Sustainable Technologies
EVALUATION PROGRAM

TECHNICAL BRIEF

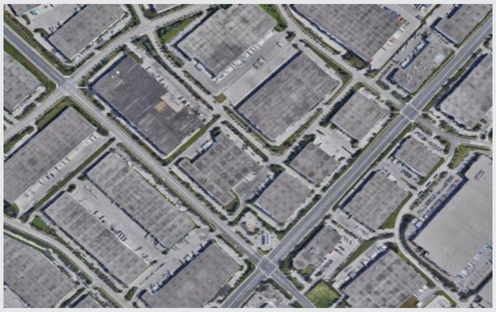
Testing the Feasibility of a Smart Blue Roof System to Improve Stormwater Management in Urban Canadian ICI Neighbourhoods

Urban municipalities across Canada are facing growing challenges with regards to stormwater management such as climate change, underserviced areas, a stormwater infrastructure deficit as well as a growing urban footprint due to development.

The industrial, commercial and institutional sector (ICI) is comprised of industrial parks, malls, shopping centers, factories, warehouses, office buildings and schools. A common characteristic of ICI sector lands is the extensive paved parking areas surrounding the buildings, as well as extensive flat-roofs.

Due to the high amount of impervious area, ICI sector lands generate large stormwater runoff volumes, which are conveyed away from the properties by municipal storm sewers. The municipal infrastructure in ICI areas is frequently overburdened (i.e. unable to accommodate up to the 10-year design storm) due to upstream development and outdated design standards, thus increasing flooding potential. To decrease pressure on municipal infrastructure and reduce the risk of flooding, smart blue roof systems are a viable option to control stormwater at the source.

Figure 1. A typical industrial area in Mississauga. ICI sector lands are comprised of large roof and parking lot areas. Such lands have 70-90% imperviousness.



- Blue roofs are an innovative new form of green infrastructure
- Smart blue roof systems can be optimized by automation using weather forecasting algorithms via internet connectivity
- Smart blue roof systems can regulate rooftop runoff by storing and controlling the release of rainwater
- In addition to peak flow control, blue roof systems can facilitate runoff reduction through rainwater reuse and evaporative rooftop cooling
- Rainwater reuse results in offsetting potable water usage and evaporative cooling has electricity and GHG saving potential.

SMART BLUE ROOFS: A SOLUTION

Preceded by green roofs and flow control roof drain systems, blue roof systems (see Figure 2) are being recognized as an innovative rooftop stormwater

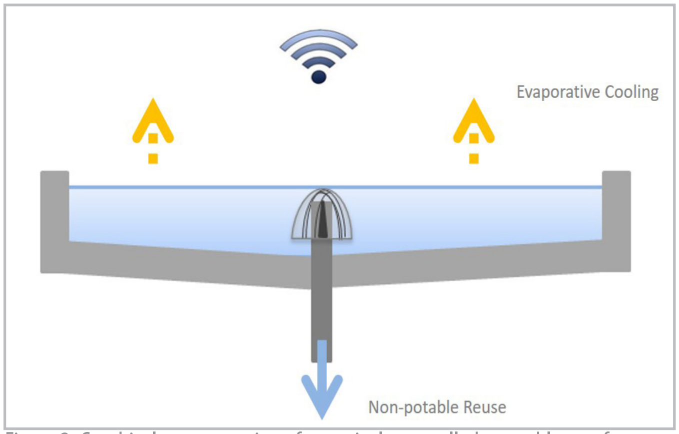


Figure 2. Graphical representation of an actively controlled smart blue roof system with RWH capacity

management solution that provides flood protection and drought resistance. Instead of quickly conveying stormwater away from a property, blue roof systems temporarily capture rainwater until it either evaporates from the rooftop, is sent to rainwater harvesting storage tanks (see Figure 3) for reuse purposes or gradually flows into the municipal stormwater system. As a result, pressure on the storm sewers is reduced and flooding is mitigated. Stored rainwater on the roof can also be used to meet a property's non-potable water demand (i.e. irrigation, toilet flushing, truck washing etc.) and thus offset potable water use.

Figure 3. Rainwater tank at CVC

Additionally, during summer heat waves, rainwater stored on a flat roof can reduce the heat load on a building and reduce air conditioning requirements through evaporative cooling. To this extent, smart blue roof systems are advantageous to both the private and public sector.

Blue roof systems can be optimized by incorporating the "Internet of Things" (IoT) technology to make blue roofs "smart." Utilizing a combination of sensors , controllers and predictive weather algorithms all linked to a building management system to monitor and manage rainwater that has or will be accumulated on a rooftop, smart blue roofs function as active, automated roof runoff management systems. Predictive analytics incorporated into smart blue roof systems allow for proactive planning ahead of impending storm events, allowing the system to take appropriate measures (i.e. to electronically open or close roof drains) depending on the short-range weather forecast (see Figure 4). System capacity and environmental threshold limits can be set so that an alert is triggered when the system is reaching capacity. Building/facility operators can be notified while the system responds automatically.

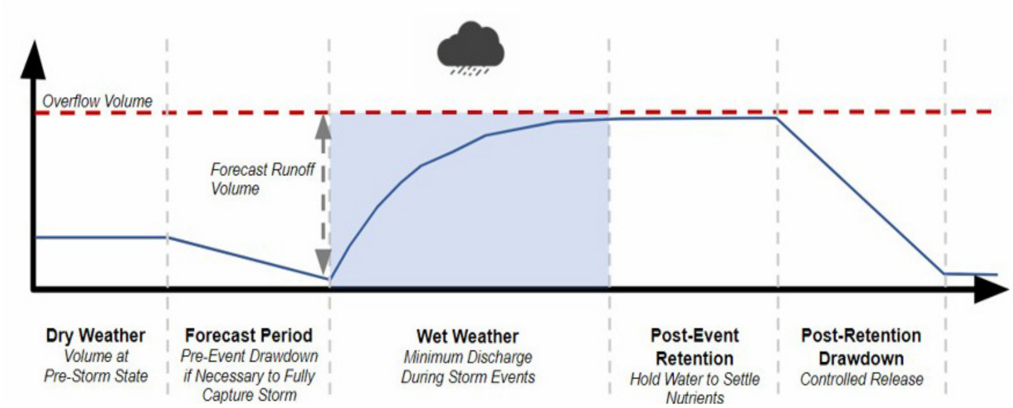


Figure 4. Smart blue roof logic (OptiRTC, 2019)

TECHNICAL AND FINANCIAL FEASIBILITY OF IMPLEMENTING A SMART BLUE ROOF

The suitability of a smart blue roof system and design options for a given building are determined based on various factors, including structural capacity, waterproofing, roof type and slope, and local regulatory requirements. In 2019, Credit Valley Conservation (CVC) with support from the Federation of Canadian Municipalities (FCM) and Region of Peel completed a technical and financial feasibility study titled "Automated Real-time IoT Smart Blue Roof Systems for the IC&I Sector for Flood and Drought Resilience and Adaptation" (www.sustainabletechnologies.ca). The study investigated the possibility of retrofitting CVC's existing Building A flat-roof (see Figure 5) into an active, smart blue roof with real-time controls to detain stormwater over an extended period, resulting in benefits to both the building owner, neighbourhood and the municipality.


Figure 5. CVC's concrete slab roof

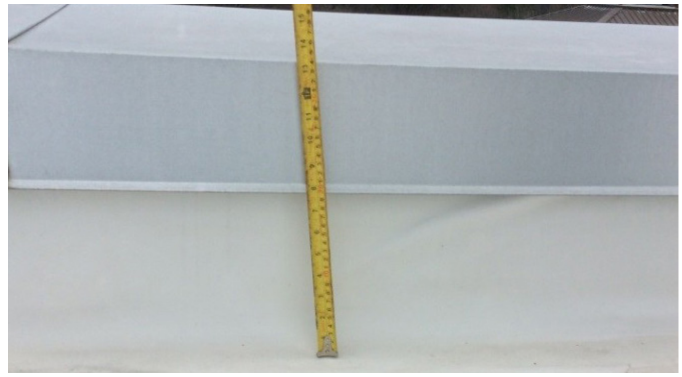


Figure 6. Parapet height

The feasibility study revealed the following when using CVC's Building A as a template to pilot a smart blue roof system:

- The building has a parapet height of 400mm (see Figure 6). Structurally, the rooftop can hold up to 180 mm of precipitation (equivalent to $21m^3$ across the roof area) thus capturing the 100-year storm
- the smart blue roof system can meet non-potable water demands of 8.84 m^3/day, exceeding our building's current non-potable water demand of 5.68 m^3/day
- by storing water on the roof, a typical air conditioning unit will see a reduction of 11.6 GJ/year translating into an annual electricity savings of 3,210 kWh, or about $302 and a GHG reduction of about 0.2 tonnes CO2e annually
- the estimated cost to implement a smart blue roof on CVC's Building A roof is $365/$m^2$

The CVC head office Building A is typical of most flat roof buildings across North America. In July 2020, Intact awarded the CVC a Climate Action Grant to pilot a Smart Blue Roof system on-site to evaluate real world performance and scalability in a Canadian context. Piloting and monitoring a smart blue roof system at the CVC office will be valuable to Canadian businesses, municipalities and insurance companies as the Smart Blue Roof concept will be tested and real-world lessons will be learned that can be transferred across the ICI sector, government organizations and to other stakeholders.

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The water component of STEP is a collaborative of:

Credit Valley Conservation inspired by nature

Lake Simcoe Region conservation authority

Toronto and Region Conservation Authority