WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: CT621

Title: Development of Predictive Tools to Infer Inhibition of Biological Nitrogen Removal at POTWs vi Long Term Bench-Scale and Full-Scale Monitoring

Focus Categories: Nitrate Contamination, Treatment

Keywords: water quality, water chemistry, wastewater treatment, toxic substances wastewater, organic compounds, nutrients, nitrogen, denitrification eutrophication, biological treatment, bacteria, activated sludge

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Non-Federal Matching Funds: $43,304

Congressional District: 2nd

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Abstract

The Long Island Sound, bordered by Long Island, Connecticut, and New York, is a vast recreational (e.g., boating) and economical (e.g., fish and shell fish harvesting, navigation) resource. Unfortunately, the Sound's ecosystem continues to be under tremendous stress, jeopardizing its current uses for the future. Although the reasons for the Sound's fragile ecosystem health are manifold, nutrient discharge in the Sound, especially nitrogen, is generally recognized as a key contributor to ecosystem deterioration [1]. Publicly owned treatment works (POTWs) in Connecticut and New York present major point sources for nitrogen loads that can enter the local watershed and the Sound, resulting in hypoxic conditions in the Sound during late summers [2]. The Long Island Sound Comprehensive Conservation Management Plan requires that both Connecticut and New York reduce their nitrogen discharges to Long Island Sound by 58.5 % [1]. In an attempt to meet these new regulations, the Environmental Protection Agencies of Connecticut and New York are investing multi-million dollar amounts to upgrade wastewater treatment plants for biological nitrogen removal (BNR) with the aim of improving water quality in the Long Island Sound. Unfortunately, many POTWs that have already installed these BNR processes are experiencing intermittent and extended periods when there is a loss of either nitrification or denitrification [2]. Not only does this result in permit violations for the municipality, but also in high total nitrogen discharges to Long Island Sound.

In order to insure that the water quality in Long Island Sound is improved and to protect this major investment, it is vital to understand and identify the cause of failures of BNR processes and to identify the factors preventing individual treatment plants from establishing BNR. The goal of the proposed research is to provide this critical information to regulatory and policy setting agencies in the states of NY and CT as

well as to the professionals responsible for the treatment of domestic and industrial waste streams in these two Long Island Sound bordering states.

The primary focus of this research is to identify the causes of poor biological nitrogen removal (BNR) in POTWs. This research will compliment an ongoing study on nitrification inhibition study to help identify determinants of N-removal failure at POTWs due to process control deficiencies and waste stream characteristics (Inhibition of Biological Nitrogen Removal: Microbiology, Physical Chemistry and Process Engineering, by B. F. Smets, D. Grasso, and J. Semon-Brown, March 1999-March 2001). Driven by an exhaustive literature review, and the results of the ongoing study, we have implicated nitrification, the biochemical oxidation of ammonium-N to nitrate-N, as the bottleneck in BNR. This study will permit the validation of developed assays to rapidly measure the kinetics of the nitrification reaction using mixed liquor from a full-scale treatment plant. Part of this validation will entail a comparison of measured kinetics with observed reactor performance of bench-scale and full-scale BNR reactors across several seasons. Validation of the developed nitrification kinetics assay will yield a rapid tool to measure kinetics of the appropriate BNR rate-limiting step in full-scale POTWs, hitherto not available. In addition, this study will permit the validation of several analytical assays that are currently being developed to identify and quantify the presence of possible nitrification inhibitors in the complex reactor influents (raw domestic wastewaters) to full scale POTWs. These assays are geared towards measuring total heavy metal content, total cationic surfactant content, and total chelating agent content of a wastewater, expressed in terms of an appropriate normalizing equivalent. Such rapid tools will prove invaluable for rapid and intermittent screening of wastewaters to assess inhibitory character. Both kinetic and inhibitor quantification assays will be developed for transfer to wide use by POTWs across the state and region to rapidly identify and mitigate BNR inhibition.