CASE STUDY 1

HAMPTON AVE.

LESSON LEARNED! CLEAN FILTERS COUNT

This backyard installation had initial challenges due to tree coverage of the roof's collection area. Filter-clogging issues undermined early-season stormwater-collection opportunities. However, once filters were regularly maintained, the system had good capture rates, easily averaging over 1,000 L / month.

Figure 1.1: Installation of ARB system on Hampton Ave.

INSTALLATION OF AUTOMATED RAIN BARREL (ARB) SYSTEM

Rain Barrel: The 500 L rain barrel (RB) was installed by the south eastern (back) corner of the house (fig. 1.1). The installation was somewhat challenging due to its location between the two houses; there is less than XX m (10 ft.) clearance between the wall of this house and the property line of the neighbouring one. The roof collection surface was estimated to be 4.5 x 6 m (15 x 20 ft.), or 28 m2 (300 sq. ft.). A standard 7.5 x 5 cm (3 x 2 in.) downspout fitted to our customized storm funnel connects to the diverter box. There is excellent drainage around the gravel base but the tree coverage of the roof area was at 100 percent.

Overflow, Bypass, and Drainage: We ran a 9 m (30-ft.) garden hose from the RB discharge tap to backyard garden. The bypass and RB overflow capacity drains to backyard by downspout. Soils are sandy and drain well; no soaker pit or French drain was necessary. No soaker hose was attached.

Automated Controller, Plug-in Modem, and Solar Panel: The automated controller was installed and tested and went into operation on June 26. The 12 x 12 cm (4 x 4 in.) solar panel was installed directly on the barrel and, although partially shaded by trees and located between houses, no power supply issues were experienced during the 2016 pilot project.

Operational Notes: This installation experienced significant filter-clogging issues and storm-surge overflow issues. At certain points in the season an overhanging fruit tree contributed to clogging the filter, which required it to be cleaned more regularly than those in other installations. Later in the season there were repeated malfunctions with the ARB system sensor, resulting in "data garble" and some Internet connectivity issues that interfered with the householder's ability to operate the system from the online dashboard. Data collection for this installation ended on November 23 as opposed to December 1. Data garble (see fig. 1.6) was resolved in a clean-up of the data set by the RainGrid Inc. supplier later in December. New sensor issues were seen during the freeze/thaw conditions in late November and early December. Sensor failure issues were seen in other installations when temperatures consistently reached the -5 ˚C range.

We discovered that each storm brought surges of rain that flowed in a highly agitated and turbulent way off the roof surface and into the downspouts, which overwhelmed the diverter box and the overflow diverter box to the secondary drainage area. This led to significant reduction in the verifiable volume of stormwater collected, stored, and therefore available for homeowner use. To rectify this issue we custom designed what we call a "storm funnel" (fig. 1.2) The storm funnel connects the downspout to the diverter box. It focuses the rainwater directly into the diverter valve, largely eliminating the overflow issue and more than doubling capture rates in many instances.

Figure 1.2: LEFT: Storm funnel (black) in diverter box (grey). RIGHT: Uninstalled storm funnels (black) and diverter box (green) with filter (white).

Results: Rain capture rates were low in July when initial collection failures were experienced due to “storm flow surges” and filter clogging. However, by August the rain barrel level filled to 60–80% (see fig. 1.5) in each storm event. Although we registered collection numbers of 2,088 L by Aug 29th, during the pilot project set-up period, there were at least five significant rain events in late June and July, when we were unable to capitalize on collection opportunities. Had we been able to anticipate filter and storm-surge issues and ensured our installation been fully prepared, we would have been able to collect an additional 1,500 L, bringing our anticipated collection total to be at least 7,000 L over the June 23 to November 23 data collection period.

Challenges: Clogged filters and storm surge overflow led to missed collection opportunities. Sensor failure leading to data garble and overstated collection metrics.

Solutions: Storm-funnel installation, predictable filter-maintenance notifications, more reliable sensors and data set clean up would resolve these challenges.

2016 STORMWATER COLLECTION RESULTS

HAMPTON AVE. ARB SYSTEM INSTALLATION

Projected Annual Stormwater Collection, Storage and Diversion Estimate

(Based on 10-Month Season):

14,000 L

Data Collection Duration:

5 Months: June 23–November 23

Average Verifiable Monthly Collection:

1,000 L

Average Estimated Monthly Collection:

1,400 L

Total Verifiable Stormwater Collected, Stored and Diverted from Storm Sewers:

5,000 L

Total Estimated Stormwater Collection, Storage and Diversion

* See Discussion Section Figure 1.6

7,000 L

Amount of Collected Water Intentionally Used on Garden:

80% or approximately **4,000 L**

Estimated Amount of Stormwater Infiltrated on Property

(Not including overflow or bypass volumes)

7,000 L

HOUSEHOLDER EXPERIENCE

"My automated rain barrel transforms stormwater from being a source of pollution and residential flooding into a free way to water my garden."

— Andrew S.

Figure 1.3. Andrew S. shows the phone app that monitors and controls his new ARB system.

Discussion of Householder Usage Patterns with 2016 Data from ARB System's Online Dashboard: During the first five storm events in June and July the system administrator and householder identified very low capture rates, less than 50 L / storm (see fig. 1.4). We investigated more closely, cleaned the filters weekly (identifying extensive build up from roof dirt and silt as well as leaves and immature fruit from overhanging tree). However, even with clean filters we observed that storm-surge overflow was occurring. This happened when the initial volume and intensity of rainwater coming off the roof overwhelmed the chamber in the diverter valve (see fig. 1.2) and resulted in water bypassing the rain barrel to the overflow drainage area.

Householder Satisfaction: Andrew indicated a high level of satisfaction with the system, when operating as intended. He used the dashboard regularly to monitor the water level and the collection volumes. We did encounter several issues with defective sensors leading to data garble, which interfered with his ability to keep track of the collection metrics. He intentionally used about 80% of the collected water for his backyard garden. Indicating that he saw the primary value of the system as environmental and providing benefits to the local Don River watershed as well as free water for his garden.

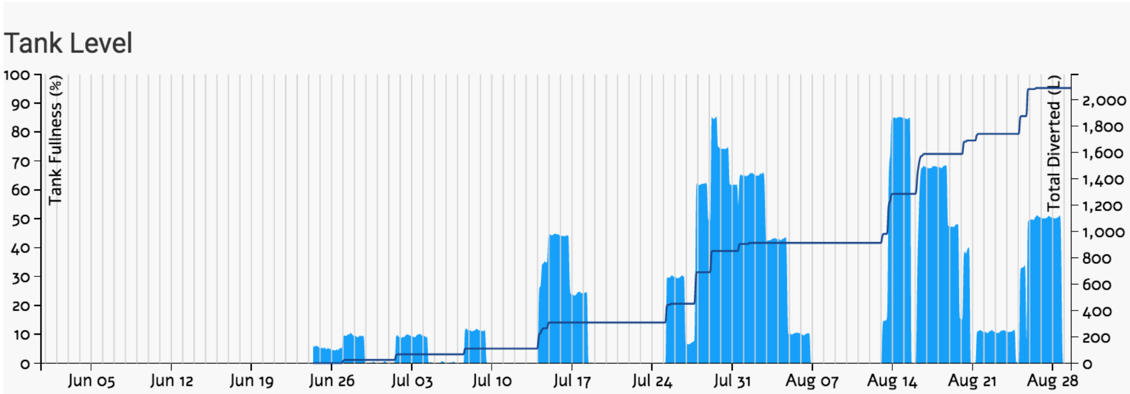

Figure 1.4: Rainfall-collection, tank-level, and water-use/drainage metrics for Hampton Ave. from June 23 to August 28.

We rectified this issue on this Hampton Ave. rain barrel, and then on all of the rain barrel installations in the pilot project, by making and installing a "storm funnel" (see fig. 1.2). Subsequent to these modifications and regular filter cleaning, we recorded collection volumes five to ten times the volumes collected in similar storms in July. Similar results were seen on many of the other rain barrel installations once storm funnels were added. This storm-surge issue was unexpected and had not been identified as an issue in any of the RB installation protocols.

Recommendation: That the storm-surge funnel and/or diverter box design be added to the installation instructions and equipment for the rain barrel (a product of RainGrid Inc.).

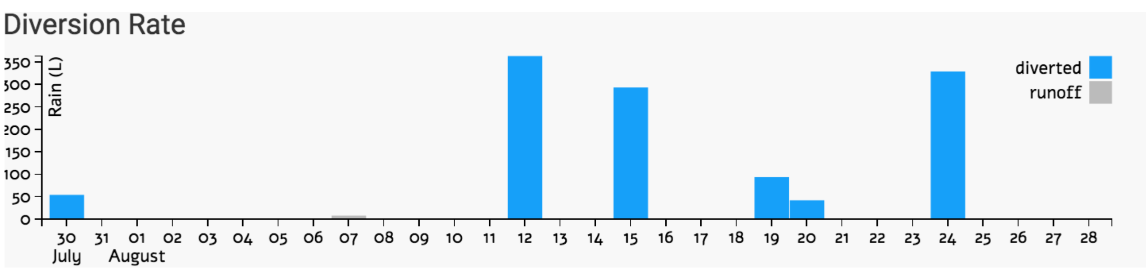

Figure 1.5: Rainfall Collection by Date:

There were five rain events in August (see fig. 1.5), three during which more than 300 L were collected. This demonstrates good collection rates and no overflow issues. However this also indicates there appeared to be some excess collection and storage capacity should rainfall volumes increase in the future.

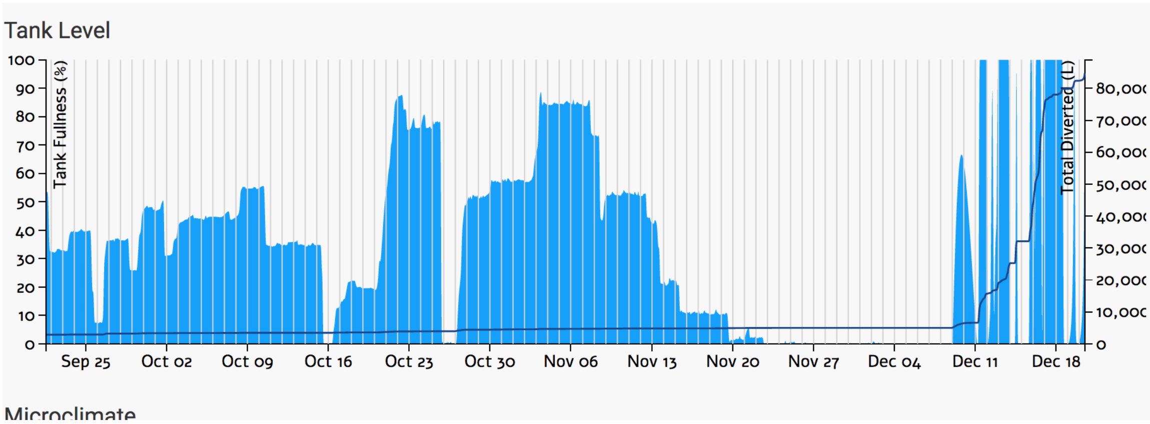

Figure 1.6: Tank level at Hampton Ave., from September 21 to November 23. From November 20 to December 18 data is scrambled due to sensor failure.

Rainfall collection data over September, October, and November (see fig. 1.6) indicate that the barrel never reached capacity, nor did it overflow. Better collection numbers were seen when the filters were cleaned before storm events. Regular use of the rainwater and the automated drain algorithm ensured the barrel was prepared for collection when it was most needed. Sensor failure after November 20 led to a premature end to data collection on this installation. Our total seasonal diversion numbers based on collection algorithm was slightly over 5,000 L. However, considering we missed at least five major storm events in June and July and saw several incidents of clogged filters over the pilot-project duration, as well as sensor failure after November 20, means that an additional 2,000 L would have been collected if the system had have been working to full potential.

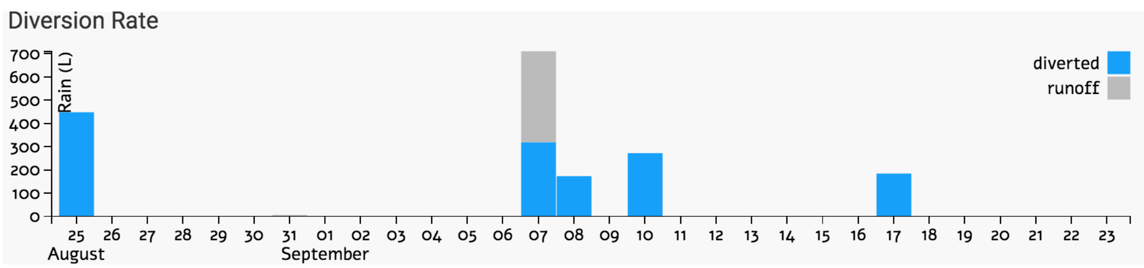

Figure 1.7. Rainwater diversion rate at Hampton Ave., from August 25 to September 13.

The data collection period of August 25 to September 23 (see fig. 1.7) shows five rain events with collection volumes ranging from 180 L to 450 L.

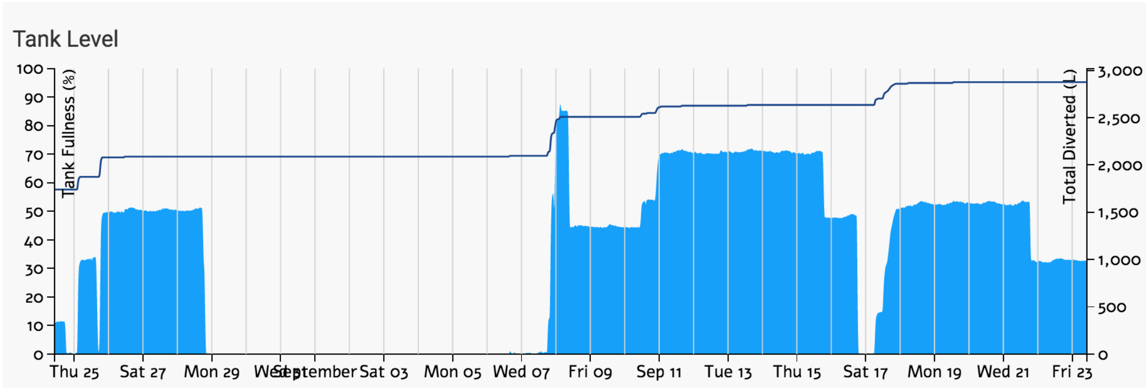

Figure 1.8: Tank-level readings over 30 days at Hampton Ave.

The graph in fig. 1.8 describes tank-level readings taken over a 30-day period in September and August. Here we are able to track excess tank capacity, overflow incidents, and water use. The barrel was emptied regularly by 10 to 50% indicating personal use in the backyard garden. The barrel never reached 100% capacity, nor overflowed due to exceeding capacity under storm conditions. Regular use of water and the automated drain function ensured all rainfall was captured and re-infiltrated over this 30-day period.

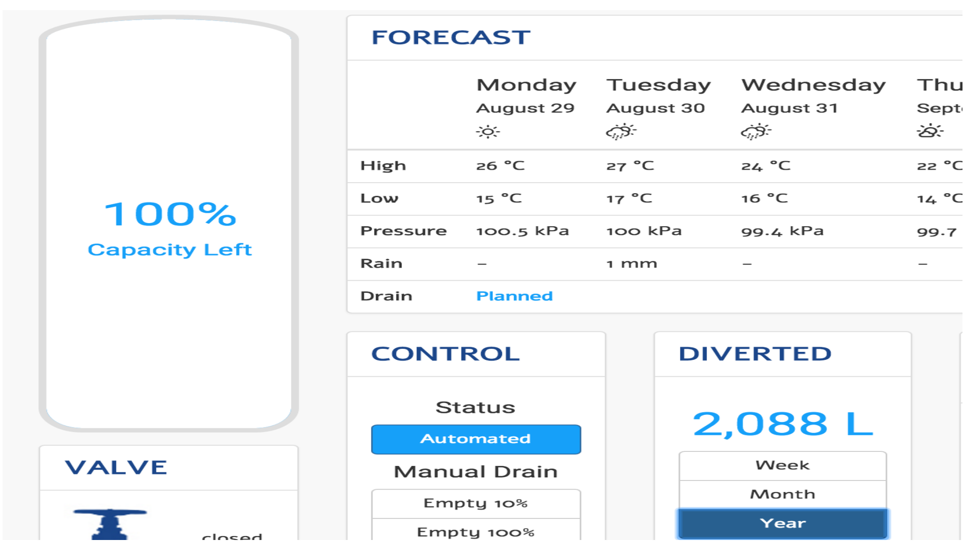

Figure 1.9: Dashboard indicating total collection volume from June 23 to August 29.

Here (fig. 1.9) the dashboard shows the total volume of rainwater collected between June 23 and August 29 was 2,088 L. It also indicates that the barrel is empty, and that there was an automated drain on the August 29.

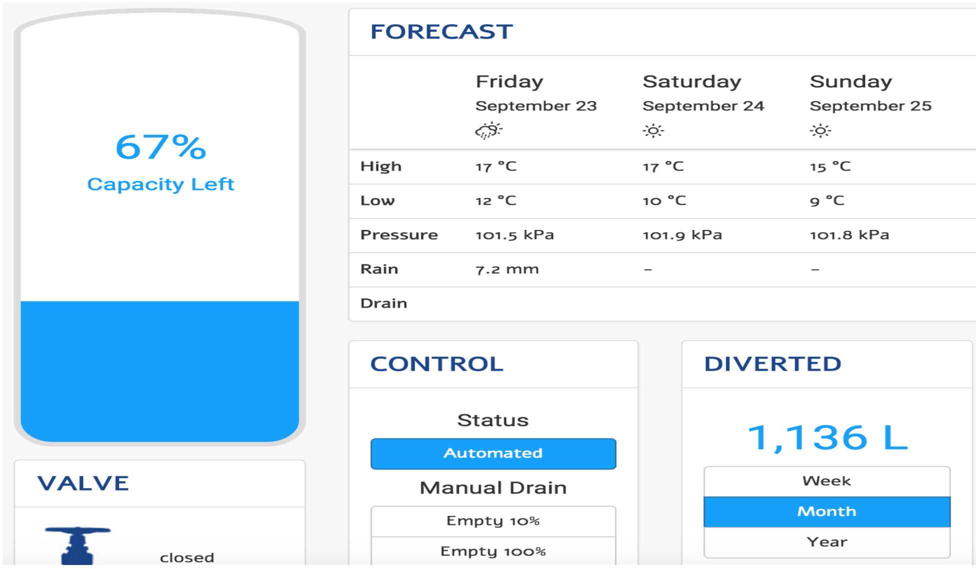

Figure 1.10: Dashboard showing 1,136 L rainwater diverted in one-month period at Hampton Ave.

This dashboard (see fig. 1.10) shows monthly collection metrics of 1,136 L. This was during a period of relatively low rainfall (about five rain events) but during a time when the filters were well maintained and the storm funnel installed.

Up until September 23 the ARB system had diverted a total of 2,875 L (see fig. 1.11).

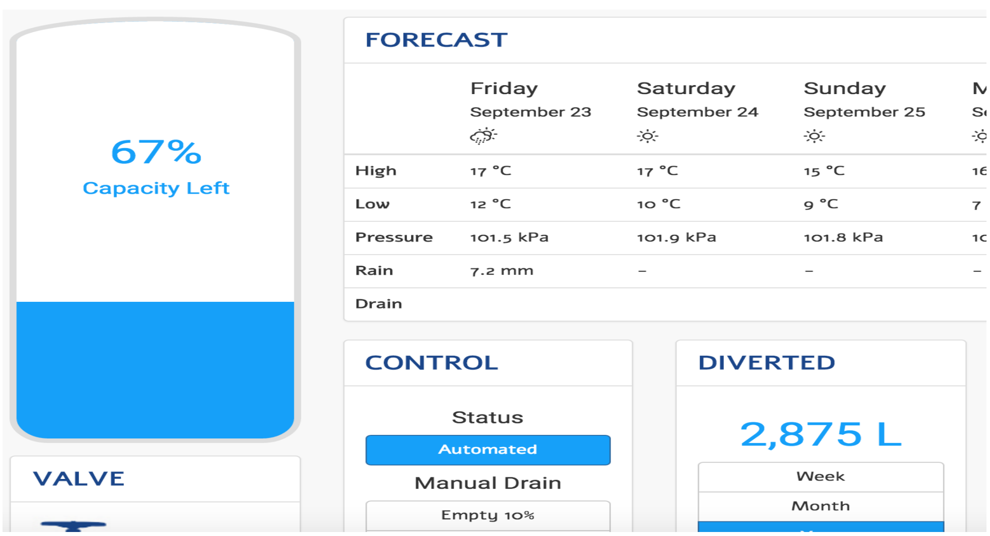

Figure 1.11: Dashboard showing total water diversion up to September 23 at Hampton Ave.