

# Rainwater Harvesting Design for Guelph's CAMTAC Plant

Rebecca Bristo, Kathryn Sutter, and Dave McCollum

**Abstract.** Abstract: This paper presents the design of a rainwater harvesting system for Linamar Corporations CAMTAC plant. The main purpose of the design is to decrease municipal water costs by supplying rainwater for manufacturing processes. The system consists of two underground concrete storage tanks placed in-line with the existing stormwater management system at the plant. After storage, the system uses a pump and pressure tank to deliver water throughout the system. Water treatment consists of two cartridge filters and an ultraviolet disinfection unit prior to entering the existing reverse osmosis unit. The storage tank level was simulated using historical precipitation and water demand data. The results showed that the design will allow for annual savings of approximately \$13,000 in municipal water costs with a payback period of 2.3 years.

**Key words:** industrial rainwater use, rainwater harvesting, rainwater treatment, underground tank, water distribution

## 1 Introduction

Our design group was approached by the Linamar Corporation to design a rainwater harvesting system for their CAMTAC plant in Guelph, Ontario. The plant uses approximately  $1,000m^3$  of water in an average month, which costs approximately \$1,700 [1]. Roughly 90% of this water is used as process water in the plants washing and cooling machinery. Since potable process water is not required, there is potential for considerable cost savings by harvesting rainwater.

Rainwater harvesting systems are becoming increasingly common in domestic applications, most often to capture collected water from rooftops for irrigation uses. More complicated systems can be installed to supply water for toilet flushing and laundry, since these needs do not require potable water. However, industrial applications have an increased potential for benefits from rainwater harvesting since manufacturing facilities typically have large roof areas and high water demands.

The system was designed to maximize rainwater use, which results in an increased cost savings. It is required that a payback period of approximately one year is achieved and that the design be safe and sustainable. The system shall comply with applicable building and city regulations. In addition, the rainwater must be treated to the level required by the existing reverse osmosis (RO) unit,

since increased levels of sediment and biological contamination could increase the frequency of maintenance to the RO unit.

The design incorporates underground storage, a distribution system and water treatment that will ensure the longevity of the system components. The design maximizes the use of existing piping and infrastructure, therefore minimizing costs and disruption to the plant. The large storage volume and minimized capital costs result in a short payback period and high annual cost savings.

The first component of the system that was designed was the required storage volume, which was determined by analyzing historical precipitation and water consumption data for the plant. The placement and material of the tanks were specified based on cost estimates and plant layout. The equipment required to treat the rainwater was designed based on a review of current technology and the required water quality. Design calculations of the piping system allowed for the pump and pressure tank to be specified. Finally, modeling was completed to analyze the tank levels based on the detailed tank design, which allowed for the cost savings and payback period to be determined.

## 2 Design Overview

The rainwater harvesting system will collect rainwater from the roof via the existing downspouts, which were assumed to collect together under the floor and outlet at the northeast side of the plant. The existing pipe, which drains into the municipal storm sewer, will be redirected into two underground storage tanks. The water will be pumped out of the storage tanks and into a pressure tank. Upon exiting the pressure tank, the water will travel across the roof of the plant via existing piping and over to the southwest side of the plant, where the RO unit is located. Prior to the RO unit, water will enter a series of two cartridge filters and an ultraviolet (UV) disinfection unit. After the RO unit, the water will be distributed throughout the plant via the existing infrastructure. The overall site plan is shown in Figure 1.

## 3 Detailed Design

### *Water Collection*

Water is collected through the existing roof drains, which have 13 mm slotted covers to block out large debris [1]. The existing downspouts converge and outlet underground at the northeast side of the plant. The existing outlet pipe will be redirected into the first tank, as shown

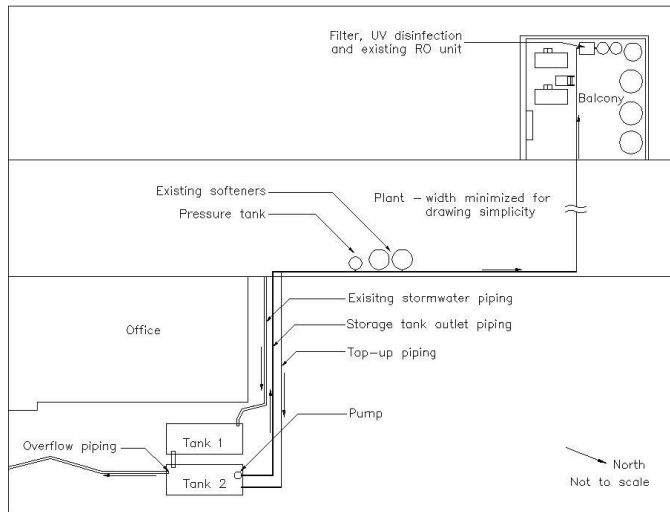


Fig. 1. Rainwater harvesting system site overview

in Figure 1.

### Storage

The storage tanks will consist of two 50,000 l underground precast concrete tanks. The tanks will be placed as shown in Figure 1, based on the assumed underground utility locations. The rainwater will enter the first tank, which will be connected to the second tank via a 400 mm polyethylene pipe. The second tank will have a 200 mm polyethylene overflow pipe, which will discharge any excess water to the existing storm sewer. The second tank will be equipped with an automatic top up system to ensure adequate water supply to satisfy the demand of the plant. A pressure sensor will be implemented to control a solenoid valve, which will allow municipal water to enter the tank. This line will be equipped with a backflow preventor in accordance with the National Plumbing Code to prevent cross contamination. The valve will be opened when the water level falls below 120 mm and will be closed when the level reaches 140 mm.

### Pump and Pressure Tank

A submersible pump will be located in the second tank and will operate at a rate of 80 l/min. The pumped water will flow to a diaphragm pressure tank, which will be installed inside the plant, as shown in Figure 1. The pressure tank was designed to have an outlet pressure of 420 kPa to accommodate the losses in the piping system and still maintain suitable pressures for the water treatment units. The storage volume in the pressure tank will allow the pump to run on cycles of approximately 7 min per 27 min. The outlet pipe from the pressure tank will be attached to the previously disconnected piping that currently carries municipal water from the northeast side of the building to the RO unit on balcony at the southwest side of the building.

### Water Treatment

The rainwater coming from the pressure tank will flow through two cartridge filtration units, which will be installed on the wall adjacent to the RO unit. The first unit will remove sediment, dirt, loose scale, rust, sand and silt up to 30 microns in size and the second to 5 microns, which is required for entry into the UV disinfection unit [2]. The UV disinfection unit will be placed on the wall adjacent to the filters. The UV system will treat the biological contaminants deposited in the water from the rooftop [3]. After the UV treatment, the water will enter the RO unit, after which it will be dispersed in the factory via the existing system.

## 4 Conclusions and Recommendations

Designing rainwater harvesting systems for large applications, such as for the CAMTAC plant, has shown to be more complicated than initially believed. However, it has also shown to have a considerable cost saving potential. Cost estimations show that this design will have a pay-back period of just over two years, with an annual savings of approximately \$13,000.

It is recommended that further studies be completed prior to design implementation. Testing of collected roof runoff will determine whether further treatment will be required prior to use of the rainwater in the plant. In addition, it is recommended that a test borehole be drilled prior to the excavation for the storage tanks in order to determine soil and ground water conditions that may affect the tank placement and design [4].

## 5 Acknowledgements

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