WATER ENVIRONMENT FEDERATION

Nutrient Removal and Recovery

Innovating, Optimizing, and Planning

June 18 – 21 2018 | Raleigh, North Carolina

CONFERENCE PROGRAM

Water Environment Federation
the water quality people

NC AWWA-WEA

The Water Research Foundation

The conference is held by the Water Environment Federation in cooperation with The North Carolina Section of the American Water Works Association & The North Carolina Member Association of the Water Environment Federation, and The Water Research Foundation.

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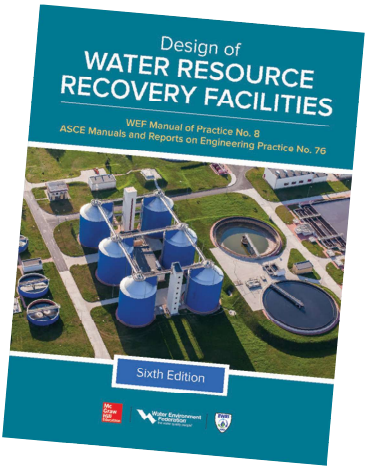

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Water Environment Federation®
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Nutrient Removal and Recovery Conference 2018

Innovating, Optimizing, and Planning

June 18 – 21, 2018
Hilton North Raleigh Midtown
Raleigh, North Carolina

This conference is held by the Water Environment Federation in cooperation with The North Carolina Section of the American Water Works Association & The North Carolina Member Association of the Water Environment Federation, and The Water Reuse Foundation.

June 18, 2018

Dear Colleagues,

Welcome to Raleigh, North Carolina! The Water Environment Federation, in cooperation with The North Carolina Section of the American Water Works Association & The North Carolina Member Association of the Water Environment Federation, and The Water Reuse Foundation are honored to have you join us for the Nutrient Removal and Recovery Conference 2018. On their behalf, we invite you to fully participate in this exceptional opportunity for education and collaboration!

This event continues WEF's tradition of addressing the challenge of sustainable nutrient management through education and sharing of best practices and is dedicated to serving the practitioners who are addressing nutrient issues in today's world. The focus for this event will be on research and collaboration to promote the rapid application of new innovative solutions for nutrient removal and recovery. Additionally, it will examine research, design, operations, and planning of nutrient resource management and provide a platform for the discussion of policy approaches to nutrient control, including an eye on the environmental and economic aspects. It will provide valuable information for researchers, students, regulators, designers, technology developers, operators, municipal agencies, industrial dischargers, and others seeking to understand the full picture of the latest developments and practical experiences on this important topic.

Speakers and attendees joining this event come from a wide variety of backgrounds including regulatory, research, design, implementation, and utility operations. The conference program is composed of 15-20 minute presentations, short technical briefings, and interactive facilitated discussion in every session. Session topics include:

- Nutrient Removal and Recovery;
- BNR Process Control;
- Watershed Management;
- Research and New Technologies;
- Case Studies within Operations;
- Granular Sludge and Biofilms;
- Mainstream and Sidestream Nitrogen Removal; and
- Compliance Strategies.

While you network with other attendees and presenters, make a point to share your experiences. We look forward to interacting with each of you and to the many interesting exchanges that will take place in the next few days – and beyond.

We hope you enjoy this informative event and find many fruitful interactions.

Sincerely,

Belinda Sturm
Conference Co-Chair

Katya Bilyk
Conference Co-Chair

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CONFERENCE COMMITTEE

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REGISTRATION

All events are held in the Hilton North Raleigh Midtown.

The Registration Desk is located in Grand Ballroom Foyer and will be open during the following times:

Hours:

Monday, June 18	7:30 AM – 5:00 PM
Tuesday, June 19	7:30 AM – 5:15 PM
Wednesday, June 20	8:00 AM – 5:15 PM
Thursday, June 21	8:00 AM – 11:45 AM

PRESENTER AND MODERATOR INFORMATION

All presenters, technical briefs, and moderators should sign in at the conference Registration Desk and attend their assigned briefing.

Presenters, technical briefs, and session moderators, participating Tuesday through Thursday should attend their assigned briefing. Presenters should attend only once unless they are speaking on different days.

Volunteer Room Monitors are also encouraged to attend.

The Speaker Briefing and room schedule is as follows:

Sessions 1 through 3
Tuesday, June 19
7:30 AM – 8:15 AM
Room: Boxwood/Dogwood

Sessions 4 through 16
Wednesday, June 20
7:30 AM – 8:15 AM
Room: Boxwood/Dogwood

RECEPTIONS AND MEAL FUNCTIONS

Welcome Kickoff Reception **Grand Ballroom Foyer**

After pre-conference workshops end for the day, join us for an hour-long kickoff reception. Connect with old friends and new colleagues over drinks and snacks before heading out to other evening activities. All full conference, exhibitor, student, and workshop participants are invited.

Monday, June 18
5:15 PM – 6:15 PM

Networking Reception **Grand Ballroom**

Come grab a beer while they last! Join us in the exhibit hall to mingle with your fellow attendees while you view the exhibits, renew acquaintances, and make new contacts. Light hors d'oeuvres and refreshments will be served. Beer will be available first come, first served with a cash bar to follow. Don't miss out!

Tuesday, June 19
5:15 PM – 6:45 PM

Luncheons **Grand Ballroom**

Lunch will be provided for all full conference, daily registrants, exhibitors, students, and expo-only participants. Please advise staff as soon as possible if you have any special dietary requirements. The luncheons will be held in the Exhibit Hall.

Tuesday, June 19
12:15 PM – 1:30 PM

Wednesday, June 20
12:15 PM – 1:30 PM

Networking Breaks

The Networking Breaks will be held:

Monday, June 18
Salon Foyer
10:00 AM – 10:30 AM and 3:00 PM – 3:30 PM

Tuesday, June 19
Grand Ballroom
10:00 AM – 10:45 AM and 3:00 PM – 3:45 PM

Wednesday, June 20
Grand Ballroom
10:00 AM – 10:45 AM and 3:00 PM – 3:45 PM

Thursday, June 21
Salon Foyer
10:00 AM – 10:15 AM

CONTINUING EDUCATION

How Do I Receive Credit For this Conference?
To receive credit for all technical sessions and pre-conference workshops, please fill out a Continuing Education Request Form and be sure to have a room monitor initial for verification.

Attendees will have to submit their CE Request Form to the Registration Desk at the end of the conference. Please request a continuing education form when you check-in and ask WEF staff at the Registration Desk if you have further questions.

Pre-Conference Workshops:
WEF offers Continuing Education Units (CEUs) for participation in workshops. **One CEU is the equivalent to 10 hours** of training or formal instruction. These are distributed for structured, relevant professional training above and beyond that of initial certification or employment in a particular field.

Technical Sessions:
WEF offers Professional Development Hours (PDHs) for participation in technical sessions. **A PDH is defined as one hour** spent engaged in an activity that contributes to the advancement or enhancement of professional skills or scientific knowledge of a professional engineer or operator.

When Will I Receive Credits For this Conference?
Certificates and transcripts for this event will be mailed within 8 weeks of the conference.
Please keep in mind that although WEF does provide these files, most states will require the individual licensee to report continuing education credits.

Note: *Educational Credits will not be recorded and documentation will not be distributed unless the attendee is a confirmed registrant of this event and the proper steps are is completed as indicated in the directions provided.*

Are WEF Continuing Education Credits Approved in My State?
WEF applies for approval in many states and will be happy to work with individuals and Member Associations for additional state or agency approvals upon request. In addition, WEF has been approved as a Training Provider through the following:
The Florida Board of Professional Engineers, the New York State Department of Education, and the Ohio EPA. Many other states accept WEF PDH credits and WEF CEU credits as long as subjects and content meets with state requirements. For example: California (CWEA), Nevada, and New Jersey.

CONTINUING EDUCATION

What Else Do I Need to Know?
WEF follows the International Association of Continuing Education and Training (IACET) guidelines along with state-specific regulations to achieve strict policies and procedures regarding its Continuing Education Program. WEF calculates education credits following a standardized method that is the most widely accepted by certification and licensing agencies. However, many states differ in the type and/or number of credits they will approve for educational events. Because of this, participants are responsible for exploring their state requirements and for ensuring that WEF conference credits are accepted.

Service and Support…
In keeping with IACET guidelines, WEF maintains a database of all continuing education files for a minimum of 7 years. You may contact WEF's Customer Service Team between the hours of 8:30am and 5:00pm EST, Monday through Friday to request these files. Please call 1-800-666-0206 or submit an email request to csc@wef.org.

State Credit Calculations:
*Some state licensing boards will accept CEUs for session under 3 hours in length. Some use different acronyms for training credits. In most instances the credits issued by WEF can be converted to meet state specific requirements that vary from the system used by WEF. This is usually managed at the state level using the following conversion method:

1.0 CEU = 10 Hours of session time
1.0 PDH = 1 Hour of session time
1.0 Contact Hour = 1 Hour of session time
For example: **1.2 CEU** Credits = **12.0 PDH** Credits or **17.0 PDH** Credits could equate to **1.7 CEU Credits** depending on individual state regulations.

**CEU & PDH credits are available for Workshops to Professional Engineers licensed in the state of New York (NYSED).*

For more information regarding WEF's Continuing Education Program, please visit http://www.wef.org/Nutrients.

ONLINE PROCEEDINGS

Conference proceedings, consisting of manuscripts for each presentation, have been made available through an online portal. Advance registrants within Full Conference, Daily, Student, and Exhibiting categories will receive access to the Nutrient Removal and Recovery Conference 2018 online proceedings on the day prior to the conference. Onsite registrants will receive an access link following the event's conclusion.

Copies of proceedings may be ordered after the conference at the member rate of $100 USD/nonmember rate of $150 USD. All orders will be processed after conclusion of the conference. You may call 1-800-666-0206 or visit www.wef.org/ShopWEF and ask for Stock Number – CPNR1805.

TECHNICAL PUBLICATION

Activated Sludge and Nutrient Removal, 3rd edition

Member: $82.95
Non-member: $105.70

This extensively revised third edition reflects industry best practices and the latest advances. It is the primary reference for the operation of the activated sludge process. Expanded content includes an updated process control section with step-by-step examples for calculations, a new laboratory chapter with detailed directions for common process control tests, and an introduction to using modeling for process control.

** * * Conference attendees save 20%.*
Pricing above includes local sales tax of 4.75% and discount.

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WEF's Vision
A community of empowered professionals creating a healthy global water environment.

Core Values
Leadership, Passion, Scholarship, and Collaboration, and Service

WEF Policies
WEF respects and takes the broadest view of human diversity and inclusion and is committed to providing a professional, safe, and welcoming environment at its events for all water professionals and their guests. WEF expects all sponsors, speakers, attendees, media, exhibitors and other participants to uphold our commitment to diversity and inclusion by helping us provide a positive conference environment for everyone.

For more information, please see WEF's Diversity and Inclusivity Policy, as well as WEF's Non-Discrimination and Harassment Policy at www.wef.org/about/about-wef.

Reporting Concerns
If you have any concerns during this conference, please stop by the conference registration desk in the Grand Ballroom Foyer of the Hilton North Raleigh Midtown Hotel or you may email the WEF Executive Director Dr. Eileen O'Neill at eoneill@wef.org.

WEF SOCIAL MEDIA POLICY

WEF strongly encourages the use of social media to share your experiences at our event. This includes sharing interesting quotes or information, taking pictures with colleagues, and using the event hashtag. However, to protect intellectual property, videotaping, filming, or live-streaming of any workshop or technical session presentation, or exhibit booth is prohibited. Any participant violating this policy must relinquish the media and may be removed from the conference. Also, promotional or commercial use of photographs taken at WEFTEC and other WEF conferences is strictly prohibited. If you are interested in content, materials, or products, please consider talking to the speaker or exhibitor, who may provide the information or grant permission.

CONFERENCE SAFETY AND SECURITY

WEF works hard to provide a comfortable and safe environment during our meetings and events, including contracting with private security firms and off-duty police officers when required. Your help also is needed to provide a safe and secure environment.

WEF recommends that you follow these safety guidelines:

1. **Share your plans**. Advise a family member or friend of your travel plans, including the dates you will be gone, how you will travel to the meeting or event, and where you are staying;

2. **Protect your identity**. Wear your name badge only inside the meeting or event venue; remove and secure your name badge when going to and from the venue; when disposing of your name badge, scratch out or destroy your name and/or the QR code to protect your personal information;

3. **Plan for an emergency**. Be aware of your surroundings. Know where the nearest exists are located. Use the buddy system. Exchange contact information with another event attendee. In case of a venue evacuation, agree where you will meet up. Call for help if your buddy doesn't meet up at the agreed location within a reasonable amount of time.

4. **See something, say something.** If you see something that raises a safety or security concern, please follow the instructions printed on the back of your name badge to alert security personnel.

Hilton North Raleigh Midtown Emergency Plan:

Hilton North Raleigh Midtown
3415 Wake Forest Rd.
Raleigh, NC 27609
Phone: (919) 872-2323

To report a medical emergency, fire, or safety or security concern,
please **Dial "0"** from any house phone.

You'll be connected to the Hotel's operator who will contact and dispatch EMS.

PRE-CONFERENCE WORKSHOPS

Pre-Conference Workshops
Monday, June 18
8:30 AM – 5:00 PM
(Separate registration fees apply)

Workshop A
Advances in Nitrogen Removal: New Processes, Pathways, and Process Control
Room: Salon ABC

There have been concerted efforts to overcome inefficiencies of conventional nitrogen removal processes. Which is also aligned with wastewater utilities embracing a new paradigm of recovery of resources from wastewater. To this end, minimization of chemicals, energy and footprint requirements for nitrogen removal has been benefited from the use of efficient biological pathways as well as innovative process control strategies. The main objective this workshop is to address current needs and challenges of mainstream nitrogen removing by showcasing and debating about recent advances.

Workshop C
Short Course: Fundamentals of Nutrients Removal and Recovery-Theory, Technologies, Process Control, and Troubleshooting
Room: Salon FG

This workshop is designed as a short course on the fundamentals of design for biological nutrient removal. It is most appropriate for young professionals and operators. The microbiology, design fundamentals, and operating controls to biological nutrient removal will be presented. Class exercises will pertain to operational responses to optimize nutrient removal or to respond to process upsets. Process simulation software will also be presented as a method to train operators or to test new design parameters.

Don't Forget!
After pre-conference workshops end for the day, join us for the
Welcome Kickoff Reception in the Grand Ballroom Foyer, 5:15-6:15 PM.
All full conference, exhibitor, student, and workshop participants are invited.

OPENING GENERAL SESSION

Opening General Session
Tuesday, June 19
8:30 AM –12:15 PM
Room: Salon FG

8:30 AM **Welcome to the 2018 Conference!**
Belinda Sturm, *University of Kansas, 2018 Co-Chair*
Katya Bilyk, *Hazen and Sawyer*, *2018 Co-Chair*

8:40 AM **Stimulating Resource Recovery from Wastewaters by Healthy Competition Among Utilities – a WEF Benchmarking Exercise**
Peter Vanrolleghem, Université Laval, WEF Board of Trustees

8:50 AM **Welcome from NC AWWA-WEA**
TJ Lynch, City of Raleigh, NC AWWA-WEA

8:55 AM **WWTP Optimization at Nutrient Removal Plants and Future Policy Direction**
Sally Gutiérrez, Water Permits Division, Office of Wastewater Management

9:25 AM **How Do Small Utilities Fit into the Paradigm?**
Jeanette Brown, Manhattan College

9:50 AM **Facilitated Panel and Q&A**

10:00 - 10:45 AM **Networking Break and Opening of Exhibit Hall**

10:45 AM **Lower Neuse Basin – Watershed Load Limits and how Utilities are Planning for Very Low Nitrogen Limits**
TJ Lynch, Assistant Utility Director, City of Raleigh

11:05 AM **Making a Business Case for Nutrient Removal at a Small Utility**
Todd Danielsen, Avon Lake Utilities Ohio

11:25 AM **The Value of Long-range Planning and Starting a Research Program**
Jeff Prevatt, Pima County

11:45 AM **The Value of a Research Program and Process Challenges with Meeting Low TN and TP Limits Simultaneously**
Christine deBarbadillo, DC Water

12:05 PM **Facilitated Panel and Q&A**

12:15 PM **Session Adjourns for Luncheon in Exhibit Hall**

TECHNICAL PROGRAM

Session 01: Optimization
Tuesday, June 19
1:30 PM – 5:15 PM
Room: Salon ABC

Moderators: Kumar Upendrakumar, Veolia North America
Jeanette Brown, Manhattan College

1:30 PM **Nutrient Removal by Optimizing Conventional Wastewater Treatment**
Grant Weaver, CleanWaterOps; Paul Shriner, EPA; Lori Weiss, ERG; Matthew Reusswig, PG Environmental

1:50 PM **Doing More with Less – Leveraging Existing Assets to Manage Capital and Operating Costs**
Phill Yi, Wendell Khunjar, Ronald Taylor, Janice Carroll, Paul Pitt, Hazen & Sawyer; Sarah Lothman, Mike Latham, Michael Rumke, Rick Zaepfel, Loudoun Water

2:10 PM **Full-Scale Testing Postpones Total Nitrogen Reduction Expansion**
Don Esping, Brown and Caldwell; David Green, City of Rochester; Mark Allenwood, Brown and Caldwell

2:30 PM ***Technical Brief:*** **Limited Operating Data? Monte Carlo Based Process Simulations Allow for Optimization of a Newly Constructed BNR Facility**
Colin Fitzgerald, Adrienne Willoughby, CH2M - Jacobs

2:35 PM **Facilitated Panel Discussion**

3:00 PM **Networking Break in Exhibit Hall**

3:45 PM **The Importance of Carbon Availability for SND: Improved Nitrogen Removal at Low DO Concentration is not Guaranteed**
Stephanie Klaus, Virginia Tech; Lindsey Ferguson, Old Dominion University; Cody Campolong, Virginia Tech; Christopher Wilson, HRSD; Bernhard Wett, ARA Consut; Sudhir Murthy, DC Water; Charles Bott, HRSD

4:05 PM **Achieving BPR Without Nitrification – A Low SRT Dilemma**
Chris Maher, Tom Thorson, Peter Schauer, Clean Water Services

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4:25 PM **Assessing Biodegradation and Exposure Effects of Bisphenol-A with Microbial Communities Involved in Biological Nutrient Removal**
Catherine Hoar, Columbia University; Sandeep Sathyamoorthy, Columbia University/Black & Veatch; Kartik Chandran, Columbia University

4:45 PM **Facilitated Panel Discussion**

5:15 PM **Session Adjourns for Networking Reception in Exhibit Hall**

Poster **Minimizing Mixing Energy in Activated Sludge Selector Basins - A Mixing Energy Pilot Study**
Sidharta Arora, Milwaukee Metropolitan Sewerage District; James Fischer, Xylem Water Solutions

Don't Forget!
After technical sessions end for the day, join us for the
Networking Reception in the Grand Ballroom from 5:15-6:45 PM.
All full conference, daily, exhibitor, and student participants are invited.

Session 02: Sustainability as a Driver for Planning and Decision Making

Tuesday, June 19
1:30 PM – 5:15 PM
Room: Salon DE

Moderator: Uma Vempati, ISG

1:30 PM **Adopting Sustainability as the Guiding Principle in Prioritizing R&D Projects at a Water Utility**
Per Nielsen, Troels Bjerre, VCS Denmark

1:50 PM **Balancing Future Growth and Nitrogen Discharge Limits in Wastewater Master Planning for the City of Raleigh**
Susan Auten, Christine Polo, John Brinkley, Black & Veatch; Eileen Navarrete, TJ Lynch, Erika Bailey, City of Raleigh Public Utilities; Steve Tedder, Tedderfarm Consulting

2:10 PM **The Role of Location in Sustainable Nitrogen Removal for Onsite Wastewater Treatment Systems**
Xiaofan Xu, Nancy Diaz-Elsayed, Qiong Zhang, University of South Florida

2:30 PM **Facilitated Panel Discussion**

3:00 PM **Networking Break in Exhibit Hall**

3:45 PM **Regulations Drive Nutrient Recovery and Reuse at Winnipeg's Largest Treatment Facility: The Winnipeg North End Sewage Plant Design-Build Upgrade Project**
Terry Goss, Damian Kruk, James Marx, Keith Sears, Simon Baker, AECOM; Michelle Paetkau, City of Winnipeg

4:05 PM **Unforeseen Consequences: The Impact of Water Conservation on Wastewater Characteristics and the Knock-on Effect on Biological Nutrient Removal**
Andrew Shaw, Black & Veatch; Wayne Bagg, Water Corporation; Rajendra Bhattarai, Austin, TX; Allen Deur, NYCDEP; Soeren Eriksen, VCS Denmark Ltd; Jim McQuarrie, MWRD; Per Nielsen, VCS Denmark; Ana Pena-Tijerina, City of Fort Worth

4:25 PM **Evaluating Nutrient Removal for Madison's Utility of the Future**
Don Esping, Nancy Andrews, Lloyd Winchell, Brown and Caldwell

Session 02 continues on following page

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4:45 PM ***Technical Brief:*** **Impact of Water Conservation on Nutrient Removal and Utilities in General**
Mario Benisch, David Clark, HDR; Werner Maier, IAT Stuttgart

4:50 PM **Facilitated Panel Discussion**

5:15 PM **Session Adjourns for Networking Reception in Exhibit Hall**

Don't Forget!
After technical sessions end for the day, join us for the
Networking Reception in the Grand Ballroom from 5:15-6:45 PM.
All full conference, daily, exhibitor, and student participants are invited.

Session 03: Mainstream Innovations in Nitrogen Removal
Tuesday, June 19
1:30 PM – 5:15 PM
Room: Salon FG

Moderators: Belinda Sturm, University of Kansas
Tim Ware, Arcadis

1:30 PM **Achieving Low TN Effluent by Operating AvN Control Coupled with Partial Denitrification-Anammox Control**
Tri Le, Catholic University of America/DC Water; Rahil Fofana, DC Water; Arash Massoudieh, Catholic University of America; Ahmed Al-Omari, Sudhir Murthy, DC Water; Bernhard Wett, ARA Consut; Kartik Chandran, Columbia University; Christine Debarbadillo, DC Water; Charles Bott, HRSD; Haydee De Clippeleir, DC Water

1:50 PM **Testing of Novel Denitratation/Deammonification Process for Mainstream Total Nitrogen Removal**
Anthony Niemiec, Hazen and Sawyer; Robert Sharp, Manhattan College/ Hazen and Sawyer; Allen Deur, NYCDEP

2:10 PM **Optimizing Carbon Addition to a Polishing Partial Denitrification/Anammox MBBR Using Online Control**
Cody Campolong, Stephanie Klaus, Virginia Tech; Lindsey Ferguson, Old Dominion University; Christopher Wilson, HRSD; Bernhard Wett, ARA Consut; Sudhir Murthy, DC Water; Charles Bott, HRSD

2:30 PM **Facilitated Panel Discussion**

3:00 PM **Networking Break in Exhibit Hall**

3:45 PM **Mainstream ANITA Mox Pilot Testing at the Joint Water Pollution Control Plant**
Michael Liu, Eric Krikorian, Thomas Knapp, Nikos Melitas, Sanitation Districts of LA County; Hong Zhao, Mitch Johnson, Veolia Water Technology

4:05 PM **Enhancing the Decoupling of Solids Retention Times In Full-Scale Deammonification Processes Using Screens**
Tim Van Winckel, Ghent University/DC Water/University of Kansas; Ahmed Al-Omari, DC Water; Imre Takacs, Dynamita; Bernhard Wett, ARA Consut; Benjamin Bachmann, University of Innsbruck; Belinda Sturm, University of Kansas; Charles Bott, HRSD; Siegfried Vlaeminck, Universiteit Antwerp/Ghent University; Sudhir Murthy, Haydée De Clippeleir, DC Water

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4:25 PM **Performance and Microbial Ecology of a Low Temperature (15℃) Mainstream Anammox Moving Bed Biofilm Reactor(MBBR) Process**
Minxi (Joanna) Jiang, Zheqin Li, Kartik Chandran, Columbia University

4:45 PM ***Technical Brief:*** **Membrane-Aerated Biofilm Reactor (MABR) Demonstration at Ejby Mølle WRRF**
Nerea Uri, VCS Denmark; Tim Constantine, J. Sandino, A. Willoughby, CH2M; Per Nielsen, VCS Denmark
**Please see affiliated poster*

4:50 PM **Facilitated Panel Discussion**

5:15 PM **Session Adjourns for Networking Reception in Exhibit Hall**

Don't Forget!
After technical sessions end for the day, join us for the
Networking Reception in the Grand Ballroom from 5:15-6:45 PM.
All full conference, daily, exhibitor, and student participants are invited.

Session 04: Phosphorus Removal: Sidestream Fermentation, Modeling, and Operations
Wednesday, June 20
8:30 AM – 12:15 PM
Room: Salon ABC

Moderators: Paul Wood, Lockwood, Andrews & Newnam, Inc.
Kumar Upendrakumar, Veolia North America

8:30 AM **The Case for Side-Stream RAS or Mixed Liquor Fermentation to Enhance EBPR**
James Barnard; Edmund Kobylinski, Black and Veatch

8:50 AM **Side-Stream EBPR Practices and Fundamentals - Rethinking and Reforming the Enhanced Biological Phosphorus Removal Process**
Nicholas Tooker, Guangyu Li, Varun Srinivasan, Northeastern University; James L. Barnard, Black & Veatch; Charles Bott, HRSD; Paul Dombrowski, Woodard & Curran; Peter Schauer, Adrienne Menniti, Clean Water Services; Andrew Shaw, Black & Veatch; Beverly Stinson, Gerry Stevens, AECOM; Patrick Dunlap, Black & Veatch; Imre Takács, Dynamita; Heather Phillips, City of Olathe; Howard Analla, City of Henderson; Andy Russell, Town of Cary; Angela Lambrecht, Regional District of Central Okanagan; James McQuarrie, Isaac Avila, Metro Water Reclamation District; Annalisa Onnis-Hayden, Northeastern University; April Z. Gu, Cornell University

9:10 AM **Sidestream RAS Fermentation for Stable Bio-P Combined with Short Cut Nitrogen Removal in an A/B Process**
Lindsey Ferguson, Old Dominion University/ HRSD; Cody Campolong, Stephanie Klaus, Virginia Tech/HRSD; Christopher Wilson, HRSD; Bernhard Wett, ARA Consult; Sudhir Murthy, DC Water; Charles Bott, HRSD

9:30 AM ***Technical Brief:*** **A Model Based Study: Revisiting Conventional BNR Configurations with Advanced Aeration Control**
Pusker Regmi, Jose Jimenez, Brown and Caldwell

9:35 AM **Facilitated Panel Discussion**

10:00 AM **Networking Break in Exhibit Hall**

Session 04 continues on following page

Session 04 continues from previous page

10:45 AM **Comparison of Microbial Ecology Between Conventional and Side-Stream Full-Scale EBPR Systems**
Varun Srinivasan, Nicholas Tooker, Guangyu Li, Northeastern University; James Barnard, Black & Veatch; Charles Bott, HRSD; Paul Dombrowski, Woodard & Curran; Peter Schauer, Clean Water Services; Adrienne Menniti, Clean Water Services; Annalisa Onnis-Hayden; Ameet Pinto, Northeastern University; April Gu, Northeastern University/Cornell University

11:05 AM **Turning Lemons into Lemonade: Conversion of a Conventional Activated Sludge System into an Enhanced Biological Phosphorus Removal System for High Strength Waste Management**
Kam Law, Greeley and Hansen; Thomas Meyer, Paul Keturi, Greater Peoria Sanitary District

11:25 AM **Application of Agent-Based Modeling to Reveal Competition Between PAOs and GAOs in Side-Stream EBPR (S2EBPR) Systems**
Guangyu Li, Nicholas Tooker, Dongqi Wang, Varun Srinivasan, Northeastern University; James Barnard, Black & Veatch; Peter Schauer, Clean Water Services; Imre Takacs, Dynamita; Annalisa Onnis-Hayden, Northeastern University; April Gu, Cornell University

11:45 AM ***Technical Brief:*** **Performance and Microbial Population in Side-Stream Enhanced Biological Phosphorus Removal Systems**
Annalisa Onnis-Hayden; Nicholas Tooker, Guangyu Li, Dongqi Wang, Varun Srinivasan, Northeastern University; James Barnard, Black & Veatch; Charles Bott, HRSD; Paul Dombrowski, Woodard & Curran;
Peter Schauer, Adrienne Menniti, Clean Water Services;
Andrew Shaw, Black & Veatch; Beverley Stinson,
Gerry Stevens, AECOM; Patrick Dunlap, Black & Veatch; Imre Takacs, Dynamita; Heather Phillips,
City of Olathe; Angela Lambrecht, Reginal District of Central Okanagan; Howard Analla, City of Henderson;
Andy Russell, Town of Cary; April Gu, Cornell University

11:50 AM **Facilitated Panel Discussion**

12:15 PM **Session Adjourns for Luncheon in Exhibit Hall**

Session 05: Control Systems for Enhanced Nitrogen Removal
Wednesday, June 20
8:30 AM – 10:00 AM
Room: Salon DE

Moderators: Joe Husband, Arcadis
Morgan Brown, Water Environment Federation

8:30 AM **Startup, Optimization, and Operational Results from a Biological Nutrient Removal Process with Ammonium Based Airflow Controls**
Eric Redmond, Jacobs-CH2M; ; Matthew Jalbert, Mike Young, Trinity River Authority; Leon Downing, Black and Veatch; Thomas Johnson, Jacobs-CH2M

8:50 AM **Understanding Simultaneous Nutrient Removal through Low Dissolved Oxygen Operation**
Jose Jimenez, Pusker Regmi, Mark Miller, Brown and Caldwell

9:10 AM **Oxygen Uptake Rate as Control Parameter for Carbon Management in High-Rate Activated Sludge**
Tim Van Winckel, Ghent University/DC Water/University of Kansas; Olajide Olagunju, DC Water/Howard University; Belinda Sturm, University of Kansas; Siegfried Vlaeminck, Universiteit Antwerp/Ghent University; Kimberly Jones, Howard University; Charles Bott, HRSD; Bernhard Wett, ARA Consut; Ahmed Al-Omari, Sudhir Murthy, Haydée De Clippeleir, DC Water

9:30 AM ***Technical Brief:*** **Implementation of Aeration Control Strategies and Nitrate-Based Internal Mixed Liquor Recycle Control Employing In-Situ Sensors and Feedback PID Controllers in an Integrated Fixed-Film Activated Sludge Wastewater Treatment Facility**
Amanda Ford, Hazen; Shawn Hawley, Robert Rutherford, HRSD; Kshitiz Uprety; Charles Bott, HRSD

9:35 AM **Facilitated Panel Discussion**

10:00 AM **Session Adjourns for Networking Break in Exhibit Hall**

Session 06: Alternate Electron Donors and Their Applications
Wednesday, June 20
8:30 AM – 10:00 AM
Room: Salon FG

Moderators: Sarina Ergas, University of South Florida
Laura Rodriguez-Gonzalez, University of South Florida

8:30 AM **Making Methanol on the Backs of Nitrifying Bacteria**
Sandeep Sathyamoorthy, Black & Veatch; Yu-Chen Su, Kartik Chandran, Columbia University

8:50 AM **Sulfur-Based Autotrophic Denitrification for Nitrate Removal in Marine Recirculating Aquaculture Systems**
Qiaochong He, Zhang Cheng, Victoria Burnett, Sarina Ergas, University of South Florida

9:10 AM **Woodchip Bioreactors for Nitrate Removal in Wastewater: Recent Findings, Applications, and Economics**
Bryan Maxwell, Francois Birgand, NCSU

9:30 AM **Technical Brief: Characterizing Nitrogen Transformation Processes in Nitrogen Removing Biofilters For Onsite Wastewater Treatment**
Stuart Waugh, NYS Center for Clean Water Technology; Xinwei Mao, Harold Walker, Christopher Gobler, NYS Center for Clean Water Technology/Stony Brook University
** See affiliated poster*

9:35 AM **Facilitated Panel Discussion**

10:00 AM **Session Adjourns for Networking Break in Exhibit Hall**

Session 07: Nutrient Removal from the Utility and Operations Perspective
Wednesday, June 20
10:45 AM – 12:15 PM
Room: Salon DE

Moderators: Erika Bailey, City of Raleigh Public Utilities
Uma Vempati, ISG

10:45 AM **Achieving Energy Neutrality in the Face of Stringent Effluent Nutrient Requirements: Setting a Vision and Empowering Operations Staff**
Tim Constantine, Julian Sandino, Jacobs; Per Nielsen, Mads Leth, VCS Denmark; Adrienne Willoughby, Jacobs

11:05 AM **Process Model Simulation Provides Effective Hands-On Approach to BNR Operator Training**
Paul Dombrowski, Woodard & Curran

11:25 AM **Using Collaborative Efforts to Maximize Nutrient Removal Permit Compliance During Facility Upgrade Construction**
Thor Young, Ladan Holakoo; Greg Jablonski, GHD; Jerome Napora; Bernard Williams, Anne Arundel County Department of Public Works

11:45 AM ***Technical Brief:*** **Culture and Organization Changes Unleashes Nutrient Removal Potential in A Conventional BNR Facility**
Warren Barlow, Fort Collins Utilities; Tanja Rauch-Williams, Carollo Engineers

11:50 AM **Facilitated Panel Discussion**

12:15 PM **Session Adjourns for Luncheon in Exhibit Hall**

Session 08: Reuse and Recovery
Wednesday, June 20
10:45 AM – 12:15 PM
Room: Salon FG

Moderators: Robert Sharp, Manhattan College/ Hazen and Sawyer
Christine Radke, The Water Research Foundation

10:45 AM **Nutrient Recycles and Other Side Effects of Co-Digestion of Organic Waste**
Alan Appleton, Tanja Rauch-Williams, Carollo Engineers; Mark Greene, O'Brien & Gere Engineers Inc; Stefan Grimberg, Clarkson University

11:05 AM **Advancing Nutrient Recovery through Urine-Derived Fertilizers (UDF) in the United States**
Nancy Love, University of Michigan; Abraham Noe-Hays, Rich Earth Institute; Krista Wigginton, University of Michigan; Linda Macpherson, New Water Resources; Diana Aga, University of Buffalo; Charles Bott, HRSD; Glen Daigger, University of Michigan; Arthur Davis, Rich Earth Institute; Joe Eisenberg, University of Michigan; Alexandria Gagnon, HRSD; Zerihun Getaneh, Addis Ababa University; Heather Goetsch, University of Michigan; Phoebe Gooding, Rich Earth Institute; Rebecca Hardin, Stephen Hilton, University of Michigan; Jose Jimenez, Brown and Caldwell; Greg Keoleian, Nicholas Lowe, Waylan Mui, University of Michigan; Rachel Mullen, University of Buffalo; Kim Nace, Rich Earth Institute; Audrey Pallmeyer, University of Michigan; Neil Patel, Rich Earth Institute; Dylan Raye-Leonard, Enrique Rodriguez, University of Michigan; Tatiana Schreiber, Rich Earth Institute, Alex Sinanaj, William Tarpeh, University of Michigan; Rebecca Wombacher, University of Buffalo; Bowen Zhou, University of Michigan

11:25 AM **Wastewater Treatment Selection and Operation to Benefit Downstream Resource Recovery: An Exploration of Three Case Studies**
Stephanie Ishii, Wendell Khunjar, Phill Yi, Enrique Vadiveloo, Buddy Boysen, Chris Owen, Troy Walker, Hazen and Sawyer

11:45 AM **Facilitated Panel Discussion**

12:15 PM **Session Adjourns for Luncheon in Exhibit Hall**

Session 09: Innovations in Phosphorus Control and Recovery
Wednesday, June 20
1:30 PM – 5:15 PM
Room: Salon ABC

Moderators: Thor Yong, GHD
Helene Kassouf, University of South Florida

1:30 PM **A Balancing Act: Achieving Both Low Level Phosphorus and Metals Limits at Upper Blackstone**
Maureen Neville, Alexandra Bowen, CDM Smith; Karla Sangrey, Upper Blackstone Water; Erik Grotton, Blueleaf

1:50 PM **Nutrient Recovery Performance and Optimization of Biological Phosphorus Removal at the F. Wayne Hill Water Resources Center**
Gaya Ram Mohan, JC Lan, Gwinnett County Department of Water Resources; Ron Latimer, Michael Lynch, Paul Pitt, Hazen and Sawyer

2:10 PM **Nutrient Whack-a-Mole - Sidestream Nutrient Control and Assessment of the Fate of Fe, S, and P**
Colin Fitzgerald, CH2M-Jacobs; Leon Downing, Black and Veatch; Thomas Johnson, Eric Redmond, CH2M-Jacobs; Mike Young, Mark Reeves, Matthew Jalbert, Trinity River Authority

2:30 PM ***Technical Brief:*** **There is Light at the End of the Pipe! Causes and Control of Struvite and Vivianite Scaling at WRRFs**
Samuel Jeyanayagam, Jacobs; Douglas Miller, Douglas L Miller Consulting LLC

2:35 PM **Facilitated Panel Discussion**

3:00 PM **Networking Break in Exhibit Hall**

3:45 PM **Holistic Approach to Phosphorus Sequestration and Recovery at Fox River WRD**
Stephen Arant, Bikram Sabherwal, James Barnard, Black & Veatch; Beth Vogt, Jack Russell, James Kerrigan, Fox River WRD

Session 09 continues on following page

Session 09 continues from previous page

4:05 PM **Comparison of Phosphorus Recovery Through Pre-Anaerobic-Digestion Brushite Precipitation and Post-Anaerobic-Digestion Struvite Crystallization**
Zhongtian Li, Menachem Tabanpour, Gerhard Forstner, Centrisys/CNP

4:25 PM **Quantification of Struvite Content of Biosolids Is Necessary to Avoid Bias in The Assessment of Digester and Dewaterability Performance**
Wendell Khunjar, Hazen and Sawyer; Isaac Avila; Liam Cavanaugh, MWRD; Alexandria Gagnon; Ron Latimer, Hazen and Sawyer; Christopher Wilson, HRSD; Blair Wisdom

4:45 PM ***Technical Brief:*** **Lost Crystals– Impacts of Struvite Recovery Performance on Plant Capacity for Achieving Low-P Effluent**
Adrian Romero, Thomas Johnson, Leon Downing, CH2M; Adrienne Menniti, Clean Water Services; William Leaf, CH2M; Matt Seib, Madison Metropolitan Sewerage District; Ron Gearhart, City of Boise; Colin Fitzgerald, Greater Minneapolis-St. Paul Area

4:50 PM **Facilitated Panel Discussion**

5:15 PM **Session Adjourns**

Session 10: Operator Q&A Panel: Experiences and Lessons Learned Meeting Low TN and TP Limits in the Mid-Atlantic Region

Wednesday, June 20
1:30 PM – 5:15 PM
Room: Salon DE

Moderators: Joe Rohrbacher, Hazen and Sawyer
Erika Bailey, City of Raleigh

Many municipalities on the east coast have to meet some of the strictest nutrient standards in the country and have been doing so for over 15 years. This session includes representatives from various municipalities in the region representing nine water reclamation facilities and they will share their stories about nutrient removal. The speakers will make 15-minute presentations and the remainder of the time will be held for a 50-minute Q&A panel with the audience. The majority of the speakers are the Wastewater Operations Director for their utility.

1:30 PM	**Welcome** Joe Rohrbacher, Hazen and Sawyer
1:40 PM	**Erika Bailey** City of Raleigh - 75 mgd Neuse River RRF
1:55 PM	**Jeff Mahagan** Town of Hillsborough - 3 mgd Hillsborough WWTP
2:10 PM	**John Dodson** City of Durham - 20 mgd North Durham WRF
2:25 PM	**Charles Cocker** City of Durham - 20 mgd South Durham WRF
2:40 PM	**Damon Forney** Town of Cary - 18 mgd Western Wake RWRF
2:55 PM	**Jonathan Bulla** Town of Cary - 12 mgd North Cary WRF
3:10 PM	**Mike Parsons** HRSD - 24 mgd Williamsburg WTP
3:25 PM	**James Grandstaff** Henrico County - 75 mgd WRF
3:40 PM	**Q&A Panel with Operators**
5:15 PM	**Session Adjourns**

Session 11: Evolving World of Biofilm Systems for Nutrient Removal
Wednesday, June 20
1:30 PM – 5:15 PM
Room: Salon FG

Moderators: Pusker Regmi, Brown and Caldwell
Christine deBarbadillo, DC Water

1:30 PM **A Pilot Scale Evaluation of Membrane Aerated Biofilm Reactor (MABR) Technology for Biological Nutrient Removal Process Intensification**
Sandeep Sathyamoorthy, Samik Bagchi, Black & Veatch; Daniel Coutts, Suez Treatment Solutions; Kelly Gordon, Black & Veatch; Dwight Houweling, Suez Treatment Solutions

1:50 PM **Partial Nitritation / Anammox Membrane Aerated Biofilm Reactor for Nitrogen Removal from Aerobic Secondary Effluent**
Brett Wagner, Glen Daigger, Nancy Love, University of Michigan

2:10 PM **Achieving Low Nutrient Effluent Quality at Lagoon Facilities using MBBR Technology: Low Temperature Performance and Bacterial Community Analysis**
Robert Delatolla, Patrick D'Aoust, G. LeBlond, Raheleh Arabgol, Warsama Ahmed, Chris Kinsley, University of Ottawa; Simon Vincent, Bradley Young, University of Ottawa

2:30 PM **Facilitated Panel Discussion**

3:00 PM **Networking Break in Exhibit Hall**

3:45 PM **New Generation of MBBR for Biological Treatment of Carbon, Nitrogen and Phosphorus**
Hugues Humbert, Romain Lemaire Tristan Germain, Veolia; Sofia Lind, AnoxKaldnes; Erin Gallimore, Kruger - Veolia Water & Technologies

4:05 PM **Retrofitting a Roughing Filter/Activated Sludge Plant for Continuous Ammonia Removal (<1 mg/L)**
Matthew Kallerud, Carollo Engineers; Ken Cook, West County Wastewater District
**Please see affiliated poster*

Session 11 continues on following page

Session 11 continues from previous page

4:25 PM **Dynamic Aerobic Granular Sludge Modeling**
Bruce Johnson, Heather Stewart, Jacobs

4:45 PM **Facilitated Panel Discussion**

5:15 PM **Session Adjourns**

Session 12: Strategies for Meeting Ultra-Low Nutrient Effluent Quality Standards

Thursday, June 21
8:30 AM – 11:45 AM
Room: Salon ABC

Moderators: Francis de los Reyes III, North Carolina State University
Tim Ware, Arcadis

8:30 AM **Applying Molecular Tools for Increasing Biological Nutrient Removal: A Discussion on Best Practices on Using DNA of Operations**
Leon Downing, Black and Veatch; George Wells, Northwestern University; Autumn Fisher; Matthew Jalbert, Freese & Nichols; Mike Young, Trinity River Authority; Colin Fitzgerald, Eric Redmond, Jacobs - CH2M; John Tillotson; Ralph Wagner, Microbe Detectives LLC

8:50 AM **Characterizing BPR Activity to Understand Overall Process Health**
Peter Schauer, Adrienne Menniti, Gavin Bushee, Clean Water Services

9:10 AM **Quantification of Influent Non-Readily Biodegradable Dissolved Organic Nitrogen to Explore Nutrient Management via Pretreatment**
Mary Sadler, Ronald Taylor, Stephanie Ishii, Hazen and Sawyer

9:30 AM ***Technical Brief:*** **Testing the Limits of TN Removal Technology - Investigating Soluble Organic Nitrogen Generation in A Biological Wastewater Treatment Process**
Ruchi Joshi, North Dakota State University; Murthy Kasi, HDR; Tanush Wadhawan, Dynamita; Eakalak Khan, North Dakota State University
**Please see affiliated poster*

9:35 AM **Facilitated Panel Discussion**

10:00 AM **Networking Break in Exhibit Hall**

10:15 AM **Lessons Learned After A Decade of Collaborative Nutrient Removal Research: What's in The Future?** JB Neethling, David Clark, HDR Inc; David Stensel, University of Washington; Julian Sandino, Jacobs; Roy Tsuchihashi, AECOM; Amit Pramanik, Christine Radke, The Water Research Foundation

Session 12 continues on following page

Session 12 continues from previous page

10:35 AM **Leveraging Research & Real World Experience to Clarify Phosphorus LOT with Ballasted Sedimentation**
Patrick Dunlap, James Fitzpatrick, Mark Steichen, Michael Tache, William Walkup, Black & Veatch

10:55 AM **Save Coagulant Dosages with Sludge Recirculation in Tertiary Chemical Phosphorus Removal Process**
Bryan Fincher, Hong Zhao, Harrison Fowler, Richard DiMassimo, Veolia Water Technologies

11:15 AM **Facilitated Panel Discussion**

11:45 AM **Conference Adjourns**

Session 13: Watershed
Thursday, June 21
8:30 AM – 10:00 AM
Room: Salon DE

Moderators: Sandeep Sathyamoorthy, Black & Veatch
Victor D'Amato, Tetra Tech Engineering, P.C.

8:30 AM **Understanding Water Quality and Nutrients in a Large Watershed**
Mike Osborne, Drew Ackerman, Robert Osborne, Black and Veatch; Gina Kimble, Catawba-Wateree Water Management Group, Charlotte Water

8:50 AM **Neuse River Compliance Association: A Success Story but What Does the Future Hold?**
Haywood Phthisic, Neuse River Compliance Association; Dan McLawhorn, City of Raleigh/Neuse River Compliance Association; Erika Bailey, City of Raleigh

9:10 AM **The San Francisco Bay Area Nutrient Watershed Permit: Challenges Associated with Evaluating 37 Different WRRFs**
Michael Falk, JB Neethling, HDR Inc; Linda Sawyer, Brown and Caldwell; Holly Kennedy, HDR Inc

9:30 AM ***Technical Brief:*** **Exciting New Nutrient Discharge Permitting Frameworks Protect Water Quality and Provide Compliance Flexibilities**
David Clark, Thomas Dupuis, HDR Inc.; Mike Falk; Michael Kasch, JB Neethling, HDR Inc.

9:35 AM **Facilitated Panel Discussion**

10:00 AM **Session Adjourns for Networking Break in Salon Foyer**

Session 14: Latest Concepts in Sidestream Nitrogen Removal and Recovery

Thursday, June 21
8:30 AM – 10:00 AM
Room: Salon FG

Moderators: Katya Bilyk, Hazen and Sawyer
Phil Ackman, Sanitation Districts of Los Angeles County

8:30 AM **Is PAD Worth It? Costs, Benefits, and Lessons Learned from the First PAD Retrofit in the US**
Cole Sigmon, Donald Colgate, JR Finley, Brad Janoka, Conor Tyler, Emanuel Watson, Chris Douville, City of Boulder

8:50 AM **Post Aerobic Digestion: Operational Experience from the Northern Treatment Plant**
Alex Haeger, Liam Cavanaugh, Orren West, Kimberly Cowan, Metro Wastewater Reclamation District; Leon Downing, Black and Veatch

9:10 AM **Tale of Two Cities: Operation of Sidestream ANITA^{TM} Mox**
Margaret Hollowed, Glenn Thesing, Samuel Liang, Veolia Water Technologies

9:30 AM ***Technical Brief:*** **Impact of Ozonation and Electrocoagulation on Refractory Nutrients Generated from Thermal Hydrolysis Processes**
Gregory Pace, Eric Dole, Hazen and Sawyer; Stephanie Ishii, University of Florida; Ruchi Joshi, Eakalak Khan, North Dakota State University; Wendell Khunjar, Marc Santos, Hazen and Sawyer; Robert Sharp, Manhattan College; Phill Yi, Hazen and Sawyer

9:35 AM **Facilitated Panel Discussion**

10:00 AM **Session Adjourns for Networking Break in Salon Foyer**

Poster **Recovery of Ammonium from Sludge Dewatering Processes for the Production of Ammonium Sulfate Solution**
Stephan Wasielewski, Eduard Rott, Ralf Minke, University of Stuttgart; Heidrun Steinmetz, University of Kaiserslautern

Session 15: US EPA National Priorities Nutrient Management Centers: Practical Outcomes from Five Years of Water Research Nationwide

Thursday, June 21
10:15 AM – 11:45 AM
Room: Salon DE

Moderators: Amit Pramanik, The Water Research Foundation
Ben Packard, USEPA

The U.S. Environmental Protection Agency (EPA) as part of its Science to Achieve Results (STAR) program established four Centers to conduct water research and demonstration projects that are innovative and sustainable using a systems approach for nutrient management in the Nation's waters. These Centers were required to take a system view of nutrient management that considered societal and technological factors in the breadth of possibilities that may influence water quality. An overview of each Center's key accomplishments will be presented along with more detailed presentations of Center products that attendees can integrate into their nutrient management strategies.

10.15 AM **Overview of EPA Centers for Water Research on National Priorities Related to a Systems View of Nutrient Management**
Ben Packard, USEPA

10:20 AM **Smart Nonwater Urinals for Improved Water Conservation and Enhanced Nutrient Recovery**
Treavor Boyer, Daniella Saetta, Hannah Ray, Arizona State University

10:40 AM **Management of Diffuse Nutrients from Stormwater and On-Site Wastewater: New Science and Community Engagement Informing Field Demonstrations of New Technologies**
Sarina Ergas, Maya Trotz, Qiong Zhang, James Mihelcic, Kebreab Ghebremichael, Laura Rodriguez-Gonzalez, Karl Payne, Michelle Henderson, Amulya Miriyala, Justine Stocks, Emma Lopez-Ponnada, University of South Florida, Damann Anderson, Hazen and Sawyer, Thomas Lynn, Texas A&M University-Kingsville

11:05 AM **Assessing Efficacy of Nutrient Removal and Recovery Technologies at Wastewater Treatment Facilities**
Brock Hodgson, Sybil Sharvelle, Colorado State University

11:25 AM **Questions and Discussion**
Ben Packard, USEPA; Amit Pramanik, The Water Research Foundation

Session 16: Carbon Redirection
Thursday, June 21
10:15 AM – 11:45 AM
Room: Salon FG

Moderators: Mehran Andalib, Stantec
Christine Radke, The Water Research Foundation

10:15 AM **Evaluating Primary Sludge Fermentation at the Central Valley Water Reclamation Facility**
Adam Klein, Brown and Caldwell; Sharon Burton, Phillip Heck, Central Valley Water Reclamation Facility; Bryan Mansell, Henryk Melcer, Brown and Caldwell

10:35 AM **High-Rate Aerobic and Anaerobic Technologies for Carbon Management and Achieving Energy Neutrality**
Mark Miller, Jose Jimenez, Brown and Caldwell; Damien Batstone, University of Queensland

10:55 AM **Westside Process Replaces TF/AS at Central Valley WRF To Meet New Utah State Phosphorus Regulation**
Henryk Melcer, Brown and Caldwell; Sharon Burton, Central Valley Water Reclamation Facility; Bryan Mansell, Adam Klein, Brown and Caldwell; Phillip Heck, Central Valley Water Reclamation Facility; Trevor Lindley, Brown and Caldwell

11:05 AM ***Technical Brief:*** **Road Map to Achieving Effluent Total Phosphorus Limit of 0.043 mg/L**
Timur Deniz, John Bratby, CDM Smith

11:10 AM **Facilitated Panel Discussion**

11:45 AM **Conference Adjourns**

TECHNICAL PROGRAM AT-A-GLANCE

Session Code	Session Title	Time	Room
Monday, June 18			
Workshop A	Advances in Nitrogen Removal: New processes, pathways and process control	8:30am–5:00pm	Salon ABC
Workshop C	Short Course: Fundamentals of Nutrients Removal and Recovery-Theory, Technologies, Process Control, and Troubleshooting	8:30am–5:00pm	Salon FG
Tuesday, June 19			
OGS	Opening General Session	8:30am–12:15pm	Salon FG
Session 1	Optimization	1:30pm–5:15pm	Salon ABC
Session 2	Sustainability as a Driver for Planning and Decision Making	1:30pm–5:15pm	Salon DE
Session 3	Mainstream Innovations in Nitrogen Removal	1:30pm–5:15pm	Salon FG
Wednesday, June 20			
Session 4	Phosphorus Removal: Sidestream Fermentation, Modeling, and Operations	8:30am–12:15pm	Salon ABC
Session 5	Control Systems for Enhanced Nitrogen Removal	8:30am–10:00am	Salon DE
Session 6	Alternate Electron Donors and Their Applications	8:30am–10:00am	Salon FG
Session 7	Nutrient Removal from the Utility and Operations Perspective	10:45am–12:15pm	Salon DE
Session 8	Reuse and Recovery	10:45am–12:15pm	Salon FG
Session 9	Innovations in Phosphorus Control and Recovery	1:30pm–5:15pm	Salon ABC
Session 10	Operator Q&A Panel: Experiences and Lessons Learned Meeting Low TN and TP Limits in the Mid-Atlantic Region	1:30pm–5:15pm	Salon DE
Session 11	Evolving World of Biofilm Systems for Nutrient Removal	1:30pm–5:15pm	Salon FG
Thursday, June 21			
Session 12	Strategies for Meeting Ultra-Low Nutrient Effluent Quality Standards	8:30am–11:45am	Salon ABC
Session 13	Watershed	8:30am–10:00am	Salon DE
Session 14	Latest Concepts in Sidestream Nitrogen Removal and Recovery	8:30am–10:00am	Salon FG
Session 15	US EPA National Priorities Nutrient Management Centers: Practical Outcomes from Five Years of Water Research Nationwide	10:15am–11:45am	Salon DE
Session 16	Carbon Redirection	10:15am–11:45am	Salon FG

PRESENTATIONS AT-A-GLANCE

We encourage attendees to participate in presentations from among all sessions. To better plan your learning, see below and on the following pages a list of presentations offered during each time block.

Tuesday, June 19 - Afternoon			
	Salon ABC	**Salon DE**	**Salon FG**
Session	**Session 01: Optimization**	**Session 02: Sustainability as a Driver for Planning and Decision Making**	**Session 03: Mainstream Innovations in Nitrogen Removal**
1:30 PM	Nutrient Removal by Optimizing Conventional Wastewater Treatment	Adopting Sustainability as the Guiding Principle in Prioritizing R&D Projects at a Water Utility	Achieving Low TN Effluent by Operating AvN Control Coupled With Partial Denitrification-Anammox Control
1:50 PM	Doing More With Less – Leveraging Existing Assets to Manage Capital and Operating Costs	Balancing Future Growth and Nitrogen Discharge Limits in Wastewater Master Planning for the City of Raleigh	Testing of Novel Denitratation/Deammonification Process for Mainstream Total Nitrogen Removal
2:10 PM	Full-Scale Testing Postpones Total Nitrogen Reduction Expansion	The Role of Location in Sustainable Nitrogen Removal for Onsite Wastewater Treatment Systems	Optimizing Carbon Addition to a Polishing Partial Denitrification/Anammox MBBR using Online Control
2:30 PM	Limited Operating Data? Monte Carlo Based Process Simulations Allow For Optimization Of A Newly Constructed BNR Facility		
3:45 PM	The Importance of Carbon Availability for SND: Improved Nitrogen Removal at Low DO Concentration is not Guaranteed	Regulations Drive Nutrient Recovery and Reuse At Winnipeg's Largest Treatment Facility: The Winnipeg North End Sewage Plant Design-Build Upgrade Project	Mainstream ANITA Mox Pilot Testing at the Joint Water Pollution Control Plant
4:05 PM	Achieving BPR Without Nitrification – A Low SRT Dilemma	Unforeseen Consequences: The Impact of Water Conservation on Wastewater Characteristics and the Knock-on Effect on Biological Nutrient Removal	Enhancing the Decoupling of Solids Retention Times In Full-Scale Deammonification Processes Using Screens
4:25 PM	Assessing Biodegradation and Exposure Effects Of Bisphenol-A With Microbial Communities Involved In Biological Nutrient Removal	Evaluating Nutrient Removal for Madison's Utility of the Future	Performance and Microbial Ecology of a Low Temperature (15 °C) Mainstream Anammox Moving Bed Biofilm Reactor(MBBR) Process
4:45 PM		Impact of Water Conservation on Nutrient Removal and Utilities in General	Membrane-Aerated Biofilm Reactor (MABR) Demonstration at Ejby Mølle WRRF

PRESENTATIONS AT-A-GLANCE

Wednesday, June 20 - Morning			
Room	**Salon ABC**	**Salon DE**	**Salon FG**
Session	**Session 04: Phosphorus Removal: Sidestream Fermentation, Modeling, and Operations**	**Session 05: Control Systems for Enhanced Nitrogen Removal**	**Session 06: Alternate Electron Donors and Their Applications**
8:30 AM	The Case for Side-Stream RAS Or Mixed Liquor Fermentation to Enhance Biological Phosphorus Removal (EBPR)	Startup, Optimization, and Operational Results from a Biological Nutrient Removal Process with Ammonium	Making Methanol on the Backs of Nitrifying Bacteria
8:50 AM	Side-Stream EBPR Practices and Fundamentals - Rethinking and Reforming the Enhanced Biological Phosphorus	Understanding Simultaneous Nutrient Removal through Low Dissolved Oxygen Operation	Sulfur-Based Autotrophic Denitrification for Nitrate Removal in Marine Recirculating Aquaculture
9:10 AM	Sidestream RAS Fermentation for Stable Bio-P Combined with Short Cut Nitrogen Removal in an A/B Process	Oxygen Uptake Rate as Control Parameter for Carbon Management in High-Rate Activated Sludge	Woodchip Bioreactors for Nitrate Removal in Wastewater : Recent Findings, Applications, and Economics
9:30 AM	A Model Based Study: Revisiting Conventional BNR Configurations With Advanced Aeration Control	Implementation of Aeration Control Strategies and Nitrate-Based Internal Mixed Liquor Recycle Control Employing In-Situ Sensors and Feedback PID Controllers in an Integrated Fixed-Film Activated Sludge Wastewater Treatment Facility	Characterizing Nitrogen Transformation Processes in Nitrogen Removing Biofilters for Onsite Wastewater Treatment
Session	***Session 04, continued***	**Session 07: Nutrient Removal from the Utility and Operations Perspective**	**Session 08: Reuse and Recovery**
10:45 AM	Comparison of Microbial Ecology Between Conventional and Side-Stream Full-Scale EBPR Systems	Achieving Energy Neutrality in the Face of Stringent Effluent Nutrient Requirements: Setting a Vision and Empowering Operations Staff	Nutrient recycles and other side effects of co-digestion of organic waste
11:05 AM	Turning Lemons into Lemonade: Conversion of a Conventional Activated Sludge System into an Enhanced Biological Phosphorus Removal System for High Strength Waste Management	Process Model Simulation Provides Effective Hands-On Approach to BNR Operator Training	Advancing Nutrient Recovery through Urine-Derived Fertilizers (UDF) in the United States
11:25 AM	Application of Agent-Based Modeling to Reveal Competition Between PAOs and GAOs in Side-Stream EBPR (S2EBPR) Systems	Using Collaborative Efforts to Maximize Nutrient Removal Permit Compliance During Facility Upgrade Construction	Wastewater Treatment Selection and Operation to Benefit Downstream Resource Recovery: An Exploration of Three Case Studies
11:45 AM	Performance and Microbial Population in Side-Stream Enhanced Biological Phosphorus Removal Systems	Culture and Organization Changes Unleashes Nutrient Removal Potential In A Conventional BNR Facility	

PRESENTATIONS AT-A-GLANCE

Wednesday, June 20 - Afternoon			
Room	**Salon ABC**	**Salon DE**	**Salon FG**
Session	**Session 09: Innovations in Phosphorus Control and Recovery**	**Session 10: Operator Q&A Panel: Experiences and Lessons Learned Meeting Low TN and TP Limits in the Mid-Atlantic Region**	**Session 11: Evolving World of Biofilm Systems for Nutrient Removal**
1:30 PM	A Balancing Act: Achieving Both Low Level Phosphorus and Metals Limits at Upper Blackstone		A Pilot Scale Evaluation of Membrane Aerated Biofilm Reactor (MABR) technology for Biological Nutrient Removal Process Intensification
1:50 PM	Nutrient Recovery Performance and Optimization of Biological Phosphorus Removal at the F. Wayne Hill Water Resources Center		Partial Nitritation / Anammox Membrane Aerated Biofilm Reactor for Nitrogen Removal from Aerobic Secondary Effluent
2:10 PM	Nutrient Whack-a-Mole - Sidestream Nutrient Control and Assessment of the Fate of Fe, S, and P		Achieving Low Nutrient Effluent Quality at Lagoon Facilities using MBBR Technology: Low Temperature Performance and Bacterial Community Analysis
2:30 PM	There is Light at the End of the Pipe! Causes and Control of Struvite and Vivianite Scaling at WRRFs		
3:45 PM	Holistic Approach to Phosphorus Sequestration and Recovery at Fox River WRD		New Generation of MBBR for Biological Treatment of Carbon, Nitrogen and Phosphorus
4:05 PM	Comparison of phosphorus recovery through pre-anaerobic-digestion brushite precipitation and post-anaerobic-digestion struvite crystallization		Retrofitting a Roughing Filter/Activated Sludge Plant for Continuous Ammonia Removal (<1 mg/L)
4:25 PM	Quantification of Struvite Content of Biosolids Is Necessary to Avoid Bias in The Assessment of Digester and Dewaterability Performance		Dynamic Aerobic Granular Sludge Modeling
4:45 PM	Lost Crystals– Impacts of Struvite Recovery Performance on Plant Capacity for Achieving Low-P Effluent		

PRESENTATIONS AT-A-GLANCE

Thursday, June 21 - Morning			
Room	**Salon ABC**	**Salon DE**	**Salon FG**
Session	**Session 12: Strategies for Meeting Ultra-low Nutrient Effluent Quality Standards**	**Session 13: Watershed**	**Session 14: Latest Concepts in Sidestream Nitrogen Removal and Recovery**
8:30 AM	Applying Molecular Tools for Increasing Biological Nutrient Removal: A Discussion on Best Practices on Using DNA of Operations	Understanding Water Quality and Nutrients in a Large Watershed	Is PAD Worth It? Costs, Benefits, and Lessons Learned from the First PAD Retrofit in the US
8:50 AM	Characterizing BPR Activity to Understand Overall Process Health	Neuse River Compliance Association: A Success Story but What Does the Future Hold?	Post Aerobic Digestion: Operational Experience from the Northern Treatment Plant
9:10 AM	Quantification of Influent Non-Readily Biodegradable Dissolved Organic Nitrogen to Explore Nutrient Management via Pretreatment	The San Francisco Bay Area Nutrient Watershed Permit: Challenges Associated with Evaluating 37 Different WRRFs	Tale of Two Cities: Operation of Sidestream ANITA (Trade Mark) Mox
9:30 AM	Testing the Limits of TN Removal Technology - Investigating Soluble Organic Nitrogen Generation in A Biological Wastewater Treatment Process	Exciting New Nutrient Discharge Permitting Frameworks Protect Water Quality and Provide Compliance Flexibilities	Impact of Ozonation and Electrocoagulation on Refractory Nutrients Generated from Thermal Hydrolysis Processes
Session	***Session 12, continued***	**Session 15: US EPA National Priorities Nutrient Management Centers: Practical Outcomes from Five Years of Water Research Nationwide**	**Session 16: Carbon Redirection**
10:15 AM	Lessons Learned After A Decade of Collaborative Nutrient Removal Research: What's In The Future?		Evaluating primary sludge fermentation at the Central Valley Water Reclamation Facility
10:35 AM	Leveraging Research & Real World Experience to Clarify Phosphorus LOT with Ballasted Sedimentation		High-rate aerobic and anaerobic technologies for carbon management and achieving energy neutrality
10:55 AM	Save Coagulant Dosages with Sludge Recirculation in Tertiary Chemical Phosphorus Removal Process		Westside Process Replaces TF/AS at Central Valley WRF To Meet New Utah State Phosphorus Regulation
11:05 AM	The Future of Nutrient and Resource Recovery is Here: Advanced Biological Nutrient Recovery - Algae is the Key to Rapid, Efficient, and Cost Effective Nutrient and Resource Recovery		Road Map to Achieving Effluent Total Phosphorus Limit of 0.043 mg/L

MOBILE APP

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EXHIBITION INFORMATION

Exhibition Schedule

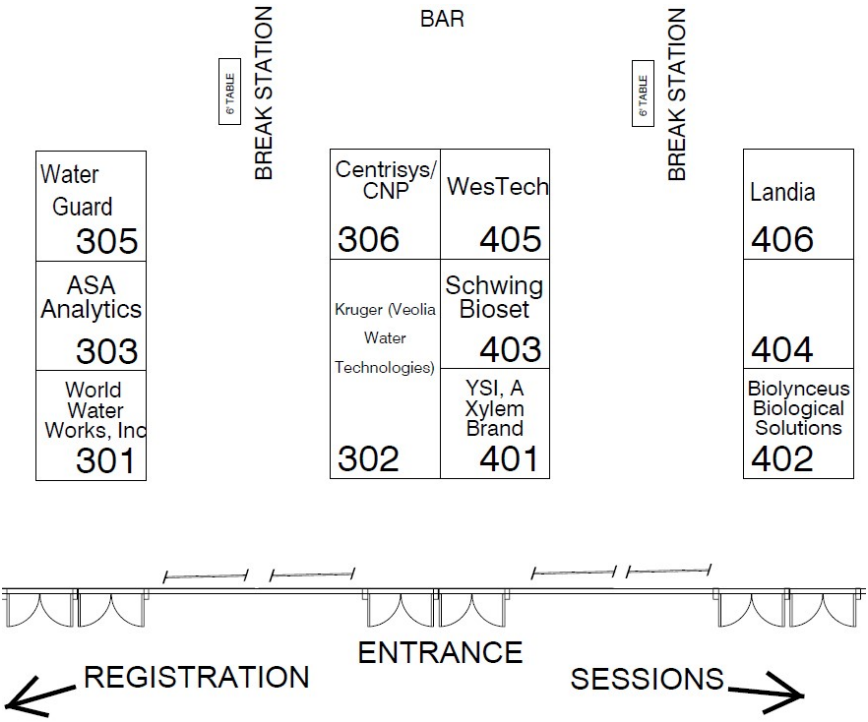
Networking events listed below are dedicated show hours.
Technical sessions will not take place during these times.

Tuesday, June 19	**10:00 am – 6:45 pm**	**Exhibit Hall Open**
	10:00 am – 10:45 am	Networking Break
	12:15 pm – 1:30 pm	Networking Luncheon
	3:00 pm – 3:45 pm	Networking Break
	5:15 pm – 6:45 pm	Networking Reception
Wednesday, June 20	**10:00 am – 3:45 pm**	**Exhibit Hall Open**
	10:00 am – 10:45 am	Networking Break
	12:15 pm – 1:30 pm	Networking Luncheon
	3:00 pm – 3:45 pm	Networking Break

Children under 18 entering the Exhibition must be accompanied by a parent or guardian at all times. The parent or guardian must obtain a child badge at registration, and assumes all risk and responsibility for the child's safety.

Due to the proprietary nature of the displays, photography of displays and materials is forbidden without exhibitors' express permission.

EXHIBIT HALL FLOOR PLAN



EXHIBITOR DIRECTORY

As of 6/7/2018

ASA Analytics..... Booth 303
www.asaanalytics.com
Phone: 229-516-0570
2325 Parklawn Dr, Ste I
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ChemScan process analyzers are individual instruments and complete systems for automatic analysis of nitrate, nitrite, phosphate, oxidants, organics, metals and dissolved chemicals at single or multiple process wastewater locations.

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Estes Park, CO 80517

BioLynceus provides organic nutrients, (F:M), biological nutrient removal, solids handling & candy carbon to optimize wastewater operations. ProBiotic Scrubber programs offer BNR, F:M, Candy Carbon, Carbon Source, Solids Handling Optimization.

Centrisys/CNP ..... Booth 306
www.centrisys.com
Phone: 262-654-6006
9586 58th Pl
Kenosha, WI 53144

Centrisys manufactures dewatering centrifuges and sludge thickeners in the US; provides global service/parts for all centrifuge brands. CNP, a division of Centrisys, designs/supplies nutrient recovery and biosolids treatment optimization systems.

Kruger (Veolia Water Technologies) ..... Booth 302
www.veoliawatertech.com
Phone: 919-677-8310
4001 Weston Pkwy
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Innovative technologies and complete wastewater treatment solutions to help systems comply with nitrogen and phosphorus limits. Our solutions are resilient, robust, resource efficient, and easy-to-operate.

Landia, Inc..... Booth 406
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WesTech Engineering Inc ..... Booth 405
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Phone: 801-265-1000
3665 S West Temple
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Phone: 201-803-8807
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YSI, A Xylem Brand ..... Booth 401
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Yellow Springs, OH 45387
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Mehran Andalib, *Stantec,* **Moderator, 16**

Alan Appleton, *Carollo Engineers,* **Presenter, 8**

Susan Auten, *Black & Veatch,* **Presenter, 2**

Erika Bailey, *City of Raleigh,* **Moderator 7, 10, Presenter 10**

Warren Barlow, *City of Fort Collins Utilities,* **Presenter, 7**

James Barnard, *Black & Veatch,* **Presenter, 4**

Mario Benisch, *HDR Engineering Inc,* **Presenter, 2**

Katya Bilyk, *Hazen and Sawyer,* **Moderator, 14**

Treavor Boyer, *Arizona State University,* **Presenter, 15**

Jeanette Brown, *Manhattan College,* **Moderator, 1**

Morgan Brown, *WEF,* **Moderator, 5**

Jonathan Bulla, *Town of Cary,* **Presenter, 10**

Cody Campolong, *Virginia Tech/HRSD,* **Presenter, 3**

David Clark, *HDR Inc,* **Presenter, 13**

Charles Cocker, *City of Durham,* **Presenter, 10**

Tim Constantine, *Jacobs,* **Presenter, 7**

Kimberly Cowan, *Metro Wastewater Reclamation District,* **Presenter, 14**

Victor D'Amato, *Tetra Tech Engineering, P.C.,* **Moderator, 13**

Francis de los Reyes III, *North Carolina State University,* **Moderator, 12**

Christine deBarbadillo, *DC Water,* **Moderator, 11**

Robert Delatolla, *University of Ottawa,* **Presenter, 11**

Timur Deniz, *CDM Smith,* **Presenter, 16**

John Dodson, *City of Durham,* **Presenter, 10**

Paul Dombrowski, *Woodard & Curran,* **Presenter, 7**

Leon Downing, *Black and Veatch,* **Presenter, 12**

Patrick Dunlap, *Black & Veatch,* **Presenter, 12**

Sarina Ergas, *University of South Florida,* **Moderator 6, Presenter 15**

Don Esping, *Brown and Caldwell,* **Presenter 1, 2**

Michael Falk, *HDR Inc,* **Presenter, 13**

Lindsey Ferguson, *Old Dominion University/ Hampton Roads Sanitation District,* **Presenter, 4**

Bryan Fincher, *Veolia Water Technologies,* **Presenter, 12**

James Fischer, *Xylem Water Solutions,* **Presenter, 1**

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Mark Miller, *Brown and Caldwell,* **Presenter, 16**

JB Neethling, *HDR Inc,* **Presenter, 12**

Maureen Neville, *CDM Smith,* **Presenter, 9**

Per Nielsen, *VCS Denmark,* **Presenter, 2**

Anthony Niemiec, *Hazen and Sawyer,* **Presenter, 3**

Mike Osborne, *Black & Veatch,* **Presenter, 13**

Gregory Pace, *Hazen and Sawyer,* **Presenter, 14**

Ben Packard, *US Environmental Protection Agency,* **Moderator 15, Presenter 15**

Mike Parsons, *Hampton Roads Sanitation District,* **Presenter, 10**

Haywood Phthisic, *Neuse River Compliance Association,* **Presenter, 13**

Amit Pramanik, The *Water Research Foundation,* **Moderator, 15**

Christine Radke, The *Water Research Foundation,* **Moderator 8, 16**

Gayathri Ram Mohan, *Gwinnett County Department of Water Resources,* **Presenter, 9**

Pusker Regmi, *Brown and Caldwell,* **Moderator 11, Presenter, 4**

Laura Rodriguez-Gonzalez, *University of South Florida,* **Moderator, 6**

Joe Rohrbacher, *Hazen and Sawyer,* **Moderator 10, Presenter 10**

Adrian Romero, *CH2M,* **Presenter, 9**

Bikram Sabherwal, *Black & Veatch,* **Presenter, 9**

Mary Sadler, *Hazen and Sawyer,* **Presenter, 12**

Sandeep Sathyamoorthy, *Black & Veatch,* **Moderator 13, Presenter 6, 11**

Peter Schauer, *Clean Water Services,* **Presenter 1, 12**

Robert Sharp, *Manhattan College/ Hazen and Sawyer,* **Moderator, 8**

Andrew Shaw, *Black & Veatch,* **Presenter, 2**

Paul Shriner, *EPA,* **Presenter, 1**

Cole Sigmon, *City of Boulder,* **Presenter, 14**

Varun Srinivasan, *Northeastern University,* **Presenter, 4**

Belinda Sturm, *University of Kansas,* **Moderator, 3**

Kumar Upendrakumar, *Veolia North America,* **Moderator 1, 4**

Nerea Uri, *VCS Denmark,* **Presenter, 3**

PRESENTER AND MODERATOR DIRECTORY

Tim Van Winckel, *Ghent University/ DC Water/University of Kansas,* **Presenter 3, 5**

Uma Vempati, *ISG,* **Moderator 2, 7**

Brett Wagner, *University of Michigan,* **Presenter, 11**

Tim Ware, *Arcadis,* **Moderator 3, 12**

Stephan Wasielewski, *University of Stuttgart,* **Presenter, 14**

Stuart Waugh, *NYS Center for Clean Water Technology,* **Presenter, 6**

Grant Weaver, *CleanWaterOps,* **Presenter, 1**

Paul Wood, *Lockwood, Andrews & Newnam, Inc.,* **Moderator, 4**

Xiaofan Xu, *University of South Florida,* **Presenter, 2**

Phill Yi, *Hazen and Sawyer,* **Presenter, 1**

Thor Young, *GHD,* **Moderator 9, Presenter 7**

CONFERENCE SCHEDULE AT-A-GLANCE

Monday, June 18

7:30 AM – 5:00 PM	Registration
8:30 AM – 5:00 PM	Workshops A, C
5:15 PM – 6:15 PM	Welcome Kickoff Reception

Tuesday, June 19

7:30 AM – 5:15 PM	Registration
8:30 AM – 12:15 PM	Opening General Session
10:00 AM – 6:45 PM	Exhibit Hall Open
1:30 PM – 5:15 PM	Technical Sessions 1, 2, 3
12:15 PM – 1:30 PM	Luncheon in Exhibit Hall
5:15 PM – 6:45 PM	Networking Reception

Wednesday, June 20

8:00 AM – 5:15 PM	Registration
8:30 AM – 10:00 AM	Technical Sessions 5, 6
8:30 AM – 12:15 PM	Technical Session 4
10:00 AM – 3:45 PM	Exhibit Hall Open
10:45 AM – 12:15 PM	Technical Sessions 7, 8
12:15 PM – 1:30 PM	Luncheon in Exhibit Hall
1:30 PM – 5:15 PM	Technical Sessions 9, 10, 11

Thursday, June 21

8:00 AM – 11:45 AM	Registration
8:30 AM – 10:00 AM	Technical Sessions 13, 14
8:30 AM – 11:45 AM	Technical Session 12
10:15 AM – 11:45 AM	Technical Sessions 15, 16

UPCOMING EDUCATION AND TRAINING EVENTS

Disinfection and Reuse Symposium 2018
July 29 - 31, 2018
Portland, Oregon
www.wef.org/disinfectionreuse

WEFTEC 2018
September 29 - October 3, 2018
New Orleans, Louisiana
www.weftec.org

WEF Education and Training 2019 Events

Mark your calendars for our upcoming events.
More information coming shortly.

Forum 2019: James Barnard Research Conference on Emerging Themes in Biological Phosphorus Removal
January 2019, Austin, Texas

AWWA/WEF The Utility Management Conference 2019
March 5-8, 2019
Nashville, Tennessee
https://www.wef.org/utilitymanagement

Residuals and Biosolids 2019 Conference
May 2019, Ft Lauderdale, Florida

Stormwater and Green Infrastructure 2019 Symposium
May 2019, Ft Lauderdale, Florida

Collection Systems 2019 Conference
June 2019, Indianapolis, Indiana

Nutrient Removal and Recovery 2019 Symposium
July 2019, Midwest

WEF/AWWA Transformative Issues 2019 Symposium
August 2019, Washington, D.C.

NOTES

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New Orleans Morial Convention Center
New Orleans, Louisiana

Conference:
September 29 – October 3, 2018

Exhibition:
October 1 – 3, 2018

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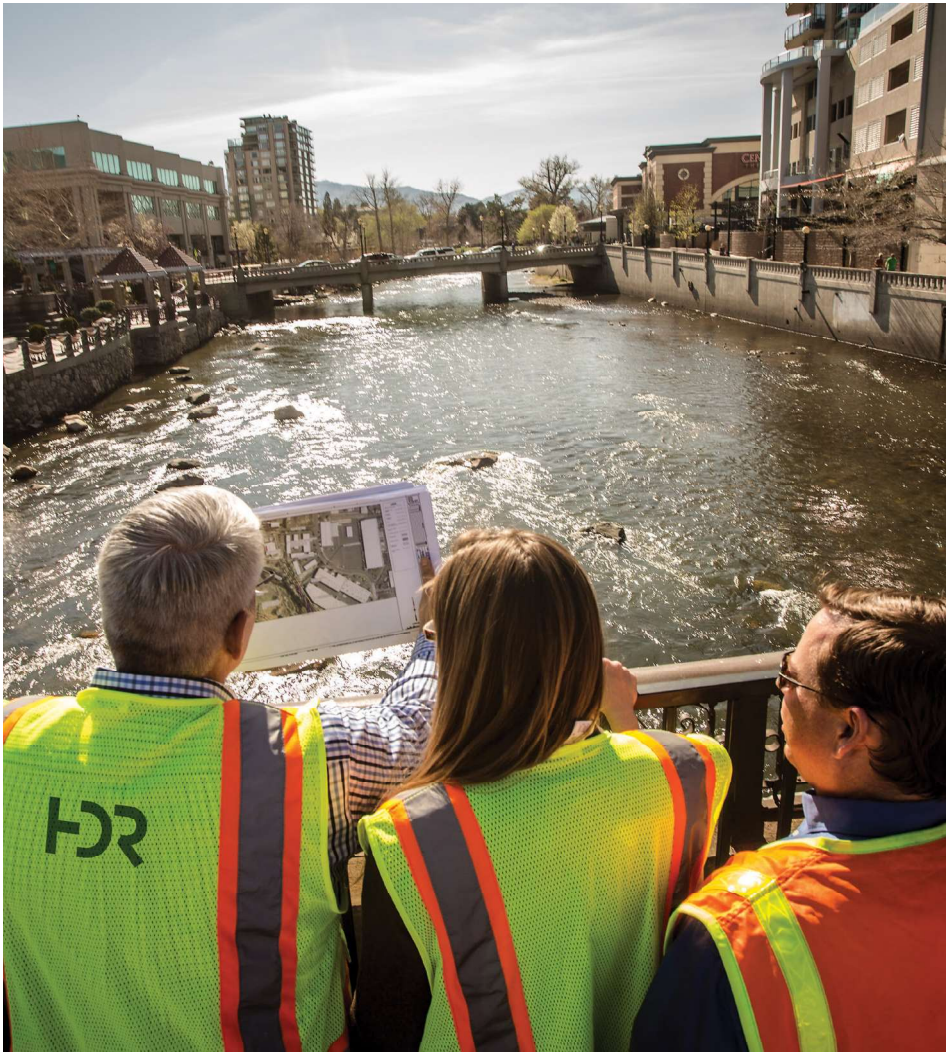

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