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URBAN WATER
INFRASTRUCTURE

Optimizing Denitrification in Stormwater using Woodchip Bioreactor

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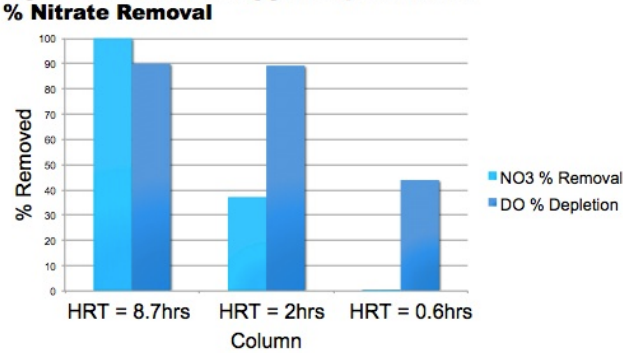
Abstract

Management of water resources has become a top priority in water stressed regions, especially in the arid West. Compared to energy intensive and expensive water desalination plants, or the "ick" factor associated with recycled water, aquifer recharge via a *Capture, Treat and Recharge* (CTR) stormwater system offers a viable alternative to water management. A main component for stormwater management is adjusting for the adverse impacts that urbanization has had on the hydrological cycle. With more impervious coverage less precipitation infiltrates to depths substantial enough to recharge groundwater supplies, which consequently leads to more runoff that drains to the surrounding water bodies. In addition to less infiltration, impervious surfaces, such as parking lots, also house a myriad of contaminants that can pollute and degrade the quality of water surrounding our cities.

The primary pollutant of interest in receiving waterways and the focus for the duration of this report is nutrient deposits, particularly Nitrogen in the form of Nitrate. In excess, Nitrogen can cause algae blooms as well as eutrophic conditions, which impair water quality and threaten sensitive aquatic habitats. The purpose of a CTR is to detain stormwater using a basin thus preventing it from entering local water bodies. Since high levels of Nitrogen also pose a threat to humans, the captured stormwater must be treated then recharged. Currently, there is not one universally applied method for stormwater treatment. Hence, the aim of this report is to provide insight on different methods and geomedias tested in our bioreactors and the progress we've made toward optimizing denitrification in urban stormwater using natural processes.

Previous column studies have indicated woodchips serve as an efficient carbon substrate to support denitrification in stormwater. However, we suspect that manipulating certain hydrologic conditions can optimize the denitrification mechanisms. Firstly, we conducted a Column Study that had four columns running with different Hydraulic Retention Times (HRT); approximately 8.7, 2 and 0.6 hours. Samples were taken every pore volume, and once the columns reached a steady state we took a depth profile, which were

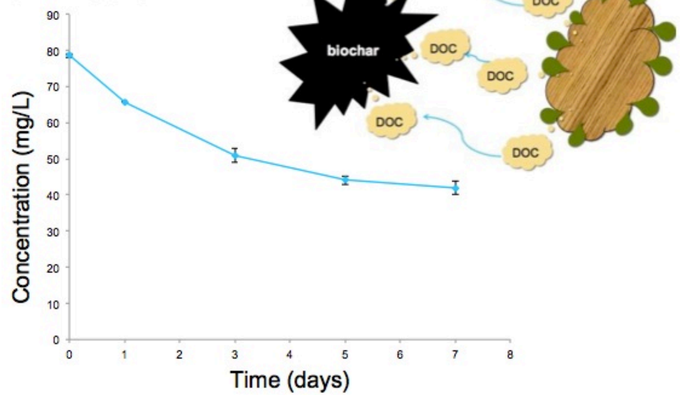
Figure 1: Dissolved Oxygen Depletion and % Nitrate Removal



samples taken at various depths along the columns' length. The depth profiles allowed us to observe how the residence times affected DON and DO concentrations as fluid moved top down through the column. Similar anoxic environments were achieved in both the 8.7 and 2 hour columns, and a trend was observed that the longer HRT was able to achieve more Nitrate removal compared to the shorter HRT, **Figure 1** shows a summary of these results.

Although woodchips perform well at removing Nitrates from stormwater, they also tend to leach DOC. In order to prevent DOC leaching from the column we performed a batch experiment to analyze a geomedias ability to act as a carbonaceous sorbent. In particular we looked at biochar, the byproduct of pyrolyzed biomass, which is known to have a very high surface area. The batch experiment supported our hypothesis that biochar will decrease the amount of DOC leached from a woodchip bioreactor, as shown in **Figure 2**.

Figure 2: DOC Sorption on Biochar



In addition to biochar sorbing leached DOC, we also wanted to test its ability to enhance denitrification in a woodchip bioreactor. We believed that a bioreactor amended with biochar would generate more available surface area for microbial communities to form. Columns with a dense microbial community, or biofilm, would in turn be able to remove more Nitrates due to more biological activity. From our preliminary data, we saw the column containing both biochar and woodchips outperformed the other columns on Nitrate removal, **Figure 3** shows these results. Since biofilms can take up to two months to form, these results are subject to change, however we still believe that a column amended with biochar enhance denitrification compared to just woodchips alone.

Figure 3: Nitrate Removal by Geomedia after 2 weeks