Managed Aquifer Recharge: Experimental Evaluation of Water Quality Impacts

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Background/Objectives. The Potomac Aquifer System (PAS) is the primarily drinking water source to the largest population center in Virginia and supplies 90% of permitted groundwater withdrawals in the region. Over-allocation of permitted groundwater withdrawals in Eastern Virginia has led to a steady decline in water levels in the PAS and unsustainable yield of groundwater resources. The Sustainable Water Initiative for Tomorrow (SWIFT) project is an initiative by the Hampton Road Sanitation District's (HRSD) to replenish the PAS using Managed Aquifer Recharge (MAR). A pilot study to treat the secondary wastewater effluent using advanced water treatment (AWT) to meet drinking water standards and to recharge the PAS at 1 MGD was initiated in 2018. A component of the Underground Injection Control permit is a comprehensive assessment of any potential for the pilot aquifer recharge well to adversely impact groundwater quality. The objective of this study was an experimental evaluation of pathogen removal and attenuation of relevant chemical constituents and chemicals of emerging concern through MAR at an appropriate scale.

Approach/Activities. Two paired laboratory columns were designed and constructed for 3-day and 30-day travel times (TT). Column lengths were either 2.3 m or 3.7 m in length. Each column diameter was 25-cm. The columns were designed to enable sufficient sample for analysis of a suite of water quality parameters, chemical concentrations, and pathogen analysis. The columns were constructed using washed and sieved PAS aquifer sediment. Experiments were conducted under saturated conditions and were surrounded by atmospheric pressure. Effluent from the AWT pilot center served as column influent. Following completion of tracer tests, pathogens tests were conducted using MS2, *E.coli*, and microbeads. Additional tests were conducted by spiking influent with 106 CECs while monitoring a range of chemical constituents.

Results/Lessons Learned. Breakthrough of MS2, *E.coli*, and microbeads was observed in the 2.3-m-long columns (3-day TT) but not in the 3.7-m columns (30-day TT). However, log removal of MS2, *E.coli*, and microbeads observed in the 3-day TT columns was 6, 6, and 3, respectively. Similarly, complete denitrification of nitrate and nitrite was achieved in the 30-day TT columns, but not in the 3-day TT columns. Bromate was completely removed in the 30-day TT columns. Only partial removal of bromate was observed in the 3-day TT columns during initial stages of the experiment, followed by complete removal of bromate thereafter. CEC indicator compounds, 1,4-dioxane and sucralose, were regularly detected in both the influent and column effluent. 1,4-dioxane was partially removal in the 1 month columns on a consistent basis. CEC detected at meaningful concentrations with frequency included acesulfame-K, iohexal, TCPP, and sulfadiazine. Overall, the experimental evaluation supported the feasibility of pilot testing of MAR at the HRSD SWIFT facility.