Draft Minutes of public meeting of the PFAS Scientific Advisory Panel on Teams

16:00 on 23 April 2025

Panel Members present:	Dr Steve Hajioff – Independent Chair
	Dr Tony Fletcher – PFAS and Health member
	Professor Ian Cousins – PFAS and Environment member
In attendance:	Standing Observer (Regulation) - Kelly Whitehead - Group Director of Regulation, Infrastructure and Environment Department
	Various US Water Treatment Experts
	Programme support team from I&E

Welcome:

The Chair welcomed everyone to the Panel meeting and reminded people the meeting was being recorded.

Introductions

The Chair and Panel members introduced themselves.

Dr Steve Hajioff, Independent Panel Chair: A retired Director of Public Health from an area of London with two major international airports and a variety of other environmental hazards and challenges, with 35 years in clinical medicine. An expert on translating science into policy, he has worked with Nice, the Greater London Authority, the EU, WHO and World Bank, several UK government departments and several international governments. Dr Hajioff has also worked extensively in the pharmaceutical industry.

Dr Tony Fletcher, PFAS and Health Panel Member: Environmental Epidemiologist at the London School of Hygiene and Tropical Medicine, working on PFAS since 2006 and member of the panel with experience of epidemiological studies on the health effects of PFAS in contaminated communities in West Virginia in the United States, in the Veneto region, in Italy, and in Ronneby, and is the health expert on the panel.

Professor Ian Cousins, PFAS and Environment Panel Member: A Professor in Environmental Chemistry at Stockholm University, an expert on PFAS, appointed as the environmental expert on this Panel and whose expertise on PFAS is on the sources, transport, fate, and exposure of PFAS.

Kelly Whitehead, Group Director for Regulation in the in the Infrastructure and Environment Department, leading on the Water Quality and Safety Programme, coordinating Government's response.

Minutes, matters arising and additional findings

Steve addressed that these will not be discussed as this is an additional meeting to accommodate time difference in US in order to hear from our US water treatment experts. These agenda items will be brought up in the main meeting on 30th April.

Declaration of interests

- Nothing to declare

Experts Introductions

Ian Ross, based in Monterey, California, originally from Yorkshire, works for CDM Smith, a company specialising in large-scale PFAS treatment. With a background in the fate, transport, and treatment of man-made chemicals, he has focused on PFAS since 2005. Ian is knowledgeable about global regulations, PFAS measurement, and removal techniques.

Christopher Bellona, an associate professor at the Colorado School of Mines in Golden, Colorado, specialises in PFAS treatment. With over 15 years of experience in PFAS treatment, he focuses on separation techniques like absorbance membrane treatment and has also worked on PFAS destruction projects. His work often involves field pilot scale evaluations of various technologies and comparing their treatment costs.

Kevin Berryhill, a consulting engineer with Provost and Pritchard Consulting Group in Clovis, California, specialises in designing treatment plants and selecting treatment processes for municipal and public drinking water supplies.

Presentation from Water Treatment Expert Ian Ross

Ian Ross began the presentation by explaining the definition and scope of PFAS (Per- and Polyfluoroalkyl Substances). PFAS are a large class of man-made synthetic molecules, primarily polyfluoroalkyl substances, which have a fluorinated carbon backbone and additional chemistry on the side. These substances transform in the environment over time through biological and abiotic reactions, forming perfluoroalkyl acids, which are the focus of most regulations. Ian emphasised the complexity and diversity of PFAS molecules, noting that there are many different types, each with unique properties and behaviours in the environment.

Ian discussed the presence of PFAS in firefighting foam, noting that these are precursors to the more commonly regulated PFAS. He used an analogy to explain the degradation process of these molecules, comparing it to the degradation of a wooden arrow in soil. The wooden part of the arrow represents the polyfluoroalkyl substance, which degrades over time due to microbial attack, eventually forming perfluoroalkyl acids. This analogy helped illustrate the transformation of PFAS precursors into regulated PFAS. Ian highlighted that the majority of PFAS in firefighting foams are polyfluoroalkyl precursors, which eventually form perfluoroalkyl acids through environmental processes.

The presentation covered the chemical properties of PFAS, including their solubility and mobility in water. Ian explained that longer chain PFAS are less soluble and travel shorter distances in water, while shorter chains are more soluble and mobile, posing challenges for treatment. He also mentioned the emergence of ultra-short chains, which are extremely mobile and difficult to remove

with traditional methods like activated carbon. Understanding these properties is crucial for designing effective treatment systems and predicting the environmental fate of PFAS.

Ian provided an overview of global regulations and analytical methods for detecting PFAS. He highlighted the disparity in regulations across different regions, with varying levels of PFAS allowed in drinking water. For example, Europe has stringent regulations for PFAS concentrations, while the US focuses on a smaller number of PFAS molecules. Ian discussed targeted analysis methods, which involve using analytical standards to quantify specific PFAS molecules. He also mentioned total oxidisable precursor assays, which convert precursors to perfluoroalkyl acids for measurement, and the more comprehensive adsorbable organic fluorine method used in California to assess the total mass of fluorine in water.

The presentation detailed three main commercial-scale treatment options for removing PFAS from drinking water: granular activated carbon (GAC), ion exchange resins, and membrane filtration (nano filtration and reverse osmosis). Ian explained the advantages and limitations of each method. Granular activated carbon is effective for longer chain PFAS but less so for shorter chains. Ion exchange resins work based on charge and are more effective for shorter chains but can be impacted by other ions in the water. Reverse osmosis provides comprehensive removal but is more expensive and requires a larger footprint. Ian emphasised the importance of selecting the appropriate treatment method based on the specific PFAS present and the water quality parameters.

Ian shared examples of large-scale PFAS treatment projects, including the largest system in California using ion exchange resins to treat groundwater. He discussed the design considerations for these systems, such as the impact of other water components on treatment efficiency and the need for pragmatic solutions based on site constraints and regulatory requirements. For instance, high organic carbon in water can reduce the effectiveness of activated carbon, while high nitrate or sulfate levels can interfere with ion exchange resins. Ian highlighted the importance of considering these factors when designing treatment systems.

The presentation described methods to treat rejectate liquids (containing elevated PFASs concentrations) from application of membrane filtration, such as foam fractionation and supercritical water oxidation, which aim to concentrate and destroy PFAS more economically. Ian explained that these methods help reduce the volume of PFAS waste, making it more feasible to apply destructive treatments such as supercritical water oxidation, sonolysis etc. He emphasised the importance of considering future regulations and the evolving scientific understanding of PFAS when designing treatment systems. Ian noted that the regulatory landscape for PFAS is constantly changing, with new standards and guidelines emerging as more scientific data becomes available.

The panel members engaged in a discussion following the presentation. Ian Cousins raised a technical question about the treatment of reverse osmosis rejectate with foam fractionation, to which Ian Ross explained the economic benefits of concentrating PFAS for more effective destruction. Steve Hajioff inquired about the speed of deployment and phased approaches for treatment systems, highlighting the need for quick solutions within existing infrastructure. Ian Ross acknowledged that ion exchange resin systems and activated carbon systems can be designed and installed more quickly than reverse osmosis systems, making them suitable for immediate needs while larger projects are being planned.

Presentation from Water Treatment Expert Christopher Bellona

Christopher provided an overview of the evolution of PFAS treatment technologies since he began working on PFAS projects around 2010. Initially, the focus was on membrane technologies like

nanofiltration and granular activated carbon (GAC). Over time, ion exchange resins and reverse osmosis have also been explored. Despite numerous research papers published annually, adsorptive treatments remain the most implemented, with ongoing efforts to develop more selective adsorbents and newer technologies like foam fractionation.

Christopher discussed the comparative effectiveness of activated carbon and ion exchange resins for PFAS removal. He explained the concept of breakthrough curves, where the normalised effluent concentration is plotted against bed volumes processed. Shorter chain PFAS tend to break through quicker than longer chains, and carboxylates like PFOA break through faster than sulfonates like PFOS. He emphasised the importance of cost analysis over breakthrough curves for evaluating treatment technologies. Despite the higher media usage rates for shorter chain PFAS, the costs of GAC and ion exchange systems are often comparable due to the higher expense of ion exchange resins.

Christopher highlighted the challenges posed by organic matter in water, which can interfere with PFAS adsorption. Higher organic matter content reduces the bed volumes to breakthrough, increasing operational costs. He discussed pre-treatment processes like ozone and biologically active filtration to remove organic matter, thereby extending the lifespan of adsorbents. This approach is particularly beneficial in conventional drinking water treatment plants that already remove organic matter through coagulation and filtration.

Christopher introduced novel adsorbents like Fluora-zorb, a surface-modified bentonite clay, which behaves similarly to ion exchange resins but at a lower cost. He also mentioned the development of porous polymer networks designed to improve selectivity and capacity for PFAS removal. Although promising, these novel adsorbents are still in the developmental stage and require further research to be viable for full-scale treatment systems.

Christopher discussed the use of high-pressure membranes, such as nanofiltration and reverse osmosis, for PFAS removal. He presented data showing high rejection rates for PFAS, even at high recovery rates. Fieldwork at a firefighting training area demonstrated the effectiveness of these membranes in separating PFAS from contaminated groundwater. However, the production of a waste stream (concentrate) remains a challenge, necessitating further treatment or disposal.

Christopher reviewed various destructive technologies, including electrochemical oxidation, plasma, supercritical water oxidation, and hydrothermal alkaline treatment. These technologies vary in energy requirements and effectiveness, with some being more suitable for short-chain PFAS. He highlighted the commercial development of hydrothermal alkaline treatment by a company called Aquagga, which has shown promising results in destroying a wide variety of PFAS.

Christopher discussed the strategy of using membrane processes to concentrate PFAS, followed by destructive technologies to treat the concentrate. He mentioned ongoing projects funded by the DoD, including field demonstrations of foam fractionation combined with hydrothermal alkaline treatment. This approach aims to make PFAS destruction more economically viable by reducing the volume of waste.

The presentation concluded with a Q&A session. Steve Hajioff inquired about the deploy-ability of adsorbents and the need for remineralisation after membrane treatment. Christopher explained that while other adsorbents can be used in gravity filters, they are typically employed in pressure vessels. He also confirmed the necessity of remineralisation for water treated with tight nanofiltration and reverse osmosis due to the removal of ions. Ian Cousins raised practical considerations for Jersey Water, including the disposal of spent ion exchange resins and the feasibility of on-site destruction technologies. Christopher noted that while regenerable ion exchange resins exist, they are less common due to lower capacity and the need for harsh regeneration chemicals. He also

mentioned that commercial units for electrochemical oxidation and plasma are available, but their long-term viability for treating PFAS concentrate is still under evaluation.

Presentation from Water Treatment Expert Kevin Berryhill

Kevin Berryhill began his presentation by providing an overview of the regulatory framework for PFAS in the United States. He explained that prior to the EPA's involvement, each of the 50 states had its own regulations, leading to a wide range of standards. New Jersey was the first state to enact a PFAS drinking water standard, while states like South Dakota had laws preventing the enforcement of standards stricter than federal regulations. In the previous year, the EPA established a maximum contaminant level (MCL) for six PFAS compounds, including PFOA and PFOS, set at four parts per trillion on a running annual average. Kevin also highlighted the introduction of the hazard index, which accounts for the combined effects of multiple PFAS compounds.

Kevin discussed proven treatment technologies for PFAS, focusing on granular activated carbon (GAC), ion exchange resins, and emerging technologies like fluorosorb. He noted that while reverse osmosis and nanofiltration are effective, they are less practical for inland utilities due to the lack of access to the ocean for waste disposal. He emphasised the importance of process selection for utilities, considering factors like water quality, operational costs, and space constraints.

Kevin detailed the operational considerations for GAC systems, which typically involve pairs of vessels in series to increase reliability and optimise carbon usage. He explained the need for 20 minutes of empty bed contact time and the challenges of backwashing and flushing the carbon, which can generate significant waste. He also discussed the potential for pH spikes, the removal of disinfectants, and the impact of naturally occurring organics on carbon life. Kevin highlighted issues like metal release, nitrate sloughing, bacterial growth, and short circuiting, as well as the incidental benefits of GAC, such as the removal of pesticides and taste and odour compounds.

Kevin compared ion exchange resins to GAC, noting that ion exchange requires only five minutes of contact time and has a smaller footprint. He discussed the complexities of on-site regeneration, which is rare due to the challenges involved. Ion exchange systems require pretreatment with cartridge filters and cannot tolerate oxidants in the water. He highlighted the potential for interference from other anions, the risk of lead release due to changes in the chloride to sulfate mass ratio, and the lack of incidental benefits compared to GAC.

Kevin introduced fluorosorb as an emerging technology that performed well in pilot studies, particularly in the Orange County Water District. He noted its resistance to organics and chlorine, and its potential to become a proven technology. However, he acknowledged the reluctance of utilities to be the first to adopt new technologies.

Kevin outlined the key parameters for selecting a treatment process, including capital and operating costs, effectiveness for short-chain PFAS, footprint, and waste disposal. He explained that ion exchange is generally less expensive and more effective for short-chain PFAS, but GAC offers incidental benefits and is more familiar to many utilities. He also noted the potential for converting GAC systems to ion exchange or fluorosorb systems if needed.

Kevin provided a survey of treatment practices across the United States. In the Northeast, utilities favour GAC due to the presence of iron and manganese in the water, which can damage ion exchange resins. In Florida, high organic content in the water makes ion exchange more practical. Arizona utilities are preparing for future regulations on 1,4-dioxane by using GAC. Colorado Springs favours ion exchange due to low TDS and sulfate levels. In California, the choice between GAC and ion exchange varies based on local water quality and existing treatment practices.

Kevin concluded his presentation by emphasising the importance of considering local water quality and regulatory requirements when selecting a PFAS treatment technology. He noted that while reverse osmosis and nanofiltration are effective, they are less practical for inland utilities. The discussion that followed included questions about the implications of discharging PFAS-rich effluent into the sea, the practical considerations for Jersey Water, and the potential for pretreatment to reduce the impact of organic matter on GAC and ion exchange systems. Kevin and the panel members discussed the challenges of space constraints, the logistics of media disposal, and the potential for on-site incineration of spent media.

Discussion with Experts

General Discussion: The meeting opened with a general discussion among the experts. Tony Fletcher raised a concern about nitrate contamination in Jersey, noting historical issues with high nitrate levels from fertiliser runoff. Kevin Berryhill responded that nitrate levels around 30 milligrams per litre are problematic, especially since nitrate is an acute contaminant. He explained that warmer temperatures can exacerbate nitrate release from carbon, but Jersey's cooler climate might mitigate this issue.

Summary of Presentations: Ian Cousins summarised the key points from the three presentations, noting that reverse osmosis and nanofiltration are not currently viable options due to high costs and waste disposal challenges. He highlighted that ion exchange resins, and granular activated carbon (GAC) are the leading contenders for PFAS treatment, with each having its own advantages and disadvantages.

Future Considerations: Steve Hajioff suggested considering a staged implementation approach, starting with GAC or ion exchange and potentially upgrading to fluorosorb or membrane technologies in the future as regulations evolve. He emphasised the importance of understanding the relative performance of these technologies, especially in light of potential future regulations targeting short-chain PFAS compounds.

Water Quality and Treatment Pathways: Christopher Bellona reviewed Jersey's water quality, noting that post-coagulation and filtration, the organic matter levels are relatively low. He recommended starting with rapid small-scale column tests to screen different adsorbents and then conducting a pilot study. Christopher emphasised that membranes might be overkill given the current PFAS levels, but nitrate levels remain a concern.

Pilot Studies: Kevin Berryhill explained the importance of pilot studies, noting that rapid small-scale column tests are a good starting point but should not be solely relied upon for decision-making. He recommended a pilot study to expose treatment options to the variable water quality in Jersey, which would take a few months to yield meaningful results.

Practical Implementation: Ian Cousins inquired about the timeline and complexity of pilot studies. Kevin Berryhill clarified that pilot studies are relatively straightforward, involving small skids about the size of a pallet. Ian Ross added that recent research supports the comparability of rapid small-scale column tests to pilot trials, but a pilot study is still essential for accurate assessment.

Future Proofing: The discussion also touched on future-proofing treatment systems. Hajioff suggested that specifying systems to allow for future upgrades could be beneficial. Christopher and Kevin noted that while future-proofing is important, it is speculative to predict the exact requirements of future media and technologies.

Jersey Water's Current Efforts: Jeanette Sheldon from Jersey Water provided an update on their efforts, including desktop studies and plans for rapid column testing. She mentioned that they are considering a range of technologies, including GAC, ion exchange, and reverse osmosis, to address various potential standards. Sheldon also raised concerns about the supply chain for GAC, to which Kevin Berryhill responded that while there are distribution delays, there is no long-term shortage of coal-based carbon.

Additional Comments: Christopher Bellona mentioned that optimising coagulation processes could improve the removal of organic matter, benefiting adsorbent longevity. He also noted that new GAC manufacturing facilities are coming online in the US, which could help address supply chain concerns.

The meeting concluded with a consensus on the need for pilot studies to determine the most effective PFAS treatment technology for Jersey. The experts agreed that while GAC and ion exchange are the current leading options, future-proofing and considering emerging technologies like fluorosorb are important for long-term planning.

Any other business

No other business was raised by the panel.

Date of next meeting

Wednesday 30th April 2025. It will be held 2pm - 5pm online.

The Chair thanked everyone for their contributions, those watching the meeting and those offering support throughout the whole process.

A reminder to the public that this meeting has been recorded, and the video will be available online on request by emailing the Regulation Enquiries mailbox on RegulationEnquiries@gov.je. This will take a couple of days to make sure the observers are anonymised.

There being no further business, the meeting was closed.

To note that the Panel can be emailed via PFASpanel@gov.je.

Details of meeting dates and times can be found at PFAS in Jersey (gov.je)