# TABLE OF CONTENTS

## OPENING GENERAL SESSION

U.S. EPA Nitrogen & Co-pollutant Roadmap and the National Priorities Nutrient Management Centers

Ben Packard, James R. Mihelcic, Amit Pramanik

A Comprehensive Theory to Understand all Biological Phosphorus Removal Observations

James L. Barnard, Patrick Dunlap, Mark T. Steichen

## SESSION 1: CARBON REDIRECTION

Carbon Redirection in Water Reuse and Recovery Facilities: Technologies Overview

Jose A. Jimenez

A Novel Strategy for Carbon Redirection at Biological Nutrient Removal Facilities

John Fraser, Anton Dapcic, Tanja Rauch-Williams, Rod Reardon, Nancy Love, Lutgarde Raskin

Primary Filtration for Carbon Redirection and Energy Efficiency Improvements

Jeffrey Sober, Sherri van der Wege, Leon Downing

Aerobic Famine-Feast Regime Enhances fiFresh EPSfi Production, Bioflocculation and Carbon Harvesting in High-Rate Processes: Bringing Back Contact-Stabilization

Arifur Rahman, Mariela Mosquera, Jose A. Jimenez, Charles Bott, Bernhard Wett, Ahmed Al-Omari, Sudhir Murthy, Haydee De Clippeleir

Pinpointing Bioflocculation Limitations For Enhanced Carbon Management In high-rate Activated Sludge

Xiaocen Liu, Tim Van Winckel, Birthe V. Kjellerup, Imre Takács, Belinda Sturm, Siegfried E. Vlaeminck, Ahmed Al-Omari, Sudhir Murthy, Haydée De Clippeleir

## SESSION 2: BNR PROCESS CONTROL

Development of Ultra-low DO Operation at a Full-scale MBR System and the Corresponding Impacts on Microbial Ecology

Yunjie Tu, Zia Bukhari, Yanjin Liu, Jianfeng Wen, Mark W. LeChevallier

Achieving Less than 3 mg/L TN with Low DO Operation at Orange County Utilities’ Northwest Water Reclamation Facility

Mark W. Miller, Pusker Regmi, Jose Jimenez, Keny Rivera

Full-scale Implementation of Simultaneous Nitrification/Denitrification in an AO Process Configuration with Simple Aeration Control

Paul Wood, Jeremy Nakashima

Advanced Biological Control Reduces Operating Expenses and Produces Effluent TN < 3 mg/L and TP < 1 mg/L with No Capital Expense

Trevor Ghylin, Daniel Sheldon, Asa Henrikssson, Glen McCurry, Nathan Polcyn, Christian Baresel

Saving Carbon with SND Using Ammonia Based Aeration Control

David Wankmuller, Katya Bilyk, Paul Pitt, Dana Fredericks, Ron Latimer, James Grandstaff, Perry Greene, Joshua Irby, Jeffrey Sparks

Full-scale Evaluation of Carbon and Energy Efficient Combined Nitrogen and Phosphorus Removal with Advanced Aeration and Settleability Control

Pusker Regmi, Kartik Chandran, Jose Jimenez

## SESSION 3: WATERSHED MANAGEMENT

A Collaborative Nutrient Management Program for San Francisco Bay

Yun Shang, Phoebe Grow, Bennett Horenstein, Mike Connor, Thomas Mumley, Laura Pagano, Dave Williams

Development of a Conceptual Nutrient Trading Program for San Francisco Bay

Phoebe Grow, Yun Shang, Bennett Horenstein, Alex Johnson, Erik Ringelberg, Chris Thomas
Enhanced Management of Nitrogen in Urban Stormwater Runoff through a Field Demonstration of a Modified Bioretention System ....................................................................................................................................... 156
Emma V. Lopez-Ponnada, Sarina J. Ergas, Maya A. Trotz, Freddy Barton, James R. Mihelcic

Phosphorus Recovery from Runoff Particulates Using Fungal Bioextraction ......................................................................................................................................................... 161
Andro Mondala, Shaun Shields, Katie Gaviglio, Yuji Arai, Stephen Kaczmarek

SESSION 4: PHOSPHORUS REMOVAL

Polishing of Secondary Wastewater Effluents Through Elimination and Recovery of Dissolved Phosphorus with Reusable Magnetic Microsorbents ................................................................. 169
Asya Drenkova-Tuhtan, Michael Schneider, Carsten Meyer, Matthias Franzreb, Carsten Gellermann, Karl Mandel, Heidrun Steinmetz

Full Scale Demonstration of Non-VFA Pathway Enhanced Biological Phosphorus Removal .......................................................... 182
Mehran Andalib, Edris Taher, Bob Money, Mike Carlson, Sara Arabi

Using Heterogeneous Nucleation to Remove Non-Reactive Dissolved Phosphorus from Sludge Dewatering Centrate ................................................................. 196
Marco Abel-Denee, Cigdem Eskicioglu, Giampiero Galvagno

Performance Testing and Long Term Operations Demonstrate Successful Application of Discfilter System for Stringent Effluent Phosphorus Limits .......................................................... 210
Mark Stewart, Ron Palumbo, Christina Rossi

SESSION 5: SIDESTREAM SHORTCUT NITROGEN REMOVAL

Demonstration of a Separate Centrate Deammonification (SCAD) Process at the 26th Ward Wastewater Treatment Plant ............................................................................................................................................... 219
Sarah Galst, Kartik Chandran, Allen Deur, Rob Sharp, Gregory Pace, Wendell Khunjar

Effect of Solids Retention Time on Nitrogen Removal and Microbial Consortium in a Novel Algal-Bacterial Shortcut Nitrogen Removal System ................................................................. 225
Nadezhda Zalivina, Ryan Keeley, Larissa T. Arashiro, Angelica Ruda-Ariza, Meng Wang, Kathleen Scott, Peter van der Steen, Sarina J. Ergas

Mitigation of Nitrous Oxide Emission from Nitritation/Denitritation Process ............................................................................................................................. 231
Lai Peng, José M. Carvajal-Arroyo, Dries Seuntjens, Giovanni Colica, Cristina Pintucci, Siegfried E. Vlaeminck

Construction and Startup of the Rocky Mountain Region’s First Anammox Sidestream Centrate Treatment System ................................................................................................................................. 234
Tom Dingeman, Matt Gough, Gina Rust, Adam Parmenter

Lessons Learned in the Procurement, Start-up and Operation of a Granular Deammonification Sidestream Process ............................................................................................................................................... 245
Julian Sandino, Soren Eriksen, Nerea Uri, Per H. Nielsen, Tim Constantine, Carsten Steen

Lessons Learned About Deammonification from Design, Startup and Operation of an ANITATM Mox System .................................................................................................................................................. 253
Katya Bilyk, Wendell Khunjar, Greg Pace, Thomas Worley-Morse, Charlie Cocker, Simon Lohdell, Ron Taylor, Bob Gasper, Paul Pitt

Pre-Treating Dewatering Centrate in a Deammonification Reactor: Results and Lessons Learned after 2 Years of Operation ............................................................................................................. 264
Paula Sanjinés, Hong Yin, Savita Schlesinger, Tim Constantine

Side-Stream Deammonification, Tri-City Oregon Pilot Study .................................................................................................................................................. 276
Christophe D. Desmottes, D. Richwine, N. Chowdhury, D. Horner, Cory Robertson

SESSION 6: INTERESTING CASE STUDIES

Innovative DBO Two-stage Activated Sludge Upgrade At The Woonsocket WWTF To Achieve 3 mg/l TN and 0.1 mg/l TP ............................................................................................................................................. 286
Bruce R. Johnson, Lee Tharps, Jennifer Philips, Laurie Toscano, Adel Banoub

Four Million Pounds of Nitrogen - Successful Startup and Operation of a 114-mgd BNR Facility .......................................................................................................................... 294
Jeffrey S. Berlin, John Luna, Tanja Rauch-Williams, Edyta Stec-Uddin, Sherman Papke, A.D. Norford, Tom Acampora

A Case Study of the Cascading Impacts and Recovery from Leachate Discharge to A BNR Facility ........................................................................................................................... 305
Yuan Fang, Edward Cronin, Matthew Pugh, Clair Watson, Edwin Edmondson, Robert Stone
Achieving BNR with Bioaugmentation and High Purity Oxygen: Rigorous Technology Review and Process Modeling Leads to Successful Startup of the Harrisburg AWTF BNR Retrofit ................................................................. 314
Kevin Frank, David Stewart

Pushing the Limits: 11.4-ML/D (3-mgd) Pilot Process Train at Brockton Achieves Low-Cost Nitrogen Removal to 3 mg/L TN ......................................................................................................................... 342
William C. McConnell, David A. Norton

Paradigm Shift if Dewatering Process Moved to the Center of a Nutrient Removal Plant Universe .......... 356
Murthy Kasi, William Wehner, Mario Benisch, Anthony Perriera, James Wodrich

Mining Existing Databases as an Alternative to EPA’s Mandatory Section 308 National Study of Nutrient Removal and Secondary Technologies ................................................................. 371
Michael Kasch, David L. Clark

SESSION 7: INTEGRATING ION EXCHANGE

Zeoilte-Anammox Process: Sustainable Nitrogen Removal ........................................................................ 399
Robert S. Collison, Jimmy Dang, Amanda Roa

Novel Hybrid Ion Exchange Resins for Concurrent Removal, Recovery, Reoncentration, Reuse, and Recycle of Pollutant Nutrients (Nitrogen)N and Phosphorus(P) .......................................................... 408
Ed Weinberg, Arup K. SenGupta, Chelsey Shepsko

Experimental and Modeling of a Hybrid Algal Photosynthesis and Ion-Exchange (HAPIX) Process for Side Stream Wastewater Treatment ................................................................. 426
Meng Wang, Karl Payne, Shuang Tong, Sarina Ergas

High-capacity Hydrogel Polymer Composite Adsorbent for Nitrate and Phosphate Removal from Water ........................................................................................................................................ 438
Enrico Nadres, Jem V. Perez, Debora F. Rodrigues

SESSION 8: GRANULAR SLUDGE

Implementation of an External Selector to Improve the Stability and Nutrient Removal of Aerobic Granular Sludge with Low-Strength Municipal Wastewater .................................................................. 461
Rasha Faraj, Belinda Sturm, Theresa Amante, Mariela Mosquera

Enhancing Biological Phosphorus Removal and Improving Settleability Using Mainstream Hydrocyclones for External and Metabolic Selection ........................................................................ 468
Amanda C. Ford, Bob Rutherford, Bernhard Wett, Charles Boll

Using Metabolic Selectors to Facilitate the Development of Activated Sludge Granules .......................... 480
Wendell Khunjar, Kevin Gilmore, Floyd Koch, Jason Koch

Evaluation of Process Kinetics and Toxicity on Granular Activated Sludge ........................................... 484
Sunayna Dasgupta, Ananda Shankar Bhattacharjee, Ramesh Goel

SESSION 9: NUTRIENT RECOVERY

Nutrient Recovery at the F. Wayne Hill Water Resources Center: Experience and Lessons Learned after 18 months ........................................................................................................................ 492
Ron J. Latimer, Scott Hardy, Edward McCallum, Brandon Brown, Kent Kilby, JC Lan, Tyler Richards

Phosphorus Recovery at the Madison MSD: Turning Lemons into Lemonade ........................................ 495
Leo A. Kucek, Alan L. Grooms, Kim A. Ericson

Phosphate Harvesting Options for a Thermal Hydrolysis Anaerobic Digestion Facility ...................... 511
Leon S. Downing, Jeff Sober, Mike Young, Sherr R Van der Wegge, Matt Jalbert

Roadmap for Setting Up Optimal Treatment Trains for Nutrient Recovery at WRRFs ......................... 519
Céline Vaneeckhaute, Evangelina Belia, John Copp, Erik Meers, Filip Tack, Peter Vanrolleghem

Strategies to Maximize P Recovery and Minimize Biochar Formation from Hydrothermal Liquefaction of Biomass ................................................................................................................. 526
Sirwan Almoradi, Robert Hable, Susan Stagg-Williams, Bellinda Strum

Effect of Pilot Plant Configuration on the Electrochemical Precipitation for Phosphorus Recovery with the ePhos Technology ........................................................................................................ 534
Iosif Mariakakis, Jennifer Bilbao, Siegfried Egner

There is Light at the End of the Pipe! Causes and Control of Struvite and Vivianite Scaling at WRRFs ................................................................. 538
Samuel Jeyanayagam
SESSION 10: EMERGING BIOFILMS

Mass Transfer and Mixing in Wastewater Treatment Biofilm .......................... 541
Andrew J. Schuler, Patrick McLee, Kody Garcia

An Innovative Engineered Biocatalysts Technology for Nutrient Removal from Wastewater ........................................ 546
Carla Cherchi, Douglas Cote, Hector Castro, Harold Schmidt, Harold Aiken, Kellogg Schwab, Joseph G. Jacangelo

Application of Increased Shear Force on Mature Steady State Nitrifying Biofilms Grown on Modified 3-D Printed Surfaces .......................................................... 554
Philip M. Roveto, Chase Stearnes, Andrew J. Schuler

Enhanced Gas Permeability of PVA/alginate Carriers for Deammonification Process ........................................... 571
Jinyoung Jung, Daehye Choi, Wonsang Yun, Seunghoon Song, Yang Oh Jin

SESSION 11: MAINSTREAM SHORTCUT NITROGEN REMOVAL

Assessment of Parallel Biofilm and Suspended Growth Deammonification Reactors using Actual Mainstream Wastewater ................................................................. 575
Paul Roots, Alex Rosenthal, Fenghua Yang, Joseph Kozak, Heng Zhang, George Wells

Selection of COD Source for Integration of Partial Denitrification Driven Final Polishing Step within Mainstream Short-cut N Removal Systems........................................ 592
Bo Peng, Tri Le, Alba Torrents, Arash Massoudieh, Ahmed Al-Omari, Bernhard Wett, Charles Bott, Sudhir Murthy, Haydeé De Clippeleir

The Application of Tertiary Anammox Biofilter for Energy-efficient Short-cut Nitrogen Removal ........................................... 597
Hongkeun Park, Daehwan Rhu, Mi Hyung Kim, Sandeep Sathyamoorthy

SND in Well-mixed Plug Flow Processes: How Much Denitrification is Really Achieved Under Low Do Conditions? ................................................................. 605
Stephanie Klaus, Kathryn Printz, Lindsey Ferguson, Berhard Wett, Sudhir Murthy, Charles Bott

Identifying Selective Pressures to Induce Integrated Sidestream & Mainstream Nitritation at Hunts Point WRFF Mainstream Nitritation at Hunts Point Water Resource Recovery Facility ................................................................. 610
Krish Ramalingam, Mahsa Mehrdad, John Fillos, Allen Dear, Mauro Orpianesi, Dimitrios Katehis

Challenges of Partial Nitriation Prior to Anammox Application for Mainstream Sewage: A Pilot Study For Bursa Sewage Treatment Plant in Turkey .................................. 620
Bilge Alpaslan Kocamemi, Hilal Uflaz, Halil Kurt

High-rate Ammonium Oxidizing Bacteria (AOB) for Nitrite Shunt process using a Sequential Batch Reactor (SBR) ................................................................. 634
Moomen Soliman, Ahmed Eldyasti

SESSION 12: MEMBRANE AERATED BIOFILM REACTOR

Full Scale MABR Plants: From Process Concepts to Field Results ................................................................. 643
Ronen Shechter

OxyMem, The Flexible MABR ................................................................................................................................. 650
Eoin Syron, Barry Heffernan

Nutrient Removal Intensification with MABR - Developing a Process Model Supported by Piloting ................................................................. 657
Jeff Peeters, Zebo Long, Dwight Houweling, Pierre Cote, Glen T. Daigger, Spencer Snowling

Author Index