

## TORONTO PIONEERS UNDERGROUND BIORETENTION

### Stormwater “proof of concept” Silva Cell installation



*Perforated distribution pipes are placed throughout the system*

The Silva Cell has primarily been used as a system to provide large volumes of un-compacted planting soil for trees in dense urban centers. Lesser known, but equally important, is the system’s complementary ability to manage stormwater runoff as the source control.

Toronto Water, the city’s water authority, wanted to test the Silva Cell’s capacity to manage surface runoff. In conjunction with Ryerson University and DeepRoot Canada Corp., the city installed a proof-of-concept installation on the Queensway, a commercial area between Moynes and Berl Avenue on the North side. Pave-It, the contractor, excavated trenches for two Silva Cell systems, each two frames deep and with spots for two tree openings that straddled the sidewalk and parking bays.

The Silva Cells were filled with a bioretention soil mix that has a 20% water holding capacity. All of the rainwater runoff is collected in the city’s standard stormwater catch basin. In effect, the Silva Cell is being used to create a giant raingarden underneath the sidewalks and parking bays that serves two purposes: reducing peak-flow runoff and filtering out pollutants.

A typical rain event in Toronto is 0.09-0.12” (2-3 mm) in 24 hours, and 50% of Toronto’s annual precipitation events are less than .19” (5 mm).

The Silva Cell system was sized and laid out to manage the runoff from a 2” (5 cm)/24 hour rain event.

The system captures all of the run-off from the crown of the street to the building face and from one end of the block to the other. All of this water is cleaned, retained, and detained by the bioretention soil. The system also meets AASHTO H-20 loading requirements to support parking. The entire installation took three days to complete and provides a total of almost 600 cubic feet (16 cubic meters) of soil per tree.

An 8” (20 cm) PVC pipe runs from the street catch basin into the top layer of the Silva Cell system, delivering all of the surface runoff from the roadway and adjacent sidewalk into the bioretention soil. A perforated PVC pipe then distributes the surface runoff evenly throughout the soil and the water infiltrates through the soil until it reaches the bottom of the system. At the bottom of the trench is a perforated drain line that carries any excess overflow into the existing stormwater system. Depending on the site, the runoff that percolates to the bottom of the Silva Cell system can be infiltrated into the subsoil to help replenish the aquifer.



*Asphalt covers the parking bay and pavers cover the sidewalk.*

**Table 3: Storm Event Characteristics**

Storm Event Characteristics	Small Event	Large Event
Date	June 12, 2015	June 22-23, 2015
Total Rainfall Depth (mm)	4.20 (on-site rain gauge), 3.81 (Swansea Station)*	19.40 (on-site rain gauge), 26.38 (Swansea Station)*
Total Rainfall Volume (m <sup>3</sup> )	1.62 (on-site rain gauge), 1.47 (Swansea Station)*	7.47 (on-site rain gauge), 10.17 (Swansea Station)*
Rain Duration (min)	289	336
Peak Intensity (mm/hr)	12.24	76.20

\* Closest City of Toronto precipitation monitoring station (2.7 km to the north east)

Table 3 from interim monitoring report.

As the two trees in each of the trenches mature, they significantly increase the efficiency of the system, evapotranspiring large volumes of rainwater out of the soil through their roots systems, and interdicting and evaporating much of the rainfall with their canopies.

Pollutant	Concentration Reduction (%)	
	Small event	Large event
Total Phosphorous	52%	62%
Total Suspended Solids (TSS)	95%	77%
Aluminum	89%	45%
Zinc	57%	71%
Lead	92%	81%
Nickel	58%	79%
Copper	44%	63%
Iron	89%	85%

Silva Cell system concentration reduction from two rain events. Extracted from interim monitoring report.

The City, with assistance from Ryerson, installed monitoring equipment to track the volume of infiltration and quality of water in and out of the Silva Cells. According to an interim results report both sets of trees were irrigated with stormwater runoff for four years.

After four years, one set of trees was disconnected from the associated catch basin – meaning it only receives whatever water that happens to flow into the tree opening – in order to create a control. The other tree was left connected. The pollutant reduction concentration results, and well as other interim findings, are included in a report issued by the city. The system will continue to be monitored throughout 2016, and a full report should be complete in 2017.

**Installation Summary:**

Total soil per tree: 688 ft<sup>3</sup> (19.5 m<sup>3</sup>)  
 Number of Silva Cells: 260 frames, 130 decks  
 Installation date: October 2008  
 Installation type: Trees and stormwater  
 Water volume treated: 656 ft<sup>3</sup> (18.5 m<sup>3</sup>)\*  
 Watershed area treated: 8,288 ft<sup>2</sup> (770<sup>2</sup>)  
 Project designers: Toronto Water and Kestrel Design Group  
 Client: City of Toronto

\*Based on a 2" (5 cm) storm event

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