Replace Treated Water with Well/Surface/Rain Water (Arc 3.4159)

(The analysis below was extracted from one of the assessment reports by the Clemson University Industrial Assessment Center (IAC). This is only an example recommendation and hence, not all the background information and sources for numbers are included here.)

Est. Water Savings	= ***10,771,944 gal/yr***
Est. Total Cost Savings	= ***$25,853/yr***
Est. Implementation Cost	= ***$4,700***
Simple Payback Period	= **2.2** ***months***

<u>Recommended Action</u>:
It is recommended that rainwater be captured from the roof and use it for non-potable purposes after treatment.

<u>Background:</u>
Rainwater harvesting (RWH) is the practice of capturing, storing and utilizing rainwater. By managing the water on site, RWH can decentralize and diversify both the water supply and stormwater management infrastructures. Thus, harvested rainwater can be used for cooling, washing, toilet flushing and other non-potable purposes. Rainwater harvesting systems are designed to capture the rainwater from the roof (catchment) for either immediate use or for storage and use in the future (Figure 1). Since the water captured from the rainwater harvesting system may not be enough to fulfill the total demand, the connection to municipal water supply can be retained as a supplemental or backup source.

Figure 1. Conceptual Rainwater Harvesting on site.

Rainwater cistern is designed based on a comparison of rainwater supply and facility water demand monthly [1]. If the volume of water demand is more than the available rainwater supply, then the cistern size is based on the supply and vice versa:

$$V_c = V \text{ (If } V<V_r)$$
$$V_c = V_r \text{ (If } V>V_r)$$

Where,

V_c = Volume of cistern (gallons)
V = Water demand (gallons)
V_r = Volume of rain available for capture in one month (gallons)

Based on the water bills of 2016, the water demand of the facility was quantified as 69,004,200 gallons per year which is equal to 5,750,350 gallons per month.

Therefore, **V = 5,750,350 gallons per month**

Volume of water available for capture is the monthly volume of water that can be supplied through the rainwater harvesting system.

$$V_r = R_{avg} \text{ x } \eta \text{ x } A$$

Where,

V_r = Volume of rainfall available for capture in one month (gal)
R_{avg} = Average monthly precipitation = 4 (in)
η = Rainwater catchment system efficiency (default value = 90 %)
A = Building roof area = 400,000 (ft^2)

$$\mathbf{V_r = 4 \text{ inch } /12 \text{ (inch/ft)} \times 0.90 \times 400{,}000 \text{ ft}^2 \times 7.48052 = 897{,}662 \text{ gallons/month}}$$

Where, 7.48052 is the conversion factor for cubic feet into gallons.

Therefore, V_r = 897,662 gallons per month, which is equal to 15% of the water demand at the facility. A cistern of **V_c = 900,000 gallons** was recommended for the plant for the use of harvested rainwater. Rest of the water (V-Vr = 4,852,688 gallons) will be withdrawn from municipal water supply system.

Anticipated Savings:
Savings were calculated based on the amount of municipal water replaced by rainwater harvesting system on an annual basis.

Est. Water Savings (EWS) = 897,662 gal/month **= 10,771,944** gal/year

Est. Total Cost Savings = Est. Water Savings × Utility rate

Est. Total Cost Savings = 10,771,944 gal/year × $ 0.0024 / gal

Therefore,

Est. Total Cost Savings (TCS) = $25,853

<u>Implementation Cost</u>:

An Industrial rainwater harvesting system consists of a rainwater storage tank, piping systems, valves, and gutters. The assessment team noticed an existing tank that can be used to capture rainwater and was big enough to capture anticipated runoff from the roof. Therefore, only the cost of gutter (from roof to storage tank), one valve (one at the tank), pipe (from storage tank to treatment system) was considered in this report. As the plant already has treatment facility on site, the cost of water treatment was also excluded. The total cost of gutter, valve, and pipe as well as the cost of installation is presented in Table 1 below.

Table 1. Itemized cost of rainwater harvesting components

Item	Total Cost ($)
Gutter including leaf separator and flow diverter	2,500
Valve	100
PVC Pipes including bends and tees	1,000
Labor @ $9 per linear foot)	1,000
Total	**$4,700**

Therefore, Total Implementation Cost is equal to,

IC = $4,700

<u>Simple Payback Period</u>:

The *simple payback period*, *SPP*, associated with installation of the proposed lamps, ballasts, and occupancy sensors in a given area.

$$SPP = \frac{IC}{TCS} \times 12\ months/yr$$

$$SPP = \frac{\$4{,}700}{\$25{,}853} \times 12\ months/yr$$

SPP = 2.2 months

<u>References</u>:

1. Devkota, J., et al., Development and application of EEAST: A life cycle based model for use of harvested rainwater and composting toilets in buildings. Journal of environmental management, 2013. 130: p. 397-404.