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Monitoring and Modeling the long-term rainfall-runoff response of the Jacob K. Javits Center green roof

Noura Abualfaraj[1], Joseph Cataldo[2], Yara Elborolosy[2], Daniel Fagan[2], Sloane Woerdeman[1], Tyler Carson[3], and Franco Montalto[1,*]

[1] Drexel University, College of Engineering, CAEE Department, 3141 Chestnut St. Philadelphia, PA 19104
[2] The Cooper Union, Albert Nerken School of Engineering, Department of Civil Engineering.
[3] Arcadis of New York, Inc., Long Island City, NY.
* Correspondence: fam26@drexel.edu; Tel.: +1-215-895-1385

Abstract: Drainage from the 27,316-square meter Jacob K. Javits Convention Center (JJCC) Green Roof was investigated in the field in order to quantify the roof's long-term rainfall-runoff response. The JJCC hosts one of the largest extensive green roofs in the United States. Using four years of rooftop observations made with a weather station, custom designed and built drainage systems, and three Parshall flumes equipped with pressure transducers, and weighing lysimeters, this study quantifies the 25.4 mm deep green roof's ability to decrease the volume and peak rate of runoff. Driven by the rooftop precipitation observations, an EPA SWMM model with a green roof LID control scaled to the site was found to predict event total runoff volume and event peak runoff rates to within +10% to -20% and +15% to -25% of the observations, respectively. The analysis conducted indicates that approximately 55% of the precipitation that fell on the Javits Convention Center extensive green roof during the monitoring period (June 2014 – November 2017) was captured and retained. The average percent retained on an event-basis was 77%. This quantity of retention is significant and implies a substantial reduction in the volume of runoff generated from the roof compared to the pre-green roof condition, when most, if not all, of the precipitated water would have immediately resulted in runoff. Our research suggests that 96% of rainfall events of 6.35 mm or less were retained within the green roof, while on average 27% of the total event volume was retained for events greater than 12.7 mm in total depth. The analysis also included a sensitivity analysis on the substrate depth and the effects of forecasted climate change on the hydrological performance of the roof. This revealed a strong likelihood that performance increases with deeper roofs up to 127 mm, while increased precipitation coupled with warmer temperatures as a result of climate change could decrease the performance of the roof by up to 5%.

Keywords: Green Roofs; Stormwater Management; Green Infrastructure

1. Introduction

Built even in ancient times [1,2] green roofs have emerged as one of the most effective methods of distributed stormwater control in contemporary cities, particularly where stormwater runoff can cause flooding, sewer surcharges and overflows, and pollutant loading to receiving waters [3-6]. In dense cities with limited undeveloped space, one key advantage of green roofs over other types of green infrastructure is that they can be retrofitted into existing buildings [7]. As runoff capture options in the right of way are rapidly exhausted, rooftops, which account for 20- 25% of impervious cover in American cities [8,9] are becoming increasingly critical features in urban stormwater management. Precipitation incident to the roof is intercepted, detained, and evapotranspired, reducing the rate and