Industrial Rainwater Harvesting Design for CAMTAC Plant in Guelph, Ontario

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Abstract. This paper details the design for an industrial rainwater harvesting (RWH) system at the Linamar CAMTAC plant in Guelph. The purpose of the system is to substitute the use of city water in plant processes with rainwater. The design consists of three principal components: catchment, storage and treatment. The catchment is an internal drainage system that transmits rainwater from the roof to a storage tank. The tank reserves a rainwater supply for future demand. Treatment systems adjust rainwater parameters to the quality required for process water. Raw rainwater is subjected to first flow diversion, pH adjustment, filtration and ultraviolet (UV) disinfection before being processed by an existing reverse osmosis (RO) unit. The capital cost is projected to be approximately $18,500 with a payback period of 3.2 years.

Key words: rainwater harvesting, industrial, Linamar

1 Introduction

Linamar Inc. has recognized the potential cost-cutting benefits of implementing a RWH system in their CAMTAC plant in Guelph, ON. CAMTAC consumes an estimated average of 1307 m$^3$ of water per month. The primary function of the RWH system is to offset the consumption of city water by securing an adequate supply of rainwater for use in plant processes. Linamar requires a high return on investment (ROI) and ideally a one year payback. A longer payback period is justifiable in the case of greater returns over the practical lifetime of the system. This paper focuses on Phase I of the project, wherein the basic system is designed to pay for itself in the shortest amount of time and be readily upgradeable. In addition, guidelines are given for system expansion in Phase II to attain maximum returns over the useful life of the system. The water produced by the system must meet basic requirements of the plant processes and the system must conform to pertinent building codes and regulations. The safety of plant personnel must be maintained at all times.

2 A Conceptual Design

It was recognized that in addition to their primary function (collection of water from the roof), the catchment pipes constitute a large volume that could be used to store water in addition to a cistern. This feature adds up to 4000 additional gallons of otherwise unused storage potential. The design is entirely composed of prefabricated materials and off the shelf products. Where sizing was a factor, the optimal configuration of the design was found by comparing the component costs relative to the resultant output. Beneficial output is the reduction in the monthly water bill at a rate of $1.72/m$^3$. The quantity of water that may potentially be harvested is calculated using daily weather data collected by the Ministry of the Environment at Station 6143090 (Guelph Turfgrass)[1]. The collected of water is quantified as a dollar value as presented in Fig. 1.

![System Sizing](Image1)

Fig. 1. Gross Savings.

2.1 Catchment

CAMTACs existing internal roof drainage system consists of 35 four-inch vertical downspouts distributed evenly over the plant footprint. The downspouts service the entire roof area (roughly 20 000 m$^2$). Each downspout empties into the drainage network in the floor that leads to the storm sewer. The proposed catchment system networks each of the downspouts together with PVC pipe to transport water to the storage area along a 0.5% slope. The catchment pipes are attached to the ceiling girders using clevis pipe hangers on 3/4” steel rod at 1.2m intervals to bear the combined weight of pipe and water.
Each downspout is fitted with screens at the roof level to prevent insects and large debris from entering the system. Inside the plant, the drains are augmented with a series of fittings which provides overflow protection utilizing the existing drainage network.

### 2.2 Treatment

Removing sediment from collected water is an important feature to avoid premature fouling of the RO membrane. This is accomplished in two stages. A first-flush diverter is installed to vent the majority of accumulated detritus with each precipitation event. The second stage is a 5 micron mechanical filter incorporated into the UV unit. Ultraviolet (UV) radiation is used to sterilize the water. Many cost-effective prefab units are readily available, often incorporating mechanical pre-filters to limit the amount of particulate matter available for pathogens to reside in. As rainwater is generally acidic, pH is adjusted to 7.8 plus or minus 0.5 using sodium hydroxide (NaOH) where required.

### 2.3 Storage

A tank is used to store the collected rainwater while it is extracted for treatment and distribution to the plant. A float switch in the cistern controls a solenoid valve regulating the release of rainwater when it is available. When there is insufficient rainwater, city water is used. Dual check valves are installed on the city water lines before the solenoid valve to prevent backflow of rainwater into the city mains.

### 3 Discussion

Given the fixed costs, the ROI-maximizing size is a 2500 gallon tank and 50% of downspouts (see Figure 2). This yields lesser gross savings than a larger tank size but the shortest payback period. Thus, it is highly suitable to use this configuration for the Phase I system as proof of concept. For Phase II, the largest tank that will fit into available space and use of all downspouts is recommended.

### 4 Conclusion

The two phase design allows CAMTAC to implement a small scale version of the system and confirm that it will pay back within the projected time. Once satisfied with the system performance, Phase II may be implemented. Phase II takes advantage of the large-scale rainfall harvesting capacity and maximizes the overall savings produced.

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### References

1. MOE Rainfall Data Station 6143090 (Guelph Turfgrass)