Evaluation of Bioretention Systems for Stormwater Quality Improvement and Reuse: A Case Study of Size-Constrained Systems in Manly, Australia

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Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Abstract

Stormwater runoff in urban areas is known to carry high concentrations of sediment, organic matter, nutrients, metals and pathogens, which can cause environmental issues in natural water bodies. Bioretention systems (also known as bio-filtration basins and rain-gardens) are a type of stormwater treatment device that attempt to remove pollutants from stormwater by harnessing natural processes. There has been limited use of bioretention systems due to the lack of sufficient space in urban areas for stormwater treatment. Size-constrained bioretention systems have a low bioretention area to catchment size ratio giving them a higher potential for more extensive use in urban areas.

The aim of this study was to evaluate the effectiveness of sized-constrained bioretention systems in removing pollutants from stormwater runoff. The studied size-constrained bioretention systems promote the horizontal sub-surface flow of stormwater through the bioretention media. This is different to the vertical flow of water seen in conventional bioretention systems. However, once established, both types of bioretention systems rely on the same pollutant removal processes, including filtration and adsorption. The three size-constrained bioretention systems that were studied are located in the Northern Beaches area of Sydney, Australia. These were closely monitored between August 2009 and December 2010, which involved collecting water samples every 10-15 minutes at the inflow and outflow of the bioretention systems during rainfall events.

The bioretention systems reduced total suspended solids concentrations by an average of 78%, while total copper, zinc and lead concentrations were reduced by an average of 66%, 58% and 61%, respectively. Nutrient and faecal indicator bacteria removal rates were more varied, with the oldest system, located at Jellicoe St. performing the worst of the three systems, leaching all forms of nitrogen and faecal indicator bacteria. The newest system located at Tutus St. performed the best of

the three systems, reducing total nitrogen by 44%, total phosphorus by 63%, faecal coliforms by 72% and *Enterococci* by 35%. Considering the small area occupied by the sized-constrained bioretention systems, they were generally found to be effective in removing pollutants from stormwater. However, size constrained bioretention systems may require greater maintenance compared to conventionally sized bioretention systems.