CASE STUDY 4

CAVELL AVE.

GARDENING WITH SOAKER-HOSE IRRIGATION USING AN ARB SYSTEM

This Cavell Ave. installation was more complicated than most of the installations in this pilot project. This was largely due to the need for overflow and bypass drainage into a French drain situated 5 m (15 ft.) from the rain barrel. The homeowners wanted to situate the ARB system to be able to irrigate the backyard garden's raised beds and to be able to monitor and control the collected water via the online dashboard. This meant the rain barrel had to be raised almost a foot to facilitate gravity-fed flow to the backyard garden by a soaker hose. Although rainfall collection by this installation was effective, we discovered the type of soaker hose used by the homeowner significantly restricted drainage.

Figure 4.1: Installed Cavell Ave. ARB system with solar panel (right) and storm funnel attachment (left).

This rain barrel installation was raised approximately 24 cm (8 in.) with paver stones at its base (see fig. 4.1) in order to ensure gravity-fed drainage to the backyard raised-bed garden.

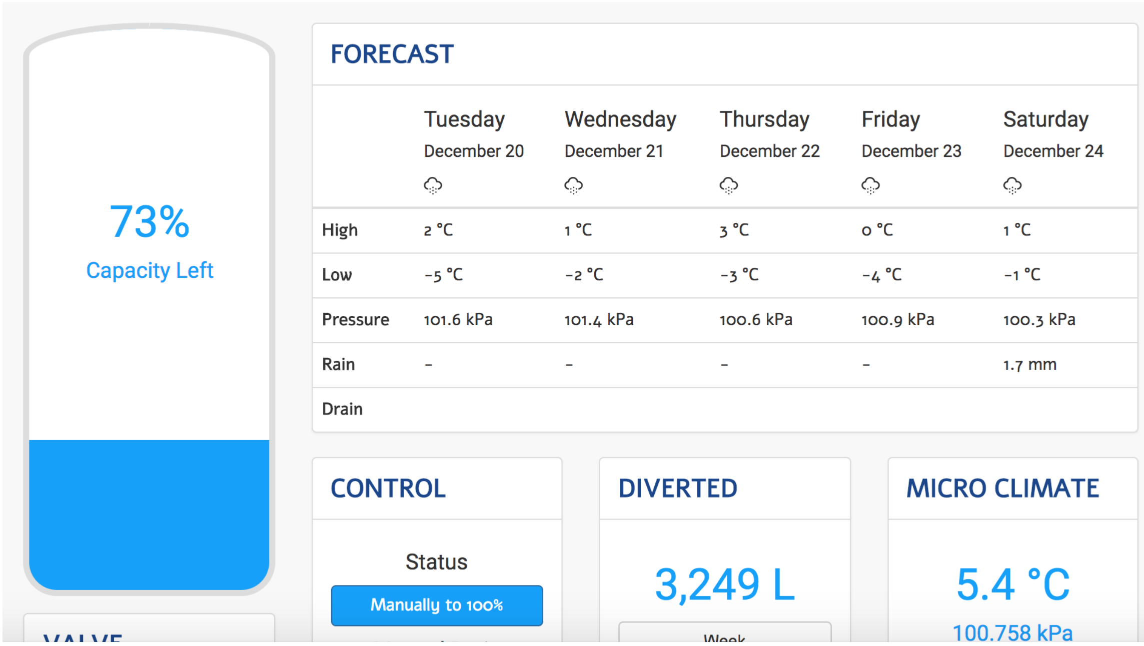

Figure 4.2: Dashboard showing Cavell Ave. rainwater diversion total for 2016 (middle bottom).

From June 26 to December 1 this installation recorded diversion of 3,249 L.

INSTALLATION OF ARB SYSTEM

Figure 4.3: North-facing view of Cavell Ave. fully installed ARB system, with downspout disconnected from the storm sewer and overflow and bypass running along house to French drain (not pictured).

Rain Barrel: The 500 L rain barrel was installed in between two properties up against the west wall of the east-side property. The roof collection surface was estimated at 3 x 9 m, or 27 m^2 (10 x 30 sq. ft., or 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 no drainage around the rain barrel's base and no significant tree coverage of the roof collection area.

Overflow, Bypass, and Drainage: From the convenient online dashboard, rainwater from the barrel was dispersed via gravity though a 12 m (40 ft.) soaker hose to the backyard's raised-bed gardens. The homeowners used a black, rigid type of soaker hose that drained very slowly. In order to create a significant gradient away from the house the rain barrel was elevated.

Overflow and bypass water is directed from the diverter valve along the back wall by 7.5 x 5 cm (3 x 2 in.) drainpipe to buried 10 x 10 cm (4 x 4 in.) connector to a French drain. The French drain dug 10 ft. from the back of house about 2 feet deep and 2 x 4 feet wide. The French drain was filled with gravel and covered with sandy topsoil providing a discrete and effective overflow area. The soils are a sandy loam and drain well despite heavy rainfalls.

Automated Controller, Plug-in Modem, and Solar Panel: The automated controller was installed, tested, and went into operation in late June. The 10 x 10 cm (4 x 4 in.) solar panel was installed directly on the barrel and, although partially shaded by the neighbour's house, even with a west-facing exposure no power issues were experienced during the 2016 pilot project.

Operational Notes: Data collection period ended November 13.

Results and Discussion: Had we been able to anticipate filter clogging, storm-surge issues and downspout instability early in the collection season, we believe this installation would have been able to collect at least 1,500 L more than the dashboard recorded. In addition, significant reduction in per-storm collection due to the soaker hose restricting timely drainage and leaving the barrel only partially full or incompletely drained would have meant additional collection of at least another 1,000 L bringing our anticipated collection total to approximately 5,700 L over the 4 month 3 week period ending December 1. This would translate to an average of approximately 1,100 L per month or 11,000 L over a full 10-month season.

Challenges:

1) Clogged filters and storm-surge overflow resulted in significant missed collection opportunities.

2) Soaker-hose design failed to drain adequate with just gravity pressure.

Solutions:

1) Storm funnel installation, early-season filter maintenance, and ongoing email notifications about filter maintenance.

2) We discovered that there are two soaker hose designs on the market. We found that the black, rigid version does not drain quickly enough (i.e., within 6 hours) to meet the response time needed to ensure the barrel is fully drained and prepared to capture the maximum available stormwater flow. When the homeowners punched extra holes into the hose to increase flow and decrease drain time intervals (after the system administrator identified the challenge and requested this solution), the flow did increase, but the results diminished quickly over time. The solution turned out to be a different hose: a soft plastic "inflatable" version that drains well when gravity fed.

2016 STORMWATER COLLECTION RESULTS

CAVELL AVE. ARB SYSTEM INSTALLATION

Projected Annual Stormwater Collection, Storage and Diversion Estimate:

(Based on 10-Month Season)

10,400 L

Data Collection Duration:

5 months (June 24 to November 12)

Average Verifiable Monthly Collection:

650 L

Average Monthly Collection Estimate:

1,040 L

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

3,249 L

Total Estimated Stormwater Collected, Stored and Diverted from Storm Sewer:

* *See Discussion Section Figure 4.5.*

5,200 L

Amount of Collected Water Intentionally Used on Garden:

100% or approximately 3,250 L

Estimated Amount of Stormwater Infiltrated on Property:

(Not including overflow or bypass volumes)

3,250 L

HOUSEHOLDER EXPERIENCE

Discussion of Householder Usage Patterns with 2016 Data from ARB Online Dashboard: Vicki and Marcello were active participants in the ARB system pilot project, especially during the installation process. We had to disconnect the existing downspout from the storm sewer, rerouting it to the rain barrel. The homeowners were doing extensive landscaping in their backyard and wanted to ensure the prevention of basement flooding as well as to use collected water for their raised-bed vegetable garden. They indicated that 100% of the water collected was used on the backyard garden. The tank level graphs (see figs. 4.4 to 4.7) confirm the slow and constant draining of the rain barrel to the garden via soaker hose over the full season.

Householder Satisfaction: Vicki and Marcello were satisfied with the ARB system and used it regularly from their online dashboard. They were very happy with the way we were able to integrate the ARB installation to complement the functionality of their backyard landscaping design.

We achieved three key goals for the homeowners:

1) Disconnected the downspout from the local storm sewer (in effect, preventing the discharge of an estimated 11,000 L of storm flow per year), bringing this Cavell Ave. property into compliance with the *Toronto Sewer Disconnect Bylaw.*

2) Built a French drain to facilitate drainage away from the foundation to eliminate the risk of basement flooding**.**

3) Provided a means to collect free, clean rainwater to water the backyard garden from the convenience of the online dashboard.

Comments: The restricted rain barrel capacity, due to an inability to fully drain the barrel in a timely manner, proved to be a problem for maximizing collection metrics.

Recommendations: Filter maintenance must be scheduled and done quickly once reduced collection is indicated on the dashboard. Filter and soaker-hose restriction notifications should be sent to the householder by done by automated email or text.

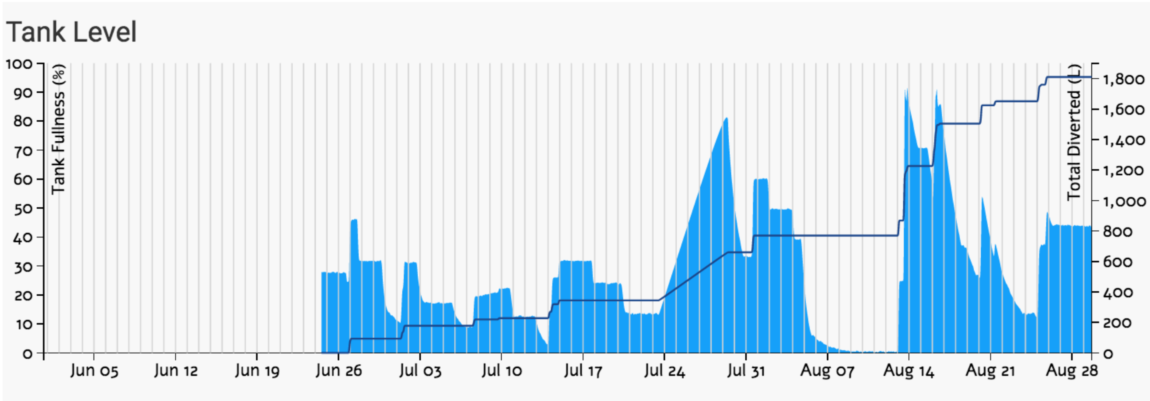

Figure 4.4: Rainfall collection, tank-level and water-use/drainage metrics, from June 25 to August 28.

In fig. 4.4 we see significant increases in stormwater collection metrics, reflected in higher tank levels, by the end of July and August when filter-clogging issues were rectified and the storm funnel was connected. In August we started to see the rain barrel drain times taking up to three days.

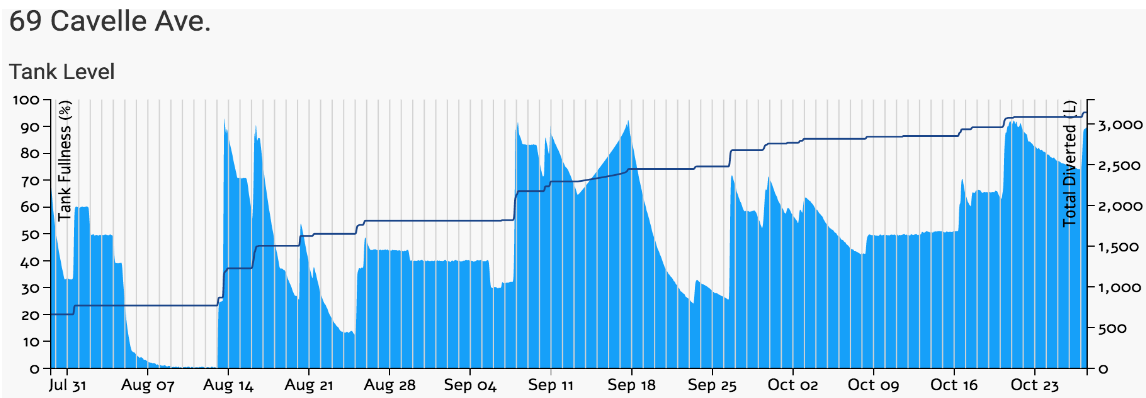

Figure 4.5: Rainfall-collection, tank-level, and water-use/drainage metrics for Cavell Ave., from August 28 to October 28.

Since the first soaker hose was unable to fully drain the rain barrel by gravity alone after August 21 (see fig. 4.5), the rain barrel was always more than 25% full. In effect, this reduced the tank capacity by at least 125 L. Luckily, the roof collection area in this installation was only about 27 m^2 (300 sq. ft.), so even when the rain barrel was already partially full, reaching capacity during a storm event resulting in overflow was not a major issue. Any additional roof area would have resulted in overflow issues and reduced diversion metrics. The estimated volume of stormwater that could have been collected if the installation had have been fully prepared and the soaker hose operating without restraining the drain (thus tank capacity) is in the range of 2,000 extra Liters.

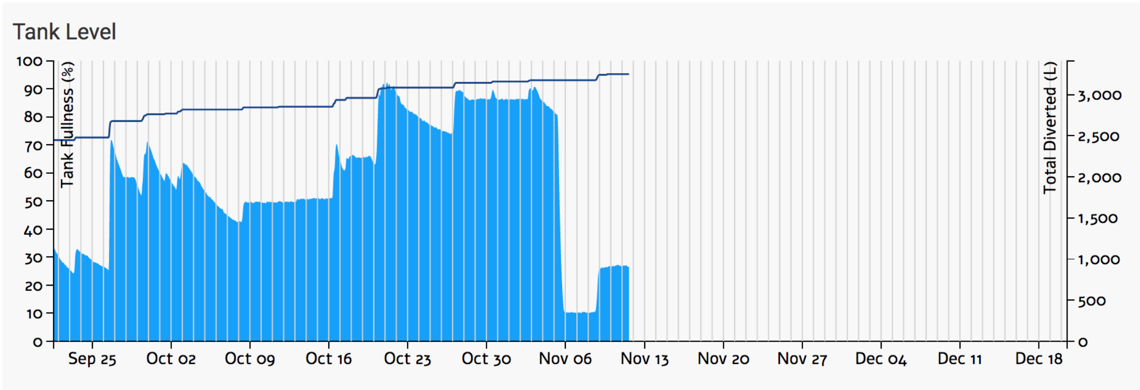

Figure 4.6: Rainfall-collection, tank-level, and water-use/drainage metrics for Cavell Ave., from September 25 to November 12.

The first, flow-restrictive, soaker hose was removed on November 5, after which the barrel could quickly and fully drain (see fig. 4.6).

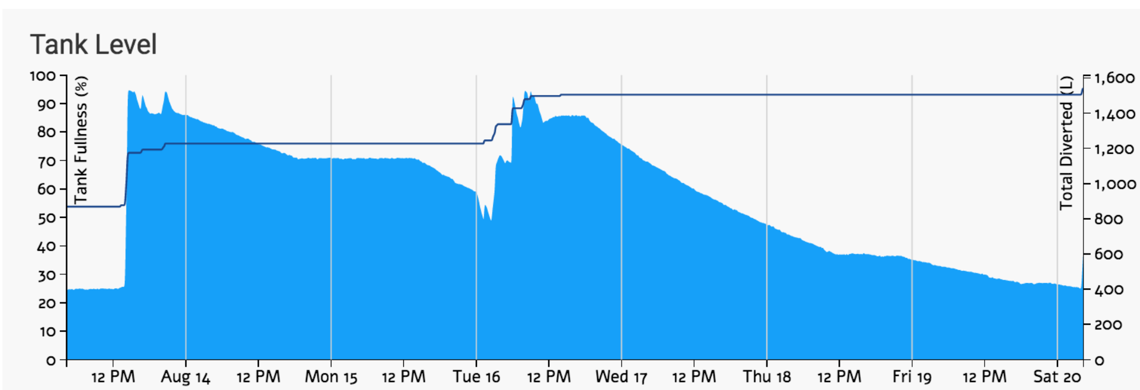

Figure 4.7: Tank level and drainage times for Cavell Ave., over a one-week period.

The graph in fig. 4.7 shows the slow and incomplete drain due to using the wrong type of soaker hose. Here we can see it took five days to drain from 90% full to 25% full.

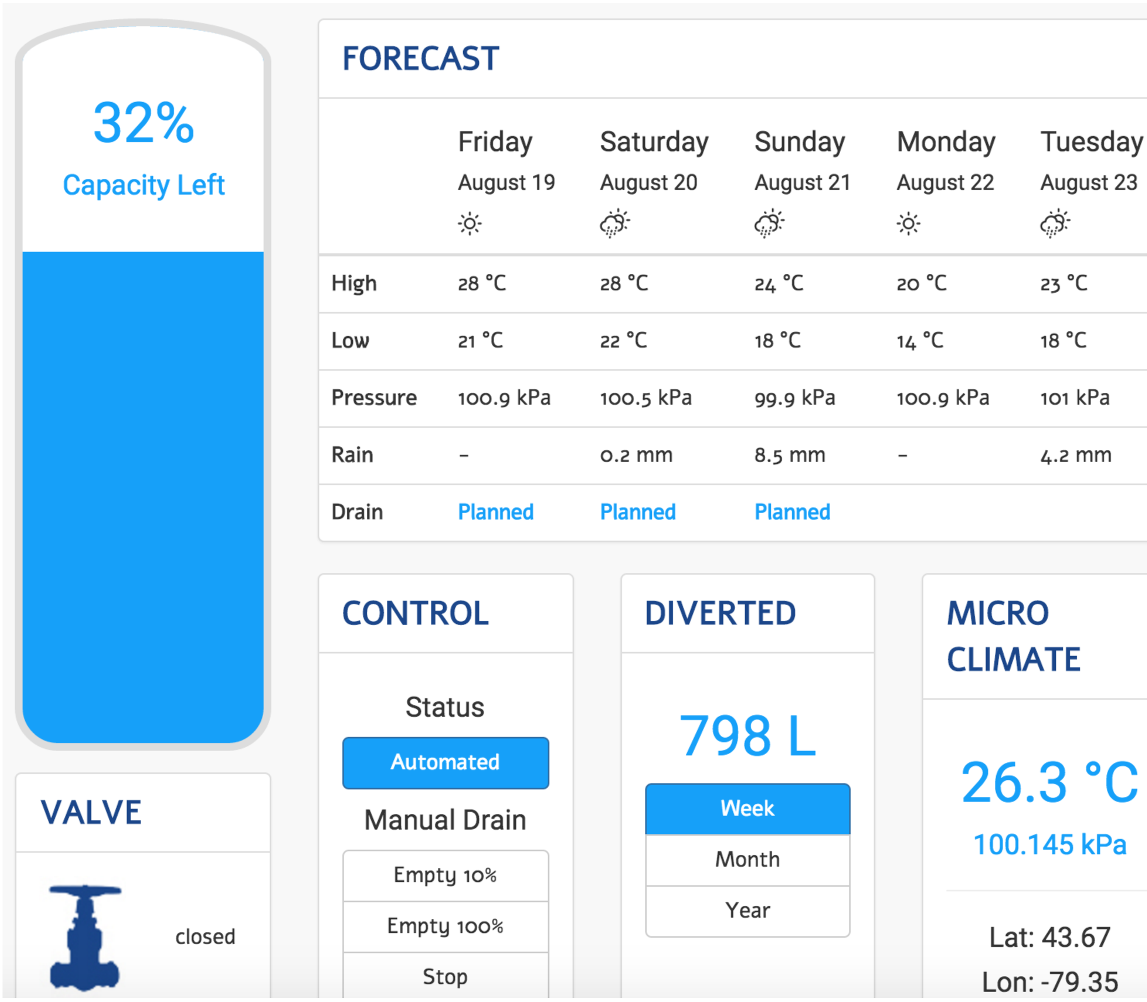

Figure 4.8: Rainwater diversion metrics for Cavell Ave., over one week.

The dashboard shown in fig. 4.8 shows that this ARB system installation collected, stored, and diverted 798 L in one week.