

2015 New WERF Research Products

— As of December 31, 2015 —



Water Environment Research Foundation
Collaboration. Innovation. Results.



Water Environment Research Foundation
Collaboration. Innovation. Results.

2015 New Research Products Summary

(As of December 31, 2015)

2015 Summary of Research Products Issued*

Biosolids

SRSK4T08: Wastewater Treatment Plant Design and Operation Modifications to Improve Management of Biosolids: Regrowth, Odors, and Sudden Increase in Indicator Organisms

Stock No. SRSK4T08

The goal of this project was to investigate ways to manage regrowth, odors, and sudden increase (ROSI) of indicator and pathogenic bacteria in biosolids cake exposed to high-shear dewatering such as centrifuges. The results from this work offer guidance for practitioners and utilities to help them understand the potential for ROSI and to manage these issues. The research report describes approaches to study and identify the issues and pathways for mitigation. 150 pages. Online PDF.

Climate Change

U4R07b: Greenhouse Nitrogen Emissions from Wastewater Treatment Operations: Molecular Level through Whole Reactor Level Characterization – Phase II

Stock No. U4R07b

This project continued the research into microbiological pathways involved in the formation and emission of nitrous oxide (N₂O) from wastewater treatment processes in Phase II by building on previous work by the project team (WERF U4R07). This report focuses on the impact of process conditions such as glycerol-based denitrification in a full-scale nitrification-denitrification process, anoxic-oxic cycling, and inorganic carbon limitation. Because plant operations have a key role in N₂O emissions, the report provides insight into the mechanisms influencing emissions and direction to ultimately create environmentally sustainable BNR operating strategies and configurations. 104 pages. Online PDF.

Energy

ENER1C12: A Guide to Net-Zero Energy Solutions for Water Resource Recovery Facilities

Stock No. ENER1C12

Energy neutrality for the domestic wastewater industry is within reach, and this project contributes greatly to the industry's understanding of the complexities, opportunities, and challenges that face water resource recovery facilities (WRRFs) as they strive for energy neutrality. The goal of this collaborative project with NYSERDA is to help WRRFs quickly assess their energy management performance and move toward "net-zero" energy use through current best practices and proven technologies in the areas of energy efficiency, demand reduction, and onsite renewable energy production. The study investigated the energy neutrality potential of these facilities through detailed modeling of the energy flows around and between individual unit processes. 440 pages. Online PDF.

*These products are available to order on WERF's website at www.werf.org under *Search Resources*; by e-mail at gstreet@werf.org or call Gina Street at 571-384-2112.

ENER1C12b: Demonstrated Energy Neutrality Leadership: A Study of Five Champions of Change

Stock No. ENER1C12b

The champions of change profiled in this report achieved high energy performance at their respective facilities and their experiences can aid utilities that want to improve their energy management programs. Findings from the case studies highlight new ways of thinking about energy efficiency and recovery, and inspire and propel other water resource recovery facilities to consider approaches to move their facilities toward net-zero energy. The findings also explore opportunities to save costs and enhance sustainability, as well as provide solutions to overcome obstacles common to energy projects. 106 pages. Online PDF.

ENER7C13: Identification of Barriers to Energy Efficiency and Solutions to Promote These Practices

Stock No. ENER7C13

The information presented in this report builds on the Water Environment Federation's Energy Roadmap (WEF, 2013) framework by tracing the path of a successful energy program and identifying common barriers and strategies that promote progress along that path. The research included a national survey of more than 110 wastewater service utilities which provided their input on those barriers along with the outcomes of utility focus groups designed to capture detailed experiences. 206 pages. Online PDF.

ENER7C13a: Current Energy Position of New York State Wastewater Treatment Facilities

Stock No. ENER7C13a:

This research project assessed the magnitude of increases or decreases in wastewater electrical consumption over the past 10 years in New York state based on the net effect of efficiency gains, increased electrical production, and increased process requirements. The researchers also explored the impact of organizational initiatives such as energy benchmarking, energy audits, goal setting, energy-use tracking, and operational optimization to reduce energy use. 88 pages. Online PDF.

ENER7C13b: Assessment of Technology Advancements for Future Energy Reduction

Stock No. ENER7C13b

This research reviews 18 areas of emerging technology that have the potential to reduce the need for purchased energy and could improve the wastewater industry's ability to beneficially recover resources. The review includes an assessment of the technology's current level of maturity and potential opportunities for adoption. The review also considers which wastewater treatment, solids stabilization, and energy generation technologies are of greater interest relative to established technologies. 102 pages. Online PDF.

ENER7C13c: Pathways to Energy Neutrality: Victor Valley Regional Water Reclamation Facility, California

Stock No. ENER7C13c

This informative 13-page factsheet documents VVRWRF's journey from aging facility with outdated infrastructure to one that incorporated energy neutrality as a utility-wide goal, allowing it to be named the second-best plant of its size in California two years in a row. Less than 10 years after compliance challenges and regulatory fines, the VVRWRF is on its way to being one of the nation's first completely energy-neutral wastewater treatment facilities. With final infrastructure now installed, VVRWRF has largely eliminated its dependency on outside power sources and creates more biogas than it uses. 13 pages. Online PDF.

ENER7C13d: Energy Performance Benchmarking Summaries and Recommendations for Energy Neutrality Opportunities at Three New York Water Resource Recovery Facilities

Stock No. ENER7C13d

WERF is working collaboratively with the New York State Energy Research and Development Authority to advance implementation of energy-efficient best practices in the industry. This research contributes to the industry's understanding of the complexities, opportunities, and challenges that water resource recovery facilities (WRRFs) face as they strive for energy neutrality and will help WRRFs move toward net-zero energy use through near-at-hand practices and technologies in the areas of energy, demand reduction, and enhanced production. This document highlights three case studies and builds on concepts developed in the WERF/NYSERDA energy research portfolio, combining the findings of the ENER7C13 and ENER1C12 research series. 32 pages. Online PDF.

Infrastructure

INFR1R12/12a : Structural Capabilities of No-Dig Manhole Rehabilitation (Report + Tool + User Manual)

Stock No. INFR1R12/12a

This project investigated the structural capabilities of commonly used manhole rehabilitation materials and methods via literature review, case study compilation, lab tests on mechanical strength, and computational modeling. It provides a classification for manhole rehabilitation techniques based on their structural capabilities (i.e., fully, semi-, or non-structural). The report provides decision support to wastewater and stormwater utility personnel and consulting engineers on material and method selection alternatives for wastewater rehabilitation projects, thereby reducing sanitary sewer overflows and their effects on the environment. Included is an Access-based decision support tool which can be used to choose structural class and construction methods appropriate for a manhole considered for rehabilitation. 224 pages. Online PDF.

INFR1R14: Assessing the Impacts of Pulp Loading from Non-Dispersible Materials on Downstream Sewer Systems

Stock No. INFR1R14

The primary objective of this research study was to subject non-dispersible wipes from five different manufacturers to a variety of tests to determine if changes to their physical characteristics occur when introduced into a sewer system and what effect the shredded material (pulp) has on the downstream sewer and their interactions with other materials within the sewer system. Shredded and non-shredded wipes were used in the study utilizing specialized bench-scale testing and live sewer testing. 148 pages. Online PDF.

INFR5R12: Visual Decision Support Tool for Supporting Asset Management Performance, Risk, and Cost Analysis

Stock No. INFR5R12

The project was designed to create incentives for implementing strategic asset management in U.S. wastewater utilities by demonstrating integrated, effective, and usable leading-edge tools. It sought to leverage the impact of existing and new tools by bridging SIMPLE, AWARE-P, and WaterID in a combined usage perspective. This report summarizes the work carried out, outlines the relevant outcomes, and focuses on the AWARE-P components that were tested and developed in this project. 144 pages. Online PDF.

INFR6R11: Mainstream Deammonification

Stock No. INFR6R11

This research investigated the feasibility of applying deammonification, which is already highly successful and proven in sidestream configurations, to the mainstream treatment process. The successful application of full-plant deammonification could save wastewater utilities operations costs for aeration and external carbon costs in the life cycle. Through demonstration and conceptual application at collaborating utilities, this research developed an evaluation framework for implementing full-plant deammonification.

Integrated Water

SIWM2T12: Institutional Issues for Integrated 'One Water' Management

Stock No. SIWM2T12

Governance, regulations, finance, and culture are often cited as barriers to achieving integrated water management and innovation in water technologies. In an effort to clarify and explain these barriers WERF, the Water Research Foundation, and Water Research Australia undertook this study to define those barriers. Three in-depth case studies and 25 snapshot case studies provide practical examples of how agencies and communities worked through institutional barriers so they could practice a more integrated and sustainable approach to water resource management. Case studies looked at initiatives and interactions between different levels of government, private entities, NGOs, and citizens across a range of institutional barriers. Published by WERF, Water Research Foundation, and Water Research Australia Ltd. 206 pages. Online PDF.

Linking Contaminants Sources to Impacts

LINK2T14: Modeling Guidance for Developing Site-Specific Nutrient Goals – Demonstration: Boulder Creek, Colorado

Stock No. LINK2T14

Based on WERF's research on modeling guidance for developing site-specific nutrient goals, WERF and the Colorado Monitoring Framework conducted a demonstration of WERF's Nutrient Modeling Toolbox (NMT). The team applied the LINK1T11 process to select and calibrate a nutrient response model of the Boulder Creek watershed. Results indicated that it would be practical to reduce bottom algae and pH in specific stream segments. This project demonstrated that models can be used effectively in screening-level fashion to support adaptive management. Regulatory frameworks such as NPDES and total maximum daily loads (TMDLs) often required the use of uncertain models to produce precise, quantitative outputs, such as wasteload allocations to meet in-stream criteria. Given the uncertainties of modeling bottom algae and other complex stream processes, stream nutrient models may be best applied in screening level fashion in the context of adaptive management. The model also indicated that environmental benefits could be maximized by more phosphorus control and less nitrogen control than would be pursued under default regulations. This approach would allow stakeholders to take advantage of information gleaned from early implementation steps to refine the modeling framework and adjust subsequent steps. 118 pages. Online PDF.

NUTR1R06m: The Bioavailable Phosphorus (BAP) Fraction in Effluent from Advanced Secondary and Tertiary Treatment

Stock No. NUTR1R06m

Excessive amounts of phosphorus (P) in receiving waters can cause environmental problems such as harmful algal blooms, hypoxia, and fish kills resulting from biomass decay, if not controlled. This is because P is one of the two key macro-nutrients (the other being nitrogen) that algae need to grow, primarily in inland waters. Wastewater treatment plants located inland are increasingly being required to reduce the amount of P (and N) in their treated effluent – often below current detection/measurement levels – using significant amounts of energy and chemicals with very little understanding of whether the various fractions of P are readily bioavailable for algae growth. This study investigated the current analytical methods, speciation of P in different wastewater treatment processes, and the influence/effect of various molecular forms of P on algae growth. 100 pages. Online PDF.

NUTR1R06p: Mineralization Kinetics of Soluble Phosphorus and Soluble Organic Nitrogen in Advanced Nutrient Removal Effluents

Stock No. NUTR1R06p

Given the importance of watershed protection plans, determination of phosphorus (P) mineralization kinetics in advanced wastewater treatment facility effluents is crucial for developing strategies to minimize eutrophication in receiving surface waters. This study looked at the dissolved P uptake kinetics characterization for five treatment facilities in the Spokane, Washington Region. Appendix A (Quality Assurance/Quality Control Data) is available by request. 106 pages. Online PDF.

NUTR1R06s: Evaluating the Impacts of Cold and Wet Weather Events on Biological Nutrient Removal in Water Resource Recovery Facilities

Stock No. NUTR1R06s

The primary goal of this project was to evaluate strategies employed by biological nutrient removal facilities in response to adverse weather events (AWEs), and to present a compendium of those that were successful. The researchers worked with 12 water resource recovery facilities that experience AWEs to identify critical challenges they face when attempting to maintain optimal BNR performance during these weather events. The research also evaluates strategies that are currently implemented by BNR facilities for mitigating these impacts. 190 pages. Online PDF.

NUTR1R06u: Application of Membrane Bioreactor Processes for Achieving Low Effluent Nutrient Concentrations

Stock No. NUTR1R06u

Although a well-established water reclamation technology for reuse applications, there is a need to further understand the capabilities of membrane bioreactor (MBR) technology in municipal water resource recovery applications requiring achievement of low effluent nitrogen and/or phosphorus concentrations. The aim of this research was to evaluate MBR process designs in municipal water resource recovery facilities. Various MBR biological nutrient removal (BNR) process configurations and unique features of MBR processes for nutrient removal were considered. Results from full-scale and pilot-scale MBR BNR installations were used to evaluate process designs, technology performance statistics (TPS), and operating issues for achieving low effluent concentrations of nitrogen and phosphorus. 152 pages. Online PDF.

NUTR1R06v: Evaluation of Performance and Greenhouse Gas Emissions for Plants Achieving Low Phosphorus Effluents

Stock No. NUTR1R06v

This project evaluated operational practices and performance results for water resource recovery facilities designed to meet very low effluent total phosphorus (TP) concentrations, focusing on what can be learned from existing facilities to help utilities operate more sustainably while achieving the necessary level of performance. The researchers identify design and operating practices that impact phosphorus removal performance and consumption of resources. 288 pages. Online PDF.

NUTR1R06w: Technologies for Sidestream Nitrogen Removal

Stock No. NUTR1R06w

Reviews technologies which treat nutrient-rich industrial wastewaters and recycle streams ("sidestream") generated by the dewatering of digested municipal sludges, animal manures, and source separated wastes, focusing on treatment technologies for the removal and recovery of nitrogen. Includes a brief description of the general principles of biological and physical/chemical processes. 110 pages. Online PDF.

NUTR1R06x: State of Knowledge of the Use of Sorption Technologies for Nutrient Recovery from Municipal Wastewaters

Stock No. NUTR1R06x

The recovery of nutrients from wastewaters may be a viable nutrient source. Adsorption offers a highly efficient, stable, and low cost technology for phosphorus (P) and nitrogen (N) removal. Desorption of the nutrients from the sorbent will allow P and N to be easily recycled using nutrient recycling technologies. This report reviews current literature for use of adsorbent for P and N removal using both conventional and innovative sorbents for nutrient recovery. 80 pages. Online PDF.

NUTR1R06y: BNR Process Monitoring and Control with Online Nitrogen Analyzers for Nitrogen Credit Exchange Program in Connecticut

Stock No. NUTR1R06y

The objective of this research was to maximize the benefit of introducing online analyzers under the funding by the Connecticut Nitrogen Credit Advisory Board by collectively evaluating the performance of those analyzers and investigating the process control scheme to optimize the BNR performance. The study presented in this report summarizes the use of online analyzers by water pollution control facilities in Connecticut, as well as considerations for their use for automated process control. Includes case studies from the wastewater treatment facilities in Connecticut, which shed light on the practical approaches towards automated online process control for the improvement of BNR process performance. 216 pages. Online PDF.

NUTR1R06cc : Phosphorus Analysis in Wastewater: Best Practices – White Paper

Stock No. NUTR1R06cc

This white paper assesses whether the lessons learned from freshwater analysis apply to wastewater, or if wastewater has unique characteristics that confound low level phosphorus measurements. It presents potential issues with phosphorus analysis (pH, reagent ratios, time, matrix effects, digestion method), how to detect and potentially correct the issues, and presents best practices from surface water and wastewater as a practical tool and quick reference for wastewater analytical labs. 60 pages.

*These products are available to order on WERF's website at www.werf.org under *Search Resources*; by e-mail at gstreet@werf.org or call Gina Street at 571-384-2112.

NUTR5R14e: Impact of Advanced Oxidation Processes on the Composition and Biodegradability of Soluble Organic Nutrients in Wastewater Effluents

Stock No. NUTR5R14e

This research investigated the impact of advanced oxidation processes (AOPs) on the composition, speciation, and biodegradability of soluble nutrients in wastewater effluents in order to provide preliminary evaluation of the feasibility of enhancing effluent dissolved organic nutrients removal via sequential AOP followed by down-stream biological treatment. The results provide insight and an initial understanding of how AOPs may potentially transform wastewater effluent-derived organic nutrients and their biodegradability. The information provides preliminary scientific basis in the feasibility of applying AOPs for developing treatment technology and strategy in order to achieve recalcitrant organic nutrients removal. 70 pages. Online PDF.

U4R10: Algal Nutrient Removal During Wastewater Treatment

Stock No. U4R10

This report provides a comprehensive evaluation of the use of encapsulated algae as a means for nutrient removal in treated wastewater effluent with the goal to optimize algal growth in reactors designed for wastewater treatment by deploying encapsulated algae in bioreactors to enhance nutrient removal. 90 pages. Online PDF.

Receiving Waters

WERF3C14: Ammonia Criteria Implementation Stakeholders Meeting Proceedings Document

Stock No. WERF3C14

In 2014, WERF collaborated with NACWA, ACWA, and WEF to meet with 32 experts representing municipal wastewater agencies, state and federal agencies (EPA and USGS), the scientific and academic communities, and consultants. The objectives of the meeting were to:

- Identify data and information gaps regarding implementation of the revised criteria.
- Identify what tools/projects are needed to provide information that will fill these gaps and clarify options in EPA's flexibility guidance.
- Provide clear guidance on a way to move forward on implementation of the criteria.

There was general agreement that the criteria can have major impacts on small communities and may present complexities for larger systems that are in the process of upgrades to meet new requirements for nutrient control. However, it was also agreed that implementation of EPA's new ammonia criteria provides a unique opportunity to introduce new permitting concepts and options to allow for more flexibility in meeting water quality standards and to re-evaluate and prioritize ways to meet Clean Water Act goals in light of competing priorities. The proceedings document was prepared to provide a complete summary of the stakeholders meeting and is available by request. 31 pages. Online PDF.

Resource Recovery

NTRY1R12a: Towards a Renewable Future: Assessing Resource Recovery as a Viable Treatment Alternative: State of the Science and Market Assessment

Stock No: NTRY1R12a

This report presents a review of extractive nutrient recovery technologies with an emphasis on bridging the knowledge gap faced by utilities when considering nutrient recovery for nutrient management. The report provides a framework for selecting a nutrient recovery option and, depending on the conditions at a water resource recovery facility, establishes whether keeping phosphorus in biosolids is more or less beneficial than concentrating it in an inorganic phase such as struvite. 122 pages. Online PDF with an interactive electronic technology summary matrix.

NTRY1R12b: Towards a Renewable Future: Assessing Resource Recovery as a Viable Treatment Alternative: Case Studies of Facilities Employing Extractive Nutrient Recovery Technologies

Stock No. NTRY1R12b

This research characterizes factors that influence the adoption of extractive resource recovery systems and provides guidance on the implementation of these technologies at water resource recovery facilities. The report presents a compilation of case studies of facilities at various stages of implementation of extractive nutrient recovery technologies in the form of struvite crystallization, as struvite harvesting technologies via chemical crystallization have been found to be the most mature extractive nutrient recovery option available to date. The data collected was used in the development of the Tool for Evaluating Resource Recovery-Phosphorus (TERRY – Phosphorus). 140 pages. Online PDF. (2015)

NTRY1R12m: Extractive Resource Recovery Technology Matrix (Excel File)

Stock No: NTRY1R12m

This interactive Excel document summarizes the key findings from WERF's NTRY1R12 literature review on nutrient- based recovery technologies. Interactive Excel file.

NTRY1R12t: Tool for Evaluating Resource Recovery – Phosphorus

Stock No: NTRY1R12t

The Tool for Evaluating Resource Recovery – Phosphorus (aka the TERRY Tool) can help utilities assess their plant's potential to recover phosphorus. TERRY can provide utilities with a quick and straight-forward idea of whether or not nutrient recovery may be viable at a specific facility. It can provide a rough estimate of the capital costs and the operating and maintenance costs of the system, as well as providing insight into non-cost factors such as environmental and social factors. Interactive Excel file.

Water Reuse

WERF5T10b: Considering the Implementation of Direct Potable Reuse in Colorado

Stock No. WERF5T10b

A white paper that investigates the potential challenges that Colorado utilities will face in implementing direct potable reuse (DPR). The authors propose actions that the state could take to facilitate the use of DPR as a water supply alternative. The paper focuses on four areas critical for the implementation of DPR in Colorado: 1) Regulatory implementation, 2) Technical considerations related to the design of DPR systems, 3) Operational considerations related to the operation of DPR systems, and 4) Public acceptance of DPR. 59 pages. Online PDF.

*These products are available to order on WERF's website at www.werf.org under *Search Resources*; by e-mail at gstreet@werf.org or call Gina Street at 571-384-2112.