

# **Refining Residential: Using customer consumption records to tell a story of utility management**

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## Introduction

The drought of 2007 and 2008 significantly impacted the operations of many of North Carolina's water and wastewater utilities. Although individual circumstances varied greatly between them, the political, public, legal and actual climate temporarily changed the way utilities operated and communicated, as well the way residential customers used water. For some utilities, these changes in both operations and residential water use may even be permanent. The ability to understand this customer behavior, in light of service area conditions, can have a large impact on immediate and long-term financial and management decisions. In a continuation of research conducted for the Urban Water Consortium (UWC), the Environmental Finance Center (EFC) researched how residential consumption and irrigation behavior changed from a largely non-drought year (FY07) to a drought year (FY08) for five UWC utilities.

The research sought to refine and understand a customer class that so many times is just lumped together in utility billing databases as "residential." The EFC focused exclusively on residential customers in this analysis for three reasons: (1) residential customers comprise the bulk of most utilities' premises or connections; (2) residential customers can more easily be compared from one utility to another; (3) the highly variable and seasonal nature of residential water demand drives system peaks and is the target of many water reduction strategies during a drought.

In this study, we began with a complete list of utility customers from each utility and tracked each individual customer's water use through 30 months. We then categorized and summarized the residential customers in a number of different ways to provide utilities with a more refined view of their customer base and create analogous groups for comparison purposes. Some of the customized groups included:

- Customers with active irrigation systems, both with and without irrigation meters
- Peakers, those that use significantly more water during a portion of the year above their baseline
- "Big spenders" , significant contributors to revenue
- Responsive to drought conditions and restrictions

## Methodology

This research was conducted on customer billing records from Fayetteville Public Works Commission (PWC), Greenville Utilities Commission (GUC), City of High Point Utilities (HP), Charlotte-Mecklenburg Utilities (CMU), and Orange Water and Sewer Authority (OWASA). The records covered the time frame from July 2006 through December 2008 (30 consecutive months). These five utilities were chosen from the 11 (now 12) UWC members because they were able to extract monthly consumption records from their billing databases and represented a range of drought conditions and response settings.

Each participating utility provided a database of every billing transaction record, along with premise identification numbers. At a minimum, data included the billing month, account and rate structure classifications, meter sizes and types, usage through each meter and billed amounts. Some utilities also provided information on zip codes, penalties and cutoffs.

One of the key elements of this research is being able to track each customer's consumption over time. Utilities often track various meters that belong to the same house or lot under one premise number, but using several account numbers. For example, a household might have a different account number for their irrigation meter than their standard domestic meter. In this case, the premise would include two water meters. Our analysis combined these two meters for an overall premise (or household)-level consumption.

Using account classifications, rate schedules applied, meter sizes and number of dwelling units per premise, the individually metered households and single family dwelling units were identified. These are residential premises have standard meters  $\frac{3}{4}$ " in size or less, and did not have more than one dwelling unit per premise. Hence, master-metered apartment complexes or multifamily housing units, commercial, industrial, institutional and wholesale customers are not included in this analysis.

Utilities typically assign unique premise numbers when a new house is first constructed, and (unlike account numbers) usually never change over time. Premise-level analysis does not track the individuals that live the homes; it tracks the water and wastewater consumption assigned to the homes. For ease of discussion, the premises are referred to as households, and do not necessarily indicate constant group of people resided at the premise for the duration of the study.

Due to the variation of billing software, the datasets produced were in different formats, using different units, and rounding at different levels. Extensive and customized data cleaning was necessary for each dataset, with the goal of producing a final dataset of accurate data that are consistent across the five utilities. Records were aggregated to produce only one record per address (or premise) per month. Premises that received wastewater service only, but not water service, were identified and excluded, leaving only water-using premises.

The data cleaning process is extensive, critical, and an actual deliverable to the utilities. As a result of our cleaning, we were able to provide utilities with a list of customers with particular water use patterns indicative of potential problems. These customers might include those that may be misclassified or have highly irregular billing and usage patterns. In our analysis, we did our best to identify and keep the good data, understand and improve the questionable data, and, if necessary in rare cases, remove the bad data to protect the integrity of the analysis.

# Key Findings

## Context

The context of residential water use during the 30-month timeframe of the study plays a large role in how each case study is interpreted and used. The most noteworthy contextual factor was a “drought of record” that impacted the entire state. It peaked in the late fall of 2007 and lasted through the summer of 2008 (and even longer for others). In the summer of 2008, the NC General Assembly passed S.L. 2008-143 (dubbed the “drought bill”) in an attempt to better prepare the state for future droughts.

Although the entire state endured a drought during the timeframe of this analysis, the severity of the drought varied on a system-by-system basis. Such was the case in the five utilities in this study. Figure 1 shows the differences in drought conditions between the utilities by summarizing the drought status in place for the majority of each month in the study. Because of a difference of drought status, and their established drought policies, each utility employed different strategies and measures to promote water conservation in their service area.

Figure 1: Monthly summary of drought status intensity in five UWC utilities

	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
<b>PWC</b>	Red																													
<b>HP</b>	Yellow																													
<b>GUC</b>	Yellow																													
<b>OWASA</b>	Orange														Red															
<b>CMU</b>	Orange										Red																			
<b>Intensity of Drought</b>	Yellow		D1 – Moderate				Orange		D2- Severe				Red		D3 - Extreme															

Data Source: U.S. Drought Monitor Archive

Usage variation among the utilities during this period was influenced by drought conditions (weather), how utilities reacted to the drought, and the unique socioeconomic and housing characteristics of each utility. Figure 2 compares summaries of income, home ownership and home size for each of the areas served by the five utilities in 2008.

Socioeconomic and housing characteristics of a utility’s customer base can be used to predict how customers are likely to respond to different initiatives. For example, a service area with low homeownership, such as within the City of Greenville, may have a more difficult time communicating conservation signals to its residents. Renters often are less likely to directly pay for water and sewer services and are less likely to invest in costly repairs or upgrades that would influence water use.

In general, home sizes and incomes in Mecklenburg County are much larger than the other utilities studied. In a statistical study on NC water utilities’ average residential water use<sup>1</sup>, the EFC found home size (measured by number of people in the households) and income positively related to water use (i.e. areas with higher household incomes see higher household water use).

**Figure 2: Socioeconomic and housing characteristic summaries**

	<b>Median household income</b>	<b>% of owned occupied housing units</b>	<b>Average household size</b>
Fayetteville City	\$44,086	57%	2.34
Greenville City	\$32,836	38%	2.08
High Point City	\$45,861	62%	2.42
Mecklenburg County	\$57,033	64%	2.40
Orange County	\$54,390	59%	2.34

Data Source: U.S. Census Bureau, 2008 American Community Survey (ACS)

Each utility received a summary of context in their customer consumption profile. Such characteristics are important to consider when comparing water use patterns and profiles.

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<sup>1</sup> Utility Rate Setting for Cost Recovery and Conservation, Environmental Finance Center research for the NC State Water Infrastructure Commission, 2009. Available online at: [http://www.efc.unc.edu/projects/NC\\_ratesetting.htm](http://www.efc.unc.edu/projects/NC_ratesetting.htm).

## Water use case studies

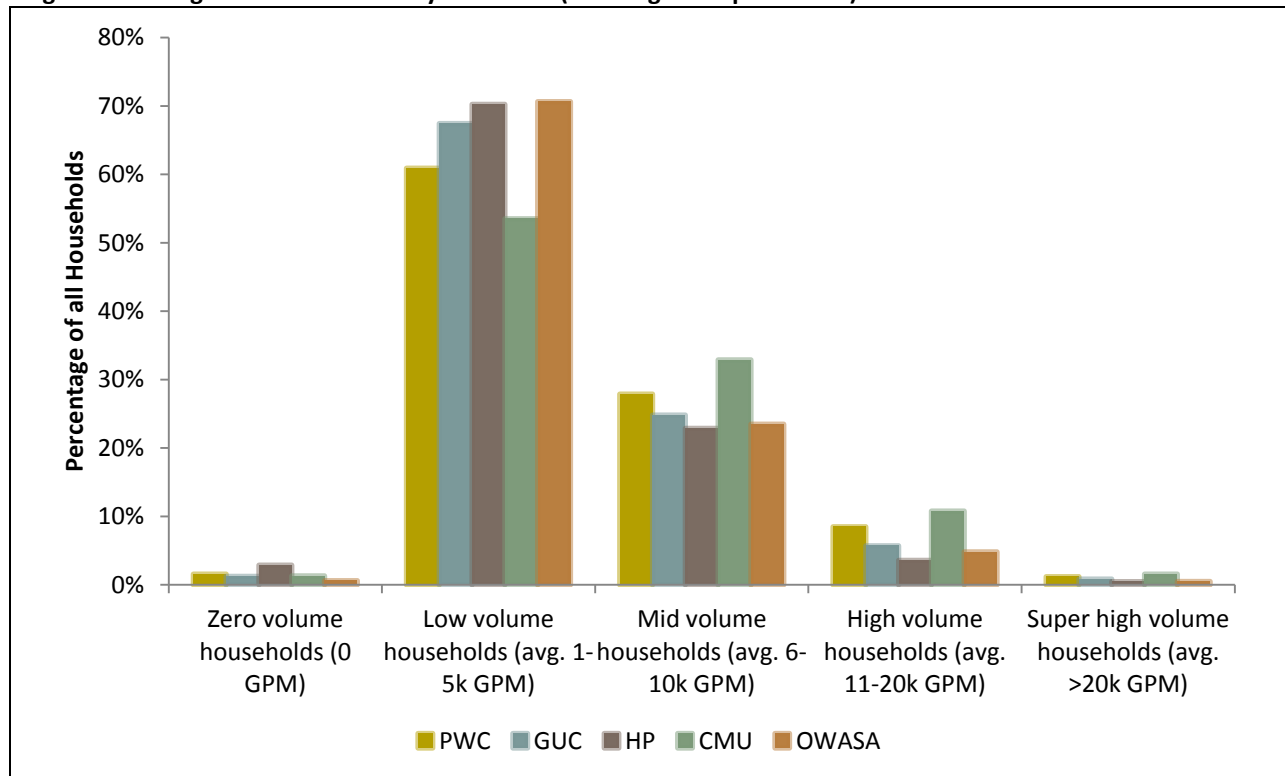
Just as New York City is the city of eight million [sic] stories<sup>2</sup>, there are many stories that could be told from the more than 10 million billing records from five of North Carolina's largest utilities. For this report, we have chosen to concentrate on a few time-relevant and noteworthy case studies. These cases were developed through an investigation of the data and enhanced by the perspective of utility staff members. The following section outlines how customer consumption profiles compare between the five utilities and highlights individual utility cases on drought response and irrigation.

## Customer profiles

### **Average water use**

Residential customers can be grouped in a number of different ways. Figure 3 compares utilities based on their customers' average household water use. Households are organized into five groups based on their average monthly volume: zero, low, mid, high and super high. The graph shows High Point and OWASA to have had the highest percentage of low volume households and Charlotte-Mecklenburg Utilities with the highest mid, high and super high volume households.

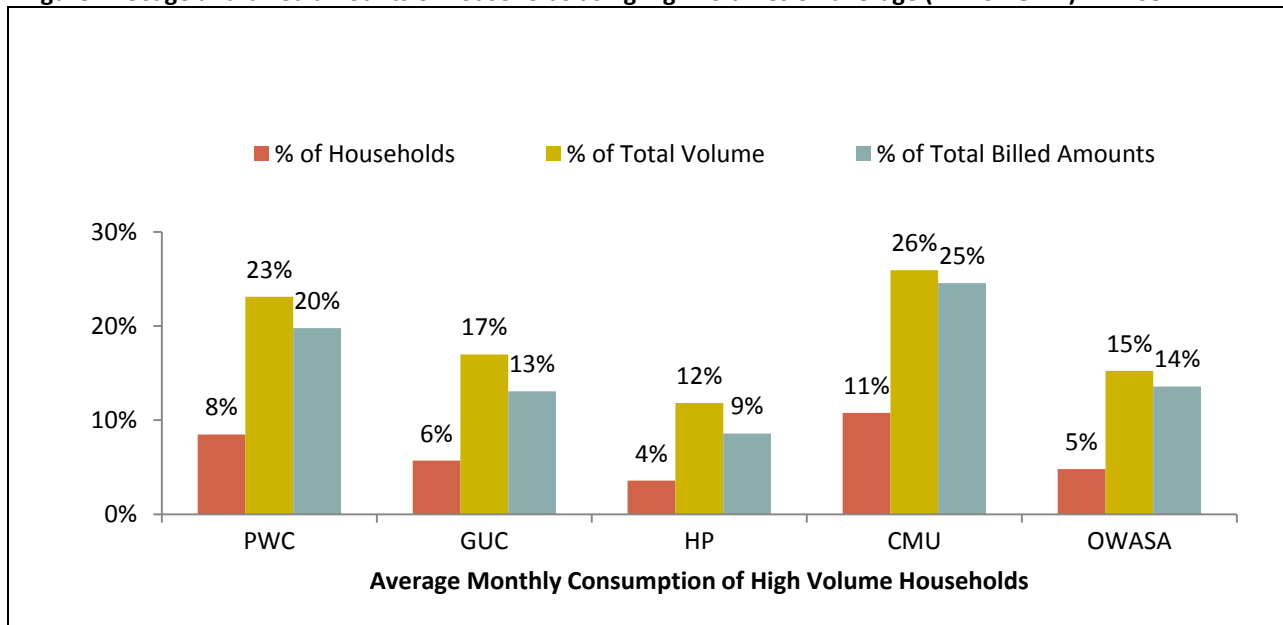
**Figure 3: Average household monthly water use (GPM = gallons per month)**



<sup>2</sup> *The Naked City*. dir. Jules Dassin, Produced by Mark Hellinger, Distributed by Universal Studios, 1948, video recording.

Figure 4 provides a more in-depth comparison of just the households with a high average use. It details the percent of total consumed by (volume) and billed to (dollars) these households. This graph not only provides insight into the differences of consumption behavior, it also elucidates differences in rate structures. For example, in FY08, both Greenville and High Point had uniform rate structures for residential water use. This is shown in Figure 4 by comparing the percent of total volume and billed amounts. The high users in these two utilities contribute less to the revenue relative to their water demands than the other systems.

**Figure 4: Usage and billed amounts of households using high volumes on average (11-20k GPM) in FY08**





## **Peaking behavior**

Average household water use alone does not speak to the changes in household consumption behavior in a given year. In order to reflect water use fluctuations, we profiled residential customers on their peaking behavior. We defined a peaking household as one whose three months of highest usage divided by their three months of lowest usage was greater than two. In other words, for a quarter of the year, peaking households were using more than double of what they were using during another quarter of the year. This behavior suggests that these households have some discretionary use, a significant portion of their demand that they can live without for at least three months out of the year.

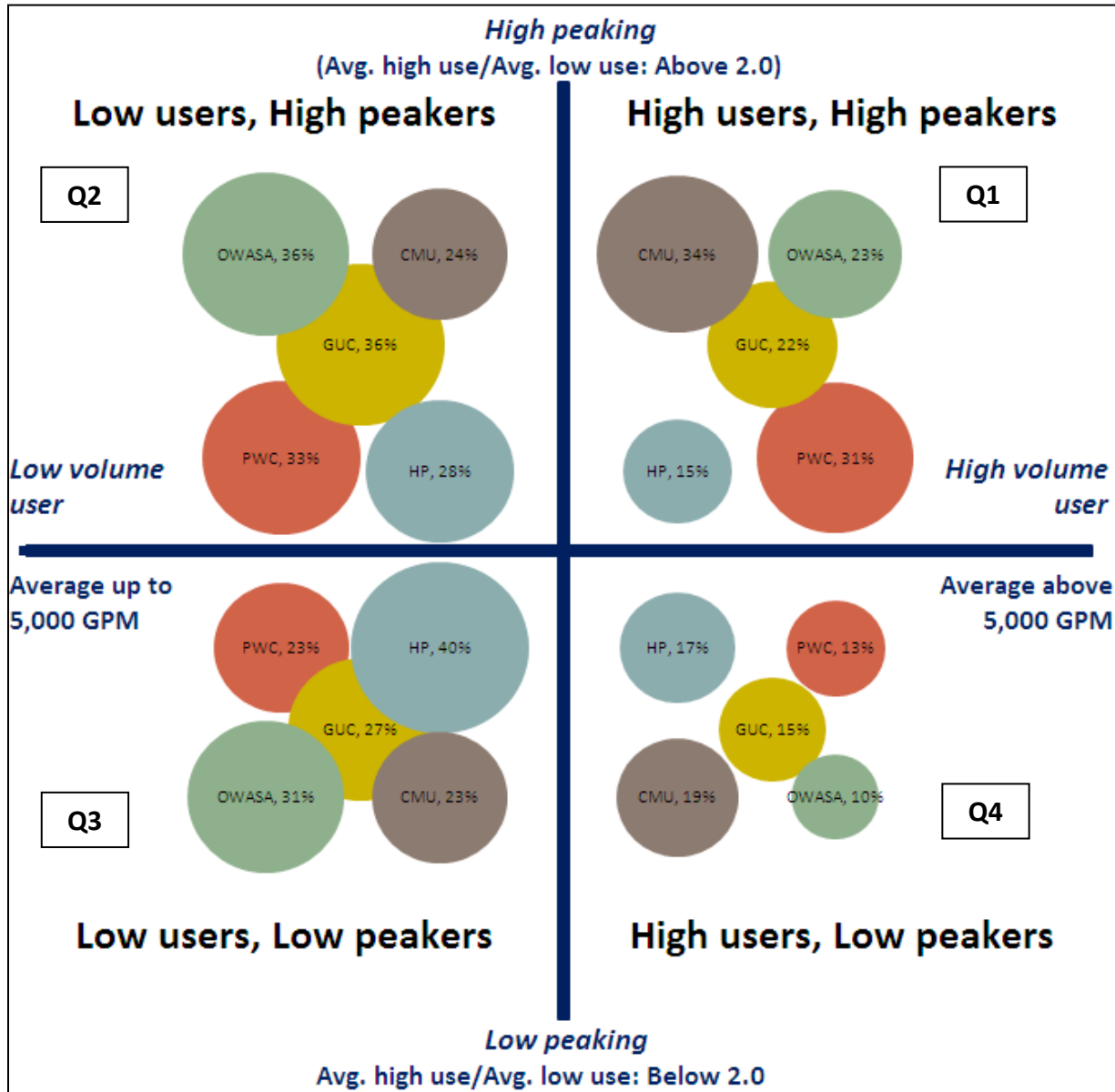
This consumption pattern is important to highlight because utilities often use pricing and conservation marketing to reduce, punish or collect on discretionary uses. For example, most increasing block rate structures are structured to charge lower level of consumptions (sometimes referred to as lifeline consumption) inexpensive rates and to charge higher levels of consumption higher rates. Furthermore, utilities design many of their facilities to meet their customers' maximum usage during the year. Customers that use 20,000 GPM for three months and 5,000 GPM for the rest of the year have a much different impact on a utility's facilities than customers that use 8,000 GPM all year long, although both customers would have the same annual average household use.

Figure 5 divides customers in each utility into four groups based on their average usage and peaking patterns:

**Q1:** The upper right hand quadrant shows the percentage of customers that use a lot of water on average and also have a high peaking ratio throughout the year. These customers are typically the stated targeted population for increasing block rate structures, with the theory that their high usage and peaking causes a utility to design larger facilities than they might otherwise need and that their peaking is indicative of discretionary use that can be influenced and reduced through pricing incentives. CMU and PWC had significantly more of these customers than the other utilities.

**Q2:** The upper left hand quadrant might also be a target group for increasing block rate structures. The households in this quadrant are those that have a low annual average, but that also use significantly more water for a few months out of the year. An example might be a small family that uses a moderate amount of water in the winter, but that waters the lawn in the summer. OWASA and GUC have more of these customers than the other utilities.

Figure 5: Profiles of household water use patterns in FY08



**Q3:** Figure 5 can guide rate setting in other ways, for example the relatively high number of low users that do not peak in High Point might suggest that if High Point did move to an increasing block rate structure, they should consider a rate structure in which increasing pricing tiers start at lower consumption points than in the other utilities.

**Q4:** Some economists worry about the unintended impacts of increasing block rate structures on customers that have less discretionary use. For example, a household that has a large family may use a lot of water all year and have little discretionary use, but would

still have to pay higher unit costs for their water. Many of these customers probably fit into the lower right hand quadrant of the figure showing customers that use a relatively high amount of water all year, but who are less inclined to peak. A utility with a large number of these types of customers (like Charlotte-Mecklenburg Utilities) that implements an increasing block rate structure will likely see less of a drop in water usage than a utility with more high use, high peaking customers.

Figure 5 helps reinforce the point that customer bases differ among utilities across the state. Therefore, rates can and should be customized to address individual situations, rather than broadly promoted and applied.

## **Drought response**

Given the context of the drought in each of the utilities, how did usage change between fiscal years 2006-07 and 2007-08? Did the weather, restrictions and rate adjustments impact household water use in these utilities? Figure 6 summarizes changes in average household water use changed from one year to the next in the five utilities.

**Figure 6: Comparing average household water use**

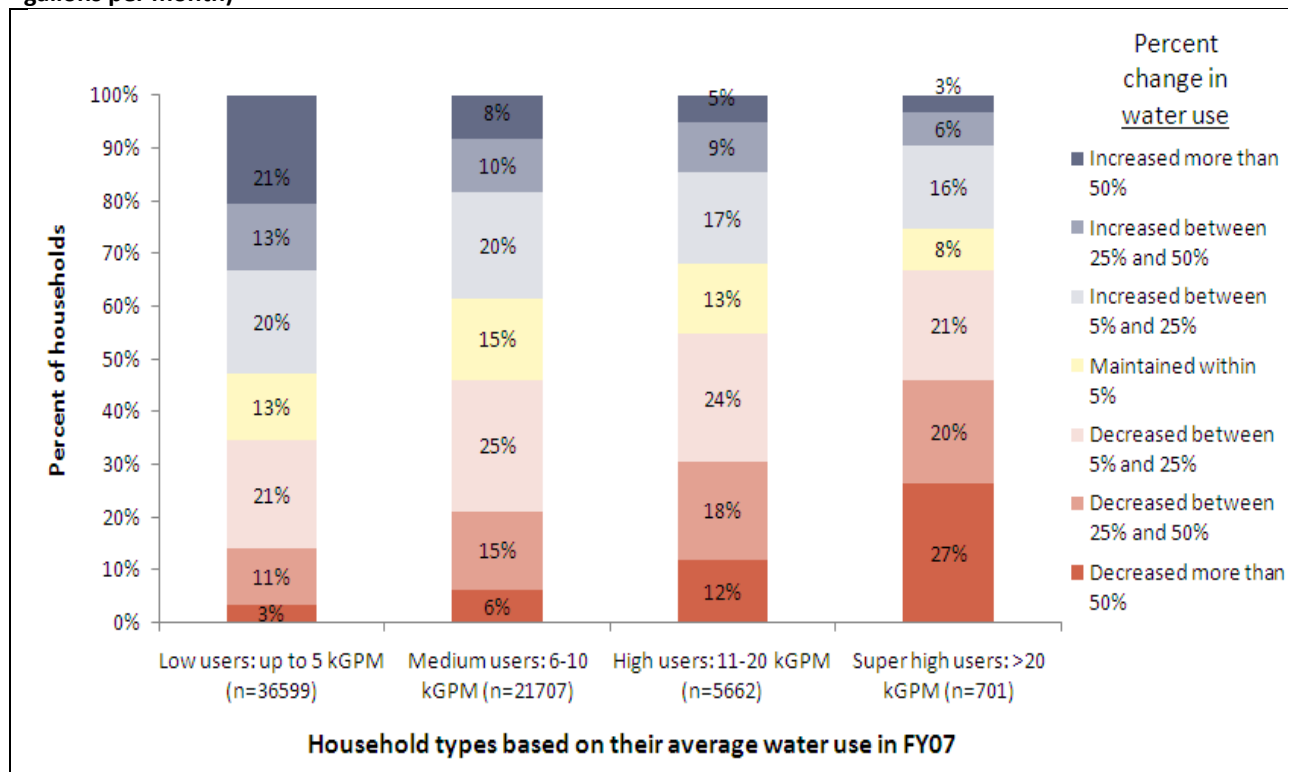
Utility	Average household water use (gallons/month)		Percent change
	FY07	FY08	
CMU	6,436	6,109	-5%
PWC	5,230	5,401	+3%
OWASA	4,916	4,501	-8%
GUC	4,641	4,788	+3%
HP	4,451	4,226	-5%

The following sections explore why some utilities experienced an increase in average household water use while others saw decreases. It highlights how watering restrictions, rate changes, media coverage, drought surcharges and irrigation shutoffs influenced residential water use behavior and patterns.

## Restrictions and Rates – Fayetteville Public Works Commission

Fayetteville Public Works Commission experienced an overall 9% increase in average household water use (the largest increase among the five). Figure 7 summarizes the changes in water use by individual households from their FY07 average to their FY08 average. Households are grouped by their average water use in fiscal year 2006-07. The bands of colors in each bar represent a percent change in water use. The redder colors represent varying degrees of conservation, the blue represent varying degrees of increases in water use. The yellow represents no change, give or take 5%. The graph shows that the households that used a lot of water in FY07 (high and super high users) did more conserving than the other two groups in Fayetteville. Meanwhile 21% of the low users increased their water use by more than 50%.

**Figure 7: Changes in water use by PWC households with varying levels of usage in FY07 (kGPM = thousands of gallons per month)**



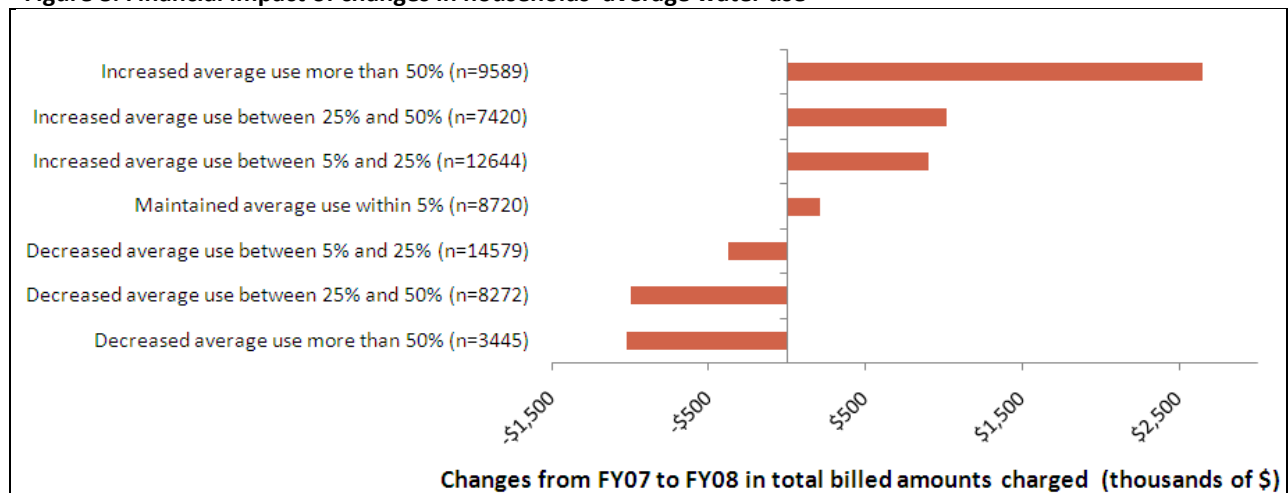
An investigation into the drought conditions, restrictions and rates reveal why this might be the case. For starters, the drought conditions didn't actually change much between the two years. In fact, Fayetteville averaged D3 (Extreme) for the entire timeframe. In addition, Fayetteville has enacted even-odd watering restrictions every year since 2002 from May 1 through September 30. The summer of 2007 was no different, except that the restrictions were not eased on October 1, and evolved into an all-out mandatory ban on outdoor water use from October 24 through May 1. Under the prohibition, the utility set a 10% water conservation goal for their customers. Figure 7 shows that the rate of

conservation among customers was anything but uniform with some customers conserving much more than 10% and other not conserving at all.

Instead something else besides restrictions seemed to have a strong influence on water usage patterns. On October 1, 2007, Fayetteville PWC adjusted their water rates. In doing so, the utility redefined rate structures from a two-tier increasing block structure (with a break at 6,000 GPM) to a three-tier increasing block (with breaks at 5,000 and 10,000 GPM). The new rate structure resulted in a much stronger conservation pricing signal for high users and super high users. The rate adjustments actually decreased rates for low water use (under 5,000 GPM).

As a result from the changes in water consumption and changes in rates, Fayetteville increased the total billed amount for these households by over \$2 million in FY08. Figure 8 shows how the total billed amount changed from fiscal year 2006-07 to 2007-08, based on the change in use. For example, those customers that increased their average water use by more than 50% (there were 9,589) paid a combined total of \$2.5 million more dollars than they did the year before. The right side is “heavier” (i.e. more red bar volume) than the left, representing the increase in total billed amount.

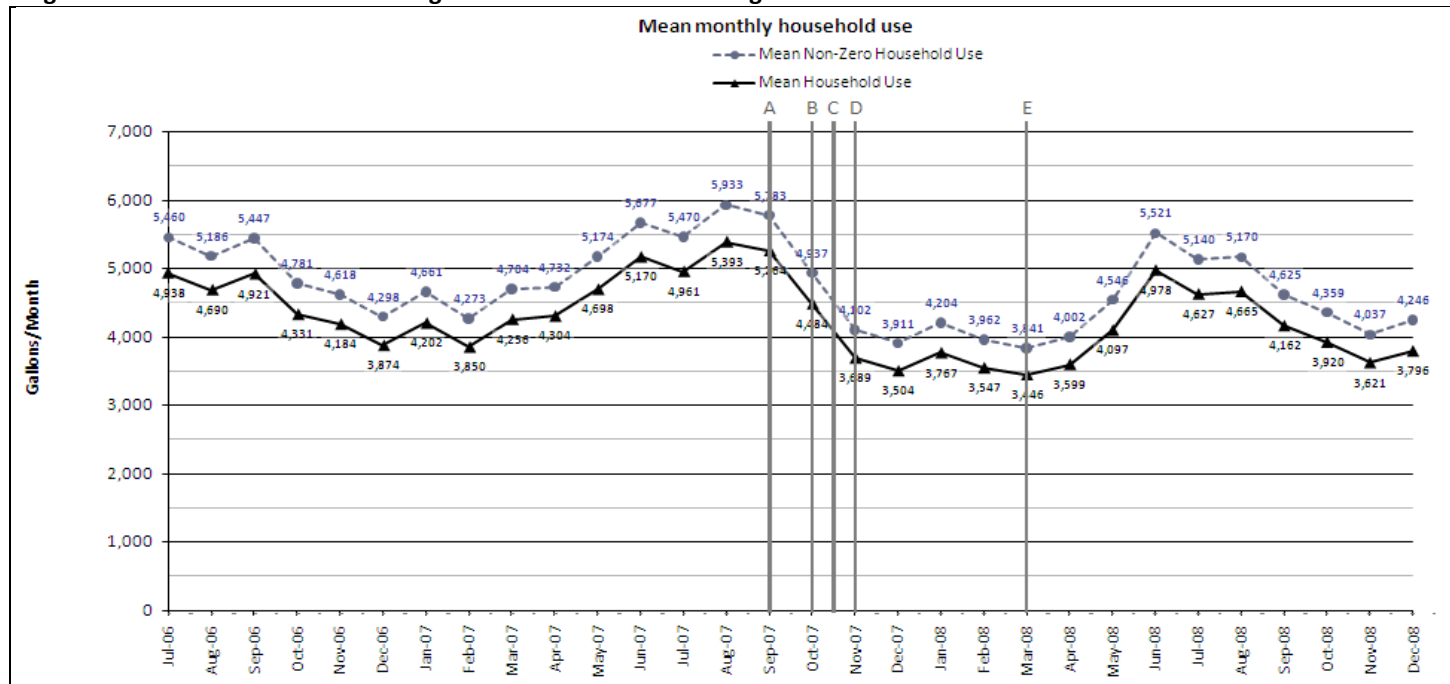
**Figure 8: Financial impact of changes in households' average water use**



**Mediashed effect – City of High Point Utilities**

High Point did not experience the increase in total billed amount that Fayetteville did. In fact, they only saw an increase of about \$220,000, despite the fact that their mandatory restrictions were only in effect for nine days. This nine-day mandatory restriction period is represented in Figure 9 as the area between lines “C” and “D.” Figure 9 plots the average monthly household use over the course of 30 months, along with drought and conservation interventions by the utility (represented by the vertical lines and letters). The graph shows High Point residential customers to be fairly conservative in their water use because there is no drastic peaking occurring the warm months. In contrast to the other four utilities, High Point has a relatively flat mean monthly usage throughout the year. Nonetheless, they still saw a decrease in average water use in the winter months. High Point’s staff believes this is because of High Point’s close proximity to Greensboro and that the decrease in average household water use was partially due to Greensboro’s strong conservation messaging in the local media, which also covers the High Point area.

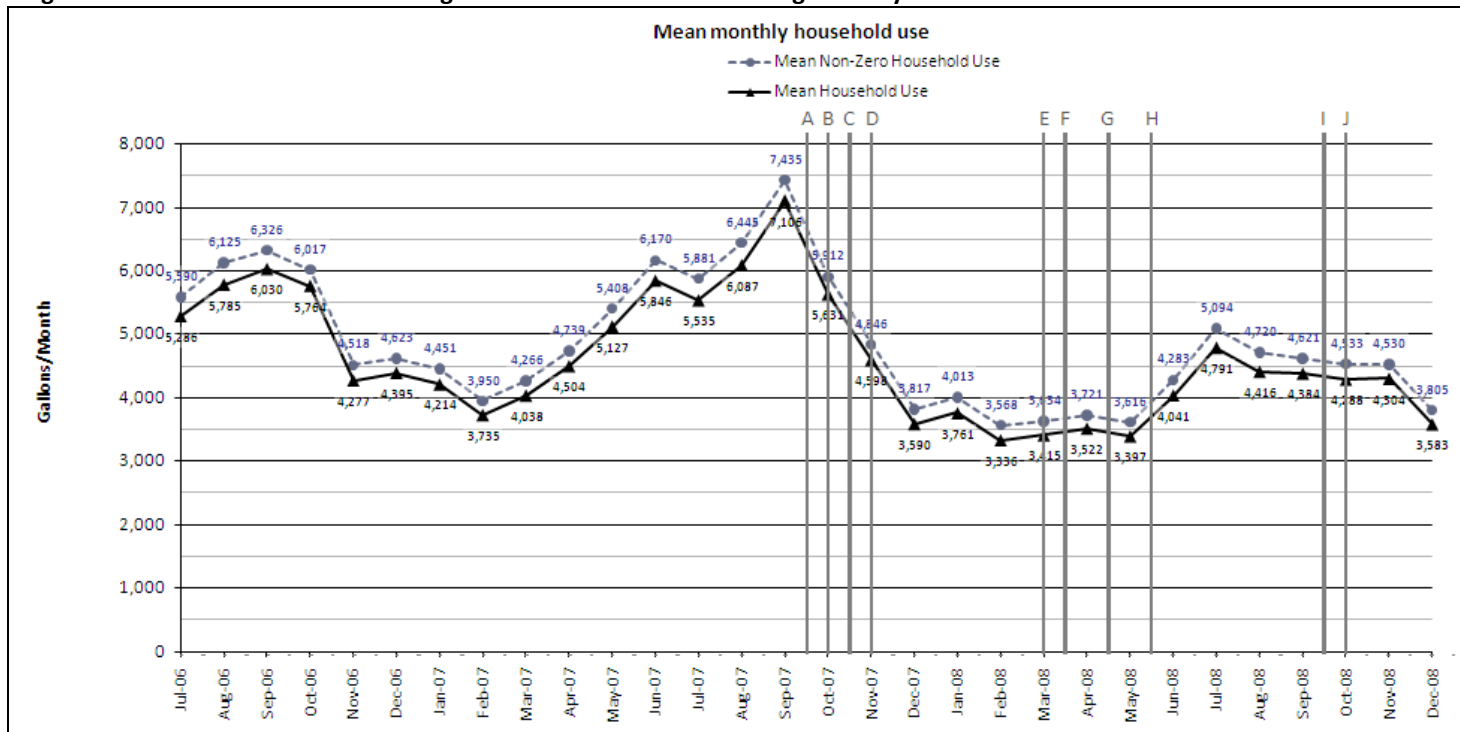
**Figure 9: Season fluctuation of average household water use in High Point**



### Drought Surcharges - OWASA

Figure 10 shows the change in average household water use by OWASA’s residential customers. The vertical lines in the graph reveal the prevalence of drought-time interventions by the utility. In OWASA’s case, the interventions include the adoption of increasing block rates (B), prohibition of spray irrigation (E), and even the implementation of drought surcharges, a temporary increase in water rates during the drought (D and F).

**Figure 10: Season fluctuation of average household water use in Orange County**



At “D,” the surcharges were applied to households using 6,000 gallons or more per month. At “F,” the surcharges increased and were additionally applied to households that use between 3,000-5,000 gallons per month. In the time period between “F” and “G,” water use at high levels received an exceptionally strong conservation signal. For all residential water use above 16,000 gallons, the water rate was five times what they normally were (from \$13.05/kgal to \$52.20/kgal). All drought surcharges were rescinded in time period “G”.



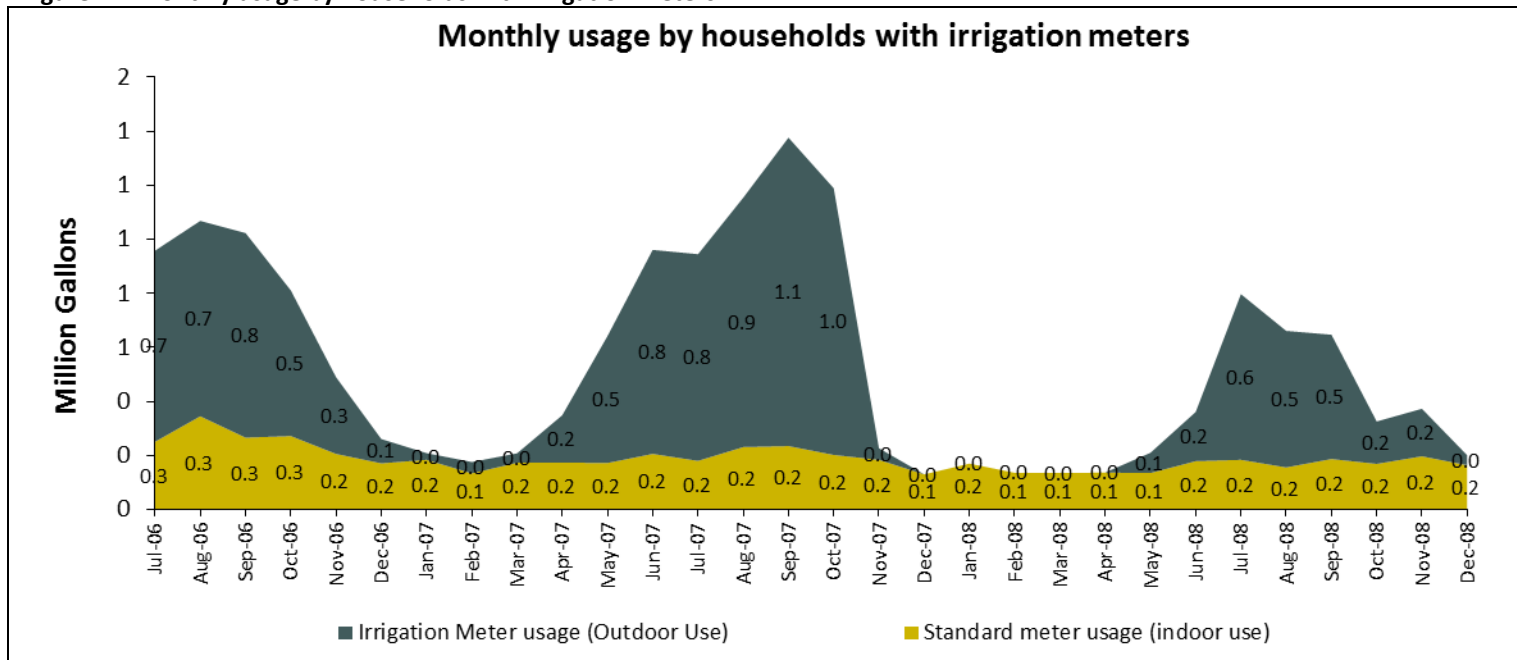
The immediate impact of the drought surcharges is not readily apparent in Figure 10. It is especially hard to separate the impact of the surcharges from the impact of restrictions and other drought-time messaging. Nonetheless, it appears that the action taken by the utility (in combination with weather conditions) had a residual impact on household water use into the summer of 2008, a time period with no restrictions or surcharges.

When presented with Figure 10, OWASA staff recounted a story from the previous year about the residual impact of their pricing signal. The story stemmed from a former Fortune 500 Chief Executive Officer that had retired to Orange County. When this residential customer received an extremely high bill due to the drought surcharges, he installed a sophisticated irrigation control system that substantially reduced his outdoor water use. The pricing signal prompted this customer to take an economical investigation into his water use. When OWASA rescinded the drought surcharge, that customer did not remove the irrigation controls. Instead, he will continue to use less water for his outdoor water use as long as the control system is maintained. In this case, a temporary rate adjustment caused a more permanent water usage adjustment. Given the median household income of OWASA's service area, this story is probably not unique to the CEO and might explain the flattening of the average household water use curve in Figure 10.

## Irrigation cutoffs - OWASA

In addition to drought surcharges, Orange Water and Sewer Authority (OWASA) intervened with other drought-time actions, including shutting off all of its irrigation meters from October 18, 2007 through April 11, 2008. Figure 11 shows the monthly water use of OWASA's residential customers with irrigation meters. The yellow baseline shows an overall relatively consistent domestic meter usage, indicating steady indoor water use. The dark blue-green portion of the graph reflects the amount of water that these customers used through their irrigation meters over the course of 30 months. This usage follows a pattern that might be anticipated, high in the summer and low in the winter. For the period in which the meters were completely shut off, the graph shows that no water flowed through these meters. Given that the shut off occurred during the winter, the action resulted in little water savings (except in the "shoulder" months) and was probably more symbolic in nature. This was a relatively easy gesture for OWASA to make. For the timeframe of the research, OWASA only had 32 households with irrigation meters. The other utilities had many more irrigation meters, with similar patterns of outdoor demand exceeding indoor use in the summer months by 3-7 times for customers with irrigation meters.

Figure 11: Monthly usage by households with irrigation meters



## **Irrigation**

But irrigation meters are not capturing all of the water used for irrigation in each of these utilities. In fact, in some cases, they are not capturing the majority of water used for heavy irrigation. Prompted by the drought bill's requirement that all "local government water systems and large community water systems require separate meters for new in-ground irrigation systems that are connected to their systems" starting July 1, 2009, we carried out a special analysis to study irrigation. This analysis attempted to capture the number of customers and amount of water likely to be attributed to heavy irrigation (i.e.: using in-ground irrigation systems, not simply hand watering). Billing records were used to estimate how many existing residential customers were using a standard meter to supply water to an in-ground irrigation system. This was done by looking at the water usage patterns for those households that did have irrigation meters and finding households without irrigation meters that had similar patterns.

Figure 12 compares the percentage households that are known irrigators (i.e. those with irrigation meters) with those that are likely to be using their standard meter for significant irrigation purposes. As can be expected, not all heavy residential irrigation is being captured by the irrigation meters, but in some cases (CMU, PWC and OWASA) the difference between the two is great. The following section explores the explanation for these differences in utility policies and rates.

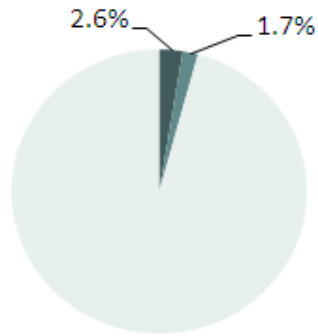
**Figure 12: Comparison of known and estimated irrigators**

<b>Utility</b>	<b>Number of residential accounts (FY08)</b>	<b>Percentage with irrigation meters</b>	<b>Percent that irrigate with in-ground systems, with and without irrigation meters (estimated)</b>
PWC	75,062	8%	12%
GUC	29,397	3%	3%*
HP	36,864	3%	5%
CMU	225,247	2%	9%
OWASA	18,018	0.2%	4%

**Policies – High Point**

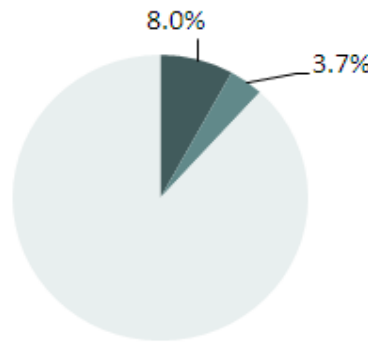
The drought bill mandates that utilities require irrigation meters for all new in-ground irrigation systems, starting July 1, 2009. But this requirement did not result in policy changes for some utilities, including the City of High Point. High Point has required all new in-ground irrigation system to be inspected and attached to a separate irrigation meter since 1998. As such, they are separately metering and billing a significant portion of their irrigation water use. Figures 13, 14 and 15 show the percent of households, usage and billed amount for which the known and assumed irrigators are responsible.

**Figure 13: Number of known and estimated irrigating households in High Point**



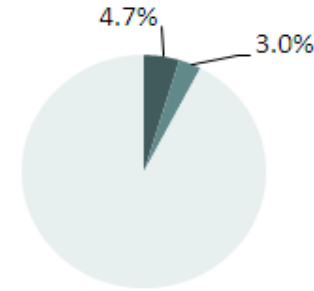
■ With irrigation meters: 929  
 ■ Estimated irrigators without irr. meters: 601  
 ■ Estimated non-irrigating: 34814

**Figure 14: Water usage by known and estimated irrigating households in High Point**



■ With irrigation meters: 145 MG  
 ■ Estimated irrigators without irr. meters: 68 MG  
 ■ Estimated non-irrigating: 1607 MG

**Figure 15: Billed amount to known and estimated irrigating households in High Point**



■ With irrigation meters: \$0.96 mil.  
 ■ Estimated irrigators without irr. meters: \$0.61 mil.  
 ■ Estimated non-irrigating: \$18.76 mil.

As time passes and all new in-ground irrigation systems are supplied with a separate irrigation meter, more NC water systems will have graphs similar to High Point's.

### **Irrigation Rates – High Point**

It is a common strategy among utilities that allow customers to purchase a separate meter for in-ground irrigation systems to charge higher rates for outdoor usage than for indoor water use. An EFC and NC League of Municipalities survey of water, irrigation and wastewater rates and rate structures in North Carolina found that, in 2009, nearly 9% of utilities have unique rate structures for water that is measured through irrigation meters. The survey revealed that two-thirds of these utilities (and 6% overall) charged higher irrigation rates than indoor water rates. Only nine of the irrigation rate structures provide a price discount to customers for their outdoor water usage. Almost all of the irrigation rates were lower than the combined water and wastewater rates for their respective utilities.

If we continue with the High Point example, a customer that uses 2,000 cubic feet during a summer month (assuming 700 for indoor, 1,300 for outdoor) could pay a relatively small irrigation tap and impact fee of \$350, and receive a total bill that is almost \$30 less than if they were paying water and sewer on all consumption (see Figure 16). Although the irrigation water has a higher rate than the indoor water rate, this rate still is much lower than the combined water and sewer rate they would be paying without the irrigation meter.

**Figure 16: The financial (dis)incentive of having an irrigation meter in High Point (FY09)**

	<b>Irrigation tap and impact fees (3/4")</b>	<b>Utility service</b>	<b>Monthly bill</b>	<b>Marginal price</b>
Without Irrigation Meter		20 ccf through standard meter	\$137.54	20-21 ccf through domestic meter: \$ 6.03 (\$2.20W + \$3.83 S)
With Irrigation Meter	\$350	7 ccf through standard meter/ 13 ccf through irrigation meter	\$59.15/\$49.54 Total: \$108.69	13-14 ccf through irrigation meter: \$3.30

Further, if that household is deciding whether or not to apply another hundred cubic feet of water to their lawn, they are looking at raising their monthly bill by \$3.30 if they have an irrigation meter. This is compared to \$6.03 if that water was going to go through a standard domestic meter. Customers in High Point with irrigation meters are receiving a much weaker conservation signal than customers without irrigation meters.

As more and more customers are installing irrigation meters, it will be important for utilities to take a holistic view of their utility rates to anticipate and mitigate changes in revenues. Two things may happen in this transition.

- (1) The utility may experience increases in water use, as customers respond to a lower price signal as described in the High Point example above.
- (2) Moving forward, the utility may experience higher price sensitivity to irrigation rate increases as described below.

Increases in rates can affect household irrigation demand (and subsequently revenues from irrigation demand). Demand for outdoor uses is typically more elastic, meaning that people are more likely to reduce outdoor water use in the face of increased rates. This is because outdoor use is considered discretionary for many. If rates are higher for irrigation, households will likely reduce their total demand more than if charged the same for indoor usage.

When irrigation rates are increased and demand reduces as a result, the typical net effect is that revenues will rise, but not as much as if demand had remained constant. Thus a utility that decides to charge more for irrigation usage, but does not factor in a reduction in demand, might find their projections overestimate demand and total revenues.

As utilities systematically install separate meters for irrigation systems, they may see reduced revenues for two reasons: not charging sewer rates for that use and the differential impact of tiered rates when usage is divided across two meters.

The first reason is more obvious. As more customers switch their outdoor usage to a separate irrigation meter, their sewer portion of the bill will decrease. The second reason, while less obvious, will also have revenue implications for utilities that use an increasing block rate structures. In these situations, customer bills will decrease if outdoor use through a separate irrigation meter starts out at the first (smallest price) block rather than accruing with indoor use to higher priced blocks. This will only occur if indoor and outdoor rates are the same because a utility could, of course, charge all outdoor use at a higher rate. Alternatively, a utility could bill such that both indoor and outdoor use accrue together, despite flowing through separate meters.

## Summary

No two utilities are exactly alike. Despite some similarities in monthly usage across the five utilities, there were significant differences in customer consumption behavior between them. This indicates that policies that might work for one utility may be ineffective in another utility where the customers behave differently. Although analyzing and understanding customer profiles are difficult, it should be an essential part of any large utility's management decision-making framework. At the very least, customer level analysis provides a summary of usage patterns across the year and can help utilities discover errors that can be easily corrected, such as using wrong rate structures classifications for specific customers.

Customer level analysis can also provide a better understanding of customers by revealing trends in usage and bill paying practices over time and customer specific practices such as peaking and irrigation usages. Producing profiles based on customer level usage history is a powerful tool in evaluating new utility-wide policy decisions affecting customers and allows utilities to better target specific marketing campaigns.

In addition to the benefit of individual utilities to understand and scrutinize their customers, an investigation into customer consumption behavior within the context of socioeconomic, housing and drought response can produce larger lessons for other utilities. This report sought to tell some of the stories using customer level analysis, supplemented with financial information and anecdotes.