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TechLink Research Summary #3343
Performance of EnviroSoxx on New Pollutants, Functional Longevity, and Multiphase Filtration Design in Stormwater Treatment

INTRODUCTION

Stormwater runoff is one of the leading sources of water pollution in the United States. Pollutants in urban, industrial, and municipal stormwater typically originate from non-point sources, and the majority of these pollutants are typically in soluble form. Berg and Carter (1980) reported that soluble pollutants may exceed 80% of the total stormwater pollutant load where land surfaces have been stabilized. In many watersheds, soluble pollutants may be of greater concern due to an increased bioavailability to aquatic organisms, relative to sediment-bound pollutants. Stormwater permit-holders need adequate technology and best management practice (BMP) information to effectively reduce site stormwater pollutants, protect the quality of receiving waters, and comply with industrial and municipal stormwater permit effluent limit guidelines for stormwater quality.

According to the U.S. Environmental Protection Agency's (US EPA) national water quality assessment, 35% of U.S. streams are severely impaired and 75% of the population lives within 10 miles of an impaired surface water (US EPA, 2007). In accordance with Section 303(d) of the Clean Water Act, the US EPA designates specific stream segments as impaired, triggering Total Maximum Daily Load (TMDL) development for specific pollutants in contributing watersheds - today there are approximately 50,000.

The US EPA National Pollutant Discharge Elimination System (NPDES) Phase II National Menu of Best Management Practices includes compost filter socks as a leading means to manage runoff (USEPA 2006), while USDA ARS and university research shows these compost-based biofilters can target and filter a variety of stormwater pollutants (Faucette et al., 2005; Faucette and Tyler, 2006; Faucette et al., 2006; Keener et al., 2007; Faucette, et al., 2008; Faucette et al., 2013). These same studies show this technology consistently removes a high percentage of particulate and sediment bound pollutants. EnviroSoxx is the latest technology to use compost biofiltration in a stormwater application to target both particulate and soluble stormwater pollutants. EnviroSoxx relies on a specified compost filter media combined with natural additives to target pollutants commonly found in urban, municipal, and industrial stormwater runoff.

The objectives of this study were to develop and evaluate the soluble pollutant removal performance of: 1) a new filtration media designed to target new pollutants for EnviroSoxx; 2) multiple storm events and effect on functional longevity of new filtration media for EnviroSoxx; 3) a multiphase filtration design using multiple EnviroSoxx with new filtration media.

MATERIALS AND METHODS

Research was conducted at SWM laboratory, 2810 Weeks Ave SE, Minneapolis MN 55414. The laboratory study was designed to simulate and evaluate the stormwater runoff pollutant removal performance of EnviroSoxx. Experiments were conducted to test the removal efficiency, functional longevity, and multiphase filtration of the EnviroSoxx for various pollutants from stormwater runoff. Pollutants evaluated included low pH (< 6.0), high pH (>9.0), aluminum (Al), iron (Fe), arsenic (As), selenium (Se), total nitrogen (TN), and ammonium-nitrogen (NH4-N).

Each experiment evaluated a single pollutant, based on concentrations typical to urban, industrial, and municipal stormwater runoff, with 10 sequential events spaced a minimum of 24 hours between events to simulate multiple stormwater runoff events. All experiments used a flume constructed of marine plywood positioned at a grade of 10%. EnviroSoxx were installed into the flume according to Filtrexx standard specifications. All EnviroSoxx were 8-inch diameter and 1 ft in length. Multiphase experiments utilized three EnviroSoxx, while all other experiments utilized one EnviroSoxx. Each experiment was conducted in triplicate to obtain statistical means, standard deviations, and to eliminate conclusions based on outliers.

Stormwater runoff was generated by adding soluble form pollutants to a stainless-steel mixing pail with 12 L of municipal tap water. Concentrated soluble pollutants were obtained from ERA Laboratory Supply Company (Golden, CO). One pail represented one stormwater event. All runoff was metered into the top of the flume and collected at the base of the flume after each simulated runoff event. All collected water samples followed chain of custody protocols and were preserved in a cooler immediately after sampling and until delivery to the analytical laboratory. All water pollutants used US EPA sampling and analytical test methods described in the Methods for Chemical Analysis of Water and Wastes (US EPA, 1983). Water quality analysis was performed by Pace Analytical Laboratories.

Removal efficiency (%) was determined for each pollutant replicate and each event by dividing the effluent concentration by the influent concentration. Final removal efficiency was the average for all replicates for the final storm event in the sequence, and mean removal efficiency was the average for all replicates for all storm events in the sequence. Averages were determined using the three replicates for each event for each pollutant over the 10-event period for influent, effluent, and removal efficiency. Results based on these methods are reported in Table 1.

RESULTS

Table 1. EnviroSoxx pollutant removal performance for new media, functional longevity, and multiphase filtration.

Pollutant	Influent (mg/L)	Mean Effluent Single ES (mg/L)	Mean Effluent Three ES (mg/L)	Final Removal Single ES (%)	Final Removal Three ES (%)	Mean Removal Single ES (%)	Mean Removal Three ES (%)	Multi-ES Filtration Increase (%)
Low pH	4.6	5.7	6.2	5.6	6.4	5.6	6.4	NA
High pH	9.9	9.8	9.6	9.8	9.6	9.8	9.6	NA
Al	2.1	1.17	0.43	45	79	44	80	80
Fe	2.3	1.28	0.59	45	76	44	74	68
Se	0.22	0.18	0.12	20	48	18	45	150
As	1.58	1.4	1.1	11	30	11	30	167
TN	9.7	7.8	6.2	21	36	20	38	84
NH4-N	3.2	2.5	1.6	25	45	22	50	129

SUMMARY AND CONCLUSION

Based on these experiments, methods, and overall evaluation, the New EnviroSoxx filtration media has the ability to increase performance and remove a wider variety of stormwater pollutants - for both first flush and multi-event exposure conditions, with consistent performance over multiple storm events. In addition, design and installation of multiple EnviroSoxx can significantly increase pollutant removal performance and further decrease concentrations of stormwater pollutants, which is a unique distinction with this stormwater treatment technology.

Based on this study, using three EnviroSoxx more than doubled pollutant removal efficiency on average. It should be noted that additional EnviroSoxx (more than three) may provide even greater filtration capability and pollutant removal performance. Furthermore, if combined with particulate or sediment bound pollutant fractions, as is commonly exhibited in the field, these total removal efficiencies will be significantly higher (i.e. soluble + particulate = total pollutant). This new research provides science-based evidence that this technology can be a very effective best management practice and stormwater treatment system used in a comprehensive treatment train design approach to meet a variety of industrial and municipal stormwater permit requirements.

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