BLUETECH Conference Briefing

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The Top 100 WEFTEC abstracts of 2020

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The Top 100 WEFTEC abstracts of 2020

BlueTech Research has completed a detailed analysis of the abstracts selected for presentation at this year's WEFTEC event. From a field of 427, we have chosen the top 100 which represent the most impactful emerging trends, and which align to the key themes that we track on behalf of our clients.

Our analysis is aimed at helping our clients sift through the many and diverse presentations on offer, but is also useful in highlighting the progress of overall trends within the water industry. Typically, BlueTech compares the frequency of certain key terms or technology types, such as MABR, for example, with the previous year. For 2020, we have taken a broader view, looking at trends from the past 5 years back to and including WEFTEC 2016.

WEFTEC will be a virtual event this year, taking place on 5th – 9th October. The unusual circumstances mean that at the time of going to press, there was some uncertainty over whether the entire list of papers would be confirmed at the show. BlueTech is basing our analysis on the papers selected at WEFTEC's mid-year review in March 2020, since their submission can itself be taken as a sign of growing interest in a topic.

Key word analysis

As ever, there is a mixed bag of perennial established topics of interest such as reuse, along with emerging concerns such as PFAs. Other trends, such as AI, are confirmed as growing in terms of interest. Others still reveal an underlying growth of even more nascent themes which we believe are set to be significant in the years ahead – an example of this would be earth observation science (using satellite data for a growing range of uses, from leak detection to watershed management). "Satellite" has grown from a single mention in 2016 to four this year, and five and six in previous years (see Figure 1 below). The subject of earth observation science is one that BlueTech will be keeping a close watch on in the coming years, and our first article on the subject will be published later in the Autumn.

There is one very noticeable gap – there is not a single mention of Covid-19, or SARS-Cov-2, and the number of mentions for "pathogen" and related terms such as "virus" has actually fallen every year since a peak of 37 in 2015, down to 25 this year. This reflects the fact that the majority of papers were written and submitted well before the current pandemic emerged, and these numbers will almost certainly be very different in 2021.

In the meantime, a very relevant paper is "Decontamination of Pharmaceutical Industry Wastewater: Treatment Options and Lessons Learned" from Arcadis, which will be of interest as vaccine production is massively scaled up globally over the coming months.

As we noted last year, the areas of smart/digital water, asset management and general network management and operations are all overlapping more and more. Searching for the terms "smart" and "smart water" has ceased to be revealing, as digital water has been embraced in various forms throughout the water industry, from IoT processes in sludge digestion to smart metering to crop irrigation. However, drilling down into more specific, emerging areas such as artificial intelligence shows a very clear growth in interest, with zero mentions in 2016 and 10 this year. This makes AI one of the fastest-growing areas of interest, as we anticipated in our insight report on the subject at the beginning of 2020.

In tracking the keywords, BlueTech has used synonyms, alternative spellings and related terms, eg PFAS/PFOA/Perfluorinated/Perflu-alkyl, etc throughout. The keywords fall into three broad groups, as shown in Figures 1-3 below: Technologies, Contaminants, and Trends.

Technologies: This examines technologies that are somewhere on the Gartner Hype Curve. UV/UV-LED disinfection, for example, is arguably at the peak of inflated expectations. The search terms used are: MABR/Membrane aerated bioreactor; Granular/Granulation/Nereda; UV/UV-LED/Ultraviolet/ultra violet; disinfection; ceramic/ceramics.

Contaminants: Looks at pollutants that are in the spotlight as well as related themes. Search terms: Peracetic Acid/PAA/PAAs; PFAs/PFOA/PFOAS/perfluorinated/per-and; Biofilm Thickness/biofilmthickness / biofilm monitoring; Pathogen/Virus; Microplastics/micro plastic/micro-plastic/micro plastics/micro-plastics; Antibiotic/Anti-biotic / antibiotics / anti-biotics; Micropollutant / Micropollutants/emerging contaminants/micro pollutants / micro-pollutants/micro pollutant/micro-pollutant; Nutrients/nitrate/nitrogen/biological nutrient/BNR/phosphorous/phosphate.

Trends: Indicates sentiment around developments within the water industry. Search terms: IPR/Direct potable reuse; DPR/Direct potable reuse; Metagenomics/Metagenomic; One Water/OneWater; satellite/earth observation; Digital/AI/artificial intelligence/machine learning/smart water/digital/iot/internet of things;circular economy/resource recovery;flooding/CSO/combined sewage overflow/sewer overflow/sewage overflow; leak detection/leak prevention.

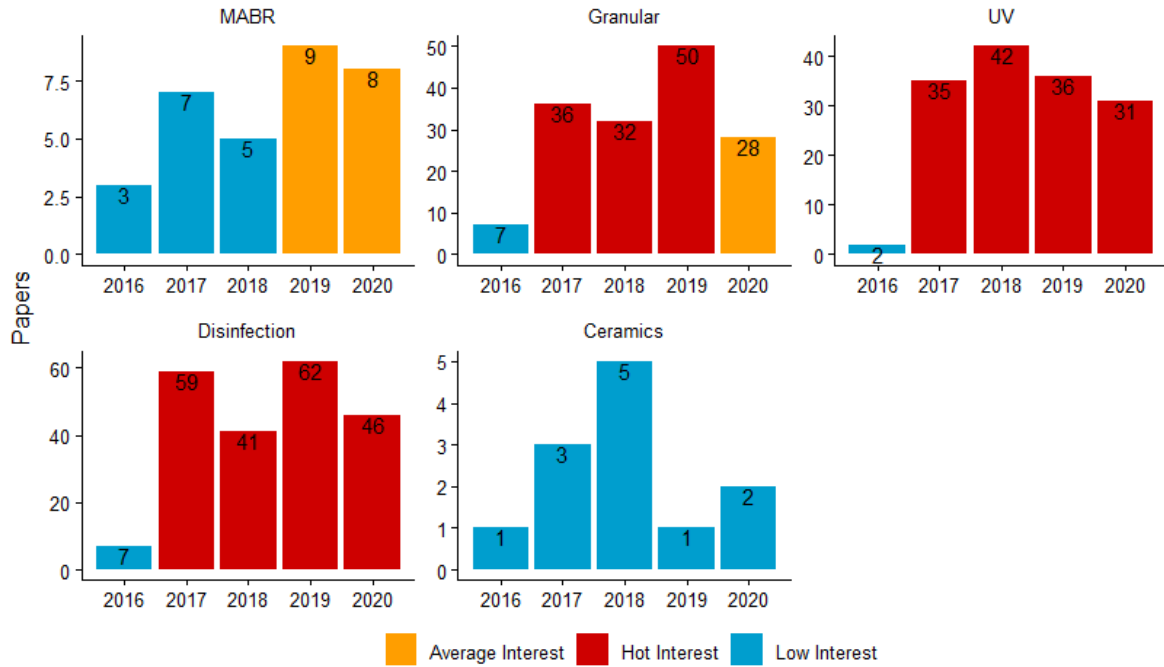## Number of Mentions in WEFTEC Abstracts

Technology Space

Figure 1: Tracking mentions of key technology themes within WEFTEC abstracts, 2016-2020.

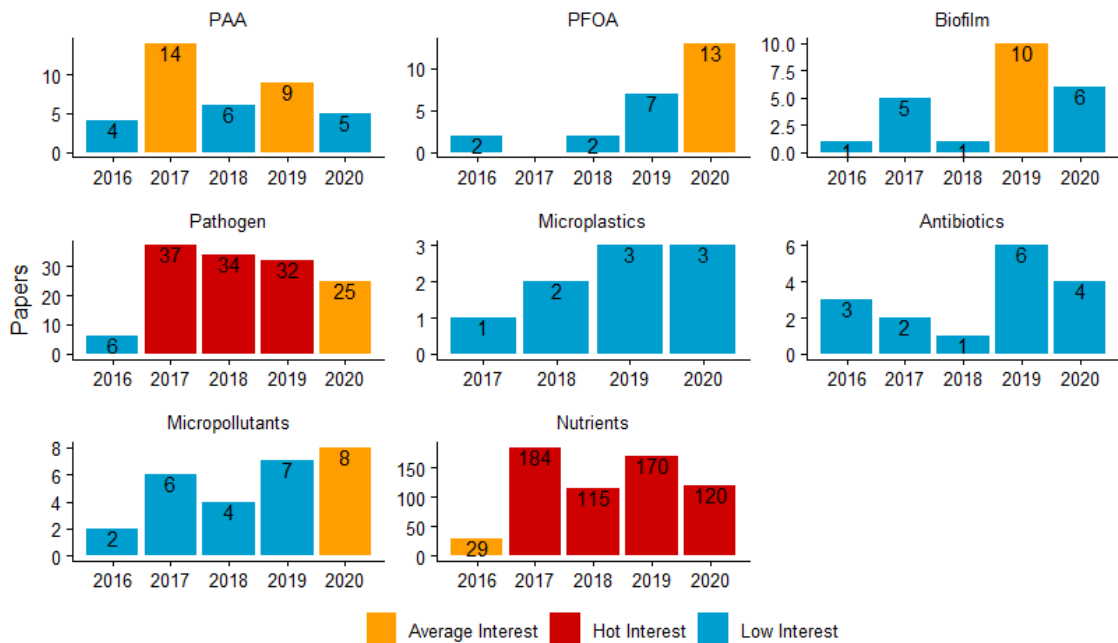## Number of Mentions in WEFTEC Abstracts

Contaminant Space

Figure 2: Tracking mentions of key contaminant/disinfection technology themes within WEFTEC abstracts, 2016-2020.

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Number of Mentions in WEFTEC Abstracts
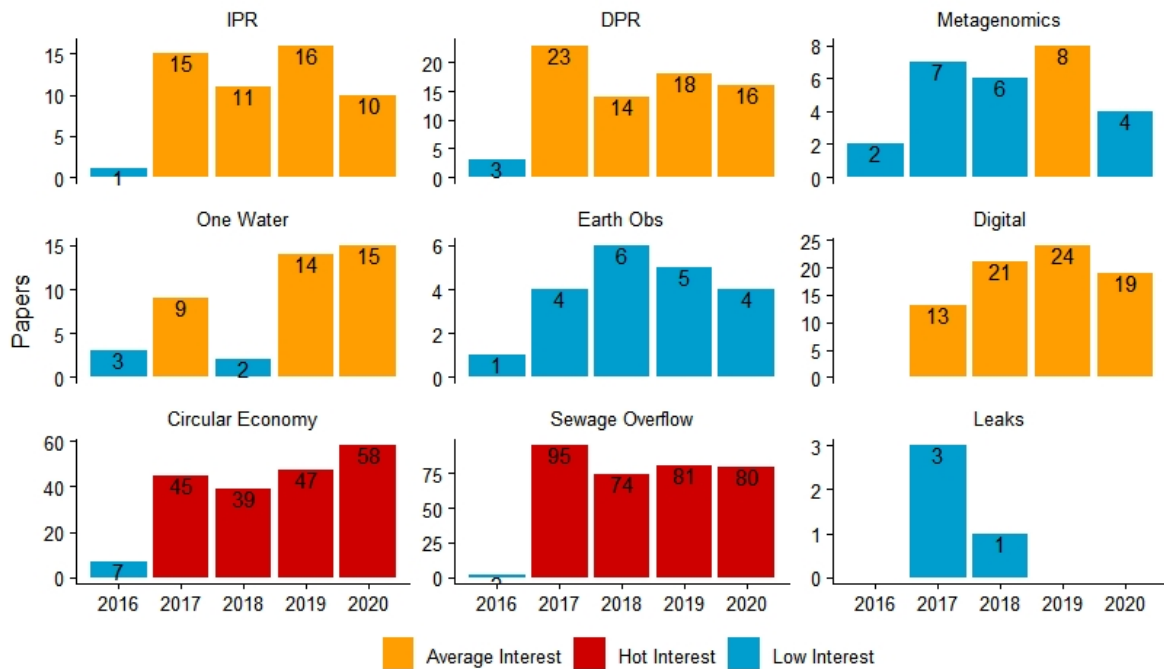
Trends Space

Figure 3: Tracking mentions of key trends within WEFTEC abstracts, 2016-2020.

The term "One Water" beginning to crop up in various conferences five years ago was one of the trends which sparked the idea for our annual tracking of themes. Figure 3 shows the growth: 3 mentions in 2016, 15 this year. More and more municipalities and utilities are becoming interested in considering how they can tackle their water challenges in a holistic way.

The changes in the way that certain technology themes are represented can themselves be classified loosely into a number of groups, as follows:

Crisis trends: The topics with a strong, clear growth are often those which combine public alarm with a strong research base and a clear anticipation of market-creating regulation in the next few years. PFAs/PFOAs, micropollutants and antibiotic-resistant genes in wastewater all fall into this category.

Established technologies: Some technology areas, such as indirect potable reuse, direct potable reuse and UV are all seeing strong commercial growth and interest, but the number of mentions has not been growing year on year. As these technologies and concepts become more mature and established, perhaps the novelty factor has worn off a little, and the focus of research is shifting to other topics. Another example

of this may be granular sludge technology, as exemplified by Nereda, which was featured last year in a paper about North America's first Nereda installation.

"Past the peak": Some topics have had a very clear surge in interest, with a strong growth in the number of papers from one year to the next, but then gradually have decreased somewhat, even if in the real world they are growing commercially. One example of this is the investigation of peracetic acid (PAA) as alternative disinfectant which leaves no by-products. While last year the subject got its own dedicated session for the first time at WEFTEC, the actual number of mentions this year are well below their peak in 2017. Likewise, UV disinfection, which has been the subject of much hype, in particular UV-LED for municipal drinking water, has certainly stopped growing. This may indicate that the peak of interest, particularly from academia, and the peak of commercial success, can arrive at very different times.

"Bubbling under": Some topics, such as ceramic membranes, again despite their increasing adoption commercially, have not seen a strong rise in the number of papers and has been steady for four years. Perhaps their relatively high CAPEX compared to polymeric membranes is putting a ceiling on their research interest for the time being. Likewise metagenomics has been growing, but unevenly. Companies such as Microbe Detectives are finding it a challenge to inform and educate the wider market about the value of DNA analysis, which up to now has been a value-driven innovation rather than one which meets a crisis. The Covid-19 pandemic and the rise of sewer epidemiology may well see a boost in attention in future years though.

Some topics, notably microplastics, are being mentioned in very few papers, despite frequent and prominent coverage in the mainstream media. This is possibly an effect of the relative lack (so far) of provable biological harm of microplastics, despite their ubiquity. It may be that emerging contaminants that cause more immediately apparent harm are taking up academic research bandwidth.

Interesting niches: Last year Dupont's paper, "Optimized Substrate Removal and Energy Consumption in Membrane Aerated Biofilm Reactor with Intelligent Biofilm Thickness Measurement and Control" prompted us to compare mentions of the phrase "biofilm thickness." Figure one shows the trend clearly rising since 2016, although falling back a little this year. One example, "Controlling Biofilm Thickness on Biofilter for Enhanced Micropollutant Removal in Water Reuse Application" from DC Water in partnership with several universities, provides an glimpse of where this might lead – the study found that Ibuprofen degrades faster with a thick biofilm while salicylic acid.

Biofilm measurement and control technologies is another area BlueTech will be monitoring closely, and we will be publishing a Horizon Scan report comparing innovations in this area later in 2020.

Another interesting stand-out is "Cultural Considerations for Wastewater Management - a New Zealand Perspective" from Jacobs. An unusual presentation, this paper is not focused on innovative technologies but on the consideration of indigenous peoples' view points regarding treatment of domestic wastewater. In the case of New Zealand's Maori, treated wastewater must traditionally have land contact (e.g. a rock channel, a wetland) prior to discharge to a water course. Although this can lead to challenges when planning wastewater treatment, consideration of indigenous cultures can result in installation of more sustainable, nature-based solutions.

Consulting engineers continue to dominate

As last year, we have drilled down beyond the top 100 further and selected a "top 10" in four categories: abstracts from academics, utilities, consulting companies, and technology/equipment suppliers. The remaining 60 abstracts are listed further below.

We have found a continued under-representation from providers of technology, services and equipment, which may partly explain why the number of papers on topics which we know are growing, such as UV and in particular UV-LED, are showing a surprising lack of growth in terms of mentions within abstracts.

Of the 116 abstracts selected during BlueTech's screening process, 26 were from academic insitutions[1], 26 from utilities, 54 were from consulting engineering firms, and just 10 were from technology and equipment suppliers.

As noted last year, this may reflect a concern from the organisers to minimise the number of potentially commercially-focussed papers extolling a particular company's solution. However, it also illustrates a known fact about the North American water market – consulting companies retain significant influence.

Top 10 Academic Papers

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Sampling of Microplastics in Water Resource Recovery Facilities: Challenges and Limits	Natalie Wick (1), Lisa Bross (1), Steffen Krause (1), Christian Schaum (1), Franziska Fischer (2), Dieter Fischer (2)	(1) Bundeswehr University Munich, Neubiberg, Muenchen, (2) Leibniz Institute of Polymer Research, Dresden	Emerging contaminants	A look at the challenges of microplastics sampling

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[1] BlueTech has defined "academic" papers as coming solely from universities. However, a great many of the utility and consulting engineering papers were produced in partnership with acacemic institutions.

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Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Long-term performance of a recirculating anaerobic dynamic membrane bioreactor for mainstream domestic wastewater treatment	Tim Fairley (1), Lutgarde Raskin (2), Steven Skerlos (1)	(1) University of Michigan, Ann Arbor, MI, (2) University of Michigan Dept of Civil Eng Env, Ann Arbor, MI	Biological treatment, Assets and networks	An interesting new technology tested for its suitability for mainstream anaerobic treatment of domestic wastewater treatment. BlueTech has been tracking the developments of Anaerobic Membrane Bioreactors (AnMBR), and this paper offers an alternative that targets historical pain-points with AnMBR technology. The anaerobic dynamic membrane bioreactor (AnDMBR) is a nascent technology. The RAnDMBR addresses high energy fouling mitigation, easy backwashing and can operate at higher fluxes than traditional AnMBRs.
Evaluation of a Novel Ultrasonic Cleaning Technique for Fine-Pore Diffusers	Leonardo Guzman-Olaya (1), Julieth Julieth Suarez-Angarita (1), Diego Sebastian Diaz (1), Laura Cortas-Rico (1), Alis Y. Pataquiva-Mateus (2), Diego Rosso (3), Gustavo Andres Baquero (1)	(1) Universidad Militar Nueva Granada, Cajica Colombia, (2) Universidad Jorge Tadeo Lozano, Bogota, Colombica, (3) University of California, Irvine, United States	Sludge management	This technology has never been used in this kind of application, and the results obtained in this test seem promising. Ultrasonic cleaning can potentially save up to 30% of the aeration energy. This directly links to increasing demand in chemical-free CIP practices.
Recent study of the fate of antibiotic resistance genes and antibiotic resistant bacteria in wastewater treatment plants	RENJIE LI (1), Michael Stenstrom (1), Jennifer Jay (1)	(1) University of California Los Angeles, Los Angeles, CA	Antibiotic resistance, Biological treatment, Sludge management	This study will present preliminary results on the removal rates of antibiotic resistance genes (ARG) in activated sludge plants of different sludge retention times. With antibiotic resistance becoming a bigger concern in many areas, it is important to identify how ARG can be sufficiently removed in wastewater treatment plants. With this presentation showing early results, it is worth following up on the complete study once finalised.
Co-treatment of produced water and blowdown water to reduce chemical and energy footprints for water reuse and byproduct generation	Golnoosh Khajouei (1), Hoil Park (2), Harry O Finklea (1), Paul Ziemkiewicz (1), Lian-Shin Lin (1)	(1) West Virginia University, Morgantown, WV, (2) West Virginia University, WV	Industrial reuse	A deep dive into specific applications outside of O&G activities where produced water can be beneficially reused. The example of cooling tower blowdown water evaluated shows synergy with produced water when treated together. The ability to substantially reduce chemical additions is reported, especially in softening treatment, due to the chemistries of the two water sources causing natural precipitation with high removal rates observed. This is an interesting way to reduce chemical addition by reusing a wastestream, however, it is possible more chemicals would be required for something like corrosion protection if produced water conductivity is too high, or biocide to control bacteria.
Sensors for pathogen removal monitoring during water reclamation for reuse	Sunny Jiang (1), Hamsa Gowda (1), Horacio Kido (1), Xiao Huang (1), Marc Madou (2), Michael Hoffmann (3)	(1) University of California, Irvine, Irvine, CA, (2) University of California, Irvine, N/A, (3) Caltech, N/A	Sensors and control systems	A look at whether real-time pathogen sensors could reduce over-redundancy in reuse systems, leading to energy savings.

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Predicting digester methane production using microbial community information: Can your biomass DNA data really be used to improve operations?	Kaushik Venkiteshwaran (1), Nathan Lang (1), Dong Ye (1), Daniel Zitomer (2)	(1) Marquette University, Milwaukee, WI, (2) Marquette University Haggerty Eng Hall, Milwaukee, WI	Resource recovery, Biological treatment, Circular economy	Practical use of metagenomics to boost AD efficiency.
Behavior of perfluoroalkyl substance (PFAS) in sludge processing at nine Canadian sludge handling facilities	Narasimman Lakshminarasiman (1), Sarah Gewurtz (2), Shirley Anne Smyth (3), Wayne Parker (1)	(1) University of Waterloo, Waterloo, ON, (2) Environment and Climate Change Canada, N/A, (3) Environment Canada, Stoney Creek, ON	Sludge management, Emerging contaminants	Knowing the concentrations of PFAS in different parts of the wastewater treatment process can help to determine the most effective ways to remove them.
Ten Years After: The status of Polybrominated Diphenyl Ethers (PBDE) in Canadian biosolids and their fate through solids treatment processes	Narasimman Lakshminarasiman (1), Sarah Gewurtz (2), Shirley Anne Smyth (3), Wayne Parker (1)	(1) University of Waterloo, Waterloo, ON, (2) Environment and Climate Change Canada, N/A, (3) Environment Canada, Stoney Creek, ON	Emerging contaminants	Covers two growing areas of interest, micropollutants and accumulation in biosolids.
Hydrogeologic soil research for green stormwater infrastructure planning and design: replicable research from the Chicago-Calumet Region (CCR)	Margaret Schneemann (1), Mary Patricia McGuire (2), David Grimley (3), Andrew Phillips (4), Ashlynn Stillwell (2)	(1) Illinois-Indiana Sea Grant, Urbana, IL, (2) University of Illinois, Champaign, IL, (3) IL Geological Survey, Champaign, IL, (4) Illinois State Geologic Survey, Champaign, IL	Assets and networks	Looks at techniques and models important to planning Blue-Green infrastructure.

Top 10 Consulting Engineering Papers

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Meeting Stringent Ammonia and Disinfection Byproducts Limits Using Preformed Monochloramine Disinfection	Jennifer Chang (1), Rachel Golda (2), Peter Schauer (3), Larry Schimmoller (4), Matthew Noesen (5)	(1) Jacobs Engineering Group, Corvallis, OR, (2) Clean Water Services, OR, Hillsboro, OR, (3) Black & Veatch, Tigard, OR, (4) CH2M, Englewood, CO, (5) CH2M, Olympia, WA	Disinfection	This paper demonstrates the benefits of Preformed monochloramine (PFM) disinfection. PFM is a chemical formed by mixing ammonia and sodium hypochlorite which when used as a disinfectant was found to generate negligible quantities of DBPs over free chlorine. If faced with more stringent DBP limits, PFM would work as a superior alternative to chlorine as it achieves good levels of disinfection with less added ammonia, so that low effluent ammonia limits can also be met.
Emerging Contaminants in a Circular Economy: How biosolids programs may be disrupted by PFAS?	Eric Spargimino (1), Ned Beecher (2), Charles Schaefer (3), Linda Lee (4)	(1) CDM Smith, Manchester, NH, (2) NEBRA, Tamworth, NH, (3) CDM Smith, Edison, NJ, (4) Purdue University Dept. of Agronomy, West Lafayette, IN	Emerging contaminants, Sludge management	This paper deals with PFAS leaching from biosolids. Since there hasn't been much data published on this topic, this study could give important insights that can be used for biosolids to land applications.

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Utilization of Recyclable Photocatalysts for Selenium Removal from Industrial Wastewater	Andrew Holmes (1), Frank Gu (2)	(1) Geosyntec Consultants, Guelph, ON, (2) University of Toronto, Toronto	Emerging contaminants, Circular economy	New method of reducing selenium in industrial wastewaters is shown to be effective. Use of a recyclable catalyst with UV light, which (BlueTech opinion) could provide a path for reduced cost due to UV LEDs, makes for an interesting approach.
Treatability Testing and Design of Unique Bioreactor for Leachate Odor Control	Lucy Pugh (1), Rohan Menon (2), Brian Brazil (3), Peter Lucas (4)	(1) AECOM, Grand Rapids, MI, (2) Waste Management, Chester Springs, PA, (3) Waste Management, Gaithersburg, MD, (4) Waste Management, Dayton, OH	Odour control, Sludge management	The landfill leachate market is still small, but is expected to have a high growth rate, with regulatory drivers increasing the requirement to treat before sewer discharge. Comparison of two treatment approaches: AOP and Biologic. Detail on pilot of one treatment leading to full scale operational design.
Wellington Water's Application Of Artificial Intelligence For Wastewater Infrastructure Planning	Andrew Faulkner (1), Joel Wilson (1), Steve Hutchison (2), Abby Jensen (3)	(1) WCS Engineering, Kingscliff, Australia, (2) Wellington Water, Wellington, New Zealand, (3) Beca, Wellington, New Zealand	Modeling and simulations, Assets and networks	Shows dramatic results in capital savings using AI - 80% overflow reduction for 55% of planned expenditure.
Decontamination of Pharmaceutical Industry Wastewater: Treatment Options and Lessons Learned	Lily Ponitz (1), Joseph Stanfill (2), Jason Rushing (3), David Liles (4)	(1) Arcadis, Atlanta, GA, (2) Arcadis, Peachtree Corners, GA, (3) Arcadis, Syracuse, NY, (4) Arcadis, Durham, NC	Industrial Issues and Treatment Technologies	Very relevant to pharmaceutical wastewater and vaccine production.
Pilot Study on Evaluating Treatment of CEC in RO Brine from Hybrid Treatment Train Produced Water by Microbial Fuel Cell	Mojtaba Farrokh Shad (1), Graham Juby (1), Ali Sharbat (2), Saied Delagah (3)	(1) Carollo Engineers, Inc., Costa Mesa, CA, (2) N/A, Pomona, CA, (3) N/A, Denver, CO	Emerging contaminants, Biological treatment	Testing the ability of microbial fuel cells to remove emerging contaminants.
Predictive Analytics: the Next Step in WRF Operation and Optimization	Katya Bilyk (1), Erika Bailey (2)	(1) Hazen and Sawyer, Raleigh, NC, (2) N/A, Raleigh, NC	Digital, Modeling and simulations, Nutrient removal	This case study on using machine learning to optimize wet weather conditions at a nutrient removal facility, represents one of many practical applications of artificial intelligence in water and wastewater treatment plants.
Per- and polyfluoroalklyl substances (PFAS) destruction by modified SiC-based photocatalysts	Gyu Dong Kim (1), Zachary Hendren (1), Jaehong Kim (2)	(1) RTI International, Research Triangle Park, NC, (2) Yale University, New Haven, CT	Emerging contaminants	A promising new method for PFOA destruction (albeit less effective with PFAS) which combines a silicon carbide (SiC) catalyst composited with single atom platinum catalyst (SAC Pt) and UV.
Forensic Sewer Modeling Using Advanced Modeling Tools to Bust Permit Violators and Anticipate Terrorist Attacks	Matthew Ward (1), Adrian Romero (2), Mark Holstad (3), Eyasu Yilma (4), Jes Vollertsen (5)	(1) CH2M, Chapel Hill, NC, (2) Jacobs, NC, (3) Albuquerque Bernalillo County Water Utility Authority, Albuquerque, NM, (4) Chester Engineers, Alexandria, VA, (5) Aalborg University, Aalborg Ost, DNK	Modeling and simulations, Assets and networks	How data-based detailed sewer flow models can help trace back the source of contamination events, with two case studies: an acid spill, and contingency planning in case of a chemical attack on Washington DC's sewer network.

Top 10 Papers: Utilities

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Mandating green infrastructure on urban development to meet TMDL requirements and increase climate resiliency	Melanie Mason (1)	(1) City of Alexandria, Alexandria, VA	Assets and networks	Building green infrastructure allows cities to be more climate resilient by using these natural systems to reduce the runoff of excess stormwater and protect against flooding. This links back to an area BlueTech is tracking, which is the adaptation of built environment to climate change.
Prediction of Remaining Useful Life of Sewer Pipe - Applying Advanced Sensors and Machine Learning to Pipeline Assessment	Walter Pishkur (1), Seyedali Abolmaali (2)	(1) Public Water Solutions, emeritus City of Arlington, Tx, Arlington, TX, (2) University of Texas, Arlington, Center for Structural Engineering Simulation and Pipeline Inspection, Arlington, TX	Asset and networks, Digital, Sensors and control systems	We are seeing sensor reading and machine learning being implemented across all aspects of water, in particular to inform assest management. The Redzone technology was one of the earliest technologies in the area of sewer condition monitoring. The combination of multi-sensor inspection combined with machine learning in detecting asset defects will help in accurately pin-pointing areas of pipe that are most imminent for failure, and avoid replacing areas of pipe that have a significant remaining useful life, saving time and money for utilities.
Too Much Data: Collection System Data Consolidation and Visualization Using Open Source	Anna Skipper (1), Alberto Bechara (1), Terry Peters (1), Nicole Wright (2)	(1) Fulton County, Atlanta, GA, (2) Fulton County Public Works, Atlanta, United States	Modeling and simulations, Sensors and control systems	Data overload is increasingly becoming an issue in the industry and this approach provides a useful way to leverage the most use out of this vast quantity of data and make it human-readable and actionable.
Targeted Onsite Reuse For Integrated Water Strategy	Denise Chow (1), Ali Poosti (2), Lenise Marrero (3), Flor Burrola (4), Azya Jackson (5)	(1) City of Los Angeles, Los Angeles, CA, (2) City of Los Angeles CA, Los Angeles, CA, (3) N/A, LA Crescenta, CA, (4) City of Los Angeles, LA Sanitation, Los Angeles, CA, (5) City of Los Angeles - LA Sanitation, Los Angeles, CA	Reuse, Assets and networks	This is a real-life example of the complexities that come up when trying to establish a localised closed loop water cycle. It also showcases the lessons learned in the process. The aim is to combine several approaches: wastewater recycling, stormwater recycling, and green infrastructure.
Controlling Biofilm Thickness on Biofilter for Enhanced Micropollutant Removal in Water Reuse Application	Mahmudul Hasan (1), Katherine Alfredo (2), Christine Debarbadillo (3), Sudhir Murthy (4), Rumana Riffat (5)	(1) George Washington University, Washington, DC, (2) University of South Florida, N/A, (3) DC Water & Sewer Authority, Davidsonville, MD, (4) NewHUB, Herndon, VA, (5) George Washington University, Falls Church, VA	Disinfection, Biological treatment	The results of this paper show that biofilm thickness can impact removal rates of micropollutants (e.g. Ibuprofen degrades faster with thick biofilm while salicylic acid is faster with a thinner biofilm). This obviously requires more (and larger scale) research, but eventually this knowledge could be used to customise biofilm thickness depending on the micropollutant in the water to ensure more efficient removal.
Produced Water Research Needs and Smart Decision Making for Reuse	Shellie Chard (1)	(1) Oklahoma Dept Environmental	Industrial reuse	Provides a broad overview of the research priorities currently identified as most applicable to advancing the reuse of produced water outside of

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
		Quality, Oklahoma City, OK		oil&gas activities, which BlueTech has observed to be slow-moving in recent years. This covers policy and regulations, treatment technology, cost, end use, and public perseption.
Better Pathogen Removal by EHRT than Activated Sludge Alone	Christopher McGibbeny (1), James Fitzpatrick (2), Kelly Gordon (2), Rebecca Ives (3), Joan Rose (4)	(1) City of Toledo Div of Water Reclamation, Toledo, OH, (2) Black & Veatch, Kansas City, MO, (3) Michigan State University, East Lansing, MI, (4) Michigan State University, N/A	Assets and networks	Bolsters the case for APT to deal with wet-weather flows.
Flowing into workforce development: from Internship to Certified Water Treatment plant operator	Lew Puckett (1), Josephus Young (2), Quinton Fletcher (3)	(1) City of Atlanta, Jefferson, GA, (2) City of Atlanta, College Park, GA, (3) City of Atlanta, Atlanta, GA	Assets and networks	Fundamental to the future of the industry: a successful trainee plant operator scheme.
Advancement of Ozone-BAC Treatment Processes for Potable Reuse Applications	Sunayna Dasgupta (1), Zia Bukhari (2), Ruth Vega (3), Vijay Sundaram (4)	(1) American Water Works Service Company Inc, Delran, NJ, (2) American Water Works Service Company Inc, Camden, NJ, (3) Shimadzu Scientific Instruments, United States, (4) Stantec, United States	Reuse	Ozone BAC is a potentially important alternative to RO-based flowsheets.
Monitoring the Performance of Permeable Interlock Concrete Paver Street as a Stormwater Control	Fang Cheng (1), Doug Turney (2)	(1) City of Columbus Department of Public Utilities, O, Columbus, OH, (2) EMH&T, Columbus, OH	Assets and networks, circular economy	Important work contributing to our knowledge of factors affecting the design and implemention of permeable streets as part of stormwater control.

Top 10 Papers: Technology Suppliers

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Optimal mixing of gas and chemicals in WRRFs using Computational Fluid Dynamics (CFD): Case Examples for Coagulant Dosing and Pure Oxygen Mixing	Usman Rehman (1), Wim Audenaert (1), Simon Duchi (1), Daria Sudrawska (1), Ingmar Nopens (1), Clemence Carlinet (2), Apra Boyle-Gotla (3), Rudy Lamond (4), Roel Boussemaere (4)	(1) AM-TEAM, Gent, Belgium, (2) Watercare, Auckland, NZL, (3) Watercare Services Limited, Auckland, New Zealand, (4) Air Liquide, Brussels, Belgium	Nutrients: Mainstream Nutrient Removal (Both N and P Removal) (not stormwater/watershed issues)	A good example of the use of CFD to optimise processes.
Experience with a Novel, Compact Integrated UASB-Activated Sludge Reactor in the treatment of soybean processing wastewater	Jose Ramirez (1), Rujie Hao (2)	(1) Global Water Technologies, Houston, TX, (2) Jinluo Water LTD, JinLi, Shangdon Province,	Industrial Issues and Treatment Technologies	An example of combining combination of anaerobic and aerobic processes for high COD industrial wastewater - COD between 3624 mg/L and 8,565 mg/L,

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		People's Republic of China		with total suspended solids (TSS) in the order of 2170 mg/L.
Novel integrated high-rate filtration and fixed-film biological reactor demonstrates simultaneous TSS and BOD removal in wet weather peak flows	Jon Librezon (1), Joseph Goergen (2), Aaron Rivard (2), Daehwan Rhu (3), Jonathan Chen (3), Shin Kang (4), Glen Daigger (5)	(1) Tomorrow Water, Anaheim, CA, (2) 1Genesee County Drain Commissioner WWS, Montrose, MI, (3) Tomorrow Water (BKT), Anaheim, CA, (4) Water Energy Advisors, Ann Arbor, MI, (5) University of Michigan, Ann Arbor, MI	Wet Weather Issues	Shows the performance of the Proteus high-rate filtration system, a new APT technology launched at last year's WEFTEC.
Performic acid/UV combination treatment â€" High efficient in micropollutants removal and bacterial/virus inactivation.	Iris Porat (1), Tatjana Karpova (2), Ulrik Ã–jstedt (3), Marko Kolari (2), Helvi Heinonen-Tanski (4)	(1) Kemira, Atlanta, GA, (2) Kemira Oyj, Espoo, Finland, (3) Kemira Kemi AB, Helsingborg, Sweden, (4) University of Eastern Finland, Kuopio, Finland	Microconstituents, Contaminants of Emerging Concern, and Trace Organic Compounds	The area of micropollutant treatment and removal is one that BlueTech is tracking closely. BlueTech has studied alternatives to chlorination such as using UV radiation and peracetic acid (PAA). This new emerging chemical performic acid (PFA) demonstrates positive results and is thought to be a stronger chemical with a higher oxidation-reduction (redox) potential than PAA. The trial is also backed by Kemira, a large well established player in the field.
Resource Recovery from the Soy Protein Extraction Process Wastewater	Nabin Chowdhury (1), David Swerdlyk (2), Youngseck Hong (2), Denise Horner (3), Cory Robertson (3), Adriano Vieira (3)	(1) Suez, Ashland, VA, (2) Suez, Canada, (3) Suez, United States	Industrial Issues and Treatment Technologies	Industrial wastewater from a soy protein extraction process has been assessed on its anaerobic digestion potential with positive results. This supports the move of industrial operations to a circular economy approach; something we can expect to see more and more of.
PFAS and Biosolids Complete Treatment using Supercritical Water Oxidation	Marc Deshusses (1), Kobe Nagar (1)	(1) Duke University & 374Water, Durham, NC	Residuals and Biosolids (Not Including Energy Recovery)	SCWO is a promising technology that has, however, been rather slowly progressing over the past decade. With the current focus on per-fluorinated compounds in water, wastewater and biosolids, SCWO may become a viable alternative when it comes to breaking down the persistent PFAS molecules. It is therefore important to follow the progress of SCWO for PFAS treatment because this would not 'only' remove the molecules from the feed (like RO or GAC) and produce a concentrated waste stream but rather completely break down the molecules into non-hazardous compounds.
Performance of a full scale MBBR system for biological removal of complex nitrogen compounds (cyanide, thiocyanate and ammonia) from a cyanide detoxification effluent at a gold mine.	Caroline Dale (1), Bradley Young (2), Marc laliberte (2), Maria Ekenberg (3)	(1) Veolia Environment Research and Innovation, Maisons Lafitte, France, (2) Veolia Water Technologies, Montreal, Canada, (3) AnoxKaldnes AB, Lund, SWE	Industrial Issues and Treatment Technologies	Shows 2-stage biologic treatment can reduce toxic components of mine waste, including nitrification at low temperatures.

Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Achieving Reliable Cold Weather Tertiary Ammonia Removal Using Novel Biocatalysts	Ajay Nair (1), Johanna Bobbio (2), Eve Germain-Cripps (2), Ameen Razavi (3), Fatemeh Shirazi (1)	(1) Microvi Biotech Inc., Hayward, CA, (2) Thames Water Utilities Ltd., N/A, (3) N/A, Hayward, CA	Nutrients: Mainstream Nitrogen Removal (Not stormwater/watershed issues)	Compares ammonia and BOD reduction using Microvi's microbial encapsulation, compared to traditional nitrifying sand filters in a demonstration site. Microvi's solution was shown to treat water to a higher quality/lower ammonia concentrations, even at low temperatures and moderately short retention times. This is highly relevant information for those struggling to meet tightening nutrient specifications.
A Simple Measure of MBR Integrity: Further Validation of the Solids-LRV Method	Stephen Katz (1), Pierre Cote (2), Daniella Mosqueda-Jimenez (1), Kathleen Peach (1)	(1) SUEZ Water Technologies & Solutions, Oakville, ON, (2) COTE Membrane Separation Ltd, Dundas, ON	Water Reuse, Desalination, and Brine Recovery	TSS measurement is widely available and can give higher resolution to pathogen removal in MBR systems.
Lessons Learned from Operating a Treated Sewage Effluent (TSE) Reclamation Plant for Flat Panel Display Industry	Seungho Kook (1), Won-il Song (1), Changwon Suh (1), Jonghoon Lee (1)	(1) Techcross Water & Energy, Bucheon-Si, Gyeonggi-Do, KOR	Industrial Issues and Treatment Technologies	An interesting industrial case study.

The best of the rest

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A Produced Water Clarifier Model for the Oil Industry. Analysis of the Impact of Flow Control on Oils and Solids Thickening	Sam Reifsnyder (1), Han Cao Bai (2), Yan WÃ¡ng (2), GÄ☐o ShÃ¨ng (2), Diego Rosso (3)	(1) University of California Irvine, Irvine, CA, (2) Northeast Petroleum University, Daqing, China, (3) University of California, Irvine, Irvine, CA	Industrial reuse, Modeling and simulations	Interesting adaptation of a software process simulator designed originally municipal WWTPs to produced water.
Expanding Whole Plant Simulation for Monitoring and Managing Advanced Processes in Water Reclamation and Water Treatment Plants including Reuse downstream of WWTPs	Dipankar Sen (1), Adnan Lodhi (2), Robert Angelotti (3), Matthew Brooks (4), Adil Godrej (5)	(1) Santa Clara Valley Water District, Mountain View, CA, (2) Kayuga Solution - Virginia Tech, Irvinie, CA, (3) N/A, Manassas, VA, (4) Upper Occoquan Service Authority, Centreville, VA, (5) Virginia Tech, Manassas, VA	Assets and networks, Modeling and simulations	Use of mathematical models as decision support tools in reuse.
Protozoan predation induces partial nitrification and impairs mechanical stability of biofilm on nitrifying membrane-aerated biofilm reactors (MABRs)	Bumkyu Kim (1), Robert Nerenberg (1)	(1) University of Notre Dame, Notre Dame, IN	MABR, Nutrient removal	Examines the complex effects on microbial ecology of protozoa feeding on microorganisms within nitrifying MABR biofilms, and the operational effects.
Going Bubbleless: MABR Technology Full-Scale	Timothy Constantine (1), Nerea Uri (2),	(1) CH2M, Toronto, ON, (2) N/A, Odense C,	MABR	An interesting MABR case study using OxyMem and Suez technology with

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Demonstration at Ejby Molle WRRF	Per Nielsen (3), Julian Sandino (4), Adrienne Willoughby (1)	DNK, (3) VCS Denmark, Odense, DNK, (4) Jacobs, Kansas City, MO		challenging climactic conditions at a large WWTP (p.e. 415,000).
First Full-Scale Activated Sludge Retrofit Using a Spirally-Wound MABR â€" Results and Model Evaluation	Kelly Gordon (1), Neri Nathan (2), Idit Shefer (2), Chever Ben-Yosef (2), Ronen Shechter (2), Yehuda Sisso (3), Leon Downing (4)	(1) Black & Veatch, Kansas City, MO, (2) Fluence, Caesarea, Israel, (3) Mayanot Ha'amakim Water Utility, Yokneâ€™am Illit, Israel, (4) Black & Veatch, Madison, WI	MABR, Nutrient removal	Claimed to be the first full-scale facility operating spirally wound MABRs as part of a hybrid activated sludge process.
A tale of two pilots: comparing a WAS-only thermal hydrolysis process vs. conventional THP	Sebastian Smoot (1), Matthew Higgins (2), Steven Beightol (2), Stephanie Spalding (3), Thomas Kochaba (3)	(1) HDR, Fulton, MD, (2) Bucknell University, Lewisburg, PA, (3) HDR, Virginia Beach, VA	Sludge Management, Circular Economy	An under-studied area: suggests that WAS-only thermal hydrolysis can provide substantial cost savings compared to conventional THP.
Using data driven models to improve water safety in refugee and internally displaced person camps during humanitarian crises	Usman Khan (1), Michael De Santi (1), Rahma Khalid (1), Apostolos Vasileiou (1), Syed Ali (1)	(1) York University, Toronto, ON	Disinfection, Modeling and simulations	Models chlorine decay to optimize water safety in refugee/IDP camps using an artificial neural network (ANN).
Phosphorus management in high-rate activated sludge systems: The roles of enhanced assimilation and biological P removal	Howard Truong (1), Tim Van Winckel (2), Nam Ngo (3), Paul Roots (1), Siegfried Vlaeminck (4), Belinda Sturm (5), Arash Massoudieh (3), Charles Bott (6), Christine Debarbadillo (7), George Wells (1), Haydee De Clippeleir (7)	(1) Northwestern University, Evanston, IL, (2) Ghent University, Gent, BEL, (3) The Catholic University of America, Washington DC, (4) UGent - LabMET, Gent, BEL, (5) University of Kansas, Lawrence, KS, (6) HRSD, Virginia Beach, VA, (7) DC Water and Sewer Authority, Washington DC	Nutrient removal	This study evaluates the opportunity to remove higher levels of N and P while reducing energy demands using a high rate activated sludge (HRAS). The benefit of using a HRAS is that it targets energy neutrality through carbon redirection to solids processing for energy production while offering an opportunity for nutrient redirection through high biomass growth.
Balancing Carbon for Energy Recovery and Nutrient Removal for the World's Largest MBR Facility	Emma Shen (1), Timothy Constantine (2), Colin Newbery (3), Wei Hin Yong (4), Koh Siong Teck (4), Loh Yee Wen (4), Wee Siang Liow (4)	(1) Jacobs, Toronto, ON, (2) CH2M, Toronto, ON, (3) Jacobs Engineering, Singapore, SGP, (4) Public Utilities Board Singapore, N/A	Nutrient removal, biological treatment, circular economy	Carbon management is key for on-site energy management. Concepts like carbon diversion allow for greater biogas production while reducing the oxygen demand, and blower aeration requirements further downstream. However, this can affect biological treatment downstream and such schemes will have to balance the carbon capture with the need for carbon to drive biological nutrient removal. This paper discusses how to achieve the optimal balance in carbon diversion and improved nutirent removal.

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Effect of hydrothermal pretreatment on volatile fatty acids and methane production from thickened waste activated sludge	Farokh Laqa Kakar (1), Ahmad Shabir Razavi (2), Ehssan Husseini Koupaie (3), Hisham Hafez (4), Elsayed Elbeshbishy (5)	(1) Ryerson university, Toronto, ON, (2) Ryerson University, N/A, (3) Ryerson university, N/A, (4) N/A, London, ON, (5) N/A, Toronto, ON	Circular economy, Sludge management	Hydrothermal pre-treatment (HTP) is an area BlueTech is tracking. The technology is an alternative to digestion of wastewater sludges, which achieves complete sterilization and produces usable fuel with greenhouse gas offsets. Our findings prove that over the past several decades, significant effort has been made by entrepreneurial technology companies to introduce HTP for municipal sludges, however very few municipal references exist today. This paper contributes to research efforts in the field and demonstrates that HTP can improve the biodegradability of thickened sludge.
A new Light UVC-LED for Wastewater Disinfection	Gary Hunter (1), William Decker (2), Oliver Lawal (3), Geoffrey Smith (4)	(1) Black & Veatch, Overland Park, KS, (2) AQUIONICS, Pecatonica, IL, (3) AQUIONICS, Erlanger, KY, (4) N/A, N/A	Disinfection	Most of the work on UVC-LED in the municipal space has been with drinking water, and most early companies in this space view municipal wastewater as a secondary market to be addressed as the company scales. Aqua-Aerobic was purchased by METAWATER in 2016 and is currently piloting a system designed for drinking water applications on wastewater. The tests were based on using hydraulic modeling to identify potential reactor changes to effectively achieve higher removal rates at higher hydraulic throughput rates in wastewater.
A novel kinetic ozonation model for prediction of bromate formation, bromate mitigation and trace organic contaminant removal	Wim Audenaert (1), Giacomo Bellandi (1), Robert Pearce (2), Imre Takacs (3), Samantha Hogard (2), Germano Salazar-Benites (4), Usman Rehman (1), Ingmar Nopens (5), Christopher Wilson (6), Charles Bott (2)	(1) AM-TEAM, Gent, Belgium, (2) HRSD, Virginia Beach, VA, (3) Dynamita, Nyons, FRA, (4) HRSD, VA, (5) AM-TEAM, BEL, (6) HRSD, Norfolk, VA	Disinfection, Modeling and simulations, Emerging contaminants	Bromate is formed when ozone used to disinfect drinking water reacts with naturally occurring bromide ions. The formation of bromate remains a major concern and both the US EPA and WHO have set the maximum contaminant level (MCL) for bromate at 10 ppb. This study demonstrates a model was that has been developed that predicts bromate formation dynamically based on real-time data and the impact of this model might be significant.
Your Trenchless Toolbox - The Key to Fixing Large Conveyance System	Joseph Strauch (1)	(1) Gannett Fleming Inc, Camp Hill, PA	Assets and networks	Trenchless repair and rehabilitation has become more competitive with dig-and-replace and it is now used on a larger scale. Advantages include low disruption to traffic, short-intervals of service disruptions, and noise reduction, as most of the technologies used require very little digging, in specific points along the network.
Modernizing Stormwater Programs through Digital Transformation	Gary Conley (1), Nicole Beck (1)	(1) 2NDNATURE, Santa Cruz, CA	Digital, Assets and networks	Analysting the impacts of climate change and CSO events is crucial as cities become more resilient. The use of data in stormwater management can communicate the value of stormwater program investments, can help utilties prioritize stromwater projects and educate the public on stormwater issues.
Cultural Considerations for Wastewater Management - a New Zealand Perspective	Kate Simmonds (1)	(1) JACOBS, Kerikeri, NORTHLAND, New Zealand	Decentralised, Sludge management	An unusual presentation, this paper is not focused on innovative technologies but on the consideration of indigenous peoples' view points regarding treatment of domestic wastewater. In the case of New Zealand's Maori, treated wastewater must have land contact (e.g. a rock channel, a wetland) prior to discharge to a water course. Although this can lead to challenges when planning wastewater treatment, consideration of

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				indigenous cultures can result in installation of more sustainable nature-based solutions.
Incorporating Climate Resiliency into Project Planning and Development	Flor Burrola (1), Lenise Marrero (2), Ali Poosti (3), Azya Jackson (4), Denise Chow (5), Henry Durand (6)	City of Los Angeles, LA Sanitation, Los Angeles, CA	Assets and networks, Modeling and simulations	When designing, upgrading or retrofitting wastewater or stormwater infrastructure, it is becoming more important to consider the impact of climate change. Los Angeles Sanitation and Environment utility is currently developing a climate risk tool which can help identify vulnerable sites that need specific attention. It will be interesting to see the outcomes of this tool and what actions will come out of this.
Enhancing Urban Waterways while Obtaining Water Supply Benefits in the City of Los Angeles	Jonathan Abelson (1), Andy Flores (2), Naushin Kamal (2), Venu Kolli (1), Sean Larson (1), Rita Newman (1), Pooja Sinha (1)	(1) Stantec, Pasadena, CA, (2) City of Los Angeles, Los Angeles, CA	Reuse	This is an urban example where drought events are mitigated by making use of wastewater and stormwater reuse into non-potable and potable water.
Killing More Than Just PFAS with One Stone	Tanja Rauch-Williams (1)	(1) Colorado School Of Mines, Broomfield, CO	Emerging contaminants	Although this study doesn't present new innovation for PFAS removal, it looks at PFAS removal from a holistic standpoint. It includes other micropollutants that occur in water and wastewater, while factoring in the costs.
Designing to Support the Water: Industrial Nexus: Wastewater Treatment and Reuse for a Food and Beverage Production Facility	Kyle Nelson (1), Dustin Stickney (1), James Wang (1), Joon Min (2)	(1) Montrose Environmental Group, Irvine, CA, (2) Montrose Environmental Group, Inc., Irvine, CA	Industrial reuse	A good operating example of on-site water reuse of industrial wastewater.
The Cost of Non-Potable Industrial Reuse: Three Case Studies	Anna Mehrotra (1)	(1) CDM Smith, Boston, MA	Industrial reuse	As we expect more water reuse projects in the coming years, it will become more important to have cost comparisons for different scenarios (dairy, beverage wastewater etc). This paper provides a good place to start building a guidline.
Integrating Blue and Green infrastructure in megacities: a case study of Shanghai	Camille Tigner (1), Vincent Lee (2), Thomas Sagris (3), Michael Zhao (4)	(1) ARUP, New York, NY, (2) ARUP, New York, United States, (3) ARUP, Leeds, United Kingdom, (4) ARUP, Shanghai , China	Assets and networks, Modeling and simulations	This is an interesting case study of a densely populated urban megacity looking to implement blue-green infrastructure to prevent flooding and mitigate urban heating effects that are expected to increase in the coming years. What really jumped out here is that remote sensing and machine learning were used to assess which solutions are suitable for the city of Shanghai. Over 40% of the considered area was said to be suitable for blue-green infrastructure solutions.
Development and Calibration of a Lifecycle Cost Analysis Tool for Urban Green Infrastructure Systems in Philadelphia	Shandor Szalay (1), Gerald Bright (2)	(1) AKRF Inc, Philadelphia, PA, (2) Philadelphia Water Department, Philadelphia, PA	Assets and networks, Modeling and simulations	A Life cycle cost analysis has been developed and calibrated for gravel storage beds for stormwater runoff using field data. With storm and flood events becoming more common, this tool can be helpful for urban planning and sizing of gravel storage beds.
Full-Scale Pilot for Indirect Potable Reuse: The Tampa Augmentation Project	Sarah Burns (1), Seung Park (2), Chuck Weber (3), Brad Baird (2), David Ammerman (4), Tyler Smith (5)	(1) Carollo Engineers, Inc., Tampa, FL, (2) City of Tampa, Tampa, FL, (3) City of Tampa, N/A, (4) Carollo Engineers, Inc., Orlando, FL, (5)	Reuse	Provides a roadmap with phased approach on how to evaluate an IPR feasibility study in a state BlueTech has identified as a municipal reuse hotspot. Covers details on regulatory requirements, importance of monitoring including 300 parameters tested, treatment options, and current status.

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		Carollo Engineers, N/A		
Ozone Pilot Testing in Water Reuse: Controlling Bromate Formation and Optimizing Organics Oxidation	Samantha Hogard (1), Robert Pearce (2), Christopher Wilson (3), Charles Bott (1)	(1) HRSD, Virginia Beach, VA, (2) N/A, Virginia Beach, VA, (3) N/A, Norfolk, VA	Reuse	Details the issue of DBP formation when using ozone in a municipal reuse application, and steps taken to mitigate formation using 3 different chemical additions and 3 different facilities.
City of Porterville's One Water Vision - A Forward Thinking Plan for a Small City	Penny Carlo (1), Elisa Garvey (2), Ryan Orgill (3), Anne Conklin (4), Javier Sanchez (5), Michael Knight (5), Roberto Alvarez (6)	(1) Carollo Engineers, Fresno, CA, (2) CAROLLO ENGINEERS, Walnut Creek, CA, (3) Carollo Engineers, N/A, (4) Carollo Engineers, Seattle, WA, (5) City of Porterville, N/A, (6) City of Porterville, Porterville, CA	Reuse	Covers an approach of considering all water sources, including drinking water, wastewater, and stormwater, interdependently rather than individually to take on a more holistic management approach to water resources. Details technology retrofit requirments to reuse certain sources and the cost of upgrades.
Miami-Dade Water and Sewer: Leveraging Resilience Results on All Fronts	Josenrique Cueto (1), Debbie Griner (2), Hardeep Anand (3), Louise Ellis (4), Josenrique Cueto (1)	(1) Miami-Dade Water & Sewer Dept, Miami, FL, (2) Miami-Dade County Water & Sewer Dept., Miami, FL, (3) N/A, Miami, FL, (4) N/A, New York City, NY	Assets and networks, Modeling and simulations	Details the use of a modeling tool developed in collaboration with multiple international organizations to evaluate how to make utilities more resilient to climate change stressors such as sea level rise, saltwater intrusion, flooding from hurricanes, and water security. System resiliency has become a major concern for facilities and tools like this will become increasingly sought after.
Janus hollow fiber membrane-based DCMD process for desalination of high-salinity oilfield produced water.	Jianjia Yu (1), Lusi Zou (1)	(1) New Mexico Tech, Socorro, NM	Industrial reuse	Details the performance of a new hollow fiber membrane developed specifically for produced water treatment using membrane distillation. Shows improvements in costs, flux rate, and fouling rate.
Occurrence, Distribution and Mitigation of PFAS in Landfill Liquids	Harsh Patel (1), Renzun Zhao (2), Kang Xia (3), Brian Brazil (4)	(1) N/A, Greensboro, NC, (2) North Carolina A&T State University, Greensboro, NC, (3) Virginia Polytechnic Institute and State University, Blacksburg, VA, (4) Waste Management, Gaithersburg, MD	Emerging contaminants	Discusses the likelihood of WWTPs not accepting landfill leachate due to elevated PFAS. Details difficulty of treating PFAS in high DOM streams like leachate.
Electrodialysis Treatment of a Thickener Overflow Stream in Metal Mining	Sanaz Mosadeghsedghi (1), Saviz Mortazavi (1), Tony Di Feo (1), Konstantin Volchek (1)	(1) NRCan-CanmetMINING, Ottawa, ON, Canada	Industrial reuse, Disinfection	Shows effective treatment of water for increasing the number of cycles for reuse in a water-intensive mining process. The electrified treatment also allows for a chemical free approach.
Characterizing, Categorizing, and Communicating Next-Generation Nutrient Removal Processes for Resource Efficiency	Anna Kogler (1), William Tarpeh (2)	(1) Stanford University, Stanford, CA, (2) N/A, Berkeley, CA	Nutrient removal, Resource recovery	Attempt to standardize performance evaluation, system boundaries, and assumptions in calculating metrics for state of the art Nutrient removal and recovery processes, where those standard previous did not exist. This standardization will make it much easier to compare new approaches to nutrient issues. Highlights literature

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				review, pilot testing, and voice of industry feedback for the leading technologies in this application.
Simultaneous N and P removal with Anammox and sidestream bioP	Kester McCullough (1), Stephanie Klaus (1), Sarah Schoepflin (1), Christopher Wilson (1), April Gu (2), IL HAN (3), Charles Bott (1)	(1) HRSD, Virginia Beach, VA, (2) Department of Civil and Env. Eng, Ithaca, NY, (3) Cornell University, Ithaca, NY	Nutrient removal	The two processes have conflicting uses of influent carbon, but the overall flow train still provides low effluent P and N concentrations.
An innovative mainstream partial nitrification process utilizing the thermotolerance of AOB and NOB	Mohammad Monirul Islam Chowdhury (1), Niema Afroze (2), Masuduz Zaman (2), Mehran Andalib (3), George Nakhla (2), Arthur Umble (4)	(1) University of Western Ontario, London, Ontario, (2) University of Western Ontario, London, ON, (3) Stantec, Boston, United States, (4) Stantec, Denver, United States	Nutrient removal	Advances work aimed at accomplishing the emerging approach of mainstream deammonification.The impact of different variables are discussed as well as targets that need to be met to accomplish mainstream deammonification.
Impact of shock organic loading rates on fouling and clogging frequency of membrane bioreactors	Sirwan Alimoradi (1)	(1) The University of Kansas, Lawrence, KS	Asset and networks	Identifies the lack of understanding regarding how clogging impacts fouling of membranes.This could be important information to those developing optimized cleaning schedules or programing automated membrane monitoring systems.
Impact of Thermophilic Temperature on Phosphorus and Ammonia Release from Waste Activated Sludge	Garrett Geer (1), Isaac Avila (1), Hong Zhao (2), Rich DiMassimo (2), Blair Wisdom (1)	(1) Metro Wastewater Reclamation District, Denver, CO, (2) Kruger Inc, Cary, NC	Nutrient removal, Resource recovery, Assets and networks	This paper evaluates adjusting system variables to increase the recovery of nutrients, decrease struvite precipitation and ammonia loading in digestors, and increasing the recovery for beneficial reuse. This is relevant for those needing to control nutrients in their system, optimize nutrient removal/recovery, and evaluate the impact on biogas generation.
Beyond Energy Neutrality Program: Achieving Energy Independence in a Large Water Resource Recovery Facility	Julian Sandino (1), Per Nielsen (2)	(1) Jacobs, Kansas City, MO, (2) VCS Denmark, Odense, DNK	Resource recovery, Circular economy	This work is interesting to those evaluating their water-energy nexus. BlueTech has observed an increased desire to balance water use and reuse with energy use and GHG emmisions.
Approach for Achieving Sustainable Phosphorus Removal Using Sidestream Enhanced Biological Phosphorus Removal with Unfavorable Low Carbon and Highly Variable Influent Wastewater	Cindy Dongqi Qin (1), Levi L. Straka (1), Joseph Kozak (2), Erik Gilmore (2), Jonathan Grabowy (2), Thomas Kunetz (2), Heng Zhang (2), Leon Downing (3)	(1) Metropolitan Water Reclamation District of Greater Chicago, Cicero, IL, (2) Metropolitan Water Reclamation District of Greater Chicago, N/A, (3) Black & Veatch, N/A	Resource recovery	Carbon addition is very costly in nutrient removal processes. This work evaluates an approach cited in the literature that has not been demonstrated or piloted in a real world setting until now. The work evaluates P removal in a low BOD water without the addition of carbon by using Enhanced biologic P removal in a RAS sidestream fermentation process, and shows adequete P removal without supplemental carbon addition.
Lessons and Experiences from Three Years of Monitoring Waste-to-Energy Digesters	Dao Zhong Yu (1), Dave Ellis (1)	(1) Azura Associates International, Waterloo, ON	Resource recovery, Sludge management	Documents the experience of operating waste-to-energy digesters at on-farm installations for generating power from manure and organic waste, a relatively new application increasing in deployment. This paper would be of interest to WRRFs that are considering co-digestion of off-site organics with sludges. It provides recommendations on characterization of

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				waste properties, waste handling equipment selection, and digester monitoring that will be valuable to designers and operators of these facilities. Also relevant to technologies providers who can pretreat waste.
Did Suspending a Co-Digestion System Really Save Money? A Case Study	Ralph Schroedel (1), Charles Goss (2), Steve Jossart (3)	(1) AECOM, Milwaukee, WI, (2) I Kruger Inc, Morrisville, NC, (3) City of Sheboygan, WI	Biological treatment, Assets and networks	This work is relevant to those operating or considering installing a co-digestion system. Before and after data is presented showing the impact of accepting high strength waste into the system. This work is made more interesting if taken in in tandem to "Lessons and Experiences from Three Years of Monitoring Waste-to-Energy Digesters" to determine if optimization could have been acheived.
Disinfection of Primary Effluent: Bench Scale Evaluation of Peracetic Acid to Achieve Enterococcus Limits for CEPT Marine Discharge	Benjamin Luke (1), Jason Ogg (2), Ronald Abraham (2), Kenneth Baker (2), Randall Booker (3), Eric Krueger (4)	(1) Gresham Smith, Nashville, TN, (2) N/A, Nashville, TN, (3) Arcadis, Alpharetta, GA, (4) FMC Corporation, Leander, TX	Disinfection, Assets and networks	Provides insight into PAA use with chemically-enhanced primary treatment. Has wide-ranging application possibilities for the inactivation of pathogens at CSO discharge facilities and blended wastewater effluents resulting from wet weather events.
Real-time Optimization of Peracetic Acid Disinfection at Metro Wastewater Reclamation District Using Artificial Neural Networks	Kathryn Newhart (1), Joshua Goldman-Torres (1), Daniel Freedman (2), Blair Wisdom (2), Tzahi Cath (3), Amanda Hering (4)	(1) Metro Wastewater Reclaimation District, Denver, CO, (2) Metro Wastewater Reclamation District, Denver, CO, (3) Colorado School Of Mines, Golden, CO, (4) Baylor University, Waco, TX	Disinfection, Sensors and control systems, Digital, Assets and networks	Explores the role of artificial neural networks in optimising disinfection with PAA.
Smart Sewers: A Change Catalyst for Real Time Control Facilities	Shirish Agarwal (1), Robert Kneip (2), Reese Johnson (2), Don Wendorff (1)	(1) Jacobs, Cincinnati, OH, (2) MSDGC, Cincinnati, OH	Digital, Assets and networks	An example of providing remote visibility in real time for unstaffed automated utility infrastructure.
Climate Adaptive Stormwater Management: A Living Systems Approach	April Schneider (1), Amy Seek (1), Sara Morrison (1)	(1) Stantec, New York, NY	Modeling and simulations, Assets and networks	Explores the concept of resilience to uncertainty in climate adaptation using nature-based solutions.
Decontamination of Pharmaceutical Industry Wastewater: Treatment Options and Lessons Learned	Lily Ponitz (1), Joseph Stanfill (2), Jason Rushing (3), David Liles (4)	(1) Arcadis, Atlanta, GA, (2) Arcadis, Peachtree Corners, GA, (3) Arcadis, Syracuse, NY, (4) Arcadis, Durham, NC	Decentralised, Disinfection	Very relevant to pharmaceutical wastewater and vaccine production.
Inspecting a Submerged Effluent Outfall System, Inside and Out	Richard Roll (1), Thomas Blodgett (2)	(1) GHD, East Amherst, NY, (2) Niagara County Sewer Dist #1, Niagara Falls, NY	Digital, Assets and networks, Sensors and control systems	Exemplifies advanced inspection and leak detection technologies currently on the market.
Embracing the Uncertain: Fundamentals and Benefits of Uncertainty Analysis at Water	Evangelia Belia (1), Bruce Johnson (2), Peter Vanrolleghem	(1) Hydromantis Inc., Kalamazoo, MI, (2) Jacobs, Englewood, CO, (3) N/A, Quebec	Modeling and simulations, Assets and networks	Decision modeling is a practical approach to making purchase decisions that could become common practice at utilities.

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Title	Speaker(s)	Organisation(s)	Key technology theme	BlueTech comment
Resource Recovery Facilities	(3), Eric Redmond (4), Lorenzo Benedetti (5), Adrienne Willoughby (6), Colin Fitzgerald (7), Robert Angelotti (8), Nathan Qualls (9)	City, QC, (4) N/A, Dallas, TX, (5) N/A, Lekenik, Sisacko-Moslavacka, (6) CH2M, Toronto, ON, (7) Jacobs, Evergreen, CO, (8) N/A, Manassas, VA, (9) New Water, Green Bay Metro Sewerage Dist, DE Pere, WI		
Bridging the Water Gap: A Water-Energy-Food Nexus Approach with Case Studies from Texas	Vishakha Kaushik (1), Bassel Daher (2)	(1) AECOM, Houston, TX, (2) Texas A&M University, College Station, TX	Modeling and simulations, Circular economy	This case study shows that food-water tradeoffs are made on a local level.
Integrated Used Water Management for Resource Recovery: The Right Time for a Systems Approach	Zeynep Erdal (1), George Tchobanoglous	Black & Veatch, Irvine, CA,	Resource recovery, Circular economy	This paper focuses on the concepts of energy and resource recovery, as well as the circular economy, by analyzing the key barriers to minimizing the nutrient, water, and energy footprint of wastewater treatment plants.
Validating membrane bioreactors to remove pathogens during water reuse â^' understanding key operational parameters	Amos Branch (1), Andrew Gilmore (2), Andrew Salveson (1)	Carollo Engineers	Reuse, Biological treatment	Demonstrates MBR's potential applicability in reuse.
Soft-Sensor application to improve ammonium sensor robustness in WRRFs	Francesca Cecconi (1), Yuichi Ito (2), Diego Rosso (1)	(1) University of California, Irvine, Irvine, CA, (2) HORIBA, Ltd., Kyoto-Shi, Kyoto	Sensors and control systems	BlueTech predicts that online sensors will experience rapid growth. This paper demonstrates the application of soft-sensors for monitoring contaminants as well as hardware-based sensors.
A Digital Twin is More Than Hype; How Hartford MDC is Putting It to Use for Resilient Capital Improvements Planning	Scott Craig (1), Jason Waterbury (2), Matthew Gamache (3), Ajay Prasad (1), Brian Brown (4), Amy Corriveau (5)	CDM Smith	Digital, Modeling and simulations	Demonstrates the use of Digital Twins, an emerging tools in designing treatment plants and project management.
Assessing and Visualizing Extreme Storm Event Inundation in Boston Using Spatial Rainfall, 2-Dimensional Dynamic Flood Modeling and Innovative Tools	Charles Wilson (1)	(1) Hazen and Sawyer, Boston, MA	Modeling and simulations, Assets and networks	Modelling predicts the impact of various stormfronts as well as seal-level rise in a major metropolitan.
Development of Site-Specific Nutrient Standards using the WERF Toolbox Model Selector and Screening Level Model	Andrew Neuhart, Clifton Bell	(1) Brown and Caldwell	Nutrient removal	This project advocates site-specific nutrient removal standards, with the EPA yet to set federal standards and many plants not equipped to handle nutrient removal, this may be a welcomed proposal.
Financing Stormwater Protection Projects Through the Water Infrastructure Finance and Innovation Act (WIFIA) Program	Kavita Mak (1)	(1) U.S. Enviornmental Protection Agency, Washington, DC	Assets and networks	Financing can help municipalities develop stormwater management systems, a widespread need in the US. There have been numerous reports submitted to WEFTEC on new stormwater management programs. Perhaps financing will help capitalize on this growing trend.

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Impact of Food Safety Modernization Act (FSMA) on Recycled Water Use for Irrigation of Food Crops	Bahman Sheikh (1), Kara Nelson (2)	(1) Bahman Sheikh Water Reuse Consulting, San Francisco, CA, (2) University of California, Berkeley, Berkeley, CA	Reuse	Assessment of the role the FDA will play in the irrigation of food crops with recycled water.
Bigger is Better? Challenges Associated with Large Membrane Bioreactor Water Reclamation Facilities	Andrew Gilmore (1)	(1) Carollo Engineers, Phoenix, AZ	Biological treatment, Assets and networks	Analysis of large scale MBR and applicability to large plants, will be of interest to several utilities.
Partial Denitrification Model Development in the Context of Shortcut Nitrogen Removal Processes	Ahmed Al-Omari (1), Tanush Wadhawan (2), Imre Takacs (3), Stephanie Klaus (4), Tri Le (5), Jose Jimenez (6), Sudhir Murthy (7), Charles Bott (4), Haydee De Clippeleir (8)	(1) Brown and Caldwell, Washington, DC, (2) N/A, Brampton, ON, (3) Envirosim Associates Ltd, Nyons, FRA, (4) HRSD, Virginia Beach, VA, (5) Jacobs, Charlotte, NC, (6) Brown And Caldwell, Maitland, FL, (7) DC Water, United States, (8) N/A, Alexandria, VA	Nutrient removal, Modeling and simulations	Discusses a new method for modelling partial denitrification in WWTPs.
Renewable Diesel: Unique Wastewater Treatment Challenges	Michael Mecredy (1), Jonathan Kusowski (2), Russell Freda (3), Ronald Ballard (4), Houston Flippin (5)	(1) N/A, Nashville, TN, (2) Brown and Caldwell, N/A, (3) Brown and Caldwell, Seattle, WA, (4) Brown and Caldwell, Houston, TX, (5) N/A, Brentwood, TN	Industrial reuse	An interesting look at the complexities of treating some extremely challenging industrial wastewater, which often reaches 100,000 mg/L - and is from a growing sector, diesel generated from waste oils such as tallow, cooking oil and corn oil.
Laser-Focused Odor Control Capital Improvement Planning: Using Modified Dispersion Modeling to Project Actual Project Impacts	David McEwen (1)	(1) Brown and Caldwell, Chapel Hill, NC	Odour control, Modeling and simulations	How focussing on the likely dispersal pattern specific compounds and equipment within a plant can help optimise odor control, for example it may identify a certain odor control technology (perhaps a biofilter as opposed to a carbon scrubber) as the optimal choice.
Knowledge Development Forum: Theoretical and Practical Debate to Improve EBPR Modeling Practice	Leon Downing (1), Peter Schauer (2), Peter Dold (3), Patrick Dunlap (4), April Gu (5), Evangelia Belia (6), Tom Johnson (7), Keaton Lesnik (8)	(1) Black & Veatch, Madison, WI, (2) Clean Water Services, Tigard, OR, (3) N/A, Oakville, ON, (4) Black & Veatch, Kansas City, MO, (5) Department of Civil and Env. Eng, Ithaca, NY, (6) Hydromantis Inc., (7) CH2M, (8) Maia Analytica	Nutrient removal, Resource recovery, Modeling and simulations	Struvite recovery is still a niche market and Enhanced biological phosphorus removal (EBPR) followed by struvite crystallization is the safest and most favourable option for phosphorus (P) recovery. However the use of this method is often limited based on infrastructure availability, high capital costs and high energy consumption needed for maintaining the complex aerobic, anoxic and anaerobic conditions required to stimulate the PAOs to take up excess phosphorus. This paper contributes to our understanding of factors influencing EBPR.

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