# Comparing the Full Spectrum and Multi-Level Detention design for Urban Stormwater Detention Facilities

Xiaoju Zhang[1] and Larry A. Roesner[2]
Department of Civil and Environmental Engineering, Colorado State University

**Abstract.** Peak flow attenuation and water quality control are widely used in urban stormwater systems. Standard practice typically involves peak shaving of postdevelopment flows to predevelopment peak flow levels and best management practices (BMPs) for removing pollutants from runoff for given return interval. Usually both practices are integrated by using multi-level extended detention ponds, which are designed to peak shave a variety of storms and control the water quality capture volume. Recently, Wulliman and Urbonas (2005 and 2007) have proposed the so called Full Spectrum Detention Approach to design detention facilities able to control the full spectrum of runoff events. This method is based on the concept of capturing the *excess urban runoff volume* that results from urbanization and releasing it over a period of 72 hours. This method has been tested successfully for the Denver region and excellent matching of pre-development peak flows has been achieved. However, these results have been obtained using design storms and the model has not been studied using a continuous simulation approach except peak flow comparison. Continuous simulations are useful because they provide information about the long-term performance through exceedance peak frequency and flow duration curves. Moreover, these results can be used to define the stream erosion potential, a metric that characterize the geomorphic stability of urban streams. On the other hand, continuous simulation has been successfully used to characterize the performance of multi-level extended detention practices, and propose protocols to reduce urbanization impacts in different locations.

This study compares the multi-level standard practice design approach to the full spectrum approach and assesses their effectiveness through the use of design storms and continuous simulation in a conceptual watershed. The US EPA Stormwater Management Model (SWMM) is used to simulate the response of a conceptual watershed and an extended detention pond sized using both design approaches. The methods are initially tested by comparing the peak-flows obtained using different design storms with the corresponding pre-development flows. Additionally, 60 years hourly rainfall records from two different climate regions are used to run continuous simulations and compute peak flow frequency exceedance curves, flow duration curves and shear stress duration curves, used to compute the stream erosion potential, as well as the hydrologic metrics $T_{0.5}$. The effectiveness of both design methods is assessed by comparing these results with the ones obtained for the pre-development conditions.

**Keywords**: Multi-Level Detention, Full Spectrum Detention, Peak Flow Frequency Exceedance, Flow Duration, Erosion Potential

[1] Graduate Research Assistant, Urban Infrastructure Systems Laboratory, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO 80523-1372;
(970)-491-2838; Email: xiaoju@engr.colostate.edu
[2] Professor, PhD, PE, Fellow of ASCE; Urban Infrastructure Laboratory, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO 80523-1372;
(970)-471-7430; Email: Larry.Roesner@colostate.edu