Guelph Center for Urban Organic Farming Final Design

Rohan Hakimi, Patricia Osika, and Jeffrey Snider-Nevin

Abstract. This paper presents a low impact, energy efficient designed rainwater harvesting and irrigation system for the Guelph Centre for Urban Organic Farming at the Unveristy of Guelph. The system collects water from the roofs of nearby residence buildings, stores it and delivers it to the site as needed. An analysis showed that sufficient water is provided for summer and winter months by using 3068 m^2 of roof area with a 45 m^3 underground storage tank and a 136 m^3 irrigation pond. With these parameters drought would rarely occur at the farm and if it did occur it would last only a short period. Two solar panels that produce a total of 160 W are used to power the pump. The total cost of the system is $65 000.

Key words: Drip Irrigation, Organic Farming, Rainwater Harvesting

1 Introduction

The aim of the designed water supply system for the Guelph Centre for Urban Organic Farming at the University of Guelph is to provide the site with a low impact, energy and resource efficient system to supply water to the crops. The system cannot connect to the municipal water, electricity or gas supply. The design aims to keep costs low and for all components to be safe and aesthetically pleasing.

The design assumes future precipitation will not vary drastically from past years. Collecting water from the roofs of residence buildings on the University of Guelph campus was the best method to collect the volume of water required. Splitting the storage between an underground tank for the winter and a pond for the summer was the best method for storing this quantity of water. A sensitivity analysis was performed to find the best balance between the cost of the storage devices, the catchment surface cost, and the number of drought days. A solar powered pump will be utilized for this system. Water conservation techniques will be applied to keep water consumption low.

2 Overall Design

Water is collected from roofs of the nearby East Residences and carried by gravity to an underground storage tank for winter use and an irrigation pond for summer use. These storage units were sized based on the demands calculated for each season. A solar powered pump will deliver water from the storage units to a drip irrigation system. A filter will remove large particles to prevent damage to the pump and drip irrigation system. An overview of the design can be seen in Figure 1.

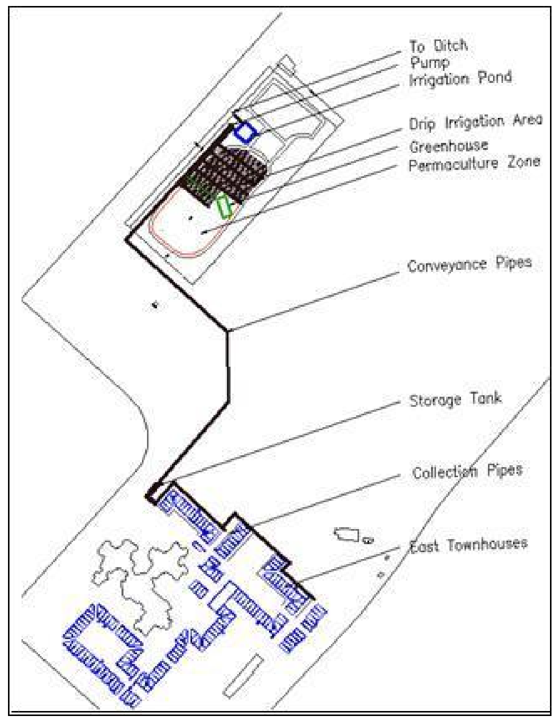

Fig. 1. Overview of Design

3 Detailed Design

3.1 Collection Surface and Conveyance Network

Water will be collected from 3068 m^2 of the roof surface area of the East Residence townhouses. This is provided by the townhouses on the north-east side of the driveway (Figure 2).

The downspouts from the existing eavesthroughs will have filters installed to remove debris. The downspouts will connect to underground collection pipes 5.1 cm (2") in diameter. These pipes will connect to a 15.2 cm (6") pipe that will carry water to the nearby storage tank.

3.2 Storage Tank

A 45 m^3 underground storage tank will store water for the winter demand of the greenhouse. The tank will be buried near the east townhouses (Figure 1), below the frost

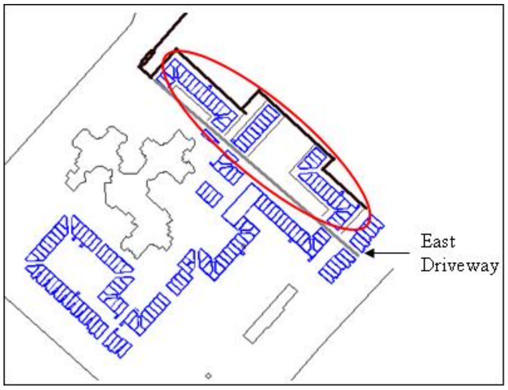

Fig. 2. Section of East Residence Townhouses used for Rainwater Collection

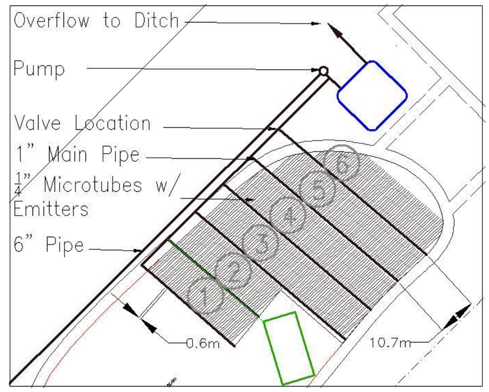

Fig. 3. Layout of Drip Irrigtion System and Components

line (1.2 m). During the summer the tank will overflow and water will be gravity fed to the irrigation pond at the site. The tank outlet will be 15 cm above its bottom to allow for sediment to settle.

3.3 Irrigation Pond

A 136 m^3 irrigation pond will store water for the summer months. This pond will use a rubber liner to reduce seepage water losses. An outlet pipe will be placed 15 cm above the base of the pond to allow for sediment settling.

3.4 Solar Panels and Pump

The pump is adjacent to the pond (Figure 1). The energy required to run the pump for the required 4 hours per day was determined to be 70 W [1]. Two 80 W solar panels provide the necessary 120 W of energy. The excess energy is to account for losses and emergency requirements of the system. Energy will be stored in three 56 Ah, 12 V batteries so that the pump can run during early morning hours when solar energy is not at its peak. The pump will draw from the storage tank in the winter and from the pond in the summer; this will be controlled by valves. The pump flow rate can e adjusted manually if required.

3.5 Drip Irrigation System

A drip irrigation system will deliver water to the site. The system is sized to deliver 3.73 m^3/day of water during the summer months. Water will be delivered on a rotating basis between 6 sections of the field (Figure 3). This reduces the total flow rate and pump size required. The emitters on the drip pipes have a flow rate of 0.4 L/hr (0.1 GPH) at 15 PSI and are spaced every 0.3 m (1 ft). Each of the 6 sections run for 1.4 hours every two days.

4 Discussion

This design provided the oppurtunity to investigate methods for collecting and providing water using low impact and energy efficient techniques. This led to research being carried out on the components of a rainwater harvesting system, solar power and drip irrigation systems.

All water demand values are estimates based on available data. Abnormal precipitation patterns beyond the historical range may affect the performance of the design.

The system costs about $65 000 and provides a reliable water supply to the site for summer and winter months. This cost may be reduced. Potentially, a lower cost could be achieved by removing the tank and a using deeper pond to supply water in both the winter and the summer. This would be a less reliable system and more water will be lost to evaporation but the cost savings would be significant.

Regular monitoring is required to ensure the system is functioning well. Monitoring of the eavestroughs, downspout filters, pump filter and drip system are required to prevent clogging. The watering schedule with the design will require refinement based on the crop types and weather patterns of each year. Irrigation should be based upon the moisture content of the soil so monitoring this would lead to the most efficient irrigation system.

Acknowledgement

Thanks are extended to Martha Gay and Karen Landman from the Guelph Center for Urban Organic Farming and the Physical Resource Department at the University of Guelph for providing information on the site and nearby East Residences. Many thanks also to Dr. David Lubitz and Amanda Farquharson for their regular guidance and review of the design.

References

1. Grundfos. (2009), SQ Flex Grunfos Product Guide, Oakville, Ontario, Canada.