Bacteria Removal Efficiency of a Bioswale located in Lockwood Folly, a Coastal Watershed in North Carolina.

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Abstract:
NC Department of Transportation (NCDOT) has obtained, through partnerships with private sector, an engineered soil to enhance removal of fecal bacteria when used in conjunction with stormwater Best Management Practices, such as bio-retention cells. The efficacy of this media is being tested at a site in Lockwood Folly, NC where a TMDL for fecal coliforms was approved by the NC Department of Natural Resources in 2010 to address shellfish harvesting impacts in the nearby estuary. Mechanisms for bacterial removal are attributed to: (1) retention of particles to which microbes adsorb and (2) mortality due to grazing by protozoans harbored by the soils. Funding is being provided by NCDOT as part of a program to evaluate pollutant removal efficiencies of various BMPs for road runoff treatment. NCDOT’s NPDES permit requires the retrofit of 50 stormwater BMPs in each 5 year cycle; they optimize their retrofits through results of research. The results of this assessment work are of much interest to South Carolina due to the large number of monitoring sites with fecal bacteria impurities that are located in settings similar to the Lockwood Folly watershed, the relatively low cost of the media, and the option of retrofitting existing BMPs to enhance bacteria removal.

Sites & Methods:
The test site at Lockwood Folly was constructed in 2012 by installing a 200-ft linear strip of media, 3 ft deep in a pre-existing stormwater swale that runs parallel to a secondary state road (NC 211) maintained by NCDOT. The removal efficiency of this bioswale is being evaluated by measuring bacteria transport into and out of the media during storm events. For each event, auto-sampled samples are being collected at the inlet and outlet of the bioswale using ISCO auto-samplers outfitted with water level sensors. The samples are being analyzed for two fecal indicator bacteria (Enterococcus and Fecal coliform), for turbidity, total & volatile suspended solids, and conductivity. Sample collection and processing is being performed by Coastal Carolina University’s Environmental Quality Laboratory.

Results:
The upstream sampling site (15W) collects stormwater runoff before it is treated by the bio-media. This site is configured to pool the runoff allowing the auto-sampler to collect water before it moves into the media. The Overflow (20D) sampling site is designed to collect any water runoff that flows over and/or around the media. Collection is based on a volumetric discharge threshold.

Discussion:
The data collected to date have shown that the bio-media has been reducing the concentrations of each parameter measured with the exception of Conductivity. Enterococcus faecalis has had an average reduction of about 3,000 Most Probable Number per 100 mL (MPN/100mL). Fecal coliform has had an average reduction of about 1,000 MPN/100mL. TSS has been reduced by about 30 mg/L, TSS by about 50 mg/L and turbidity by about 10 NTU. Conductivity, however, has shown a slight increase, averaging about 5 µS/cm. As indicated by a large event sampled on 7/4/14 (Hurricane Arthur: Event 4), high flow rates may reduce or even reverse the effectiveness of the media. During this event, the flow through the media was high and the Enterococcus faecalis values were slightly increased after passage through the media. A total of 18 events will be sampled over the next year. Discharge is being measured and will be used to infer loadings and removal efficiencies of the bacteria and turbidity.

Summary:
Overall, to this point, the bio-media has been performing the way it was designed. Bacteria levels and suspended solids have been reduced during the past five sampling events. Flow rates will also be reviewed in the future to determine the media’s performance during different types and strength of storm events and strength of runoff. If the bio-media continues to perform as designed in Lockwood Folly it could become a desirable filtering method to reduce bacteria, nutrients, and suspended solids from storm water runoff out through the country.