TechLink Research Summary #3338

StormExx® Clean Filter Media Performance Evaluation

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 particular pollutants in contributing watersheds - today there are approximately 50,000.

Storm water runoff is one of the leading sources of these pollutants. Typical concentrations in urban post-construction storm water runoff contributing to water quality impairment for total nitrogen (N) and nitrate-nitrogen range from from 0.14 mg/L to 29.0 mg/L, total phosphorus (P) from 0.24 mg/L to 3.6 mg/L (Flint and Davis 2007), oil/grease ranges from 10 mg/L to 35 mg/L (US EPA, 2002), and E. coli levels from 1,000 to 100,000 CFU/100 mL, with an average level near 30,000 CFU/100 mL (McLellan and Sauer, 2009).

Pollutants in urban storm water 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 storm water 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. Storm water permit holders need adequate technology and best management practice (BMP) information to effectively reduce site storm water pollutants, protect the quality of receiving waters, and comply with industrial and municipal storm water permit effluent limit guidelines for storm water quality.

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 (US EPA, 2006), while USDA ARS and university research shows these compost-based biofilters can target and filter a variety of storm water 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). StormExx Clean is the latest technology to use compost biofiltration in a storm water application. StormExx Clean relies on a below the grate drop inlet filter cartridge to target specific pollutants commonly found in urban, municipal, and industrial storm water runoff.

The objective of this study was to evaluate the pollutant removal performance and longevity of StormExx Clean 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 storm water runoff pollutant removal performance of StormExx Clean compost-based filter media. Experiments were conducted to test the removal efficiency and capacity of the filter media for various pollutants from synthetic runoff. Pollutants evaluated included total suspended solids (TSS), turbidity, total kjeldahl nitrogen (TKN), ammonium-N (NH-4), total P (TP), soluble P (SP), oil/grease (OG), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), cadmium (Cd), chromium (Cr), arsenic (As), selenium (Se), low pH, high pH, total coliform bacteria, fecal coliform bacteria, and E. coli bacteria.

Each experiment evaluated a single pollutant, based on concentrations typical to urban, industrial, and municipal storm water runoff, with 10 sequential events spaced a minimum of 24 hours between events to simulate multiple runoff events. Each experiment was conducted in triplicate to obtain statistical means and standard deviations. The experiment used vertically mounted columns made from from 6 in (150 mm) nominal diameter, 48 in (1200 mm) high clear PVC tubes. Each column was filled with StormExx Clean filter media to a height of 36 in (900 mm). This is approximately the same volume of media that is used in a standard StormExx Clean catch basin filter cartridge. Filtration media was added to columns manually with no mechanical compaction.

Synthetic runoff was generated by adding soluble form pollutants to a stainless steel mixing pail with 12 L of municipal tap water. Flow velocity through the media was 15 in (375 mm)/min, and flow rate was 6 L/min. Concentrated soluble pollutants were obtained from ERA Laboratory Supply Company (Golden, CO), sediment for TSS and turbidity used an AASHTO sandy loam soil, and all bacteria species used 3 oz (255 g) of field collected horse manure samples. Particle size distribution for the soil used for sediment was 10% < 0.002 mm, 7.5% < 0.06 mm, and 82.6% < 2.0 mm. One pail represented one storm water event. Prior to pouring the synthetic runoff into the column, a 16 L pail of municipal tap water was poured into each column and allowed to flow through the filter media. All runoff was metered into the top of the column and collected at the base of the column 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. Water turbidity (NTU) was measured using a Hach 2100Q handheld turbidity meter and pH was measured using an Oakton pHTestr with Cole-Parmer Calibration Kit. All other water pollutants used US EPA sampling and analytical test methods described in the Methods for Chemical Analysis of Water and Wastes (US EPA, 1983) 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 mean for all replicates for the final storm event in the sequence, and total removal efficiency was the mean for all replicates for all storm events in the sequence. Means were determined using the three replicates for each event for each pollutant over the 10-event period for influent, effluent, and removal efficiency, while standard deviations were determined for influent concentrations for precision, bias, and quality control.

RESULTS

Table 1. Mean pollutant influent, effluent, final event removal efficiency, and total removal efficiency for all pollutants.

Pollutant	Influent (mg/L)	Effluent (mg/L)	Final Event Removal Efficiency (%)	Total Removal Efficiency (%)
TSS	483 ±41	49	83	90
Turbidity (NTU)	309 ±40	73	58	76
TKN	9.4 ±0.65	7.4	34	22
Ammonium-N	8.9 ±0.43	5.5	42	41
Total P	1.07 ±0.84	0.31	74	59
Soluble P	2.47 ±0.75	0.14	88	94
Oil/Grease	150 ±0.05	0.0	99	99
pH (low)	5.4 ±0.19	6.62	NA	NA
pH (high)	9.64 ±0.05	8.31	NA	NA
Copper	0.71 ±0.16	0.17	77	75
Cadmium	0.06 ±0.007	0.001	99	99
Chromium	0.93 ±1.4	0.75	50	24
Nickel	4.5 ±0.19	2.0	45	58
Lead	1.6 ±0.08	0.64	62	60
Zinc	1.8 ±0.12	0.78	59	58
Arsenic	1.2 ±0.046	1.0	19	18
Selenium	0.18 ±0.01	0.14	26	25
Total Coliform (MPN/100 mL)	938000 ± 5.0 x105	34000	2	79
Fecal Coliform (CFU/100 mL)	165000 ± 1.4 x105	40000	67	71
E. coli (MPN/100 mL)	2477000 ± 3.3 x106	3500	60	93

SUMMARY AND CONCLUSION

Based on this evaluation, StormExx Clean filtration media has the ability to target and remove a wide variety of sediment and soluble storm water pollutants, for both first flush and multi-event exposure conditions. Average pollutant removal efficiencies over 10 runoff events ranged from 18 to 99%, including removal for metals, nutrients, pH, hydrocarbons, sediment, and bacteria. These results give science-based evidence that this technology can be an effective best management practice and treatment system used in a comprehensive treatment train design approach to meet storm water permit requirements.

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