CASE STUDY 5

WITHROW AVE.

ARB SYSTEMS AND RAIN GARDENS: INTEGRATING URBAN GREEN INFRASTRUCTURE

This ARB system installation collected stormwater from an estimated 28 m^2 (350 sq. ft.) of roof area. The overflow and bypass drains into a customized front-yard rain garden. During the 3.5-month data collection period—the dry summer months of 2016—the homeowners relied heavily on the 6,000 L of free clean water collected to irrigate their landscaped garden.

Figure 5.1: Rain barrel diverter and bypass flowing to rain garden on Withrow Ave.

Even in overflow or bypass conditions, this household's rain barrel disperses rainwater and drains it to the rain garden (see fig. 5.1). Consequently, stormwater is collected or absorbed before it makes it to the street or sewer.

Figure 5.2: Installed ARB system at Withrow Ave., with storm funnel attachment (to the left) and solar panel (at the back).

INSTALLATION OF AUTOMATED RAIN BARREL (ARB) SYSTEM

Rain Barrel: The ARB was installed in the south western (front) corner of the house (see fig. 5.2). The roof collection surface was estimated at about 4.5 x 9 m (15 x 30 ft.), or 41 m^2 (450 sq. ft.) A standard 7.5 x 5 cm (3 x 2 in.) downspout fitted to the customized storm funnel connects to the diverter box. There is excellent drainage around the gravel base, a gradient away from the house foundation, and no significant tree coverage of the roof collection area. The front yard is elevated from street level by about two meters.

Overflow, Bypass, and Drainage: This installation featured an excellent opportunity to combine the benefits of the ARB system with a rain garden, making the best use of clean technology and green infastructure to prevent residential flooding and water pollution and to reduce municipal water used on a garden. The homeowners used an older type of soaker hose that drained quickly and effectively when fed by automated or manual drainage. In this way, rainwater from the barrel was dispersed, from the convenience of the online dashboard, throughout the garden via a 9 m (30-ft.) soaker hose, and the gradient away from the house allowed this system to take advantage of gravity to drain the RB effectively. Overflow and bypass water is directed to a gravel rain garden that flows into the landscaped front yard. The soils are sandy loam and drain well despite heavy rainfalls, and the relatively steep gradient means there is no longer surface stormwater run-off to the street.

Automated Controller, Plug-in Modem, and Solar Panel: The automated controller was installed and tested and went into operation on August 13. The 12 x 12 cm (4 x 4 in.) solar panel was installed directly on the barrel and, although partially shaded by trees, had south-facing exposure, so no power issues were experienced during the 2016 pilot project.

Operational Notes: Data collection only started August 13 after the homeowner returned from the several weeks at the cottage and the plug-in modem was correctly initialized. Up until August 13, the RB was collecting stormwater, but data was not being recorded. The data collection period ended December 1.

Results and Discussion: Due to the mid-August start date we were able to anticipate filter clogging and storm-surge issues (which had arisen with other installations) and rectify them. Collection rates were good once the householder was able to reinitialize the modem to allow the automated controller to communicate with it. Over a 3.5 month period this installation collected a verifiable volume of 6,000 L. This would translate to an average of approximately 1,700 L / month, or 17,000 L over a 10-month collection season.

Challenge(s):

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

2) When the modem plug-in needs to be rebooted and there is no one in the household to do this, connectivity is lost and therefore so are control and data-collection opportunities.

Solution(s):

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

2) Consider wireless system and internet service that does not depend on the homeowner's Internet.

2016 STORMWATER COLLECTION RESULTS

WITHROW AVE. ARB SYSTEM INSTALLATION

Projected Annual Stormwater Collection Estimate:

(Based on 10-Month Season)

18,500 L

Data Collection Duration:

3.5 months, from August 13 to December 1

Average Verifiable Monthly Collection:

1,720 L

Average Monthly Collection Estimate:

1,850 L

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

6,023 L

Total Estimated Stormwater Collected, Stored and Diverted From Storm Sewers:

* See *Discussion Section Figure 5.3*

6,500 L

Amount of Collected Water Intentionally Used on Garden:

80% or approximately 5,200 L

Estimated Amount of Stormwater Infiltrated on Property.

6,023 L

HOUSEHOLDER EXPERIENCE

> *"My new automated rain barrel keeps pollution from my local river and provides free water to use on my garden. Best of all I control it all, from the convenient dashboard on my phone."*
>
> *—Nancy K.*

Discussion of Householder Usage Patterns with 2016 Data from ARB System's Online Dashboard: Nancy and Greg were regular and active participants in the pilot project. They were primarily looking to use the collected water for gardening purposes from the convenience of the online dashboard and to prevent runoff and contamination of local waterways. From the installation of their ARB to the final focus group and survey in December 2016 their support and regular input was invaluable to the overall success of the project. We did experience a delay in collecting data due to Internet failure during the summer holiday period when they were not home and so unable to manually reboot the system. They indicated that they monitored the online dashboard about fifteen times a month and used more than 80% of the stored rainwater to irrigate the front-yard rain garden. Roof area and 2016 rainfall collection patterns showed that we largely maximized collection capacity for this location. Based on verifiable monthly collection rate of 1,700 L this ARB system will collect, store, and divert about 17,000 L per season.

Householder Satisfaction: The householders indicated a high level of the satisfaction (8 out of 10) with the ARB system when it was working to specifications. They indicated they found that it was very easy to use the online dashboard but expressed some frustration when the RainGrid Inc. automated drain algorithm emptied the stored water before they were planning to use it on the garden. This "water-use conflict" issue was most evident with householders whose primary value proposition was to be able to water gardens through the convenience of the dashboard from a remote location, in their case, the cottage.

The Withrow householders felt that they would have used more than 80% of stored water for dashboard-directed irrigation if they had been able to. No flooding issues were experienced and, despite the gradient to the street, no runoff was detected.

Comments: Nancy and Greg suggested a wider range of options, not just 100%, for rain barrel drainage—for example, the option to drain the barrel 70%, 80%, or 90%. They also suggested an option to override the algorithm-derived drainage option would be useful for those who wished to do so.

Recommendations: To address conflict around water use and around the automated drainage algorithm. The RainGrid system is designed to prioritize keeping the rain barrel capacity in a constant state of readiness in order to ensure maximum collection and to minimize overflow events. The algorithm employs 48-hour weather predictions to ensure the barrels are drained in anticipation of storm events. When these predictions of rain and its expected intensity happen to be wrong, it leads to prematurely drained rain barrels and disappointed householders—especially in times of “drought” and sparse rainfall, and especially for gardeners who want to use that drained water for irrigation. This issue could be addressed by modification of the weather algorithm to drain only when rainfall is close or immanent. Instead of 48-hour predictions we suggest 4-hour predictions using real-time storm-warning reports and weather radars.

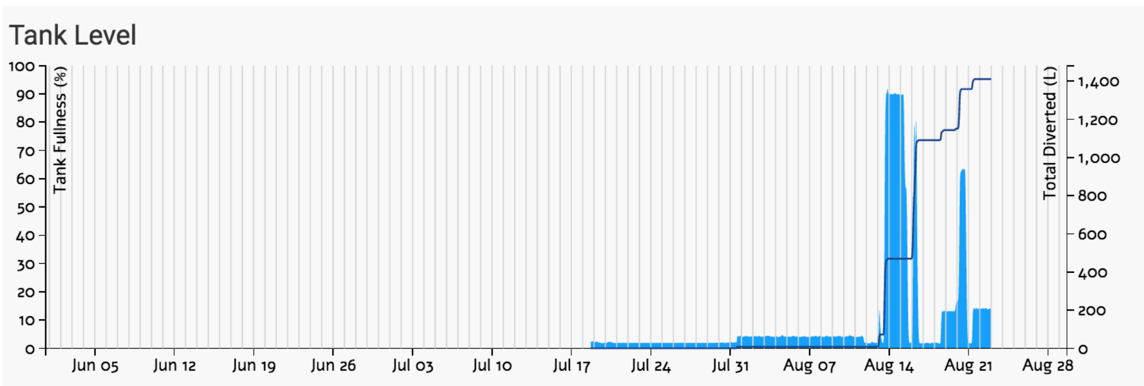

Figure 5.3: Rainfall-collection, tank-level, and water-use/drainage metrics for Withrow Ave., from July 19 to August 23.

The lack of collection in June, July, and half of August (see fig. 5.3) reflects the fact the homeowners were on holiday and were unable to reinitialize the plug-in modem to address the Internet connectivity issue. Once this issue was addressed and the storm funnel was installed, we saw excellent collection metrics for this installation. Loss of some collection opportunities due to storm surge overflow was observed and we predict at least another 500 Liters would have been captured if we had we been better prepared. Bringing total estimated collection to be in the order of 6,500 L.

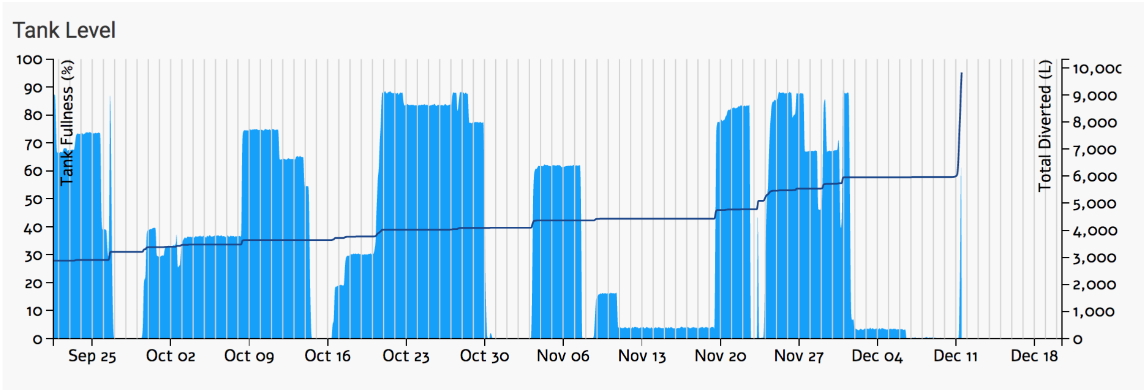

Figure 5.4: Rainfall-collection, tank-level, and water-use/drainage metrics for Withrow Ave., from September 21 to December 1.

As clearly demonstrated by the tank level (see fig. 5.4), the Withrow Ave. installation, once operational, was regularly filling to 80 to 90 % capacity. By December 1 it had a verified collection of about 6,000 L over a 3.5-month period. The December 11 spike in collection reflects a sensor failure due to sub-zero conditions.

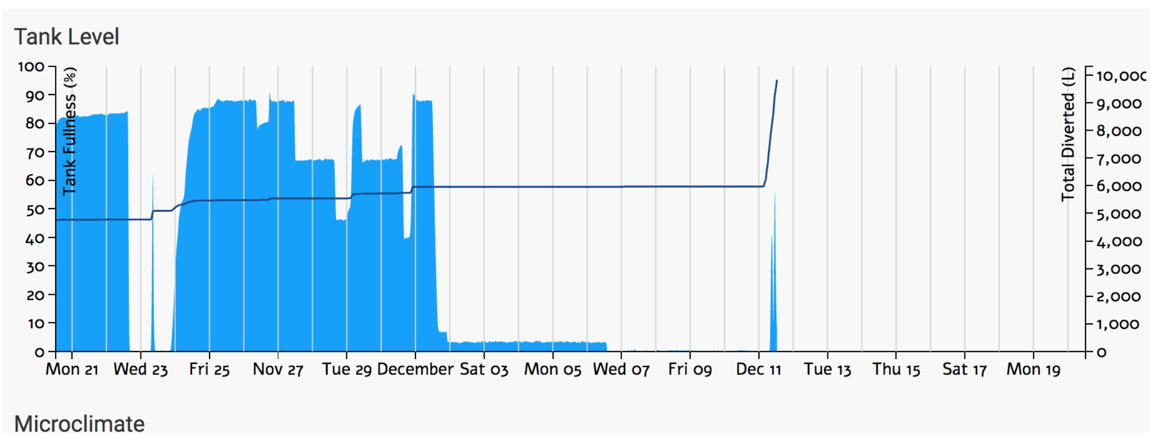

Figure 5.5: Rainfall-collection, tank-level, and water-use/drainage metrics for Withrow Ave., from November 21 to December 11.

This graph in fig. 5.5 describes the tank level over the last three weeks of the ARB system's operation. We wanted to asses the ARB system's operational tolerance in freeze/thaw and sub-zero conditions. In this case we saw the system operate until extreme cold (-5 ˚C) caused sensor failure on December 11. The ARB system was able to operate effectively right up to December 1, when we drained the barrel and set the diverter to "bypass." We were pleasantly surprised at the ability of the system to operate and in these cold conditions.

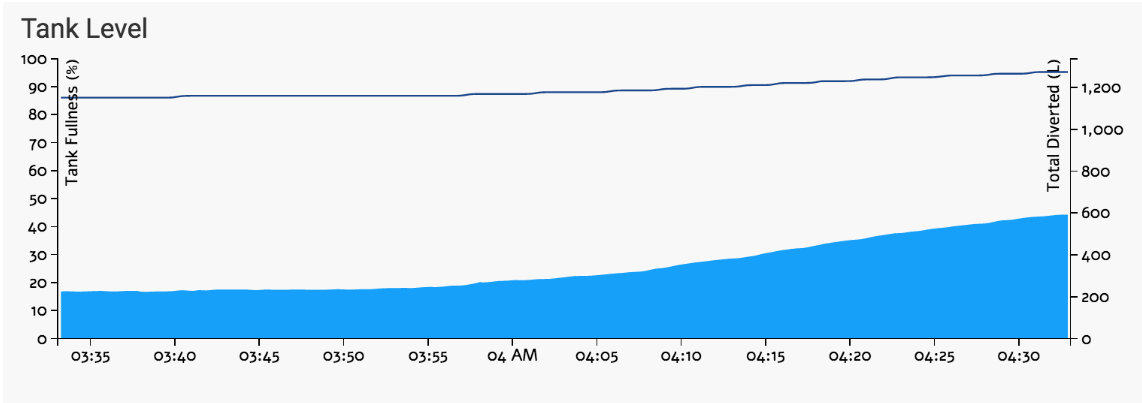

Figure 5.6: Tank level showing rain barrel filling over one hour at Withrow Avenue.

The graph in fig. 5.6 shows the rain barrel filling in a light rain over a one-hour period demonstrating good steady collection.

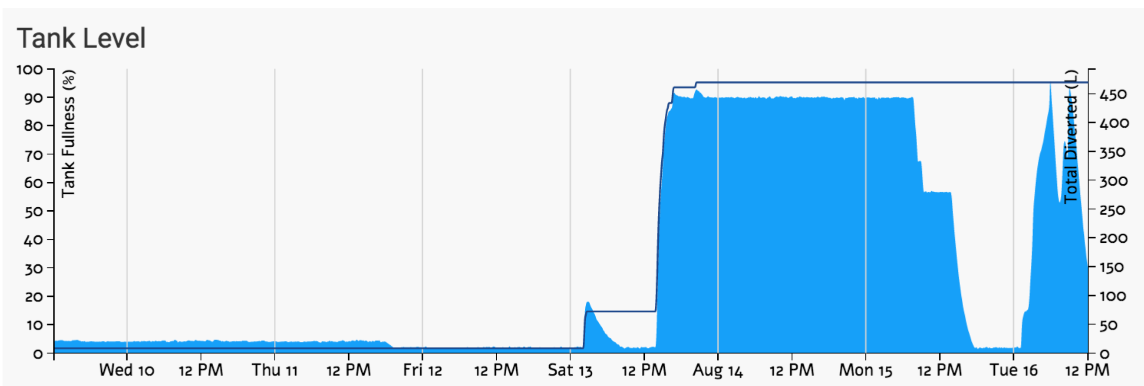

Figure 5.7: Tank level at Withrow Ave., over one week.

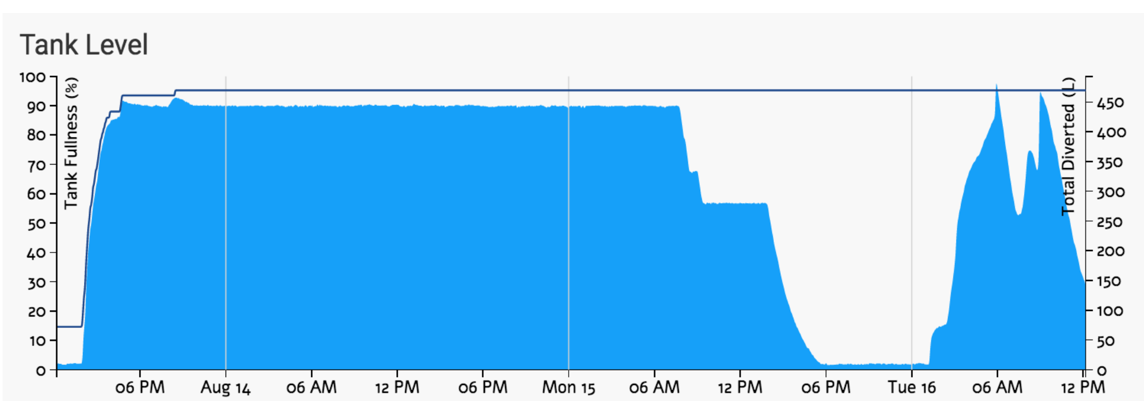

Figure 5.8: Tank level at Withrow Ave., over 48 hours.

The graphs shown in figs. 5.7 and 5.8 illustrate both collection and drainage characteristics of the Withrow Ave. installation. They indicate that the full collection capacity is reached during rain events and that drainage via a soaker hose is relatively prompt and effective (see especially fig. 5.8, where the rain barrel drains from 60% to nearly nothing in about three hours). This installation allows the barrel enough time to drain and be prepared for he next rain event. Not all soaker hoses installed on other installations were able to drain quickly enough to address this issue (see, for example, Case Study 4: Cavell Ave.).