Performance Evaluation of Three Rainwater Harvesting Systems

Toronto, Ontario

The practice of collecting rainwater from roofs and using it to satisfy daily water needs has been used in rural Ontario for well over a century. The practice is now being increasingly used in urban areas as municipalities and building owners seek new and effective ways to conserve water, delay costly expenditures on expanding or building new water treatment plants, and reduce the adverse effects of stormwater runoff on urban infrastructure and aquatic ecosystems.

The most common uses of water captured through rainwater harvesting (RWH) systems include toilet flushing, landscape irrigation, vehicle washing, and other outdoor uses. If the water is treated, the systems can also be used to supply water for drinking, laundry, bathing and dishwashing. Industries may also use harvested water for cooling and various production processes.

Study Objectives

This three year monitoring study evaluated rainwater harvesting (RWH) systems operating in three Toronto buildings. System performance was assessed year-round with respect to water conservation, stormwater runoff control, water quality and overall operation and maintenance. A model was developed and calibrated to facilitate analysis of performance under alternative scenarios (e.g. rainfall conditions, cistern size).

Site Description

Three buildings in Toronto with RWH systems were selected for the evaluation: (i) a commercial printing facility, (ii) a high rise residential building, and (iii) a large public school. All systems were designed to collect rainfall from the roof, store it in cisterns and distribute the water for toilet flushing and irrigation. Available rainwater storage in the cisterns ranged from 9 m^3 at the printing facility to 26 m^3 at the Public School. In addition to the RWH system, water use reduction features in the buildings include waterless urinals and low-flow toilets, fountains and faucets.

Figure 1: Clockwise from left to right: Minto high rise apartment, Brookside Public School, Metro Label Printing Facility.

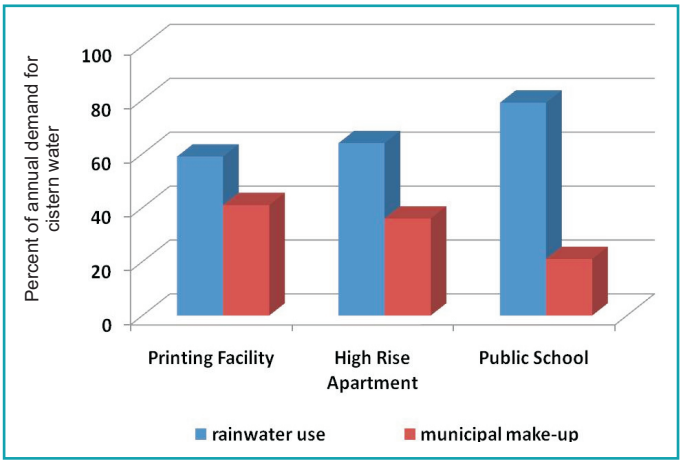

Figure 2: Rainwater use and municipal make-up as a percentage of total annual demand for non-potable water supplies during a 'normal' precipitation year.

Results

Study results indicate that rainwater harvesting systems have the potential to provide significant water conservation and stormwater management benefits. During a typical rainfall year, the systems were shown to supply between 59 and 79% of total demand for non-potable water, while diverting between 18 and 42% of annual precipitation on the roof catchment area from storm sewers (Figure 2). Instances when cistern supply needed to be supplemented with municipal water to meet building demand typically occurred during extended cold weather periods over the winter, long spells with limited rainfall, and periods when demand for non-potable water was high.

During the cold season, snowmelt provided a relatively reliable source of water, representing between 10 and 13% of total annual precipitation supply to the cisterns in the three buildings. Heat from the building combined with solar radiation resulted in melt occurring even when average daily temperatures were as low as -5°C.

Water quality sampling from the cisterns and hose bibs of the printing facility and high rise apartment revealed that water from the system was suitable for non-potable water use. Total suspended solids and turbidity levels in the cisterns were generally low (<5 NTU). If the systems were used as sources of potable water, treatment would be required to remove low levels of bacteria and trace levels of polycyclic aromatic hydrocarbons and pesticides.

A number of operational issues were encountered with the systems, including leaky cisterns, broken pipes and pump failures, all of which were eventually rectified. As experience with rainwater harvesting grows in Canada, the incidence of these problems are expected to decline. New Ontario guidelines for Rainwater Harvesting developed by the University of Guelph and the Ontario government and a new design and costing tool produced in partnership with TRCA will help to set best practices and standards, and ensure that issues unique to Canada, such as building RWH systems to handle cold climate conditions, are adequately considered.

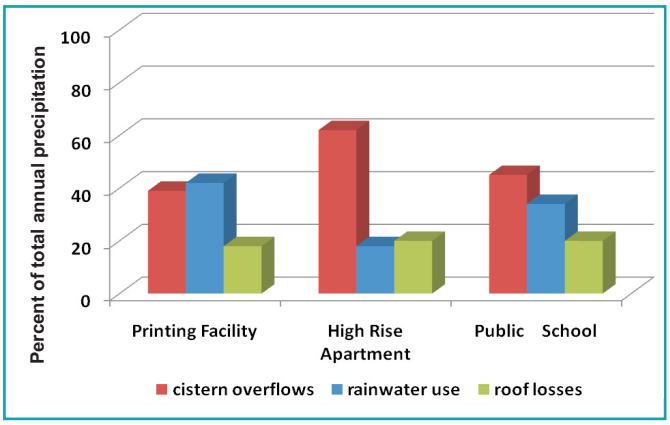

Figure 3: Rainwater use, overflows and direct losses from the roof (and patios where applicable) as a percentage of total annual precipitation inputs to rainwater catchment areas during a 'normal' precipitation year.

For more information on this project or the Sustainable Technologies Evaluation Program, please contact Tim Van Seters at (289) 268-3902. The final report for this study, the Ontario Rainwater Harvesting Guidelines, and the design and costing tool are available for download from the STEP website at www.sustainabletechnologies.ca.

Project Partners

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