94th Water Environment Federation Technical Exhibition and Conference (WEFTEC 2021)

Where the Water Community Comes to Connect

Chicago, Illinois, USA 16-20 October 2021

Online 16-18 November 2021

Volume 1 of 4

ISBN: 978-1-7138-4439-6

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2021) by Water Environment Federation (WEF) All rights reserved.

Printed with permission by Curran Associates, Inc. (2022)

For permission requests, please contact Water Environment Federation (WEF) at the address below.

Water Environment Federation (WEF) 601 Wythe Street Alexandria, Virginia 22314 USA

Phone: 1-800-666-0206 Fax: 1-703-684-1545

csc@wef.org

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400

Fax: 845-758-2633

Email: curran@proceedings.com Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

A Practitioner's Perspective on the Design of Large Membrane Bioreactor Facilities	1
Large Scale Combined Sewer Control in Buffalo, NY Utilizing Smart Sewer Infrastructure	11
Microconstituents Removal through Biofilm Thickness Control Strategies for Water Reuse	22
Improved Operating Practices for Emerging UV Systems	27
A Tale of Three Cities or Why One Resilience Size Does Not Fit All	39
The Theoretical Benefits of Mainstream Shortcut Nitrogen Removal Revisited and Validated by Full-scale Implementation of Partial Denitrification-Anammox	67
How Do Different Odor Management Approaches Impact Downstream Processes? Nutrient Removal, Harvesting, and Odor Control Assessed through Whole Plant Sulfur Modeling	77
Best Practice of Intelligent Algorithms to Optimize and Prioritize Capital Investments and Asset Rehabilitation for Jefferson County, AL	82
Whole Effluent Toxicity Evaluation at Recycled Fiber Paperboard Mill Leads to Indirect Discharge to POTW	111
The Effects of Low-EPS Producing Bacteria on the Performance of the Membrane Aerated Biofilm Reactors (MABRs) and Membrane Bioreactor (MBRs): Experimental and Modeling Study	128
Outcome Driven Approach to Balance Cost and Performance in the Bolivar North Master Plan	133
Overcoming Industrial Stormwater Permit Challenges at a Large Naval Installation	145
Overcoming Environmental and Community Constraints by Executing Record Length Curved Microtunnelling Drives	158
Maintaining Final Effluent Discharge at San Jose's RWF Amid Rising Sea Levels and Construction of USACEs Flood Protection Levee	169

Innovative Application: Medium Pressure UV Disinfects Primary Effluent	181
A Utility's Journey to Evaluate Alternatives and Craft a Collection System Odor and Corrosion Control Strategy	193
Hanting Wang	
Equilibrium Temperature Modeling at a Gulf Coast Refinery: Application of Site-Specific Daily Bio-Heat Generation Factor	223
Virtual Piloting and Development of A Digital Twin of a Novel Membrane Bioreactor Technology Miguel Daza	234
Machine Learning and Scripting to Improve Capital Planning Optimizations (DeKalb County, Georgia)	241
Considerations for the Environmentally Safe Use of Passively-Dosed Chemicals to Enhance Industrial Stormwater Erosion and Treatment Controls Brian Currier	255
Assessment of Critical Dependencies for Rapid Disaster Recovery	268
The River and The Highway: How an Interceptor Failure Produced Solutions	277
Sewer Odor Testing and Collection System Odor Mitigation	290
Treatability Assessments: From Bench to Field-Scale Testing	299
Winter Wonders: Increasing MBR Capacity in Cold Weather Months Utilizing Operational Changes	308
National Perspectives on Efforts to Enhance System Resiliency	323
Pilot-Scale Investigation of Stormwater Treatment at Various Los Angeles County Sanitation Districts' Solid Waste Facilities	338
Battling the Dark Side of Disinfection with An Empirical Modeling Tool	366
From Satellite to Snout: How Central Arkansas Water Uses High-Tech and Low-Tech to Attack Nonrevenue Water	385
Microplastics in Wastewater Treatment Facilities: A Review of Occurrence, Toxicology, Treatment, and Current Regulatory Developments	395

Capitol Region Watershed District's Diversity, Equity and Inclusion Plan	403
Maximizing Return on Investment Using Intelligent Algorithms to Prioritize Capital improvements Andrew Faulkner	411
Water Reuse and Recovery Facility Connected Digital Twin Case Study: Singapore PUB's Changi WRP Process, Control, and Hydraulics Digital Twin	425
Chemically Enhanced Primary Treatment (CEPT): The Low-Hanging Fruit for Process Optimization, Cost Recovery and Wet Weather Flow Management	440
Does Bioaugmentation of Aerated Stabilization Basins Work? Lessons From Field Scale Trials With a Control	461
Use of Strategic Asset Management Principles to Provide Long-Term Risk Management and Environmental Protection for the City of San Diego's Stormwater Program	468
Improving Efficiency of Model Calibration with Response Surface Characterization and Multi-Objective Optimization	484
How Inert COD Fractions Can Impact Methane Yield: A Food Waste Co-digestion Case Study	493
Investigation on the impact of operation and carbon fractionation on unintended nitrogen and phosphorus removal in wastewater facilities in the San Francisco Bay	506
What's the Latest? Views on MS4 Permits from across the country	515
On the Cutting Edge: Innovation in MBR Monitoring to Detect Integrity Breaches	535
Semi-Autonomous Operations for Potable Reuse	545
Glycerol Driven EBPR Correlated with Tetrasphaera Enrichment	561
Dynamic Hydraulic Model Calibration of Storm Recession Tail Runoff Hydrographs Using Soil Conservation Service Data and InfoWorks ICM	576
N ₂ O Emissions from a Full-Scale Membrane Bioreactor Treatment Plant using Aqueous and Gaseous Monitoring Techniques	585

VOLUME 2

Digital Twins	606
Long-Term Performance of Pilot-Scale Aerobic Granular Sludge at the Noman M. Cole Pollution Control Plant	611
Gregory Pace	
Impacts of Primary Effluent Filtration and Primary Filtration Technologies on Performance of Water Resource Recovery Facilities Compared to Conventional Primary Treatment	622
Leveraging Collaborative Approaches to Build Customized Asset Management Programs	637
Comparison of NMR Analysis and Traditional Wastewater Analysis to Evaluate an Anaerobic Bioreactor Upset	647
Nick Butson	
Evaluating the Potential of Nutrient Amendment and Bioaugmentation to Improve Secondary Treatment Efficiency in Bench Scale Aerated Stabilization Basins Michael Foster	660
Monitoring of Microplastics in a Water Reclamation Process with an Improved Recovery Method Yian Sun	666
Assessment of Turbidity for Assurance of Log Reduction Values by Membrane Bioreactors	683
Less is More: Using an Integrated CT Approach to Optimize the Chlorination System for Miami-Dade	697
Brian Hilts	
A New Performance Metric for Optimizing Model Calibrations	711
Building a Comprehensive GI Management Program Through Design, O&M, and Monitoring Plan Development	742
Employee Network Groups as Engines for Change: How Candid Conversations Around Gender Create an Authentic and Empowered Workforce	749
Tavernola WWTP Retrofit Success Story: Four Times Capacity Increase by Converting Existing Structures to MBBR and Media Clarifier	754
Understanding the AAA: A Promising Alternative A-stage Process for Organics Recovery from Wastewater	762
Ahmed Alsayed	
How Can Machine Learning Support New Approaches to Pipe Failure Monitoring and Asset Management Valentin Burtea	784

How Can Machine Learning Support New Approaches to Pipe Failure Monitoring and Asset Management?	798
Ensuring Purified Recycled Water Quality using Critical Control Points and Process Automation	807
Microplastics Losses in Runoff Following Biosolids Application Paper	811
High Rate Activated Sludge Fermentation as a Carbon Source for Sidestream BioP and Denitrification	820
Aqueous Pyrolysis Liquid Digestion and Co-digestion with Sludge	831
Pharmaceutical Industry Wastewater Treatment Using MABR	839
Solids Handling and Treatment Performance with Waste Activated Sludge from the Nereda® Aerobic Granular Sludge Process: Comparisons to Conventional Activated Sludge	847
Insights into Post Aerobic Digestion: Assessing N2O Production and Short-Cut Nitrogen Removal in Post Aerobic Digestion through Enhanced Monitoring and Advanced Process Modeling	863
Innovative Nutrient Removal Technologies – Case Studies of Intensified or Enhanced Treatment	875
Simplot Expands Wastewater Treatment Plant and Achieves Direct Discharge Compliance with Membrane Bioreactor System	892
Technical Innovations at the Albert Robles Center (ARC) Advanced Water Treatment Plant	903
Clean Water 2020 Economic Impacts	912
Diversity in the Water Sector: The Power in Affinity Groups	947
10-Year-Old Membranes Challenge the Tiered System with Protozoa, Virus and Surrogate Removal	953
Design, Supply, Start-Up and Operation of an Industrial Wastewater Treatment Plant, at a Petrochemical Complex in Lake Charles, Louisiana, USA	968
Secondary Clarifier Upgrades for Managing Extreme Floating Solids/Scum Conditions in a Petroleum Refinery Wastewater Treatment Unit	982

Long Beach Municipal Urban Stormwater Treatment Project- Diversion and Advanced Treatment of Urban Runoff for Compliance and Water Supply Augmentation	991
Computational Fluid Dynamics Modeling and Validation Testing of Peripheral Feed Peripheral Overflow Clarifiers at the East Bay Municipal Utility District Main Wastewater Treatment Plant	1007
Embracing the Uncertain: Fundamentals and Applications of Uncertainty Analysis at Water Resource Recovery Facilities	1015
Exciting Applications of Machine Learning in the Water Industry	1041
Monitoring Wastewater Effluent Using a Rapid, Automated Detection System for E. coli and Fecal Coliform Bacteria	1056
Wastewater-based Epidemiology Early Warning Systems and Public Health	1065
Tactful Offshore Ocean Outfall Replacement	1069
Painting the Full Picture—Condition Assessments Upgraded to Comprehensive Asset Evaluations Nitin Goel	1074
MABR How Does It Work, Where Does It Fit, and Why Is It Compelling? Lessons from 4 Full-scale Systems	1083
Oakman Blvd: Green Infrastructure to Serve the Community	1094
Colsman Tunnel: A Progressive Design-Build Solution Dave Irish	1109
A Multi-Pronged Approach for Managing PFAS in Water Resource Reclamation Facilities	1119
The Effect of Side Stream EBPR (S2EBPR) on Nitrifying Populations Dynamics and On Nitrite Accumulation in A-B Stage AvN-S2EBPR Process	1124
Comparing Virus Emissions from Urine Diverting and Mix Flush Toilets	1133
Lessons Learned from 20-years of Low-Level Phosphorus Removal	1144
Recommendations for The Analysis of Source Separated Organic Food Waste to Help Inform the Design and Operation of Co-digestion Facilities	1173
Boat Harbour Remediation, Wastewater Treatment Study	1189

An Evolution of Water Treatment Technologies in the Food and Beverage Market: 4000 m3 per day water reuse plant and energy recovery from meat wastewater	1197
El Paso Water's Comprehensive Approach to Direct Potable Reuse Implementation Paves the Way	1208
A Practical Way to 'Digital Roadmap' Your Water Landscape	1213
VOLUME 3	
Installation and Start-up of First 'Drop In' MABR System for Process Intensification (UK)	1225
Moving and Removing Mountains of Grit at SFPUC's New 250 MGD Headworks	1236
Start-up and Performance Overview of AquaNereda® Aerobic Granular Sludge Technology at Riviera Utilities WWTP at Wolf Creek	1244
The Great Lakes Water Authority Watershed Hub: A Platform for Improved Regional Collaboration in Water Resources Management	1262
Insights from Three Years of the Full-Scale Side-by-Side MABR Demonstration at the Ejby Mølle WRRF	1268
Utility Investment Optimization Using Proven TOTEX Framework - Case Studies and Lessons from UK Water Experience	1274
SARS-CoV-2 Accumulation in Sewer Biofilms and Outbreak Surveillance through Wastewater-Based Epidemiology in the State of New Jersey	1280
Comparison of Life Cycle Costs at Operating Cogeneration and RNG Facilities	1285
From Theory to Practice: Continuous Flow Aerobic Granulation Using External Selectors in Full-Scale US Facilities	1296
Real Time Predictive Modeling for Public Water Quality Alerts	1302
Increased P Assimilation of Fast-growing Heterotrophs Increases P Capture Potential in High-rate Activated Sludge Systems Howard Truong	1307
Side-stream Nitrogen Removal in Membrane Aerated Biofilm Reactor: NOB Suppression and Techno-economic Analysis	1311

Spatial and Temporal Measurements of SARS-CoV-2 in a Sewershed	1322
Alternatives Evaluation for Compliance with Proposed MCLs for PFOS and PFOA Edward Horai	1346
Advancing CSO Treatment: Now and for the Future Confirming OVIVO RapidStorm Membrane Treatment of King County's CSO Discharge	1370
Watershed Science Improves Environmental and Regulatory Outcomes: A Case Study with Phosphorus in the Midwest	1379
Recovery of Elemental Selenium Nanoparticles (SeNPs) from the Aerobic Batch Reduction of Selenite (Se(IV)) in Water by a Mixed Culture of Enterococci	1384
What Happens in Texas Doesn't Stay in Texas: How a Small-Town Texas DPR Study Inspired an International Award-Winning Carbon-Based Direct Potable Reuse Demonstration (in Florida)	1401
Pilot Scale Evaluation of Coagulation and Ultrafiltration for Phosphorus Removal	1405
Frameworks for Managing Diverse Risks within Constructed and Natural Stormwater Assets	1417
Securing a Resilient Future with New Technology and Alternative Delivery Construction: Lessons Learned from the NCPCP Disinfection Improvements Project	1435
One Water Approaches to a Regional Stormwater Management Program in Northeast Ohio	1441
Successful Controlled Microbiome-shift into Densified Biomass in Continuous Flow Bioreactors for Biological Nutrient Removal	1456
Pin Point Proof: Innovative Temperature Study Accurately Locates Potential Sources of I/I	1479
Using Passive Acoustic Sensors as An Online Signal for Optimization of Thermal Hydrolysis and Digestion Processes	1494
Development of an Integrated Resource Recovery Strategy for the 630 ML/d Duffin Creek Water Pollution Control Plant	1499
In-Tank Carbon Generation as a Primary Benefit of RAS and MLSS Fermentation for Stabilizing Biological Phosphorus Removal Performance	1521
Enhancing Anaerobic Digestion of Food Waste with A Novel Two-phase Anaerobic Dynamic Membrane Bioreactor System	1530

A Watershed Based Approach for Managing Nutrients in San Francisco Bay	1539
Molecular Evidence of Internal Carbon-driven Partial Denitrification in a A-B Stage Pilot System Coupled with Sidestream EBPR	1551
Using a Pay for Performance Contract to Deploy an Innovative Phosphorus Removal Technology	1560
Development of World's Largest Dual-use High-rate Primary & Wet Weather Flow Filtration Process using Floating Media	1571
SARS-CoV-2 Wastewater Measurements Normalized Using Biomarkers	1584
City of Memphis Implementation of a Smart Wastewater Monitoring Network	1593
Development for Watershed-based Strategies to Eliminate Phosphorus Related Impairments in the Fox River	1598
Treating High pH & Metals in Groundwater using Carbon Dioxide (CO2) Sparging	1616
A Review and Discussion of Wastewater Process Inhibitions Observed in the U.S. as a Result of COVID-19 Countermeasures	1634
Bench-Scale Study for Optimization of Co-Digestion of Creamery and Poultry Waste for City of Petaluma	1649
Ganesh Rajagopalan	
Master Plan Shows the Way Forward for Sustainable Food Waste Co-digestion and Beneficial Biogas Utilization Options	1663
Fecal Pollution Source Characterization in Environmental Waters of the Edwards Aquifer	1671
Framework to Address Regulatory Challenges when Considering Reuse of Complex Wastewaters: A Case-Study to Prioritize Constituents of Concern in Developing Permitting Programs for Surface Discharges of Produced Water by Cross-walking to State Standards and Toxicity Data	1688
Enabling Better Municipal Decisionmaking Through Improved Access to Integrated Regional Water Quality Data Tim Pasakarnis	1704
First of Its Kind Multi-Tiered Wet Weather Flow Management at a Trickling Filter Facility	1716
Porta Potties to BNR: The Epic Journey of The Flooded City of Evans Wastewater Treatment Plant	1728

Enhancing Biodiversity, Community Resilience, and Water Quality Benefits through Effective Stormwater Wetland Management	1744
Implementation of a Private Lateral Inflow and Infiltration Pilot Study	1752
Optimizing Performance of a Side-Stream Enhanced Phosphorus Removal System	1775
Data-driven Public Outreach: Using a Community Survey and Market Research to Create a Campaign that Engages Customers	1786
Digital Resiliency through Augmented Reality	1803
Enhancing Product Selectivity During Selenium Reduction Using Noble Metal-TiO2 Heterogeneous Photocatalysts	1811
A Bigger-Picture Look at Florida's Nutrient-Loading and the Relative Insignificance of Biosolids- Derived Products	1819
Potable Reuse from a Wastewater Operators' Perspective	1845
VOLUME 4	
Economic Framework and Tool for Quantifying and Monetizing the Triple Bottom Line Benefits and Costs of Green Stormwater Infrastructure	1855
Eliminating N2O Emissions to Zero: ZeeLung TM MABR Shows the Way	1864
Removal of Perfluoro-alkyl Substances (PFAS) and Recalcitrant Organic Matter in Landfill Leachate using Coal Fly-Ash	1872
Nitrous Oxide: No Laughing Matter - Case Studies from Europe	1883
One Size Doesn't Fit All: Scaling Innovation Assessment and Planning	1898
Partial Denitrification Model Extension for Mainstream Shortcut Nitrogen Removal: Model Evaluation	1906
Brushite Recovery from Autothermal Thermophilic Aerobic Digestion (ATAD) Sludge to Improve Dewatering Characteristics	

A Virtual Full-scale Ozonation Plant for Micropollutant Removal: How to Reduce (Eliminate?) Piloting Efforts	1024
Giacomo Bellandi	1924
Can Traditionally-Sized Green Infrastructure be Used for Flood Control?	1932
A One Water Approach to Understanding Contaminants of Emerging Concern	2000
Facing Obstacles to Water Reuse: A California Perspective	2012
The Savings are in the Details: Fundamentals of ABAC Design	2018
Improving Clarifier Performance and Capacity through Full-scale Implementation of High-rate Contact Stabilization	2023
Condition Assessment and Rehabilitation of a City of Tampa 54-inch Sanitary Force Main Tim Palmer	2028
Dynamic Influent Load Diversion as a Demand Response Service in Systems of Hydraulically Connected WRRFs	2041
Advancement in Peracids Disinfection of Municipal Wastewater: Approaching the Economics of Sodium Hypochlorite with Performic Acid and Advanced Process Control	2049
Integration of Biological Biogas Scrubbing System for Treatment of High Sulfate Wastewater Using AnMBR Technology: From Piloting to Full-Scale System	2059
Implementing the National Water Reuse Action Plan through Water Sector Engagement	2084
Novel Approach to PFAS Removal Using a Highly Adsorbent Material and a Robust Separator Minimizes Sorbent Usage and Waste Production	2089
Treatment of Slaughterhouse Wastewater with A Novel UASB-Activated Sludge Treatment Unit Jose Ramirez	2105
Upgrading WWTPs for energy self-sufficiency and full recycling	2110
Two-Stage Partial-Nitritation/Anammox Process Demonstrates Stable and Efficient Treatment of High-Strength Industrial Digestate	2117
High Quality Biosolids Product Enhancement Using Windrow Management	2133
Startup and Pilot Testing of MBBR and IFAS Partial Denitrification/Anammox Processes	2161

Performic Acid Disinfection for a Sustainable Future	2187
One Water - Bringing Utilities Together in Denver	2210
Separate Adsorption of Nutrients and Pharmaceuticals from Source-separated Human Urine	2220
Modeling Wastewater Treatment Using Integrated Computational Fluid Dynamics (CFD), Biokinetics, and Size-Dependent Intra-Floc Diffusion	2224
Post Digestion Phosphorus Recovery: Implications of Low Temperature Total Solids Measurements	2241
Comparing Approaches to Probabilistic Design of ABAC Aeration Systems	2253
Miami Forever: Resilient Stormwater and Coastal Management for a Changing Climate	2258
Treatability Studies for PFAS Treatment: Evaluation and Optimization	2269
Carbon Source Selection for Deep-bed Partial Denitrification: Anammox (PdNA) Polishing Filters Rahil Fofana	2278
Temporary Selector Operational Innovation Mitigates Wastewater Throughput Limitations at a Large Paper Mill	2284
Condition Assessment of Force Main	2292
Can THP Biosolids Be Composted? Why Even Consider It? Lessons from The First-ever Full-scale Pilot	2316
Synergistic Interaction Between Water Resource Recovery Facilities and Renewable Hydrogen Generation. Samuel Reifsnyder	2325
A Watershed Moment for Regionalization	2333
Putting a Pin in a PFAS Panic: Crisis Communications with the Press and the Public	2338
Demonstrating the CalPrex System for High-Efficiency Phosphorus Recovery	2343
A Guide for Control System Diagnostics: Is Your Control System Operating at Its Full Potential? Ivan Miletic	2354

Reinvesting in History and Place to Build Resiliency and Community in Quincy, MA	2362
CFD-based design optimization of secondary sedimentation: case study at the City of Kalamazoo Water Reclamation Plant (MI, USA)	2370
Addressing Aeration Control Needs for PdNA Integration	2378
Effect of Fibrous Materials Recovered from Sewage Sludge as a Dewatering Aid on Sewage Sludge Treatment with an Anaerobic Digestion Process	2385
Hydrogen from Treated Municipal Wastewater: Feasibility Assessment for Scottish Water	2402
Nitrification Kinetics of a Full-scale, Low DO Activated Sludge System: Online Monitoring for Process Analysis and Operational Training	2411
Repurposing Infrastructure for Phosphorus Removal: Developing Design Guidelines for S2EBPR <i>Leon Downing</i>	241 <i>6</i>
Overcoming Limiting Factors for PdNA in Integrated Suspended Process Schemes	2420
Failure IS An Option: Assessing Final Clarifier Performance by Quantifying Uncertainty Associated with State Point Analyses (SPA) through Monte Carlo with Latin Hypercube Sampling (MC-LHS) Brian Shoener	2427
Startup of the first US NuReSys Phosphorus Sequestration Facility	2432
School House Rock: How a Bill becomes a Law and then Fully Defined	2441

Author Index