Water Conservation Efforts Changing Future Wastewater Treatment Facility Needs

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Many studies show that water conservation programs significantly reduce potable water demands, help sustain water supplies, and delay water system expansions. Few studies, however, show water conservation program impacts on domestic wastewater collection and treatment systems. This article presents a case study that may offer a glimpse of how a water conservation program can affect domestic wastewater influent characteristics and the future needs of wastewater collection and treatment systems.

Methodology

WWTF Service Area

The wastewater treatment facility (WWTF) examined in this study serves a master-planned retirement community and treats domestic wastewater generated from residential and commercial developments and recreation centers. The retirement community is considered a successful model for potable water conservation. All residential dwellings and commercial properties are equipped with low-flow/low-flush water saving fixtures. Treated wastewater and stormwater runoff are used to irrigate extensive residential and commercial areas. Potable water is limited to indoor residential and commercial uses.

WWTF Flows & Loads Analysis

The monthly discharge monitoring reports of the WWTF from January 2005 to March 2010 were reviewed for reported flows, influent carbonaceous five-day biochemical oxygen demand ($CBOD_5$), and total suspended solids (TSS) concentrations. Influent $CBOD_5$ and TSS daily loads, in pounds per day (ppd), were calculated from the influent concentration and the reported daily wastewater flow on the same day the sample was collected. To better understand seasonal variations in wastewater flows and influent characteristics, potable water use and the number of water and wastewater service connections in the WWTF service area were also reviewed during this time period.

Results

Comparison of Wastewater Flow with Potable Water Use

Review of the WWTF and potable water data showed that the reported daily wastewater flows before mid-2008 exceeded the total metered daily potable water demands. The majority of potable water used within the service area should be returned as wastewater since potable water is not used for landscape irrigation at this community.

The wastewater collection system is relatively new and well maintained. Since this system does not experience infiltration and inflow, it is abnormal for wastewater flows to be higher than total potable water use. It was learned that the WWTF replaced the effluent flow meter in July 2008 because of meter inaccuracies. This provided a reasonable explanation for the reported higher wastewater flows compared to total potable water use before mid-2008.

The reported wastewater flows from January 2005 to August 2008 were adjusted based on a correlation between potable water use and wastewater flow from September 2008 to March 2010. As shown in Figure 1, the adjusted WWTF wastewater flows are consistently below the metered potable water use. Approximately 90 percent of potable water use is returned to the WWTF as wastewater.

WWTF Flow Analysis

Peak potable water use and wastewater flows for this retirement community typically occur between December and April (highlighted in yellow in Figure 1). This peak flow period is defined as the *high season*. The high-season average potable water use and wastewater flows were calculated and then normalized by the number of service connections.

Table 1 shows the high-season average potable water use and wastewater flows per connection. The high-season average potable water use per connection ranges from 96 to 110 gallons per day (gpd) per connection from 2005 to 2010. A Miami-Dade County water conservation study (2010) showed that system-wide potable water use was 143 to 158 gpd per connection; however, the potable water use dropped to 81 to 98 gpd per connection in water conserving areas with high-

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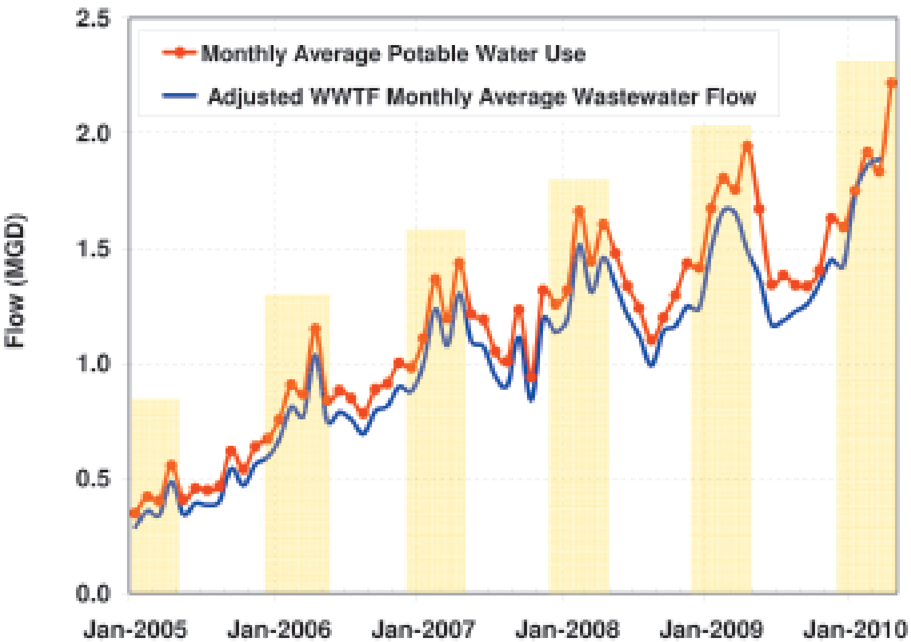

Figure 1: Metered Potable Water Use and WWTF Wastewater Flows

Table 1: High-Season Average Potable Water Use and Wastewater Flow per Connection

Year	Potable Water Use per Connection (gpd/connection)	Wastewater Flow per Connection (gpd/connection)
2005	110	95
2006	108	96
2007	104	93
2008	103	93
2009	104	92
2010	96	93

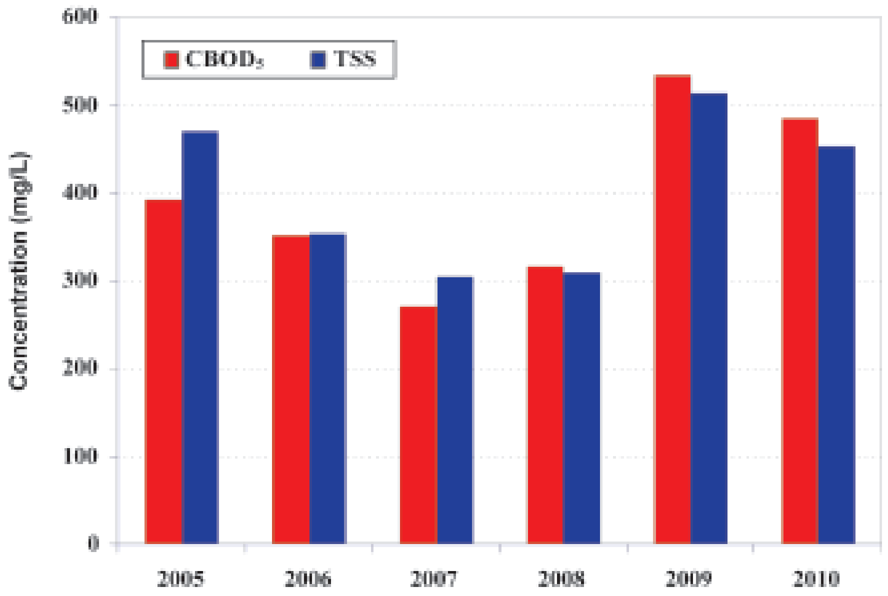

Figure 2: High-Season Average WWTF Influent $CBOD_5$ and TSS Concentration

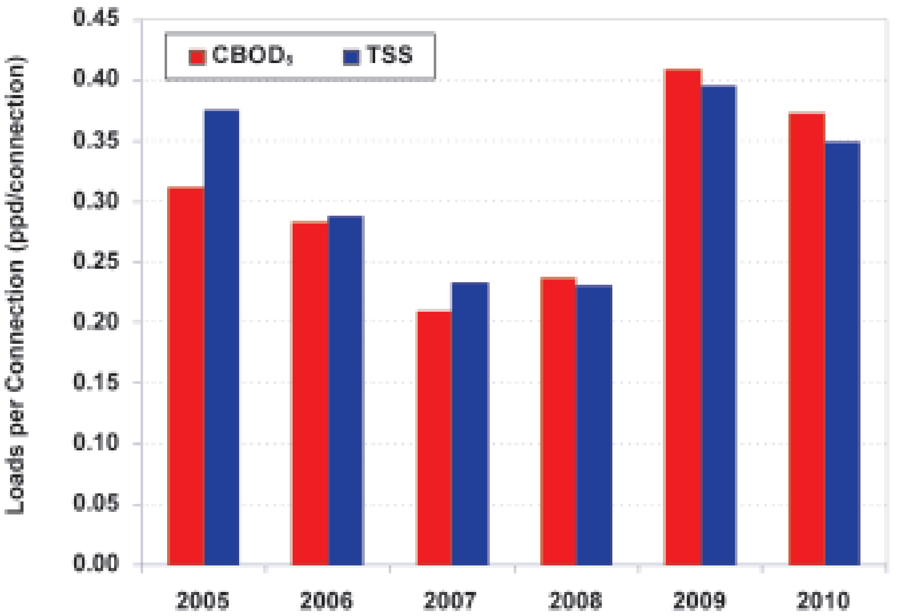

Figure 3: High-Season Average $CBOD_5$ and TSS Loads per Connection

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efficiency low-flow fixtures.

A 1998 report from the American Water Works Association (AWWA) shows an average indoor potable water use of 74 gpd per capita for non-water conserving communities, in contrast to 52 gpd per capita for water conserving communities. In the report, potable water use of 52 gpd per capita is equivalent to 99 gpd per connection, assuming 1.9 capita per connection.

Similarly, the potable water use of 74 gpd per capita is equivalent to 141 gpd per connection, so the retirement community that was the subject of this study can be considered to be a water conserving community. It is reasonable to expect that wastewater flows would be reduced as the metered potable water use decreases.

WWTF Influent Loads Analysis

Influent wastewater samples are collected by a 16-hour composite sampler. The influent composite samples are collected at the headworks before influent raw sewage is combined with any return of plant recycle. From 2005 to 2010, the influent $CBOD_5$ and TSS concentrations ranging from 200 to 750 mg/L. As shown in Figure 2, the *high-season* average $CBOD_5$ and TSS concentrations vary from 270 to 540 mg/L. These influent concentrations are higher than typically reported domestic wastewater influent concentrations of 100 to 250 mg/L.

Influent $CBOD_5$ and TSS daily (mass) loads shown in Figure 3 are calculated from the influent concentration and the reported daily wastewater flow on the same day the influent sample was collected. The high-season average $CBOD_5$ and TSS loads per connection were calculated to be 0.21 to 0.41 ppd per connection. These loads per connection are equivalent to 0.11 to 0.22 ppd per capita, assuming 1.9 capita per connection.

Although this water conserving retirement community exhibits high influent $CBOD_5$ and TSS concentrations, the high-season average $CBOD_5$ and TSS loads per connection are within typical design values. For example, the *Ten States Standards* (2004) specify that wastewater treatment designs should be based on a minimum of 0.22 ppd $CBOD_5$ per capita and 0.25 ppd TSS per capita loadings (with garbage grinders). *Wastewater Engineering Treatment and Reuse* (2003) also recommends the use of design loadings of 0.11 to 0.26 ppd $CBOD_5$ per capita and 0.13 to 0.33 ppd TSS per capita for domestic treatment facility designs and evaluations.

Discussion & Conclusion

This water conserving retirement community has shown that reducing potable water use results in lower wastewater flows and higher $CBOD_5$ and TSS concentrations to the WWTF. The community has also shown that water conservation programs do not reduce $CBOD_5$ and

TSS loadings to the treatment facilities.

DeZeller and Maier (1980) observed similar influent wastewater characteristics when mandatory water conservation was enforced during California's severe drought periods in the 1970s. The increased water conservation efforts in California during that period reduced wastewater flows by 15 to 60 percent and increased $CBOD_5$ and TSS concentrations by up to 80 percent, but the $CBOD_5$ and TSS loadings at the majority of 14 WWTFs studied in California remained relatively unchanged. Several WWTFs experienced reduced $CBOD_5$ and TSS loadings mainly because of increased solids settling in the collection system.

In general, lowering flows to the wastewater collection, treatment, and disposal facilities will reduce hydraulic loadings to flow-based treatment processes such as influent screening, clarifiers, filters, and effluent disinfection. In the future, smaller collection systems and flow-based wastewater treatment processes may be considered to serve water conserving communities, but the biological and biosolids treatment and disposal systems for water conserving communities will continue to be similar in size and capacity to systems required for non-water conserving communities.

Conversely, existing treatment facilities originally designed for non-water conserving communities may be found to have ample or sufficient hydraulic capacity, but may need additional biological and biosolids treatment and disposal capacities as water conservation efforts and practices are put in place and flows gradually increase to the plant.

It was reported that existing collection systems originally designed for non-water conserving communities experienced increased odor, odor control chemical use, pipe corrosion, solids settling, and clogging as water conservation efforts increased (DeZeller and Maier, 1980). Lift stations may need to be adjusted to operate more often to mitigate these collection system problems, but this may increase operating costs.

It was also reported that existing WWTFs originally designed for non-water conserving communities experienced increased grit loads after heavy rain and bulking problems in secondary clarifiers but required less disinfection and dechlorination chemical use with water conservation efforts (DeZeller and Maier, 1980).

As water conserving communities move toward a system-wide wastewater flow generation level below 100 gpd per connection, the planning, design, construction, operation, and financial management of a WWTF must change to meet the needs of future wastewater collection and treatment facilities that serve them. Limited published literature is available for wastewater influent characteristics associated with water conserving communities. More studies are needed to develop alternative design criteria better suited for the design of wastewater collection and treatment systems serving these communities in the future.

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