Section 4
Existing Reclaimed Water Demands

Historical reclaimed water billing and pumping records and individual customer metering data were analyzed to determine current demands on the reclaimed water system as well as peaking factors related to seasonal and diurnal variations in reclaimed water usage. The diurnal variations and peaking factors discussed in this section will be applied to future demand scenarios.

4.1 Average Annual Demand

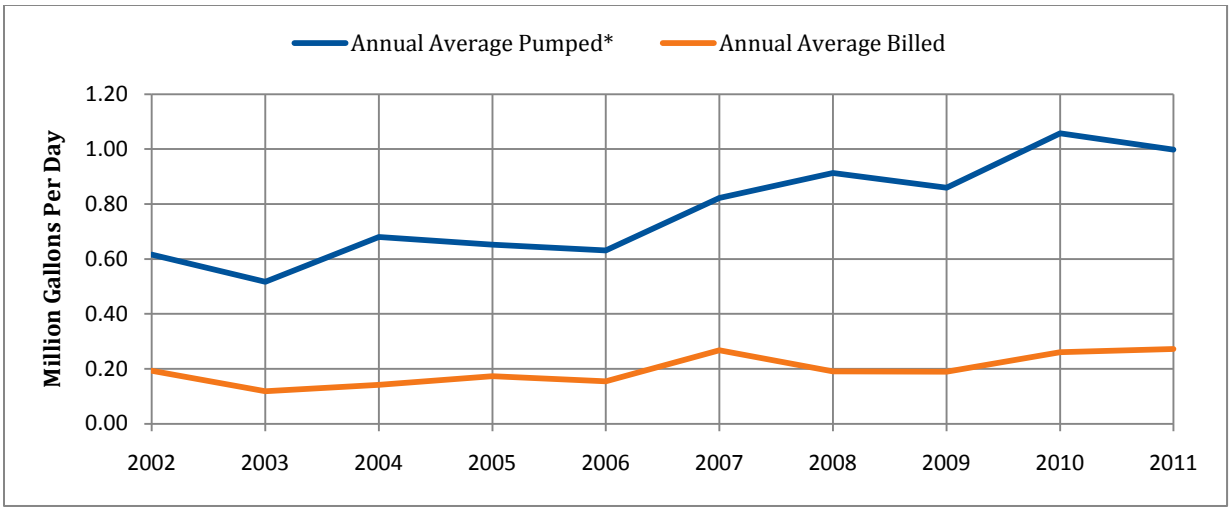
Demands on the reclaimed water system are seasonal in nature since they are primarily for irrigation and cooling water. Demands peak during the summer months and drop to a minimum during the winter months. Therefore, the system is not typically operated at an average annual flow; the seasonal and daily maximum/minimum flows are more important to consider for the evaluation of the reclaimed water facilities. However, the average annual demand is used as a basis for projecting future demands on the system and for determining total annual revenue generated by the system.

Figure 4-1 shows a comparison of average annual pumped reclaimed water and average annual billed reclaimed water since 2002 (the first full year of operation for the reclaimed water system). Figure 4-1 does not include reclaimed water use in the West Cary service area, since customers in the West Cary area were served with potable water until the spring of 2012 when the Durham County Triangle Wastewater Treatment Plant (TWWTP) reclaimed water distribution facilities were brought online.

Historically, the billed customer usage accounts for only approximately 20 to 35 percent of the annual pumped reclaimed water. The remainder is attributed to non-revenue water (NRW) uses such as on-site non-potable use at the Town's WRFs, bulk water distribution, blowoffs to maintain water quality in the system, and system losses.

The 2010 customer meter billing data serves as a baseline for projecting future demand as well as allocating customer demands in the hydraulic model because it represents the historical maximum demand. According to records at the Raleigh-Durham International Airport, annual precipitation in 2010 was 5.7 inches below average, with the peak summer months of June, July, and August all experiencing lower than average rainfall. Therefore, 2010 represents conservative conditions for the reclaimed water system (i.e. more reclaimed water is used during drier years). **Table 4-1** presents a summary of the 2010 average annual pumped, billed, and non-revenue reclaimed water demands by service area.

According to Town staff, current on-site reclaimed water use at the SCWRF averages 150,000 gpd year-round, and on-site reclaimed water use at the NCWRF averages 200,000 gpd year-round. Although the reclaimed water used by the NCWRF is pumped through the reclaimed water high service pumps, it is metered separately from the distributed reclaimed water. The estimated NCWRF reclaimed water use is included in the annual average pumped flow in Figure 4-1. Due to the configuration of the blowoff valves, most blowoff volumes cannot be metered directly and, therefore, are estimated by Town staff. Continuous blowoff of reclaimed water is currently maintained at extremities within both the North and South Cary distribution systems. Blowoffs are discussed further in Section 2.5.



*Includes metered flow at NCWRF and SCWRF plus estimated use of reclaimed water on-site at NCWRF (which is not included in the metered flow)

Figure 4-1
Historical Pumped and Billed Reclaimed Water

Table 4-1. Summary of 2010 Annual Average Pumped and Billed Reclaimed Water Use

	Number of Customers[1]	Average Pumped Flow[2] (gpd)	Billed Use (gpd)	Non-Revenue Water (gpd)		
				Bulk	WRF Non-Potable[3]	Blowoff & Miscellaneous[4]
North Cary	546	713,000	201,000	2,300	200,000	310,000
South Cary	99	344,000	59,000	100	150,000	135,000
System Total	*645*	*1,057,000*	*260,000*	*2,400*	*350,000*	*445,000*

1) Number of customers based on number of reclaimed water meters billed in 2010.
2) Annual average pumped flow including estimate of 200,000 gpd NCWRF use, which is not accounted for in daily reclaimed water meter data at NCWRF.
3) Average on-site non-potable WRF use estimated by plant staff.
4) Assuming 5% miscellaneous water use, blowoff flows are estimated at 274,000 gpd for North Cary and 118,000 gpd for South Cary, on average.

4.2 System-Wide Peaking Factors

The following sections describe the development of peaking factors that will be applied to the annual average reclaimed water projections and used for evaluation and design of reclaimed water facilities.

4.2.1 Seasonal Peaking Factors

Figure 4-2 shows the typical seasonal variation in reclaimed water flow from the NCWRF and SCWRF along with seasonal variation in billed usage. The Town's reclaimed water usage is generally highest from May to October. However, based on comparison of monthly billing and pumping data, the NRW portion of the reclaimed water flow (primarily comprised of WRF use and blowoffs) has remained relatively constant throughout the year during 2010 and 2011. Since this constant NRW demand accounts for a large percentage of the overall reclaimed water flows, it has the effect of diluting the seasonal and maximum day peaking factors attributed to the customer demand (as shown in Figure 4-

2). Customer meter billing data is only available on an aggregate monthly basis; therefore the reclaimed water peaking factors used in this study were determined by subtracting estimates of the on-site WRF use and blowoff water from the daily pumping records at the SCWRF and NCWRF during 2010 and 2011.

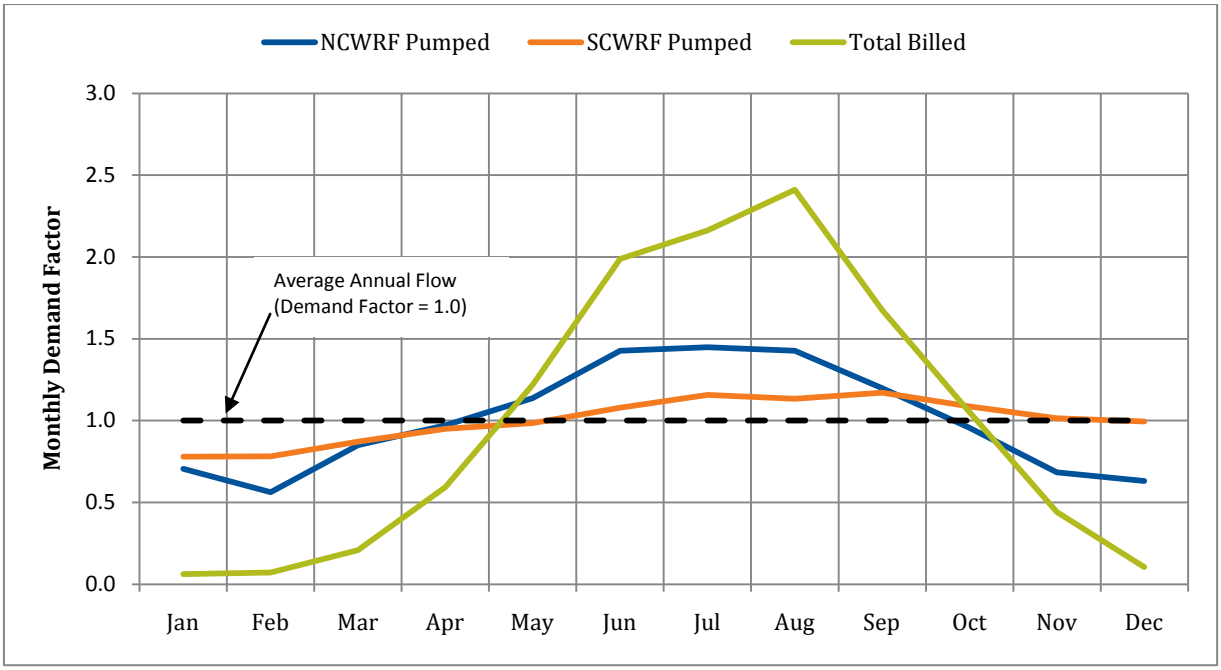


Figure 4-2
Normalized Monthly Reclaimed Water Use (Based on 2007-2011 Data)

Table 4-2 gives the seasonal 'summer' (May through October) and 'winter' (November through April) peaking factors for the North Cary and South Cary reclaimed water service areas expressed as a ratio to the average annual demand. The maximum month to average annual demand peaking factor is also presented for each service area. System-wide average peaking factors for winter seasonal demand, summer seasonal demand, and maximum month reclaimed water demand are 0.3, 1.6, and 2.4, respectively. Applying these factors to future annual average demand projections provides an estimate of the customer-related flows that the reclaimed water system must sustain on a long-term basis.

4.2.2 Maximum Daily Peaking Factor

The maximum day to average annual demand ratio (or max day peaking factor) is a key parameter for evaluating the reclaimed water system. Major elements of the distribution system are typically sized to deliver the maximum day demand reliably and consistently. In addition, reclaimed water supply is typically limited by the amount of water available to satisfy the maximum day demand, with hourly demands in excess of the maximum day satisfied through system storage.

The max day peaking factor was determined using daily reclaimed water pumping records for 2010 and 2011, as provided in Table 4-2. The average North Cary and South Cary max day peaking factors are similar; therefore, an average peaking factor of 3.4 is recommended for projecting future maximum day reclaimed water demands related to overall customer usage.

Table 4-2. Summary of Seasonal and Maximum Daily Reclaimed Water Peaking Factors

Year	Reclaimed Water Use* (mgd)					Peaking Factor			
	Average Day	Winter (Nov-Apr)	Summer (May-Oct)	Max Month	Max Day	Winter: Avg Day	Summer: Avg Day	Max Month: Avg Day	Max Day: Avg Day
North Cary									
2010	0.25	0.07	0.41	0.51	0.74	0.3	1.6	2.0	3.0
2011	0.20	0.03	0.36	0.58	0.75	0.2	1.8	2.9	3.8
Average						***0.2***	***1.7***	***2.5***	***3.4***
South Cary									
2010	0.08	0.04	0.12	0.17	0.30	0.5	1.5	2.1	3.8
2011	0.06	0.05	0.08	0.13	0.20	0.8	1.3	2.2	3.3
Average						***0.7***	***1.4***	***2.1***	***3.5***
System Total									
2010	0.33	0.11	0.53	0.68	1.04	0.3	1.6	2.1	3.2
2011	0.26	0.08	0.44	0.71	0.95	0.3	1.7	2.7	3.7
Average						***0.3***	***1.6***	***2.4***	***3.4***

*From daily pumping records at the NCWRF and SCWRF minus estimated blowoff flow and non-potable WRF use.

4.2.3 Diurnal Variations and Hourly Peaking Factors

Peak hour demand is the highest rate of reclaimed water consumption to occur during any one-hour period during a given year. Peak hour demand is often expressed as the ratio to the average annual demand. The reclaimed water facilities are sized to convey peak hour flow and storage tanks are typically sized to equalize the system demand for all demand in excess of the maximum day, including the peak hour demand. If there is no system storage, the supply of reclaimed water and the reclaimed water pumping capacity must be sufficient to meet this demand.

In order to evaluate the peak hour demand factors, hourly reclaimed flows pumped from the Town's WRFs were examined for several recent peak flow days. For the South Cary service area, hourly flows recorded by the SCWRF SCADA system for the top five flow days during June through August of 2010 and 2011 were compared to the average flow on those same days to develop unit diurnal curves. SCADA exports of hourly reclaimed flows from the NCWRF are not available. Consequently, plots from the SCADA system and strip chart records of reclaimed flow for the period of August 1 through August 5, 2011 were used to develop unit diurnal curves for the North Cary service area.

As the reclaimed water system grows and demands on the system increase, it is expected that continuous blowoff of large volumes of reclaimed water will not be required to maintain water quality, particularly on peak demand days. Therefore, prior to developing the unit diurnal curves, the estimated blowoff flows were subtracted from the hourly pumped flow records described above. The resulting average diurnal curves for the North Cary and South Cary reclaimed water service areas are shown in **Figure 4-3**. The curves are similar for both service areas, with most reclaimed water use occurring during the overnight and early morning hours. The maximum reclaimed water flow occurs at 5:00 a.m. and minimum flow occurs at noon. The peak hour to max day flow ratio is 2.5. Applying

this ratio to the max day peaking factor of 3.4 results in a system-wide peak hour to average annual peaking factor of 8.5.

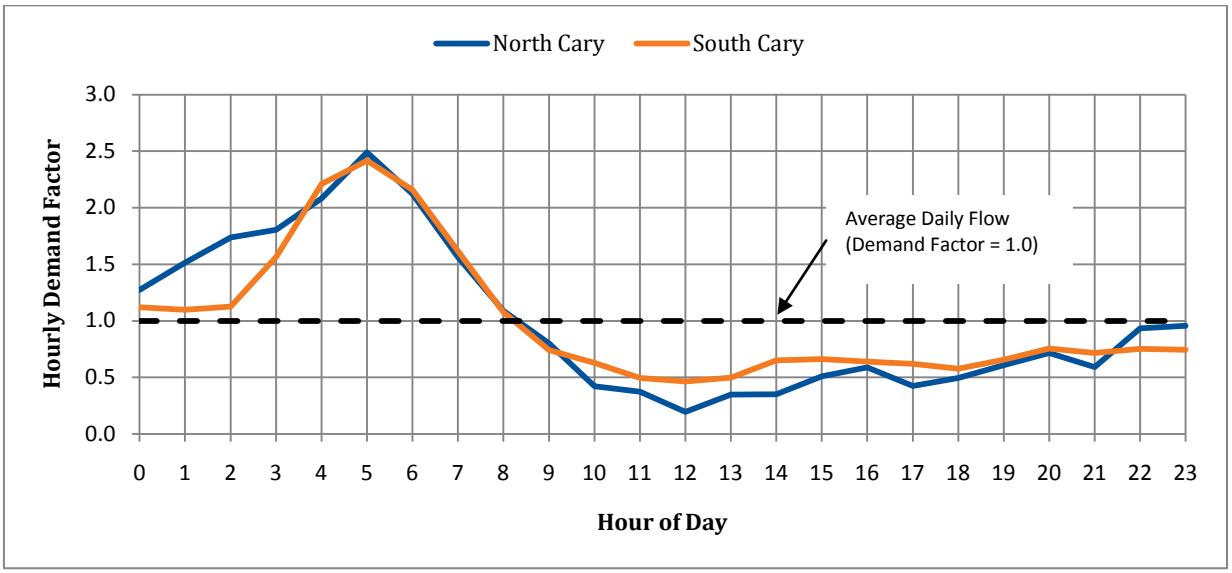


Figure 4-3
Unit Diurnal Reclaimed Water Use Pattern for Peak Flow Days

The pumped reclaimed water diurnal curves will be used to develop representative diurnal flow variations in the hydraulic models. Diurnal variations for specific customers are discussed in the following section.

4.3 Customer-Specific Diurnal Variations

The previous sections describe existing demands and peaking factors for reclaimed water on a system-wide basis. However, reclaimed water usage varies significantly among individual customers. The Town performed monitoring of reclaimed water use during the summer of 2010 and 2011 to quantify reclaimed water usage patterns of specific large customers.

4.3.1 Meter Monitoring Program

Meter Master 100EL monitors were installed on 16 of the Town's existing reclaimed water meters during June to August 2010. Monitors were installed on 10 of the Town's existing reclaimed water meters during July to August 2011. Monitors recorded water usage in one-minute increments. Data for an additional two meters was collected via radio telemetry installed on the meters as part of the Aquastar metering program.

Due to data collection limitations, data is not available continuously for the 2010 monitoring period. The USA Baseball Training Complex and Verizon Telecommunications meters monitored in 2010 were re-monitored in 2011 to provide more complete data since they are both critical large volume reclaimed water customers. **Table 4-3** gives a summary of the location, type of usage, and duration of data collection for the monitored meters. Meter locations are shown in **Figure 4-4**.

Table 4-3. Individual Customer Meters Monitored During 2010/2011

Service Area	Type	Customer Description/ Address	Meter #	Dates of Data Collection
North	Cooling Tower	Verizon Telecommunications	60260804	7/13/10 to 7/17/10 7/12/11 to 8/3/11
North	Office/Industrial Complex Irrigation	John Deere	60451098	7/12/11 to 8/3/11
North	Street Landscape Irrigation	Weston Property Owner's Association; 4001 Weston Pkwy	60181359	7/20/11 to 8/3/11
North	Street Landscape Irrigation	Weston Property Owner's Association; 9500 Weston Pkwy	60492152	6/29/10 to 7/7/10 7/12/10 to 7/20/10 7/27/10 to 8/4/10
North	Single Family Residential Irrigation	Weston Oaks Subdivision - 212 Stamford Dr	84906537	8/15/11 to 8/30/11
North	Single Family Residential Irrigation	Wessex Subdivision - 200 Midenhall Way	74829159	6/29/10 to 7/7/10
North	Single Family Residential Irrigation	Wessex Subdivision - 216 Midenhall Way	86704241	6/29/10 to 7/6/10 7/12/10 to 7/19/10
North	Single Family Residential Irrigation	Wessex Subdivision - 203 Bathgate Ln	76608755	6/29/10 to 7/3/10 7/12/10 to 7/20/10
North	Single Family Residential Irrigation	Wessex Subdivision - 303 Bathgate Ln	40558106	6/29/10 to 7/3/10 7/12/10 to 7/20/10
North	Single Family Residential Irrigation	Wessex Subdivision - 307 Bathgate Ln	75382531	6/29/10 to 7/3/10 7/12/10 to 7/20/10
North	Single Family Residential Irrigation	Bexley Subdivision - 215 Juliet Cir	84906439	6/29/10 to 7/7/10 7/12/10 to 7/20/10 7/29/10 to 8/5/10
North	Single Family Residential Irrigation	Bexley Subdivision - 505 Spencer Crest Ct	84005090	7/13/10 to 7/21/10
North	Single Family Residential Irrigation	Weston Manor Subdivision - 505 Bexley Bluff Ln	83104073	6/29/10 to 7/7/10 7/12/10 to 7/20/10
North	Apartment Complex Irrigation	Weston at Lakeside*	72077291	9/11/11 to 10/6/11
North	Cooling Tower	SAS Building D*	72387945	9/11/11 to 10/6/11
South	Landscape Irrigation	Westlake Homeowner's Association	51096230	7/20/11 to 8/3/11
South	Recreational Park Irrigation	Town of Cary - Middle Creek Park	70087844	7/15/11 to 8/3/11
South	School Irrigation	Middle Creek High School	60254346	6/29/10 to 7/7/10 7/27/10 to 8/10/10
South	Single Family Residential Irrigation	Westlake Subdivision - 4807 Homeplace Dr	83615455	7/12/11 to 8/3/11
South	Single Family Residential Irrigation	Westlake Subdivision - 1007 Wolfs Bane Dr	82664659	6/29/10 to 7/7/10 7/13/10 to 7/21/10 7/28/10 to 8/11/10
South	Single Family Residential Irrigation	Westlake Subdivision - 3007 Wolfs Bane Dr	85652490	7/13/10 to 7/21/10
West	Apartment Complex Irrigation	Chancery Village at the Park	60536040	6/29/10 to 7/7/10 7/28/10 to 8/12/10
West	Landscape Irrigation	Amberly Community Association	60615112	7/12/11 to 7/20/11 8/15/11 to 8/30/11
West	Office/Industrial Complex Irrigation	Biogen Idec	60413998	7/12/11 to 8/3/11
West	Office/Industrial Complex Irrigation	NetApp	60283080	6/29/10 to 7/7/10 7/12/10 to 7/20/10 7/27/10 to 8/4/10
West	Recreational Park Irrigation	USA Baseball Training Complex	70165718	6/29/10 to 7/3/10 7/12/10 to 7/16/10 7/12/11 to 8/3/11

* Weston at Lakeside and SAS data collected via radio telemetry installed on the meters as part of the Aquastar metering program.

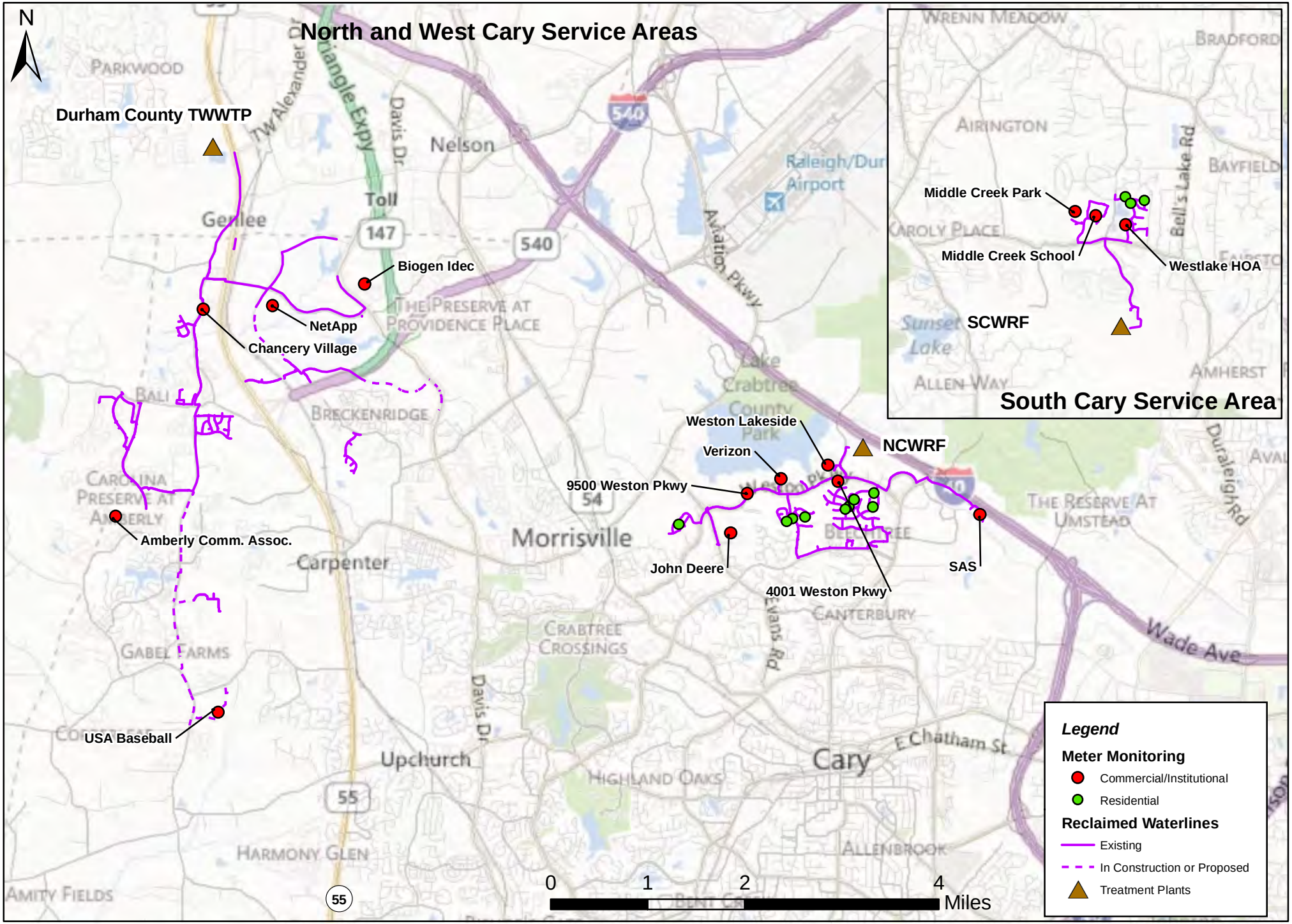


Figure 4-4
2010/2011 Reclaimed Meter Monitoring Locations

As shown in **Figures 4-5** and **4-6**, the monitoring periods during 2010 and 2011 included the maximum day of reclaimed water use for the North Cary service area. Reclaimed water use during the monitoring periods was near the maximum day each year for the South Cary service area.

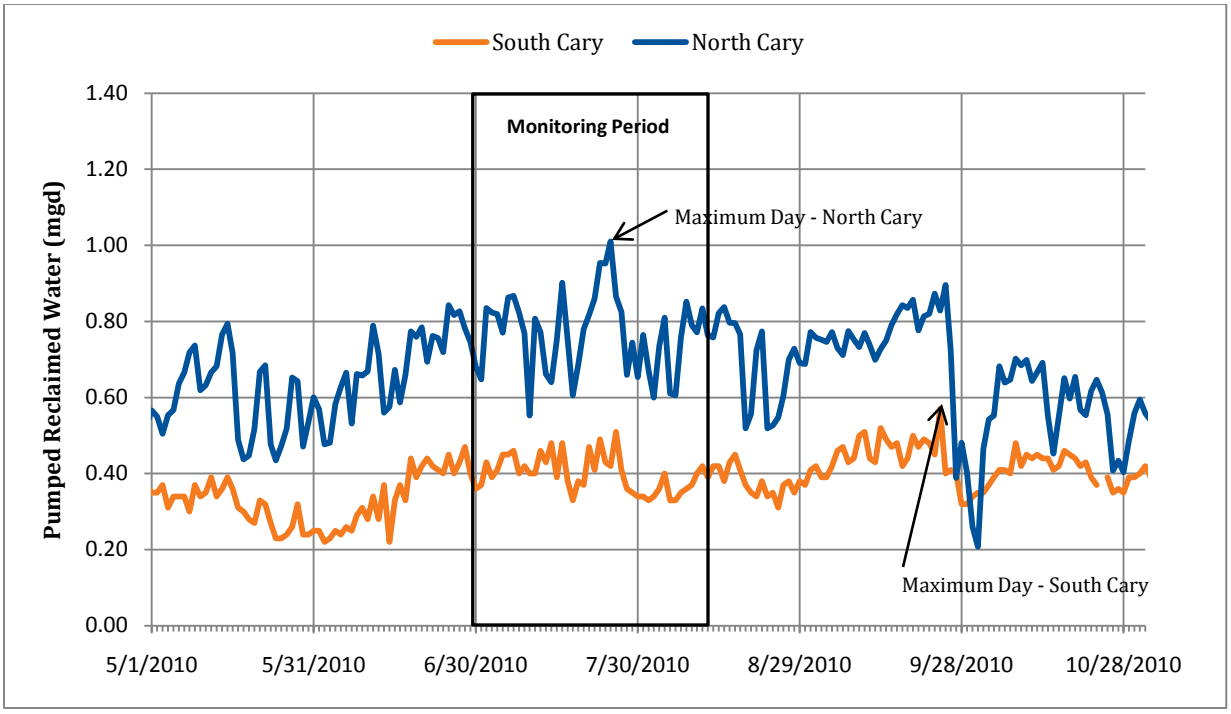


Figure 4-5
Daily Reclaimed Water Flow - Summer 2010

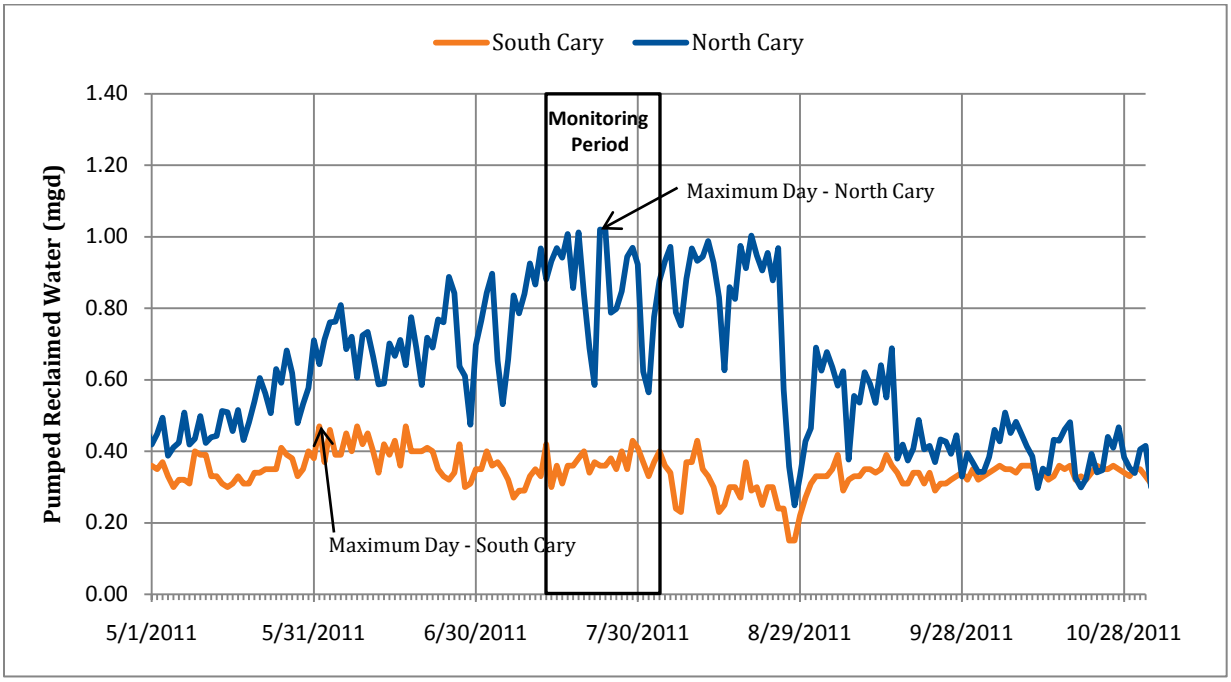


Figure 4-6
Daily Reclaimed Water Flow - Summer 2011

The meter monitoring data was summarized into hourly flow and compared to the daily average flow in order to develop unit diurnal patterns.

Analysis of the 12 residential meters monitored in 2010 and 2011 indicates that although each residence tends to irrigate on a set schedule for only a few hours of the day, there is not a 'typical' usage pattern that can be generally applied to all residential customers. The peak hour for irrigation varies from residence to residence and is dictated by individual irrigation system settings. Individual reclaimed water consumption curves for the residential customers included in the meter monitoring program are provided in **Appendix D**.

Since a typical residential pattern could not be determined directly from the residential meter monitoring data, a generalized diurnal pattern was determined for residential customers within the North and South Cary service areas by subtracting the large commercial metered flows from the pumped reclaimed water flow at the WRF. The generalized diurnal curves are provided in the following sections and will be used for hydraulic modeling of the reclaimed water systems.

4.3.2 North Cary Service Area

Large reclaimed water users monitored during 2010/ 2011 within the North Cary service area include Verizon Telecommunications, Weston Property Owners Association, and John Deere. In addition, hourly data was obtained for the irrigation meter at Weston at Lakeside and the new SAS Building D cooling tower. These two locations could not be outfitted with the Meter Master monitors during July to August 2011, but new meters with radio telemetry were installed in September as part of the Town's Aquastar metering program. Hourly data was collected September 11 through October 6, 2011 for the two Aquastar meters. The monitored meters represent approximately 20 percent of the average annual customer demand in the North Cary service area.

Figure 4-7 shows the unit diurnal reclaimed water usage pattern observed at each meter. This pattern was developed by averaging the individual daily data for each meter on days with the highest reclaimed water use. Therefore, this pattern is applicable for peak summer reclaimed water demand. The hourly data for all days used to compute the average water usage patterns is provided in Appendix D. The majority of reclaimed water use by the large commercial customers occurs between 8 p.m. and 10 a.m. The exception is Verizon Telecommunications, which uses reclaimed water for cooling tower use and maintains a relatively consistent demand throughout the day. An average pattern for the SAS cooling tower could not be determined due to gaps in the metering data.

Table 4-4 presents the maximum day peaking factor for each individual customer, calculated by comparing maximum day demand during the meter monitoring period to the average annual demand for that customer. It should be noted that the maximum day demand does not occur on the same day for all customers.

A generalized diurnal pattern was developed for all remaining residential and commercial customers within the North Cary service area using an hourly mass balance approach. For each hour of the day, the reclaimed water use attributed to non-potable demand at the WRFs, blowoffs, and the large commercial users included in the meter monitoring program was subtracted from the reclaimed water pumped at the NCWRF during that hour. The remainder of the reclaimed water flow each hour was compared with the daily average remaining flow to create a unit diurnal pattern that can be applied to residential customers and other customers that were not monitored directly. The diurnal pattern calculated for the remaining customers peaks at 5 a.m. and is provided in Figure 4-7.

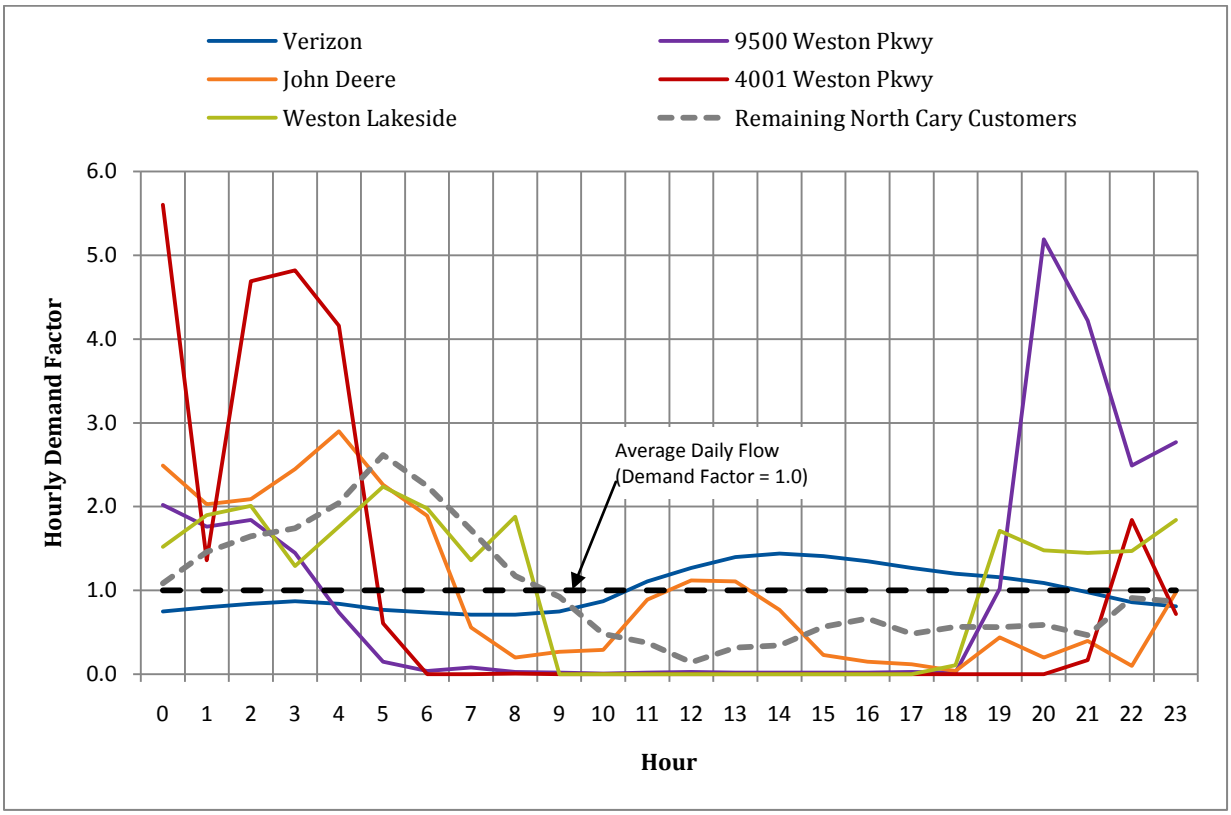


Figure 4-7
North Cary Customer-Specific Unit Diurnal Reclaimed Water Use Patterns

Table 4-4. Comparison of Maximum Monitored Day to Average Day Demand for North Cary Reclaimed Water Customers

Meter #	Customer	Average Annual Demand (gpd)	Maximum Monitored Day		Max Day: Avg Day Peaking Factor
			Demand (gpd)	Date	
60260804	Verizon Telecommunications	9,200	23,200	7/22/2011	2.5
60451098	John Deere	6,800	43,200	7/24/2011	6.4
60181359	Weston Property Owner's Association; 4001 Weston Pkwy	4,100	10,400	7/21/2011	2.5
60492152	Weston Property Owner's Association; 9500 Weston Pkwy	5,200	18,600	7/15/2010	3.6
72077291	Weston at Lakeside	11,100	29,800	9/15/2011	2.7
72387945	SAS Building D*	7,200	11,900	9/16/2011	1.7

*SAS meter installed in May 2011; average annual demand is estimated

4.3.3 South Cary Service Area

The largest reclaimed water users within the South Cary service area are the Middle Creek School (3 meters), the Town of Cary Middle Creek Park (2 meters) and the Westlake Homeowner's Association (5 meters). The remaining customers include the Park at Westlake, Primrose School at Westlake, and individual residences. One meter each for the Middle Creek School, Middle Creek Park, and Westlake HOA were monitored. Based on 2010 meter billing data, these three meters represent approximately 16 percent of the average annual customer demand in the South Cary service area.

Figure 4-8 shows the unit diurnal reclaimed water usage pattern observed at each meter. This pattern was developed by averaging the individual daily data for each meter on days with the highest reclaimed water use. Therefore, this pattern is applicable for peak summer reclaimed water demand. The hourly data for all days used to compute the average water usage patterns is provided in Appendix D. The majority of reclaimed water use by the large commercial/institutional customers occurs between midnight and noon. During the monitoring period, the Middle Creek School irrigated for only two to three hours per day and, therefore, has a very high hourly flow factor during those hours. **Table 4-5** presents the maximum day peaking factor for each meter, calculated by comparing maximum day demand during the meter monitoring period to the average annual demand for that meter. It should be noted that the maximum day demand does not occur on the same day for all customers.

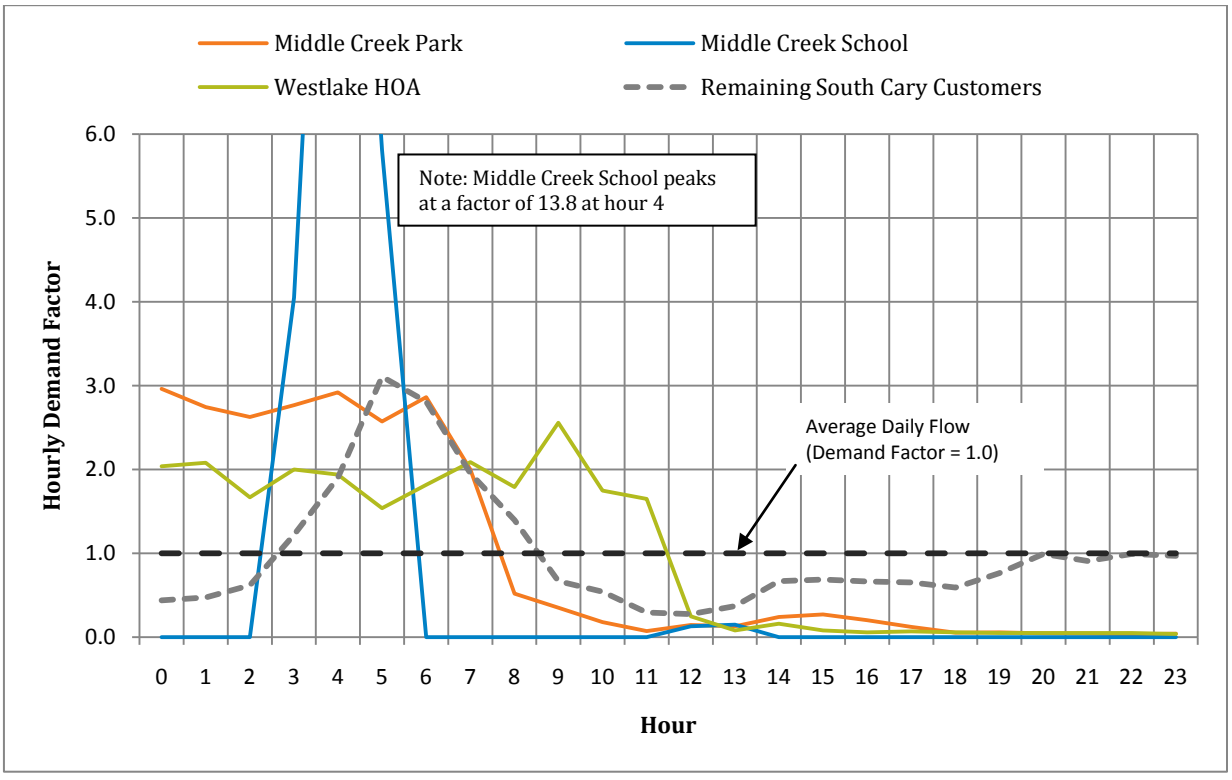


Figure 4-8
South Cary Customer-Specific Unit Diurnal Reclaimed Water Use Patterns

Table 4-5. Comparison of Maximum Monitored Day to Average Day Demand for South Cary Reclaimed Water Customers

Meter #	Customer	Average Annual Demand (gpd)	Maximum Day Monitored		Max Day: Avg Day Peaking Factor
			Demand (gpd)	Date	
51096230	Westlake Homeowner's Association	2,100	8,500	7/27/2011	4.0
70087844	Town of Cary - Middle Creek Park	5,500	56,200	7/29/2011	10.2
60254346	Middle Creek High School	1,700	13,800	7/28/2010	8.1

A generalized diurnal pattern was developed for all remaining reclaimed water customers within the South Cary service area using an hourly mass balance approach. For each hour of the day, the reclaimed water use attributed to non-potable demand at the WRFs, blowoffs, and the large users included in the meter monitoring program was subtracted from the reclaimed water pumped at the SCWRF during that hour. The remainder of the reclaimed water flow each hour was compared with the daily average remaining flow to create a unit diurnal pattern that can be applied to residential customers and other meters that were not monitored directly. The diurnal pattern calculated for the remaining customers in the South Cary service area peaks at 5 a.m. and is provided in Figure 4-8.

4.3.4 West Cary Service Area

Large commercial irrigation customers monitored during 2010 and 2011 within the West Cary service area include Biogen Idec, USA Baseball Training Complex, Amberly Community Association, NetApp, and Chancery Village at the Park (apartments). During the monitoring period, these meters were supplied with potable water from the Cary-Apex Water Treatment Plant, but will be converted to reclaimed water from the TWWTP once the Jordan Lake Water Reclamation and Reuse (JLWR) pipeline is complete. These five meters represent approximately 45 percent of the average annual customer demand expected when the JLWR pipeline is completed.

Figure 4-9 shows the unit diurnal irrigation water usage pattern observed at each meter. This pattern was developed by averaging the individual daily data for each meter (included in Appendix D) on days with the highest irrigation water use. Therefore, this pattern is applicable for peak summer reclaimed water demand. Irrigation use peaks in the early morning or evening hours, between 7 p.m. and 7 a.m., except for Biogen Idec and the USA Baseball Training Complex. These two meters did not have a consistent daily pattern, but both had a relatively constant demand over 24 hours on the peak irrigation day.

Table 4-6 presents the maximum day peaking factor for each individual customer, calculated by comparing maximum day demand during the meter monitoring period to the average annual demand for that customer. It should be noted that the maximum day demand does not occur on the same day for all customers.

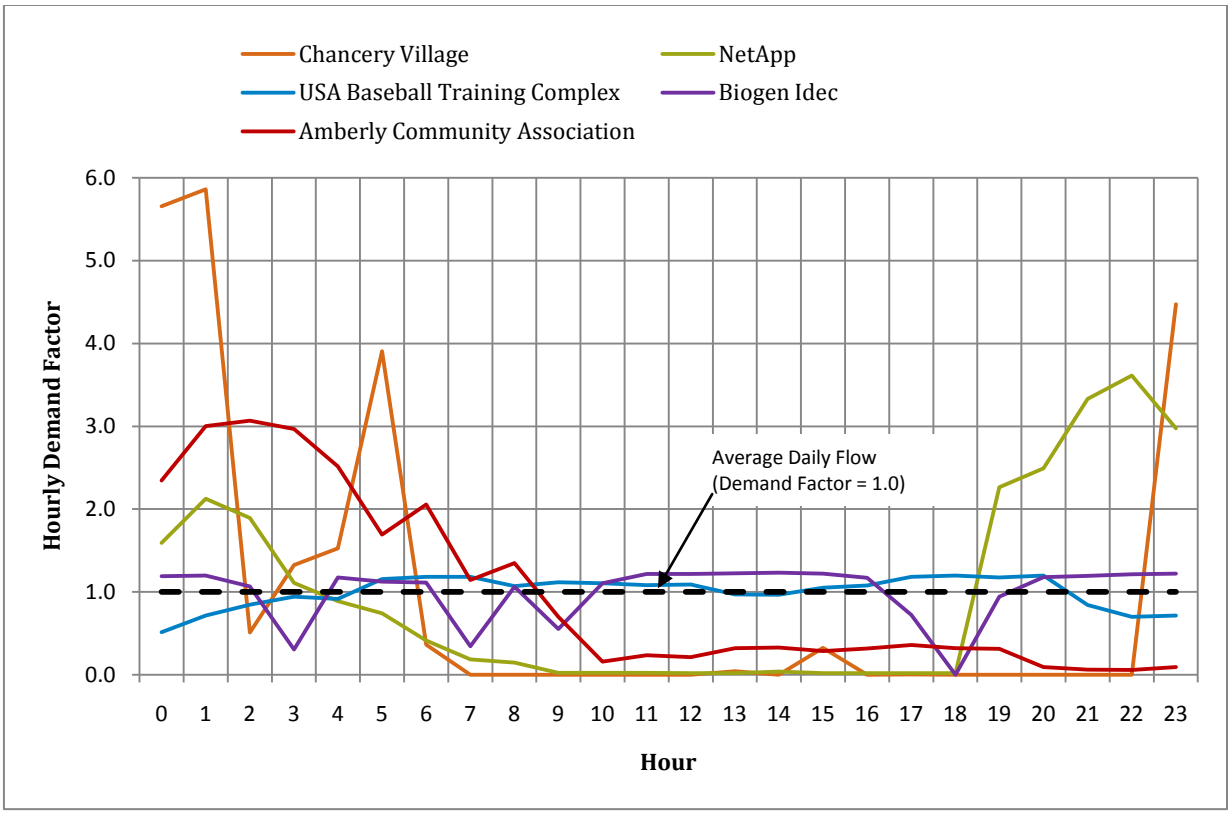


Figure 4-9
West Cary Customer-Specific Unit Diurnal Irrigation Water Use Patterns

Table 4-6. Comparison of Maximum Monitored Day to Average Day Demand for Future West Cary Reclaimed Water Customers

Meter #	Customer	Average Annual Demand (gpd)	Maximum Day Monitored		Max Day: Avg Day Peaking Factor
			Demand (gpd)	Date	
60536040	Chancery Village at the Park	1,900	13,100	8/8/2010	6.9
60615112	Amberly Community Association	14,700	37,200	7/14/2011	2.5
60413998	Biogen Idec	30,100	74,800	7/20/2011	2.5
60283080	NetApp	7,000	58,700	8/1/2010	8.4
70165718	USA Baseball Training Complex	26,300	209,400	7/30/2011	8.0