinking water, we need to think about what are the uses of that water, what are those demands for water and then how do we apply innovation to treat the water for the standard that it needed for the user, whatever that might be.

C: Great, thank you so much. We've got another one that popped in a little bit earlier, Paul I'm going to throw the ball to you first on this one. What's your position on

functionalised biochar in water treatments, making the assumption that the person asking this question is talking about activated carbon and the like, otherwise please do specify in the sli-do, but I'll throw the ball over to you first, Paul.

PG: Yeah, I'm not 100% sure what *[unclear 0:38:27]* but biochar is more than just activated carbon, it's more a circular economy thing so using waste agricultural products, I don't know, and burning them up to get a biochar. So yeah there's no moral stand per se saying no we shouldn't be using them but obviously we are producing drinking water so we've got to be aware, and this goes for any new process, we've got to be aware of what we're taking out and what we're putting in to the water and is there something we can leach into the water by using a new process. There're some quite stringent regulation we've got to go through to ensure that we're protecting public health because after all we really don't want people to get ill by drinking our water. So in terms of doing early stage trials then absolutely no issue, in terms of putting it through to embedment then there are a number of regulatory hurdles we need to get through just to ensure that public health isn't affected unintentionally by anything we do.

RP: Caecilie would you mind if I just came in briefly, would that be okay just on biochar?

C: Yeah, absolutely please jump in Robin.

RP: So I know this is generally more a clean water discussion but just thinking about innovation biochar, one of the things we're really interested in is recycling of bio-resources, so the sludge element. So when we've finished with the wastewater treatment process and the water recycling treatment process and we have sludge one of the areas we are looking for now, there's a lot of legislation coming around the disposal of bio-resources to land, the land bank, the amount of land available to us as water companies is reducing due to particularly concerns around nutrients and phosphate getting back into the environment. So one of the big areas we're driving forward is advanced thermal treatment processes like pyrolysis to produce biochar, because what you get is you get biochar and you get biocrude. So you get an oil, you get a potential fuel source so we're tremendously excited at the opportunities on the water recycling, the wastewater side of our business around this kind of opportunity. The pyrolysis *[unclear 0:40:53]* doing work at the moment to make sure it removes forever chemicals, microplastics, that sort of thing, is it hot enough to *[unclear 0:40:59]* those sorts of things off. So there're some really, really exciting… biochar is a bit of a trigger, I'm quite excited about biochar at the moment and just the opportunities there. But biochar and biocrude, what can we do with that as an alternative fuel source.

C: That's great, anybody else if there is additional comments to add after Q&As please do feel free to jump in. We've got another one coming up and I think this was a question that popped in while Stuart you were talking about the various aspects of the water cycle, there was a question that popped in around if other countries aren't currently using chlorine in their drinking water how come the UK does and what are the current alternatives to that. So I'll throw the ball over to you first, Vanessa, I think and then we can take follow-up from the rest of the speakers.

VS: Okay great, yeah that's a very interesting question and that's also something we've just launched a new three-year project start examining. In general, the countries like the Netherlands and Germany who are not using chlorine have much higher degree of treatments at their treatment works than we do and then they also have generally newer pipe networks so less of a chance of ingress because of leaks and bursts and problems in the

drinking water network. So what we're interested in researching and I think the UK is in general as we've heard earlier can we, with a different sort of set-up also safely remove the chlorine. We're still under the belief that it's protecting against those people intrusions of contamination and providing a final layer of treatment in case some microbes do get into the drinking water network, but what we really need to understand is is that actually true and how does it affect the biosome and we've got lots of exciting research coming up on that, so stay tuned.

C: Great, Nick, do you want to follow up?

NB: Yeah of course, so I guess just to add to what Vanessa's said there is one of the really attractive things about chlorine is that there's a measurable residual value of chlorine that can be measured within the water. So for water companies it provides confidence that the water is still safe to drink when it reaches customers' homes. So as Paul and Vanessa touched on there our water distribution system isn't a completely closed network as much as we'd like it to be, there are all these potential points where there could be ingress into the water and bacteria could get into that. So by having this chlorine within the water and having that measurable residual at the customers' homes we can have confidence that that water is still safe to drink. In terms of alternatives there are a number of different disinfection alternatives and some of those include things like ozonation. So using ozone in the *[unclear 0:44:09]* to treat water, it's got great disinfection properties but lacks that measurable residual and the same is true for ultraviolet disinfection, so using ultraviolet light-waves to disinfect water and destroy bacteria, it's possible to do but you can't measure the ongoing effects of that in the distribution network. So whilst they are options they haven't been fully rolled out in the UK yet because of the attractive nature of the chlorine residual.

C: I think that's really interesting. They've got another question that's popped in, I actually think this popped in, Robin, while you were answering one of Stuart's questions. I think you mentioned sludge water so there's a question that popped in around how sludge water is currently being used, but also how is it being stored.

RP: Yeah it's a really, really hot topic. So as the climate becomes ever more volatile, as we all know globally the effects of climate change are felt first through water, through drought and by flood, and what we find, very prominently in the UK but also around the world, is you get this kind of sawtooth effect of suddenly we'll have the wettest January on record which we had a couple of years' ago, followed by the driest April on record literally within three or four months, then the next year it'll be the wettest February and then the driest May. So records are broken it would appear every year but we still haven't joined this up as a nation, other places in the world may do this better and we see flood water as a problem, we see water as a problem to be got rid of during those times and then we think oh crikey it hasn't rained for ages, where's the water gone. So we've changed the landscape, we have canalised rivers, we've straightened rivers, we've used them to basically get water out of the North Sea. I live in East Anglia, we try and get water away from fields, away from lands and properties into the North Sea as quick as we can.

So the answer of course is… and then we're having conversations about desalination, so we're letting all that flood water be pumped into the North Sea and then we're talking about desalination. So we've got something not quite right there. So the answer is storage, we've got to grab that flood water, we've got to put it somewhere kind of safe where it's away, where it's going to be useful and we've got to use it when the sun has shone a bit longer and

when it's a dry period. So this is not rocket science at all, but we just don't' seem to have cracked this. So storage of water, holding water within the landscape be that in wetlands, through nature-based solutions, be that through far irrigation reservoirs, be that industrial reservoirs used for hydrogen plants or industry or we get to kind of the large reservoirs that we have very few of within the landscape. We've just put plans through as Anglian Water for two very large new reservoirs, one in Lincolnshire and one in the Cambridgeshire Fens, both of which will take flood water, will take excess water and will store it. But they are monstrously expensive, we're trying to design them to be multi-sector so they also provide massive environmental good, they provide social benefits, they provide water for irrigation and other industrial use.

Again a huge amount of innovation needed in the financing mechanisms, the regulatory mechanisms, some of those sorts of things but we are determined that we're going to do it. We don't build reservoirs anywhere often enough but that's the answer and I think personally I'd build 10 reservoirs before I build one desalination plant kind of thing, I think desalination should be the last resort if we're pumping flood water out to see but we do need desalination in this country so I'm not here to cancel that out or whatever or say we shouldn't be doing it. There are places that are going to need it but let's grab some flood water, store it and use it on a drier day.

C: Thanks very much, Robin. We've got another one that's popped in, Nick I'm going to throw the ball your way so it's around how can customers be encouraged to use less water indoors and out and how can customers expect to be part of the solution.

NB: Thanks, Caecilie and a really good question. The answer to this is absolutely customers can be part of the solution and in fact water companies are relying on it. So there's a forecast to see a significant deficit in the amount of water that we've got available for customers by 2050 I think the figure is broadcast to be around 3 billion litres of water a day and one of the ways in which that can be addressed as you've noticed here is through helping customers understand how they can reduce their consumption to sort of close that gap. So there are a number of ways in which this can be done. A lot of them require behaviour change which is not easy to do but there are ways that water companies can engage their customers to get them to change their behaviour. So they can be things like having baths less frequently, having shorter showers, washing your car less frequently and things like that but there are also technological solutions that can help with this.

One of the biggest challenges is helping customers understand what impact they have on this water cycle and generally it's a bit of a disconnect with customers not understanding how much water they use, how much water use is good or bad. If I use 100 litres a day is that good or is that bad? A lot of customers don't know. One way that we can help connect them to the water supply a bit more effectively is through the use of smart meters. So smart meters are water meters that are installed at the customer's property and they measure that volume of water that's used over a period of time and they can send that data and make it available to customers so they can understand more clearly on a daily basis how much water they're using and what impact those changes are having on their water consumption.

C: Yeah, great, thank you very much Nick and I think there's probably a parallel there as well to the energy sector where we also see the use of smart meters being more and more implemented so people can see their consumption on an hourly, daily basis and kind of change their habits based on that.

NB: Absolutely, I mean everyone who's got an energy meter will have turned the kettle on and just seen that bar go up and seen that using the kettle uses loads of energy. So the same could happen to the water.

RP: If I can just come in Caecilie, yeah the insight we're now getting from the smart meter, we're going quite hard and quite fast in Anglian Water around smart metering and the insight we're getting now in terms of the ability to almost pinpoint particularly customer side leakage and we're estimating somewhere in the region of about a third of leakage that we're looking at is beyond the boundary box, it's on the customer side particularly things like leaky loos and stuff where the cistern is leaking. So lots of innovation around smart metering as Nick says, actually that's a real golden thread for us but it's how we use that data and how you share that data and you need a bit of social science to kind of talk to and engage with your customers to talk about well actually do you realise, Mr Price, you are using slightly more water than your neighbours are. I'd be horrified to think that, so we can use that data in all sorts of ways to encourage customers that actually customers are a part of the solution here, most definitely.

C: That's great, thank you very much, Robin. The next question coming in I've been excited to read this one out loud for a little while now, Vanessa I'll throw the ball to you first. So there's a question that came in saying that given that Metaldehyde, I think that's how you pronounce it, isn't particularly harmful unless you are a slug, is oxidising it with significant associated carbon emissions better than drinking it? I'll throw that to you first, Vanessa.

VS: Okay well yes it isn't a very pleasant chemical if you're a slug which is why we use it, but it is a regulated pesticide and there are limits that are being measured. So first of all it's required that the water companies meet those limits and measure metaldehyde. It is toxic, it is a neurotoxin and a lot of pesticides like this one may not kill you if you drink a little in your drinking water immediately, but you can have build up effects over a lifetime. Most of these pesticides' regulatory levels are developed by considering a lifetime's exposure of drinking this continuously in your water and there's all sorts of research going on, not just for metaldehyde but other pesticides as well showing that its' really in the long term not a good thing that we're consuming those on a regular basis. So given that metaldehyde is a known toxin it's been added to that list and in fact has been banned in many countries because of its toxicity.

C: Thank you very much. Jumping straight on to the next one, Paul I'll throw this one your way first but Vanessa feel free to jump in afterwards as well. How are water companies encouraging customers to use more rainwater outdoors rather than processed tap water?

PG: There're a number of ways we as water companies can help. Doing surveys with customers to make them understand their water usage and what they're using in different areas. So I love throwing out the question, how much water do you use in a day on average as a person, people will go, oh about 50 litres, maybe 20 litres, and when you actually tell them well the average is 150 litres they're astonished and obviously quite a bit of that would be taken on with hosepipes in the summer and using hosepipes. So some of the ways is education, also some companies give either discounts or free water butts to customers to help them to collect rain water and then use those in the garden instead. So it's a bit of encouragement, a bit of nudging as Robin said earlier and also a bit of freebie or discounted things for customers.

C: Checking if anybody else wants to jump in in terms of encouragement to customers to use rainwater. No?

RP: I'll come in. To really encourage customers to have water butts is a marvellous thing, to really encourage customers to store and hold rainwater back this is enormously marvellous for helping us manage surface water. So we have an awful lot of surface water finding it's way into the foul system, a whole other webinar on storm overflows and that sort of thing, absolutely, but this is one of the problems that exacerbates spills and releases to the environment around excess stormwater finding their way. So the more we can get customers to grab that water in things like water butts or whatever, in tanks in the garden and hold it back so we don't get this sudden deluge of water into our wastewater system would be fantastic. So yeah, lots to do there as well.

C: Excellent, thank you so much. We've questions here coming in and I will open it up to the full panel. Do the drinking water treatment processes currently remove microplastics?

NB: A really good question and I'm going to give a fairly horrible consultant answer to this and that's that ultimately it depends. It depends what water treatment processes are being used, some will be more effective at removing microplastics than others. So for example membrane treatment processes that use really small bores in membranes to filter out material are likely to be more effective at removing microplastics because they create that physical barrier. Whereas filtration methods with sand are slightly less effective in the small size of particles they can filter out. So it's possible that some microplastics would get through those processes. Microplastics is sort of an emerging challenge area both for water and wastewater, I know there's lots of ongoing research into this area to fully understand what impact both water treatment and wastewater treatment processes have on removing microplastics. Some others in the group might have something else to add in.

PG: Yeah I guess if I can jump in there. With microplastics we are conducting quite a bit of research with the UK Water Industries Research Group which all the companies in the UK, Ireland and Jersey are part of. So we have found that most conventional water treatments work, coagulation, filtration are quite effective actually in removing microplastics but it is an emerging subject as Nick said, so we're still looking at the research and understanding how we can prevent them. Really the prevention rather than removing, we should be looking at preventing in the first place because at the moment microplastics are absolutely everywhere, even in the remote reservoirs we're finding lots of microplastics which is quite worrying.

SM If I can jump in there, please Caecilie, I completely agree with Paul's point. There's a question as well that's coming around, can we capture them at source, like at the sinks of our houses before it gets into the sewers. I think we need to go further up the supply chain really and target the manufacturers and stop the manufacturers putting… lobbying on that front and stop using the products that contain these microplastics. I know that's a societal thing and it's being pushed on to the consumer but there needs to be a mechanism to target the manufacturers of the products that contain these microplastics where possible.

C: I can see that there's something that's popped in while we've had this conversation as well. So is there something that could be done earlier in the household to filter, something in the drains, the plugs, suggestions have come in. Nick or Stuart, maybe you want to jump on that one first, we can open it up as well.

NB: Yes, I'll quickly jump in here. The simple answer is yes absolutely, often tackling these problems at the source is more effective than trying to tackle them down the line. There are all sorts of technological solutions that are available for this. I know particularly when people are using their washing machines there are microplastic bags and filters that you can use that help prevent microplastics from the clothes coming off and getting into that wastewater that then will go back into the environment. Yes, it's a good place to start and like Steve said it's probably most effective to try and target those manufacturing industries where the biggest impact is going to be felt.

RP: Since I've been on LinkedIn this week about washing machine filters so actually things like when we wash fleeces and things like that, they can be a source of microplastics. If you remember many years ago we were all buying fleeces that were 'I'm made from 1000 recycled bottles', well 'when you wash me I release microplastics into the environment' so yeah really, really exciting developments around that. I've just seen a comment in the chat from Jason King around these opportunities to put things on washing machines and dishwasher. Really great, great, great innovation.

C: There is just the next question that popped in, Paul I might throw this one back to you straight away, conscious that we've just got two minutes until we're closing off the webinar but how do treatment processes differ for different feeds in different regions, is there a need for different treatments efforts based on your location within the UK?

PG: In general, yes, in some respects as we use a lot of surface water in Welsh Water other areas will use a lot of aquifers. Generally speaking, you need more treatment for if you're taking from a reservoir or a river than you would need if you were taking it from an aquifer. So a very quick, general answer but yes and no, it's all to do with the different sources.

C: Great, we might just have time to just do one more question, Robin I'll throw this one to you first, Vanessa and the rest of the panel feel free to jump in. What is the industry doing about the removal of microplastics in wastewater, are there solutions to remove the source within households? I think we've touched on this one earlier on when we were covering microplastics, so this is just a lance chance for the panel to add their last say on the topic.

RP: So Paul mentioned a lot of research going on through the UK Water Industry Research and other places around the removal of microplastics through drinking water, through potable processes, we're also looking at the same on wastewater processes as well. Again, the early results as Nick said earlier it does depend on the treatment process but a lot of more advanced water recycling and sewage treatment processes are very effective at removing microplastics which is reassuring.

C: Great, any final words on the topic of microplastics before I hand back to you, Stuart. I think not. Thank you very much I will just hand back to you, Stuart, for the last few words for today.

SM: Brilliant, thank you Caecilie. Well thank you all for joining us today and your well-informed questions and thank you very much to the speakers as well who came with their knowledge and insight and answered all the questions beautifully, so thank you very much for that. As I mentioned earlier there's a series of webinars that we will undertake over the next few weeks so please keep an eye out for those and they travel through the water cycle and address some of the additional questions that we talked around today in terms of the

wastewater treatment process. Thank you all for your interest and engagement. Have a great afternoon.