Appendix A
Water Use Analysis

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TECHNICAL MEMORANDUM

Long Range Water Resources Plan Update, Water Use Analysis

Prepared for

Town of Cary

316 N. Academy Street
Cary, NC 27513

December 2017

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Acronyms and Abbreviations

AMI	advanced metering infrastructure
AWWA	American Water Works Association
CH2M	CH2M HILL North Carolina, Inc.
COM	commercial
CPZ	Central Pressure Zone
GIS	geographic information system
GPCD	gallon(s) per capita per day
GPD	gallon(s) per day
IBT	interbasin transfer
ID	identification
IND	industrial
INS	institutional
IQRL	interquartile range lower
IQRU	interquartile range – upper
IR	irrigation meter
IWRMP	Integrated Water Resources Management Plan
LQR	lower quartile range
LRWRP	Long Range Water Resources Plan
MFR	multifamily residential
MGD	million gallons per day
NCWRF	North Cary Water Reclamation Facility
NRW	nonrevenue water
OPS	operations
QC	quality control
RDU	Raleigh-Durham International
REU	Residential End Uses of Water
RTP South	Wake County portion of Research Triangle Park
RW	reclaimed water
SAS	SAS Institute Inc.
SCWRF	South Cary Water Reclamation Facility
SFR	single-family residential
SPZ	Southern Pressure Zone
Town	Town of Cary

U.S.	United States
USCB	U.S. Census Bureau
USGS	U.S. Geologic Survey
UQR	Upper Quartile Range
WA	potable water meter
WWRWRF	Western Wake Regional Water Reclamation Facility
WLCC	Water Loss Control Committee
WPZ	Western Pressure Zone
WRF	Water Research Foundation
WTP	water treatment plant

SECTION 1

Introduction

In early 2017, the Town of Cary (Town) partnered with CH2M HILL North Carolina, Inc. (CH2M) to update the 2013 Long Range Water Resources Plan (LRWRP), to be executed in two phases. One of the initial tasks for Phase One of the LRWRP Update was to update the 2010 Water Use Analysis (CH2M, 2010). The 2010 work included an in-depth analysis of water consumption trends from 2005-2009, incorporating prior analysis results from the 2007 Integrated Water Resources Management Plan (IWRMP) (CH2M, 2007) and providing a record of consumption trends from 2001-2009. As part of the LRWRP, recommendations were made for unit consumption factors to be used in forecasting future water demand and wastewater flows through 2060 based on the observed trends through 2009. In addition, the analysis results were used in evaluating the effectiveness of water conservation and demands for reclaimed water.

Since the 2010 water use analysis, the Town has evolved its water meter system to an advanced metering infrastructure (AMI) system, Aquastar. The Aquastar system provides the Town with water meter reading data on an hourly and daily basis, compared to the previous system that only provided monthly billing data. The increased frequency of the meter readings provides for a more accurate representation of consumption patterns, compared to monthly billing data. The data used in prior analyses were billing data, which represents consumption for a prior 30-day period, approximately, and is based on the meter reading cycle, which could straddle a 2-month period. Therefore, adjustments to billing data to better align with actual consumption timing is challenging across thousands of water meters and does not yield the same level of accuracy on consumption timing as the AMI data. In addition, the finer resolution of consumption data provides the ability to complete more robust comparative analyses with other daily data, such as the Cary/Apex Water Treatment Plant (WTP) production data, daily wastewater flow monitoring data, and weather data.

The updated water use analysis presented in this document provides insights on water consumption trends from 2001-2016 for the entire Town service area, inclusive of the Town of Cary, the Town of Morrisville, the Wake County portion of Research Triangle Park (RTP South), and Raleigh-Durham International (RDU) Airport. The Aquastar data were used to develop a better understanding of the daily and seasonal consumption patterns. In total, the analysis integrates previous analysis results from the 2010 analysis to provide long-term consumption trends for a period of time that has included two significant droughts (2002 and 2007), an economic recession (2008-2010), and most recently, a series of years with normal weather patterns, compared to 30-year averages (State Climate Office of North Carolina, 2017).

SECTION 2

Water Use Analysis Objective and Approach

2.1 Analysis Objective

As part of the kick-off workshop for the LRWRP Update project, held on April 27, 2017, the objectives for each phase of the project were defined by the project team (Town and CH2M staff). The resulting agreed upon objective for the water use analysis update is:

> *Update the 2010 water use analysis to understand the patterns and trends in water usage within the Town's service area, in support of defining the unit consumption values to be used to forecast future water demand and wastewater flows, and plan for future water resources management.*

This objective is the overarching guide for the water use analysis; this section outlines the analysis approach for achieving this objective.

2.2 Analysis Approach

This section provides a summary of the water usage and utility account information data sources, important utility account attribute information, the database and analytical tools, and the database query development used to support the water use analysis.

2.2.1 Water Usage and Utility Account Data

The data used to define the water consumption patterns for the water use analysis include, by time period:

- 2001-2005: Data from the 2007 IWRMP (this information was summarized in the 2010 Water Use Analysis [CH2M, 2010])
- 2006-2009: Data from the 2010 Water Use Analysis; the analysis results from the 2010 Water Use Analysis have been incorporated into the analysis results presented in this document
- 2013-2016: Aquastar data provided by the Town for each utility account

The Aquastar data provided by the Town, as direct exports from the SAS Institute Inc. (SAS) database, included two different data sets: daily usage data by year, identified by meter record, and a water meter information table containing account information. Each account has a unique LocationID and CustomerID; the combination of these two identifications (IDs) was used to define an individual account, and the LocationID was used to define the service location. Service location was selected in this analysis to define consumption patterns, since the CustomerID has the potential to change multiple times over the analysis period for an individual service location. Data analyses are presented by service location throughout this LRWRP Update. Further details regarding the analysis process are included in Appendix A.

One data gap exists: During transition to the Aquastar system, specifically, from 2010-2012, no water usage data were available for this analysis. Where appropriate, water consumption summaries from the Town's Finance Department were used; these summaries only provide consumption data for the service area and not for individual water meters.

The Town provided a water meter information table containing the following utility account information:

- Service location (ID, address, and meter X,Y coordinates)
- Jurisdiction

- River basin
- Sewer basin
- Wastewater flow monitoring basin
- Service type
- Customer type

In several cases, the Town has generalized the account attribute information (service type and customer type) for this analysis the account attribute descriptors leveraged as part of the updated water use analysis include:

- Jurisdiction:
  - Town of Cary
  - Town of Morrisville
  - RTP South
  - RDU Airport
- River Basin:
  - Neuse River Basin
  - Cape Fear River Basin
- Pressure Zone:
  - Central Pressure Zone (CPZ)
  - Southern Pressure Zone (SPZ)
  - Western Pressure Zone (WPZ)
- Sewer Basin:
  - North Cary Water Reclamation Facility (NCWRF)
  - South Cary Water Reclamation Facility (SCWRF)
  - Western Wake Regional Water Reclamation Facility (WWRWRF) (once the facility began operation in 2014)
- Wastewater Flow Monitoring Basin:
  - Numerical ID by basin defined by the Town
- General Service Type:
  - Potable water meter (WA)
  - Irrigation meter (IR)
  - Reclaimed water meter (RW)
  - Sewer meter – excluded from analysis
- General Customer Type:
  - Single-family residential (SFR)
  - Multifamily residential (MFR)
  - Commercial (COM)
  - Industrial (IND)
  - Institutional (INS)
  - Operations (OPS) – metered operational usage of water (for example, treatment facility use, flushing, and line cleaning)

In addition to the Aquastar meter data, the Town provided Cary/Apex WTP production data, water reclamation facility reclaimed water distribution data, and the wastewater system flow monitoring daily

flow data used in this analysis. The Wake County parcel and building data sets were used to spatially link meter account service locations with parcel and building data, specifically:

- Parcel and lot size
- Building square footage
- Building tax value
- Number of bathrooms

The spatial link between the meter record data and the parcel and building data was completed for all meter records, but most of this information was targeted for use with SFR service locations.

2.2.2 Database and Analytical Tools

The following tools were used to support the water use analysis:

- Microsoft Access: Access was used to link, compile, and query Aquastar meter records usage data and water meter and account information, as well as the Wake County parcel and building data (once spatially linked to the meter data). The Cary/Apex WTP production data and wastewater system flow monitoring data were compiled and queried within Access.
- Microsoft Excel: Excel was used to post-process consumption and production data compiled in Access, including the development of outputs in tabular and graphical format.
- Palisade Corporation StatTools: StatTools is a Microsoft Excel add-in that was used to complete statistical analyses on unit consumption trends and correlation analyses.
- Esri ArcGIS: ArcGIS was used to complete a spatial analysis to link the Aquastar water meter information table to the Wake County parcel and building data sets. ArcGIS was also used to fill data gaps of spatial attribute information, such as river basin and pressure zone; very few data gaps existed within the data set, as the Town had completed a comprehensive spatial analysis before transmittal of data to CH2M.

2.2.3 Database Query Development

The Town-provided Aquastar meter records were linked together within a single Access database; this database was used to query the data by:

- Generalized service type
- Generalized customer type
- Jurisdiction
- River basin
- Sewer basin
- Flow monitoring basin

The database was used to query usage data for several different time steps: annual, monthly, and daily usage data. The queries used were based on previous analyses completed for the 2010 Water Use Analysis, as well as newly developed queries. The Access database that contains these queries has been provided to the Town as a template for ongoing water usage monitoring activities.

The Aquastar daily usage data provided by the Town included the raw meter data compiled from 2013-2016 (direct export from SAS); the daily data for this time period amounted to approximately 23 to 24 million data points per year. The daily usage data included four fields of data:

1. Meter record key
2. Date

3. Consumption (calculated based on meter readings [end-of-day meter reading for current day minus prior day end-of-day meter reading])
4. Daily reading (Aquastar system meter end-of-day reading)

Limitations were identified in the daily usage data, as discovered during the quality control (QC) review process, and were specifically related to the calculated consumption field data resulting from missed readings or erroneous, calculated data points. It was determined that the use of an aggregate of the monthly data by meter record, calculated based on month-end readings, would provide the best data set for detailed analyses of water consumption trends and unit consumption. The calculated monthly usage data were used moving forward in the analysis, including in the development of the annual average daily consumption values for each meter.

The summary total monthly and annual usage data was matched to summary billing information independently developed by the Town's Finance Department. This comparison yielded a difference in the annual total usage from the Finance Department summary between -1 and -6 percent, which is an acceptable deviation considering the Finance Department summary is billing data developed from the same Aquastar base data, but managed separately and rolled up specifically for billing purposes. The billing data were shifted up 1 month to more accurately align the billing data with actual usage timing for the comparison.

During the unit consumption analysis performed for Section 6, some outliers were identified. These were treated on a case-by-case basis. Some were corrected by observing the raw reading data field and identifying obvious errors in data entry, others (approximately three) were omitted from the analysis. There were also some account records with inconsistent customer type data field entries (for example, SFR account with corporate ownership and valuation far beyond what is reasonable for an SFR); these were omitted from the SFR-specific analyses.

The largest deviation from the billing summary was in 2013, which was the first year the Aquastar system was live across the entire service area; there appears to be a slow change over to the Aquastar system in RTP South and other portions of the service area, causing less water usage to be accounted for in the Aquastar data than should have been in the first 3 to 6 months of the year (specifically, for commercial and industrial customer types). This fact was confirmed with Finance Department staff, and little could be done to overcome the differences in 2013. However, it was determined that the difference was small enough to move forward with analyses.

The Aquastar daily data were deemed to still be useful for summary comparative analyses with other daily data sources; the detailed account level analysis was completed on the calculated monthly and annual consumption data, as described. Aquastar daily readings data were used in Section 4 of this LRWRP Update for visualizing Daily Demand patterns, calculating Daily Peaking Factor, and calculating Weather Correlation, and were also used in Section 6.3 for calculating Daily Peaking Factors.

SECTION 3

Water System Overview

The section provides a high-level review of the overall annual water system demands, including:

- Both potable and reclaimed demand
- Population and service locations
- Annual potable water demands by customer type
- Cary/Apex WTP production trends
- Comparison of population growth to growth in water demand
- Reclaimed water demand trends

Cary's water system is defined by all jurisdictions and service areas that are provided water service by the Town, including Cary, Morrisville, RTP South, and RDU Airport.

3.1 Overall Water System Demand

Table 3-1 provides a summary of the Town's water supply profile, in million gallons per day (MGD) for the data from January 2001-December 2016. Table 3-2 summarizes the total annual average daily demand profile, including reclaimed water demand for the Town's service area. Daily data are not available from 2010-2012 due to the conversion period of the meters. This table, as do others that summarize daily data, depicts those years in gray to acknowledge this missing information.

3.2 Population and Service Locations

Table 3-3 presents the population estimates and service locations for the Town's service area. Service locations represent each location within the service area that is connected to the Town's water distribution system. Corresponding growth trends are included in Table 3-4. Table 3-5 presents the service location by customer type and river basin. Similar to annual average daily water demand, total SFR comprises the majority of the daily water demand and service locations, followed by the MFR and commercial customer types. In the Town's service area, growth has been greatest in the Cape Fear River basin, increasing from 14 percent of the total service locations in 2005 to 29 percent in 2016.

Tables 3-6 and 3-7 include the number of service locations by customer for separately metered irrigation and reclaimed water accounts, respectively. Figure 3-1 shows the number of separately metered irrigation accounts, and Figure 3-2 shows the number of closed irrigation accounts from 2012-2016 based on the Aquastar meter information table data. A total of 510 accounts were closed during this period. The relatively flat growth in separately metered irrigation accounts, as indicated in the data presented in Table 3-6 and the accounts closure on Figure 3-2, shows a trend that is much different than what was observed from the data used in the 2010 Water Use Analysis (2001-2009 data set).

Table 3-1. Water Supply Profile – January 2001-December 2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

	Annual Average Supply (MGD)															
Water Supply to Town of Cary	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Surface Water (Cary/Apex WTP) [a]	7.0	14.3	13.1	14.0	15.0	14.4	16.8	16.0	15.8	17.3	16.9	15.9	15.3	15.7	17.4	18.0
Percent of Jordan Lake Allocated Capacity (%) [d]	23	47	43	46	49	47	55	52	52	57	55	52	50	51	57	59
WTP System Process Loss [e]	2.0	2.2	1.6	1.7	2.2	1.6	1.5	2.1	2.7	3.2	2.4	2.3	1.9	1.7	2.7	3.2
Total WTP Potable Water Produced	5.0	12.1	11.5	12.3	12.8	12.8	15.3	13.9	13.1	14.2	14.5	13.6	13.4	14.0	14.8	14.8
Groundwater (Private Wells) [b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purchases: Potable Water [c]	7.0	0.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.01	0.08	0.00	0.02	0.01	0.00	0.16
Total Potable Water Supply (conveyed to Cary, including Morrisville, RDU, and RTP South)	**12.0**	**12.8**	**11.5**	**12.3**	**12.8**	**12.9**	**15.4**	**13.9**	**13.2**	**14.2**	**14.6**	**13.6**	**13.5**	**14.0**	**14.8**	**14.9**
Reclaimed Water Supply [f]	0.2	0.4	0.3	0.5	0.5	0.4	0.6	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.6	0.6
Total System Water Supply	**12.2**	**13.2**	**11.8**	**12.8**	**13.3**	**13.3**	**16.0**	**14.6**	**13.9**	**14.9**	**15.2**	**14.3**	**13.9**	**14.4**	**15.3**	**15.5**

Data Source: Cary/Apex WTP Production Data and IBT Tracking database

[a] This does not include the portion of the water supply sent to the Town of Apex or sales to Chatham County.

[b] Groundwater resources are used within Cary's service area, but are not part of the Town's distribution system.

[c] Water purchases in the future are expected to be only be for emergency purposes and IBT management.

[d] Jordan Lake Round Three Allocation for Cary (including RTP South and Morrisville) is 30.5 MGD; the Round Four Allocation of 39 MGD has yet to be enacted.

[e] WTP system process loss (for example, water used for backflushing) attributable to Cary's portion of the WTP capacity (77%).

[f] Distributed reclaimed water totals from 2010 - 2016 as calculated in water reclamation facility operational data, not including reclaimed water used onsite or for bulk use.

- = not applicable
% = percent
IBT = interbasin transfer

Table 3-2. Annual Average Day Total Water Demand Profile in MGD (including reclaimed water) – 2001-2009, 2013-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

Water Demand	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
SFR	5.4	5.84	5.07	5.6	5.89	5.87	6.8	5.89	6.17		6.04	6.19	6.38	6.40
MFR	2.09	2.08	2.12	2.23	2.19	2.25	2.38	2.32	2.46		2.61	2.67	2.73	2.79
COM	2.76	2.80	2.58	2.87	2.97	3.19	3.63	3.35	3.36		2.93[a]	3.16	3.39	3.48
IND	0.37	0.36	0.32	0.35	0.36	0.40	0.40	0.35	0.31		0.18[a]	0.30	0.32	0.34
INS	0.26	0.30	0.17	0.21	0.22	0.22	0.24	0.22	0.21		0.29	0.29	0.29	0.29
RDU Airport	0.27	0.28	0.24	0.27	0.34	0.27	0.26	0.25	0.28		0.25	0.23	0.26	0.28
Transfers	0.35	0.48	0.81	0.35	0.50	0.50	0.63	0.87	0.87		0.00	0.01	0.25	0.01
Bulk Sales	-	-	-	-	-	-	-	0.08	0.04		0.04	0.07	0.05	0.08
Total	**11.5**	**12.16**	**11.32**	**11.89**	**12.47**	**12.69**	**14.36**	**13.32**	**13.70**		**12.34**	**12.91**	**13.42**	**13.66**

Data Source: Town Billing database (2001-2009), Aquastar meter data (2013-2016)

[a] As discussed in Section 1, in 2013, commercial and industrial account consumption is not fully represented in the Aquastar data.

Table 3-3. Population Estimates and Number of Service Locations, 2001-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Population																
Cary [a]	99,798	103,260	106,715	108,152	111,039	115,854	122,643	130,716	135,955	136,590	139,382	142,257	144,982	149,859	153,868	157,259
Morrisville [a]	8,973	9,976	11,464	12,371	13,827	14,800	15,393	16,102	16,292	18,084	20,516	20,164	21,696	22,962	23,682	24,456
Total	**108,771**	**113,236**	**118,179**	**120,523**	**124,866**	**130,654**	**138,036**	**146,818**	**152,247**	**154,674**	**159,898**	**162,421**	**166,678**	**172,821**	**177,550**	**181,715**
Number of Service Locations [b]																
Cary	32,836	33,449	33,946	34,783	36,610	38,314	40,051	42,454	43,859				47,413	48,334	49,535	50,625
Morrisville	3,044	3,513	4,109	4,546	4,715	4,883	5,436	5,633	5,924				6,492	6,703	7,073	7,363
RTP South	17	18	18	20	22	22	21	21	23				19	22	21	20
Total	**35,897**	**36,980**	**38,073**	**39,349**	**41,459**	**43,218**	**45,508**	**48,108**	**49,806**				**53,924**	**55,059**	**56,629**	**58,008**

[a] Data Source: July 1 estimates by U.S. Census Bureau (USCB)

[b] Data Source: Town Billing database, Aquastar meter data (2013-2016)

Table 3-4. Annual Percent Increases in Population and Service Locations, 2001-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Population Increase (%)																
Cary	-	3.5	3.3	1.3	2.7	4.3	5.9	6.6	4.0	0.5	2.0	2.1	1.9	3.4	2.7	2.2
Morrisville	-	11.2	14.9	7.9	11.8	7.0	4.0	4.6	1.2	11.0	13.4	-1.7	7.6	5.8	3.1	3.3
Increase in Number of Service Locations (%)																
Cary	-	1.9	1.5	2.5	5.3	4.7	4.5	6.0	3.3				-	1.9	2.5	2.2
Morrisville	-	15.4	17.0	10.6	3.7	3.6	11.3	3.6	5.2				-	3.3	5.5	4.1
RTP South	-	5.9	0.0	11.1	10.0	0.0	-4.5	0.0	9.5				-	15.8	-4.5	-4.8

Data Source: July 1 estimates by U.S. Census Bureau (USCB), Town Billing database (2001 - 2009), Aquastar meter data (2013 - 2016)

Table 3-5. Number of 2005, 2009, 2013, and 2016 Service Locations by Customer Type and River Basin

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

	2005 - River Basin		2009 - River Basin		2013 - River Basin		2016 - River Basin	
Customer Type	**Neuse**	**Cape Fear**	**Neuse**	**Cape Fear**	**Neuse**	**Cape Fear**	**Neuse**	**Cape Fear**
SFR	25,671	4,822	28,286	8,408	29,420	10,554	29,885	12,090
MFR	7,389	902	8,384	1,730	8,483	2,860	8,961	4,166
COM	2,303	169	2,483	271	2,219	154	2,385	257
IND	69	1	71	2	32	2	33	2
INS	121	12	146	25	178	22	230	47
Total:	**35,553**	**5,906**	**39,370**	**10,436**	**40,332**	**13,592**	**41,494**	**16,562**
Percent of Total (%):	**86**	**14**	**79**	**21**	**75**	**25**	**71**	**29**

Data Source: Town Billing database (2001 - 2009), Aquastar meter data (2013 - 2016)

Table 3-6. Town of Cary Water System Summary of the Service Locations with Separately Metered Irrigation Accounts, 2001-2009 and 2013-2016
Includes the Town of Cary, Town of Morrisville, and RTP South

Customer Type	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016	% Change (2001 - 2016)	% Change (2009 - 2016)
SFR	2,114	2,569	2,854	3,205	3,557	4,687	5,334	6,176	6,255		6,729	6,879	6,878	6,885	226	10
MFR	80	84	92	98	123	120	144	143	142		247	253	247	237	196	67
COM	470	473	476	515	558	617	659	693	701		630	667	696	672	43	-4
IND	10	10	14	13	18	13	12	13	10		6	7	7	7	-30	-30
INS	20	24	22	31	35	32	36	33	31		38	41	40	40	100	29
Total	**2,694**	**3,160**	**3,458**	**3,862**	**4,291**	**5,469**	**6,185**	**7,058**	**7,139**		**7,650**	**7,847**	**7,868**	**7,841**	**191**	**10**

Data Source: Town Billing database (2001 - 2009), Aquastar meter data (2013 - 2016)

Table 3-7. Town of Cary Water System Summary of the Number of Reclaimed Water Accounts, 2001-2009 and 2013-2016
Includes the Town of Cary, Town of Morrisville, and RTP South[a]

Customer Type	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016	% Change (2001 - 2016)	% Change (2009 - 2016)
SFR	204	260	250	262	250	293	454	476	485		517	512	549	546	168	13
MFR	2	5	5	4	3	3	6	7	8		15	16	17	17	750	113
COM	35	49	52	50	52	46	58	54	55		76	79	94	89	154	62
IND	1	1	1	1	1	1	1	1	1		2	2	2	2	100	100
INS	4	5	5	5	5	3	2	3	3		6	6	7	8	100	167
Total	**246**	**320**	**313**	**322**	**311**	**346**	**521**	**541**	**552**		**616**	**615**	**669**	**662**	**169**	**20**

Data Source: Town Billing database (2001 - 2009), Aquastar meter data (2013 - 2016)

[a] RDU Airport does not currently have RW service

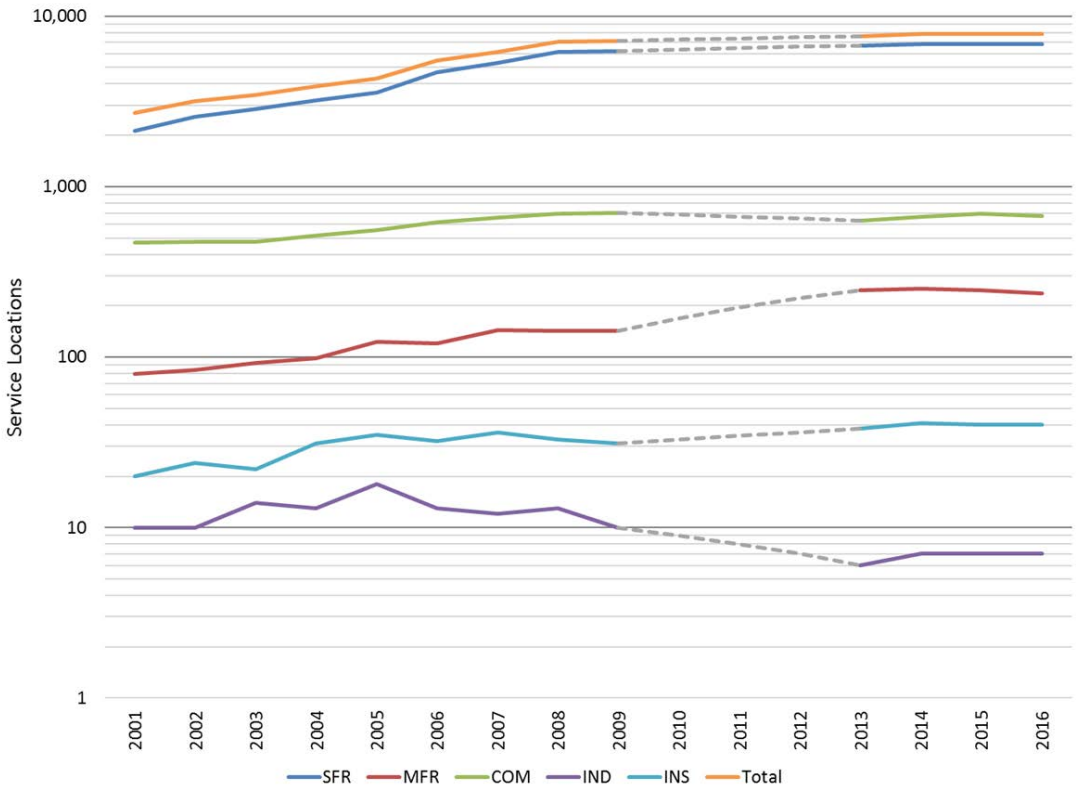


Figure 3-1. Town of Cary Water System Summary of the Number of Separately Metered Irrigation Accounts, 2001-2009 and 2013-2016

Includes the Town of Cary, Town of Morrisville, and RTP South

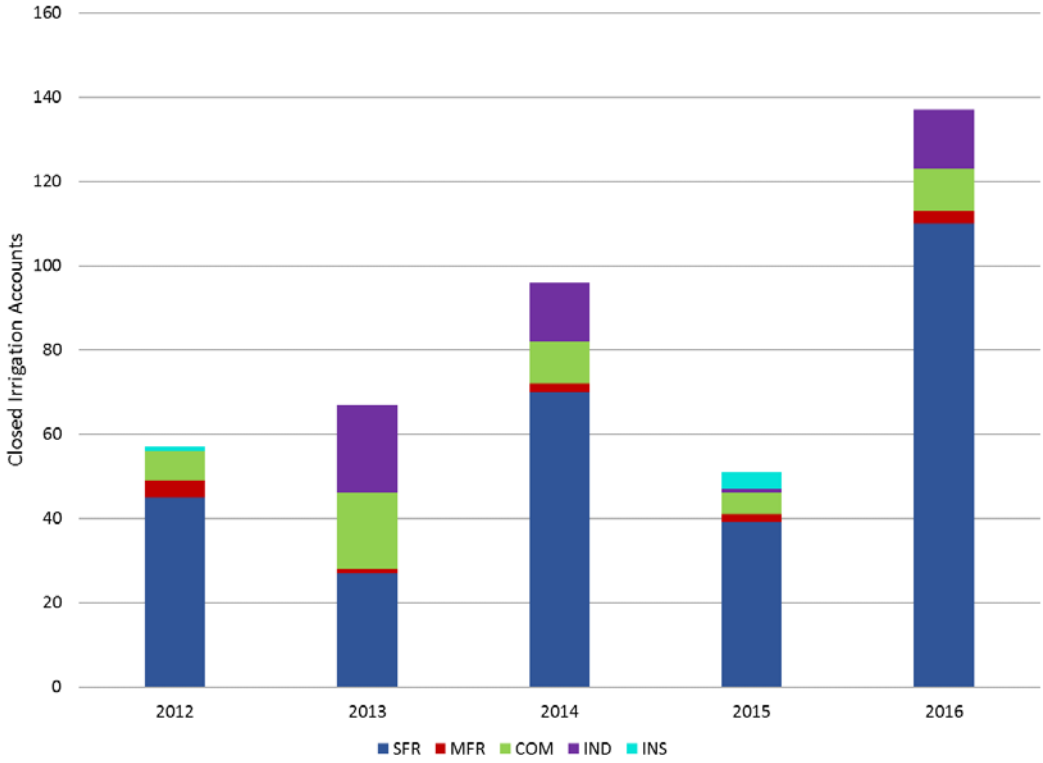


Figure 3-2. Closed Irrigation Accounts by Customer Type, per Year

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

3.3 Cary/Apex Water Treatment Plant Production Trends

The Cary/Apex WTP production data provide a summary of the overall finished water demands for the Town's service area; Figure 3-3 provides a comparison of the daily finished water pumped (including purchases and excluding sales) to the Town's service area and the annual average daily demand value from 1997-2016. Finished water in this analysis includes any potable water purchases made by the Town and excludes all bulk sales. Figure 3-4 presents the maximum day demand and its associated peaking factor (ratio of the maximum day demand to the annual average daily demand) for finished water pumped to the Town's service area. A general declining trend is observed in the peaking factor from 1997-2016.

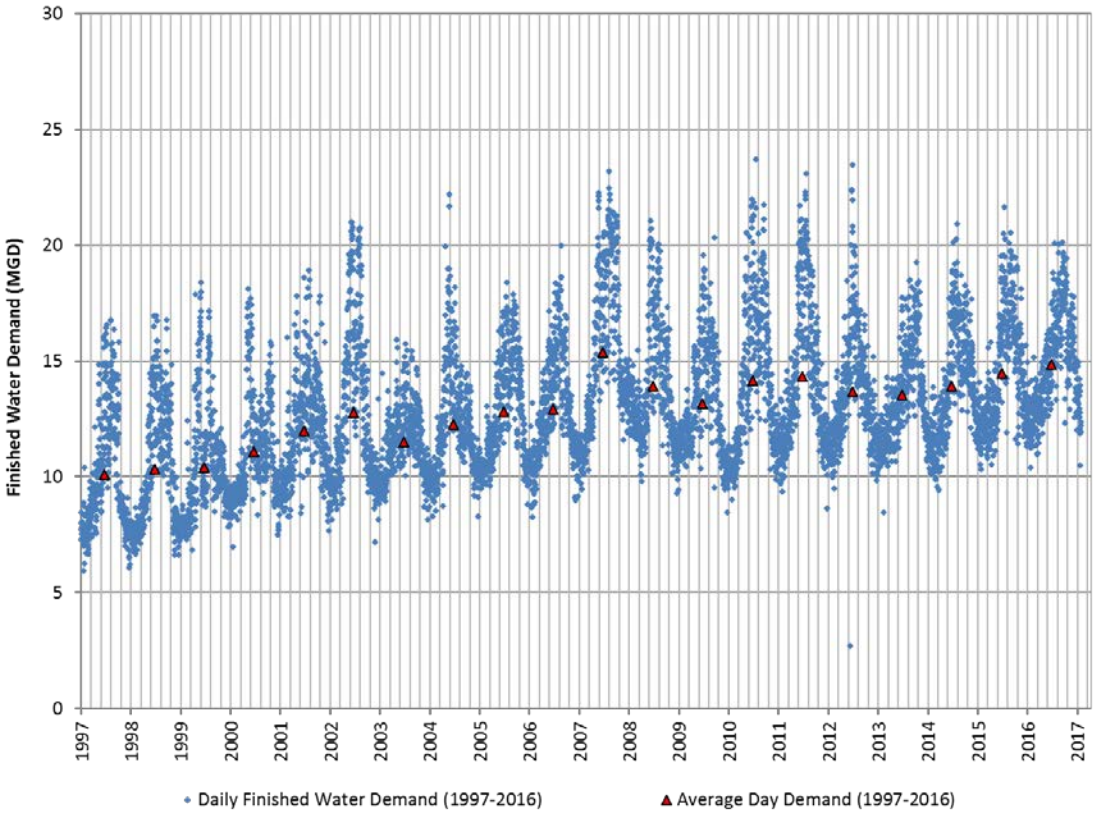


Figure 3-3. Daily Finished Water Demand – 1997-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

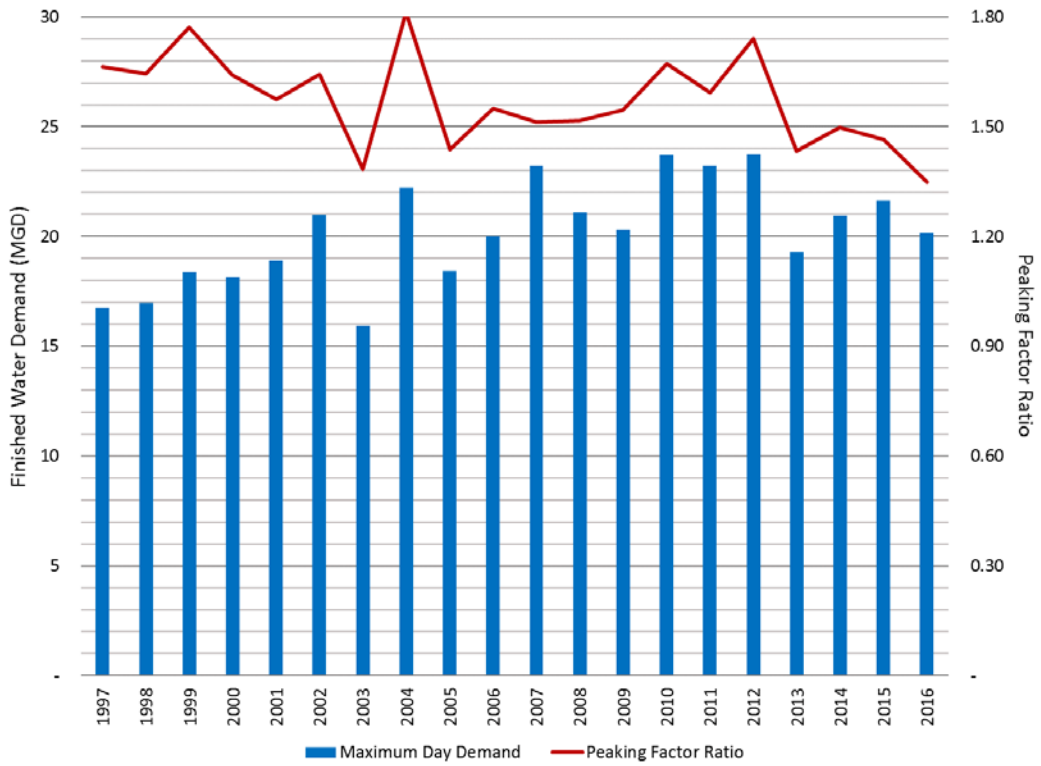


Figure 3-4. Maximum Day Finished Water Demand and Peaking Factors – 1997-2016
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

3.4 Water Production Trend Comparison to Population Growth

Figure 3-5 provides a comparison of the population growth to the growth in finished water demand from the Cary/Apex WTP for the Town's service area from 2001-2016. As shown in Table 3-4, population has averaged an annual growth rate of 5 percent since 2001, and water demand has grown at an average rate of approximately 1 percent per year for the same time period. Since 2013, total water demand has increased slightly, at a rate of 2 percent per year, while the population's annual growth rate has remained steady at near 5 percent. As can be seen overlaid on Figure 3-5, with population increasing at a faster rate than water demand, the Town's water customers are using less water on a unit basis. The overall system gallons per capita per day (GPCD), shown in Table 3-8, has decreased from 114 to 81 GPCD from 2001-2016.

Table 3-8. Overall Gallons per Capita per Day Demand – 2001-2016
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GPCD	114	117	98	102	103	100	112	96	87	92	90	84	81	80	82	82

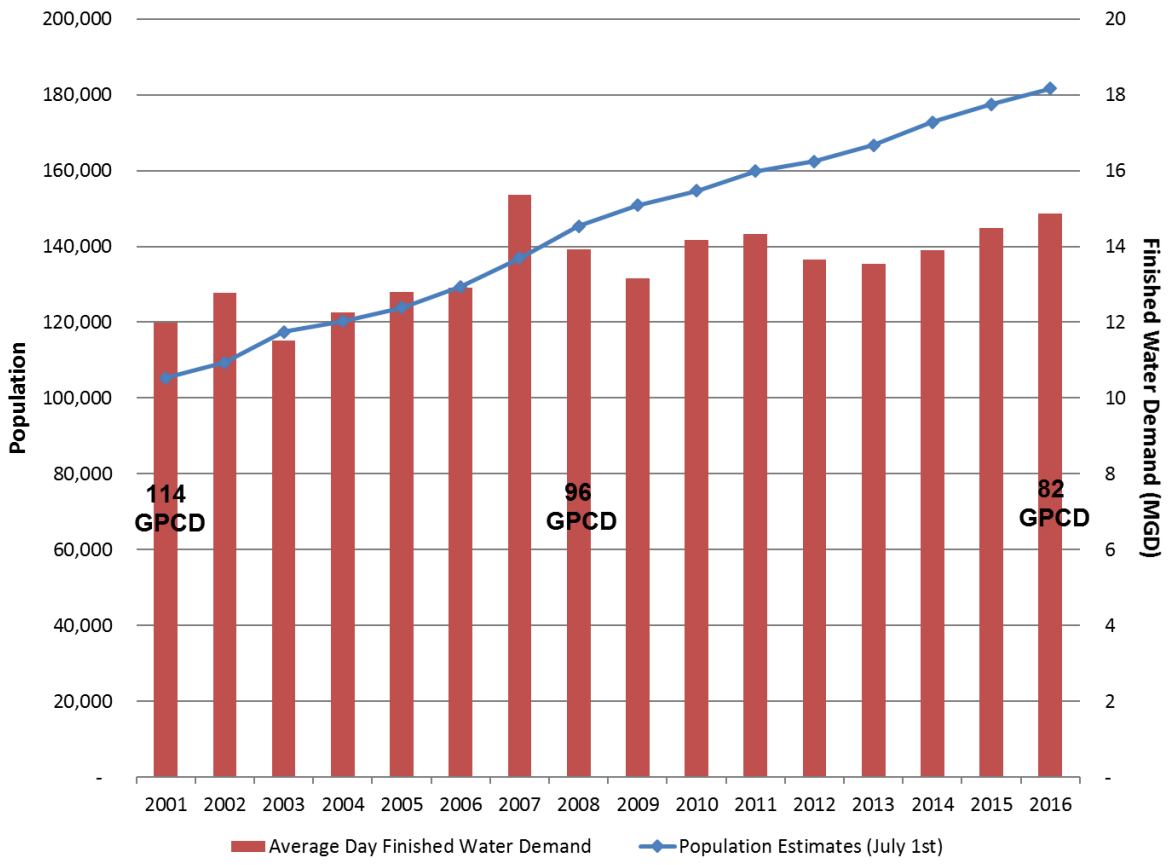


Figure 3-5. Comparison of Annual Population and Water Demand Growth – 2001-2016
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

3.5 Annual Average Daily Potable Water Usage

Table 3-9 presents the annual average daily potable water usage by river basin, with the percent change from 2001-2016 and 2009-2016. Potable water usage has been flat to slightly declining in the Neuse River basin; and in the Cape Fear River basin, usage has significantly increased from 2001 levels, which parallels the growth in service locations in the Cape Fear River basin, as identified in Table 3-5.

Table 3-10 presents the annual average daily potable water usage by jurisdiction and customer type, with the percent change from 2001-2016 and 2009-2016. In general, water usage has increased from 2001-2016, continuing the 2010 Water Use Analysis results showing annual average increases in demand of approximately 1 percent per year.

Table 3-9. Summary of the Annual Average Daily Potable Water Usage by River Basin, in million gallons per day

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

River Basin	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016	% Change (2001 - 2016)	% Change (2009 - 2016)
Neuse	9.97	10.12	9.34	9.93	10.12	9.92	10.86	9.75	9.95		9.56	9.86	10.10	10.21	2	3
Cape Fear	1.19	1.39	1.27	1.49	1.72	1.82	2.26	2.12	2.35		2.63	2.98	3.27	3.40	186	45
Total	**11.16**	**11.51**	**10.61**	**11.42**	**11.84**	**11.73**	**13.13**	**11.87**	**12.30**		**12.20**	**12.84**	**13.37**	**13.61**	**22**	**11**

Data Source: Town Billing database, Aquastar meter data, and water reclamation facility operational data

Note: Numbers in table have been rounded; % Change values derived from unrounded data.

Table 3-10. Summary of the Annual Average Daily Potable Water Usage by Jurisdiction and Customer Type, in million gallons per day

Includes the Town of Cary, Town of Morrisville, RTP South and RDU Airport

Customer Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013[a]	2014	2015	2016	% Change (2001 - 2016)	% Change (2009 - 2016)
Town of Cary															
SFR	5.21	5.55	4.90	5.25	5.49	5.37	6.21	5.36	5.62	5.51	5.64	5.78	5.78	11	3
MFR	1.76	1.70	1.76	1.81	1.76	1.81	1.93	1.86	1.99	2.04	2.08	2.11	2.15	22	8
COM	2.17	2.08	2.04	2.2	2.19	2.19	2.45	2.34	2.36	2.09	2.20	2.34	2.43	12	3
IND	0.11	0.10	0.10	0.12	0.10	0.13	0.10	0.10	0.09	0.07	0.06	0.06	0.07	-40	-26
INS	0.21	0.26	0.15	0.18	0.2	0.19	0.21	0.2	0.18	0.25	0.26	0.26	0.24	16	35
OPS	-[b]	-	-	-	-	-	-	-	-	0.15	0.30	0.34	0.34	-	-
Subtotal	**9.45**	**9.69**	**8.94**	**9.56**	**9.75**	**9.68**	**10.90**	**9.87**	**10.24**	**10.11**	**10.54**	**10.89**	**11.01**	**17[b]**	**8[b]**
Town of Morrisville															
SFR	0.25	0.31	0.28	0.35	0.4	0.45	0.49	0.43	0.46	0.47	0.49	0.53	0.56	122	21
MFR	0.37	0.39	0.39	0.43	0.43	0.44	0.45	0.44	0.46	0.56	0.59	0.61	0.62	69	36
COM	0.37	0.37	0.33	0.38	0.42	0.42	0.49	0.43	0.44	0.51	0.55	0.60	0.62	67	40
IND	0.12	0.07	0.06	0.05	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	0.01	-89	-33
INS	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	75	-12
Subtotal	**1.11**	**1.15**	**1.07**	**1.21**	**1.31**	**1.37**	**1.49**	**1.35**	**1.40**	**1.56**	**1.66**	**1.76**	**1.83**	**65**	**31**
RTP South															
COM	0.18	0.21	0.18	0.19	0.23	0.21	0.24	0.21	0.21	0.17	0.20	0.21	0.24	33	14
IND	0.14	0.18	0.17	0.18	0.22	0.19	0.23	0.20	0.17	0.10	0.22	0.25	0.26	83	51
Subtotal	**0.33**	**0.39**	**0.36**	**0.37**	**0.44**	**0.41**	**0.48**	**0.41**	**0.38**	**0.27**	**0.42**	**0.46**	**0.50**	**50**	**31**
RDU Airport	0.27	0.28	0.24	0.27	0.34	0.27	0.26	0.25	0.28	0.25	0.23	0.26	0.28	4	0
Total	**11.16**	**11.51**	**10.61**	**11.42**	**11.84**	**11.73**	**13.13**	**11.87**	**12.30**	**12.20**	**12.84**	**13.37**	**13.61**	**22[b]**	**11[b]**

[a] As discussed in Section 1, commercial and industrial account consumption are not fully represented in the Aquastar data in 2013.

[b] Operational data are not fully represented in the meter data for the period before 2013.

Data Source: Town Billing database, Aquastar meter data, and water reclamation facility operational data

Note: Numbers in table have been rounded; % Change values derived from unrounded data.

3.6 Annual Average Daily Reclaimed Water Usage

Table 3-11 presents the annual average reclaimed water supply, shown as water pumped to the reclaimed water distribution system, and the annual average daily reclaimed water demand from 2001-2016. A small amount of reclaimed water is used onsite at the WRFs; this amount is not captured in the metered daily supply listed in Table 3-11. In addition, the difference between the supply and demand is presented. Reclaimed water demand has grown since 2001, and the portion of the reclaimed water supply required for operation of the system, including flushing for water quality purposes and nonrevenue reclaimed water, is, on average, approximately 50 percent of the annual reclaimed water supply volume.

Table 3-11. Reclaimed Water Supply and Demand Profile – January 2001-December 2016

Reclaimed Water	Annual Average (MGD)															
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Daily Supply	0.2	0.4	0.3	0.5	0.5	0.4	0.6	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.6	0.6
Daily Demand	0.1	0.2	0.1	0.2	0.2	0.2	0.3	0.2	0.2				0.3	0.3	0.3	0.3
Daily Difference	0.1	0.2	0.2	0.3	0.3	0.2	0.3	0.5	0.5				0.2	0.1	0.3	0.3

Data Source: Town Billing database, Aquastar meter data, and water reclamation facility operational data

3.7 Nonrevenue Water

The percent of nonrevenue water (NRW) as a portion of the total water production and purchases has been estimated as follows:

$$NRW = 100 \times (Qp - Qs)/Qp \qquad \text{(Eq. 1)}$$

Where:

NRW = Nonrevenue water percentage
Qp = Total water production and purchases
Qs = Total water sales, including bulk sales

Table 3-12 summarizes the annual average percent NRW for the Town's water system from 2008-2016; 2008 was selected as the starting point due to changes in how the Finance Department aggregated bulk sales and operational bulk usage (nonbillable) prior to that point. The range of annual average NRW for the entire period was from 4 to 11 percent, compared to a water industry standard of 10 to 15 percent, as reported by Water Research Foundation's (WRF's) Residential End Uses of Water (REU) (WRF, 2016). The Town completes an annual water audit of its system using the American Water Works Association (AWWA) Water Loss Control Committee (WLCC) Water Audit Software.

Table 3-12. Nonrevenue Water Summary, January 2008-December 2016, in million gallons per year
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

Water Usage	2008	2009	2010	2011	2012	2013	2014	2015	2016
Water Produced	6,063	5,871	6,247	6,336	6,015	5,899	6,205	6,605	6,618
Water Purchased									
Raleigh Purchases	-	-	1	10	-	1	-	-	-
Durham Purchases	0	1	4	18	2	7	4	1	60
Holly Springs Purchases	-	-	-	-	-	-	-	-	-
Total Finished Water Supply	6,063	5,871	6,252	6,364	6,017	5,907	6,209	6,606	6,678
Apex Usage	996	1,072	1,076	1,048	1,061	1,028	1,157	1,220	1,274
Transfers to Durham	188	0	7	93	7	0	3	91	2
Cary Finished Water Supply	4,879	4,800	5,170	5,222	4,950	4,879	5,049	5,296	5,402
Cary Retail Sales	3,749	3,864	4,292	4,252	4,001	3,964	4,031	4,062	4,119
Morrisville Retail Sales	491	511	586	615	587	595	620	663	682
Bulk Sales	23	11	12	21	13	14	20	16	20
RDU Airport Sales	92	103	95	104	75	92	84	94	98
Total Demand	4,355	4,489	4,985	4,992	4,675	4,665	4,755	4,834	4,918
NRW[a]	523	311	184	230	275	214	294	461	484
NRW %	**11**	**6**	**4**	**4**	**6**	**4**	**6**	**9**	**9**

Data source: Finance Department billing summary (Utility Usage spreadsheet)

[a]Note: Cary Metered Operational Use is included in NRW.

SECTION 4

Daily Water Use Trends

With Aquastar daily usage data, the Town can review patterns and relationships of daily customer use data to operational data and weather data, which was not previously an option with monthly billing data. This section provides a review of daily water demand patterns, maximum day demand analysis, and the correlation of water demand and weather variables.

4.1 Daily Demand Patterns

Figure 4-1 presents a comparison of the Town's daily finished water usage, including wholesale water sales versus daily Town usage for its retail customers. The largest differences within the usage pattern are seen when the Town transfers water to the City of Durham; the transfer in 2015 created a maximum day finished water usage that exceeded the Town service area maximum day usage level.

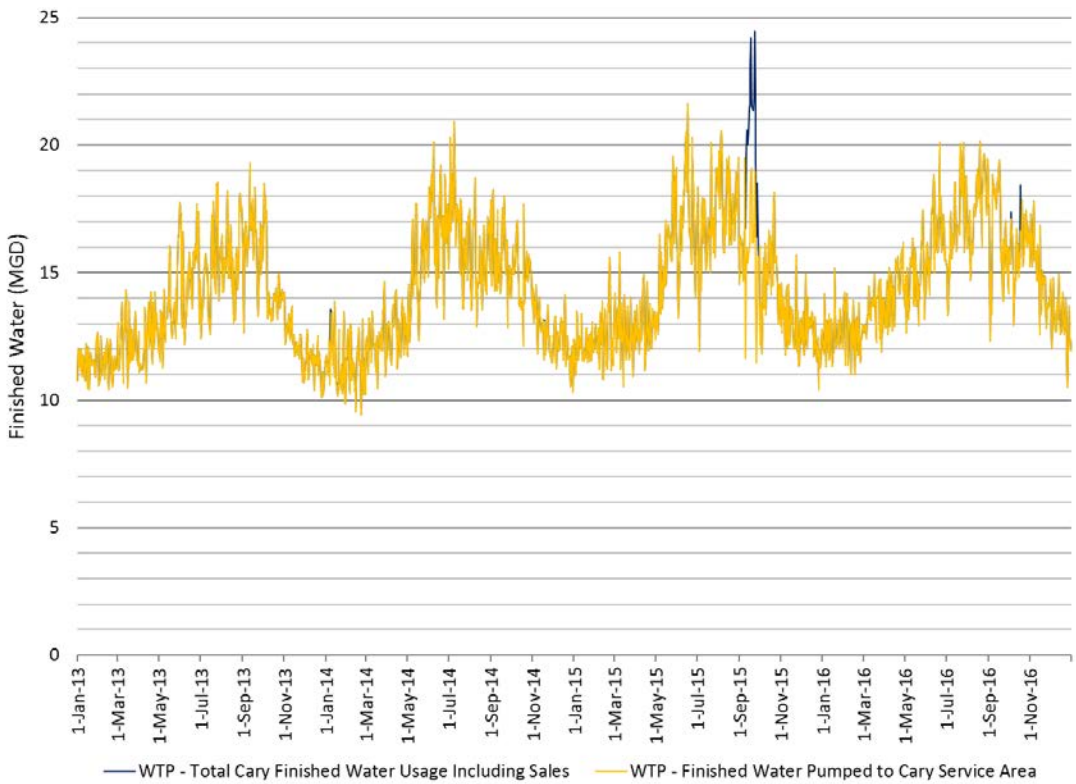


Figure 4-1. Comparison of Town Finished Water Usage With and Without Wholesale Water Sales, 2013-2016
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport, Plus Wholesale Water Sales

Figure 4-2 presents a comparison of the daily finished water production (finished water pumped to the Town's service area, after wholesale water purchases) with the daily Aquastar usage data for January 2013-December 2016. It is evident that the seasonal and daily patterns in the production data are driven by the seasonal pattern in the demand. A correlation analysis was run between the daily production and usage data; the results of that analysis indicated a strong correlation between the data sets (0.91). This is an intuitive result, but the results also provide an indication that other factors outside of the metered usage that affect the daily production trends. Figure 4-2 presents the difference between daily production and daily customer usage data. This difference likely comprises unmetered operational usage of water (including filling water tanks, unmetered line flushing, or line cleaning); water loss; or unmetered usage, such as bulk water sales.

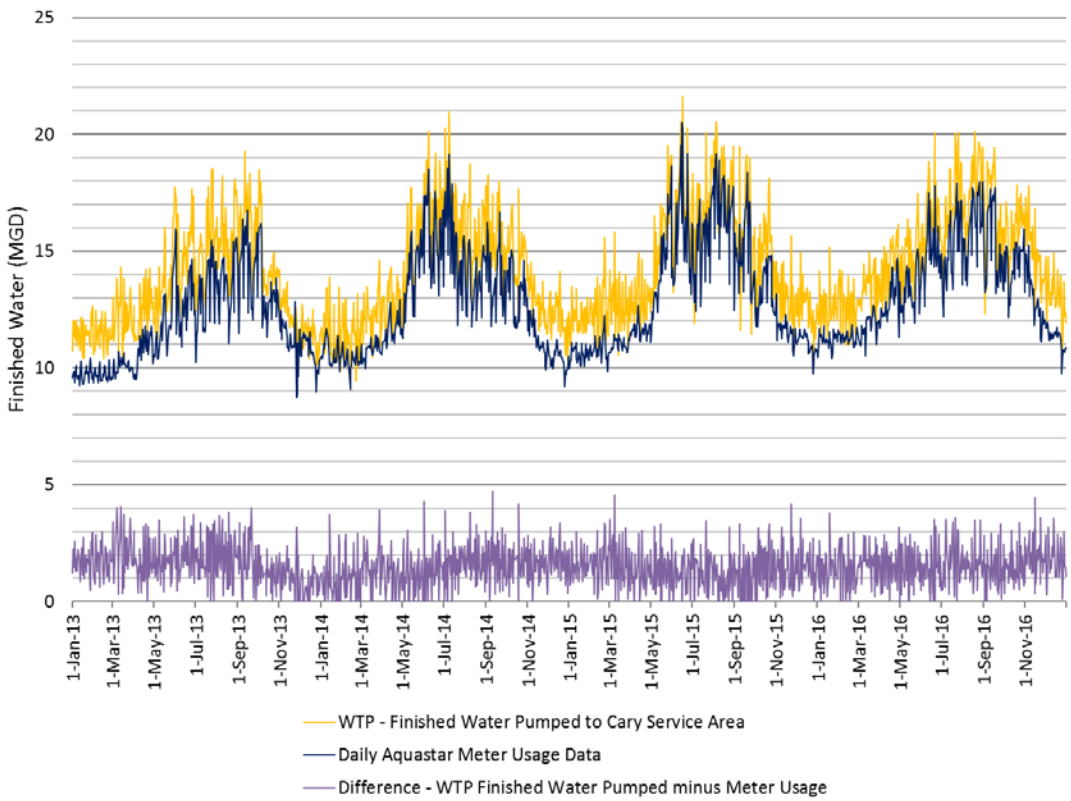


Figure 4-2. Comparison of Daily Finished Water Production and Aquastar Usage Data –2013-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport, but Excludes Wholesale Water Sales

Figure 4-3 presents a comparison of the daily usage by customer type to the Aquastar daily total usage and the daily production data. Data show that SFR and COM accounts are the primary drivers of the seasonal and daily demand patterns, and this is also confirmed on Figure 4-4, which shows the total daily usage for each customer type as a percentage of the total daily metered potable water demand. Figure 4-4 shows that SFR usage has been relatively stable as a percentage of the total daily demand across the year, while COM seasonal usage increases over the course of year, with a higher percentage of daily water demand in the summer time, and the percentage of the total daily demand for MFR accounts reduced in the summertime.

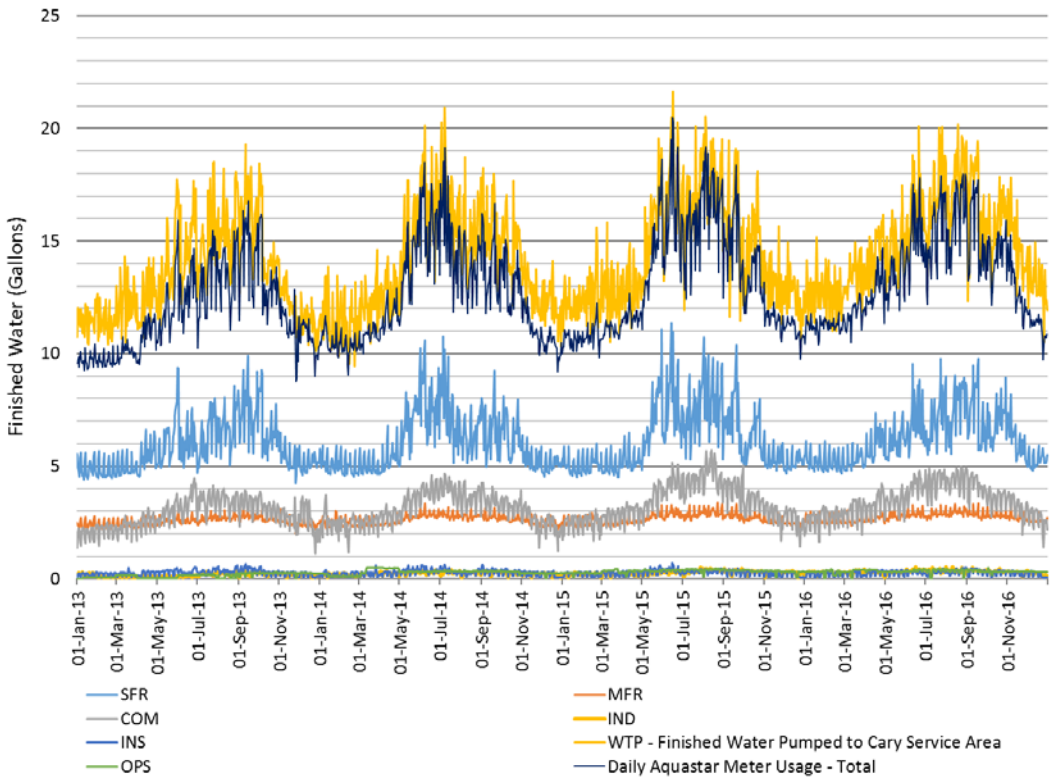


Figure 4-3. Comparison of Daily Finished Water Production and Aquastar Usage Data, by Customer Type, 2013-2016
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport, but Excludes Wholesale Water Sales

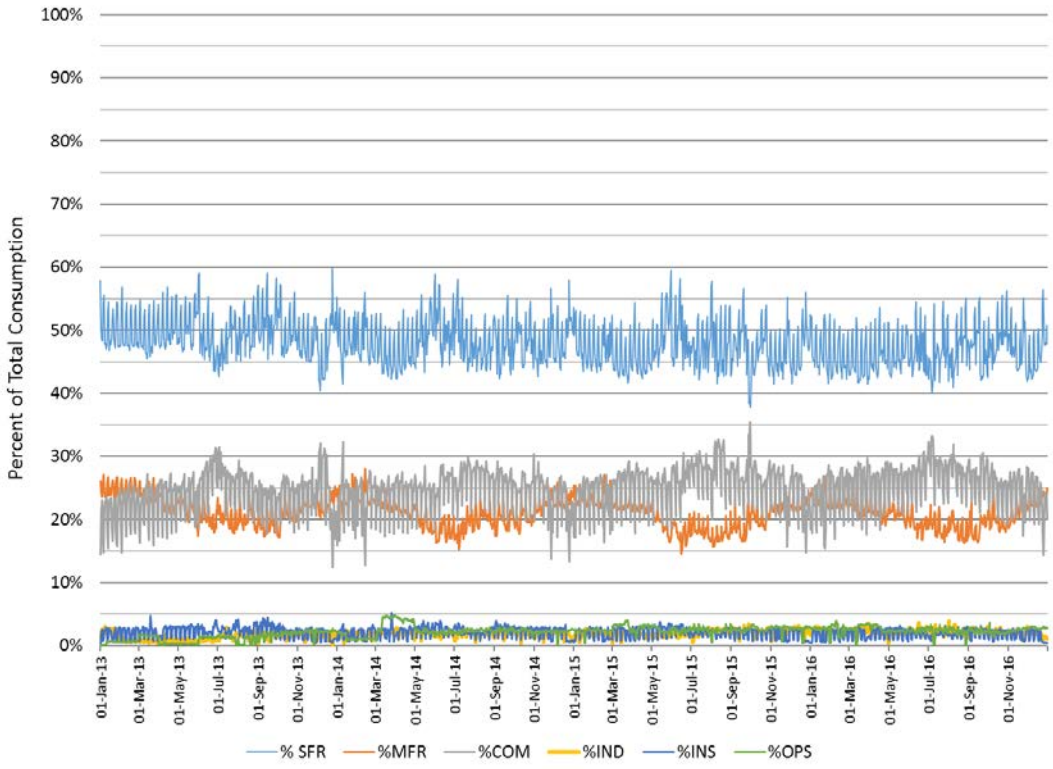


Figure 4-4. Percent of Total Aquastar Daily Usage Data, by Customer Type for 2013-2016
Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

4.2 Maximum Day Demand Analysis

The Aquastar daily usage data also allow for the investigation of the customer types and accounts driving the single maximum day demand in a given year for finished water pumped from the Cary/Apex WTP to the Town's service area, excluding wholesale water sales. Figure 4-5 presents the percent of service locations that comprise the maximum day demand for 2013-2016; this chart focuses on the top 1 percent of service locations for better resolution of the highest users within the graph. The findings for this analysis can be summarized as follows:

- 80 percent of the usage on the maximum day is from approximately 30 percent of the Town's service locations (approximately 16,000 locations), and most are SFR and COM accounts.
- Approximately one-third of the service locations that comprise 80 percent of the maximum day demand are separately metered irrigation accounts.
- The top 10 percent of service locations, those with the greater usage on the maximum day, comprise between 60 and 63 percent of the maximum day demand; and 50 percent of these customers are separately metered irrigation accounts.
- The top 10 individual users on the maximum day were generally the same for all 4 years in the analysis, and mostly were COM and IND accounts, with one OPS account.

Table 4-1 provides a summary of the maximum day finished water pumped from the Cary/Apex WTP to the Town's service area compared to Aquastar metered usage total and by customer type, both by volume and percent of the maximum day usage.

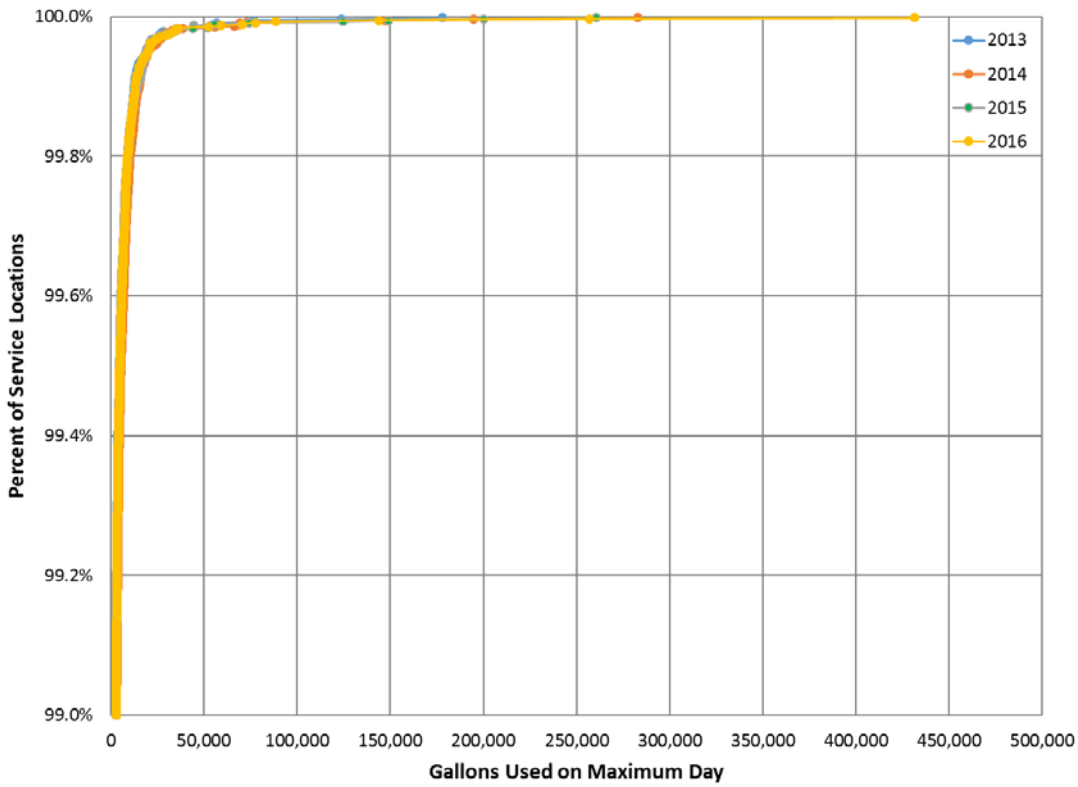


Figure 4-5. Top 1 Percent of Service Locations that Comprise the Single Maximum Day Demand for 2013-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

Table 4-1. Maximum Day Finished Water Pumped to the Town's Service Area and Aquastar Customer Type Usage, 2013-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport, but Excludes Wholesale Water Sales

Maximum Day Finished Water	2013	2014	2015	2016
Pumped to Service Area (MGD)	19.28	20.93	21.63	20.15
Day	September 11	July 8	June 17	August 19
Aquastar Total Usage (MGD) on the Maximum Day	16.06	19.13	20.27	16.67
Customer Type – Total Aquastar Usage (MGD) on the Maximum Day				
SFR	8.35	10.19	10.95	7.94
MFR	2.79	2.92	3.07	2.92
COM	3.84	4.67	4.89	4.80
IND	0.31	0.36	0.33	0.28
INS	0.67	0.64	0.63	0.32
OPS	0.10	0.34	0.39	0.41
Customer Type Demand - % of Total Aquastar Usage on the Maximum Day				
SFR	52	53	54	48
MFR	17	15	15	18
COM	24	24	24	29
IND	2	2	2	2
INS	4	3	3	2
OPS	1	2	2	2

Further analysis of the maximum day demand with a focus on the SFR portion of the daily demand was warranted. Figure 4-6 provides an indication of percentage of the SFR usage on a maximum day (minus wholesale customers) in 2016 by a range of SFR account and service type groupings, including:

- Single meter – nonirrigators
- Separately metered – indoor use
- Separately metered – outdoor use
- Single meter irrigators – indoor use
- Single meter irrigators – outdoor use

The single meter irrigators are 'hidden' irrigators who likely irrigate their lawn but do not have a separate irrigation meter (this includes either an unmetered, separate irrigation system [put in before requirements for metering these systems] or SFR residents who water their yards with a hose and sprinkler). One method used to segment this usage is the Customer User Profile metric using baseline demand and peaking factor (AWWA, 2013). The hidden irrigators were defined for the maximum day as those accounts that, on average, had a peaking factor ratio similar to or greater than the average peaking factor for the separately metered irrigation accounts (peaking factor ratio of 4 in 2016). Another method is presented in Section 6.4.2.

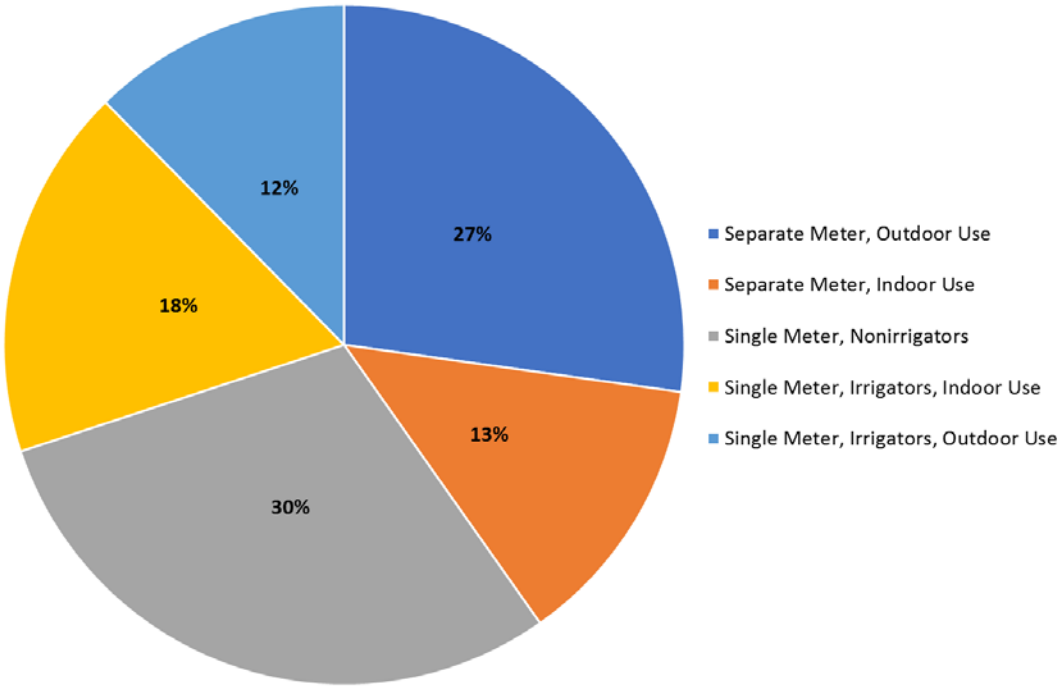


Figure 4-6. 2016 Single-family Residential Maximum Day Usage Profile, Percentage of Total Maximum Day Demand by Single Meter and Separately Metered Irrigation Accounts

Figure 4-7 shows the volume of water usage by each of the SFR account and service type groupings listed. General observations on the data presented on Figures 4-6 and 4-7 include:

- In 2016, 40 percent of the SFR demand on the maximum day was used outdoors, a volume of approximately 3 MGD.
- Outdoor usage from separately metered accounts was more the 2 times greater than indoor water usage on the 2016 maximum day.

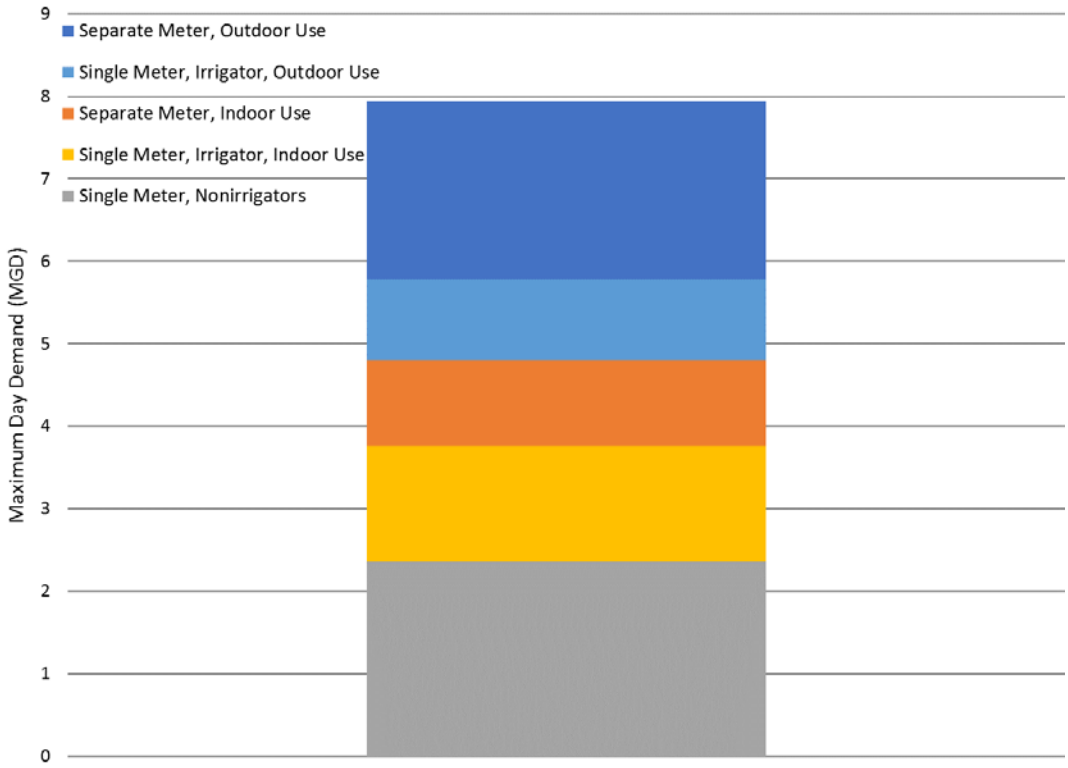


Figure 4-7. 2016 Single-family Residential Maximum Day Usage Profile, Total Maximum Day Demand by Single Meter and Separately Metered Irrigation Accounts

Figure 4-8 presents a scatter plot for SFR service location maximum day peaking factor ratio (location of individual maximum day usage divided by the annual average usage) and base usage (annual average usage). The scatterplot is divided into four quadrants based on a baseline annual average usage of 3,000 gallons per month (100 gallons per day [GPD]) and a daily peaking factor ratio of 4 (average peaking ratio for separately metered irrigation accounts). The SFR service locations to the right of the baseline usage line are high baseline users, and the SFR location above the peaking factor ratio line are high peaking users.

Figure 4-8. 2016 Single-family Residential Service Location Comparison of Annual Average Daily Demand and Maximum Day Peaking Factor Ratio

Quadrant classification from AWWA (2013).

General observations on the data presented on Figure 4-8 include:

- Less the 20 percent of the SFR service locations are classified as “low peakers,” with a maximum day peaking factor less than 4.
- More than 30 percent of SFR service locations are low base users, using less than 3,000 gallons per month (100 GPD), but “high peakers” have a maximum day peaking factor greater than 4.
- Nearly 50 percent of the SFR service locations are classified as “high base user” and “high peakers.”
  - Over 60 percent of separately metered accounts fall within this classification.

4.3 Weather Variable Correlation

A correlation analysis was completed between the daily Aquastar usage data and a number of weather variables, including daily average temperature, maximum daily temperature, and daily precipitation total. In addition, a calculated variable ‘days since last rain’ was also included in this analysis and was specifically for days since a last rainfall of more than 0.1 inch. The objective of this analysis was to identify the strength and direction of the linear relationship between the daily water usage data and daily weather data. For previous analyses, the only statistical comparisons that could be completed were monthly due to the time interval for the collection of water meter data, which resulted in an averaging of weather conditions over an approximately 30-day period compared to 30-day average usage patterns. The daily usage data allow for a review of usage patterns compared to weather patterns that are more reflective of the conditions when the usage occurred, at least at a finer increment than a 30-day average.

For this analysis, weather data were compared to the total daily usage totals for the SFR quartile ranges as follows:

- Lower quartile range (LQR) (minimum value to the 25th percentile value)
- Interquartile range lower (IQRL) (25th percentile value to the median value)
- Interquartile range upper (IQRU) (median value to the 75th percentile value)
- Upper quartile range (UQR) (75th percentile to the maximum value)

The quartile ranges were created from SFR GPD values for 2013-2016, and each SFR service location was identified by the quartile range it fell within in a given year. For the correlation analysis, the daily total usage for a quartile range was used.

Table 4-2 provides the correlation coefficients for the analysis of the 2013-2016 daily usage totals, by SFR quartile range, and the daily weather variables. The direction of the linear relationships, as indicated by the correlation coefficients, are accurate (that is, the only negative relationship should be with daily precipitation: the more precipitation, the less water is used); but the linear relationships for all are not strong. The typical standard is that a correlation coefficient less than 0.5 is a weak relationship, and any coefficient more than 0.8 is strong. Most of the values are less than 0.5, and all are less than 0.8.

In addition to the correlation analysis, a regression analysis was completed for the UQR and IQRU, and each weather variable. This analysis yielded r-squared values less than 0.55, providing an additional indication that the variability in the quartile range demands is not fully explained by the weather variables. However, it was determined that most of the variables were significant (p-values less than 0.01, and t-statistics greater than 2.0) in explaining some of the variation in the data of the SFR quartile range daily usage totals.

Table 4-2. Correlation Coefficients for the Comparison of the 2013-2016 Daily Usage Totals by Single-family Residential Quartile Ranges to Daily Weather Variables

Weather Variable	LQR	IQRL	IQRU	UQR
Daily Average Temperature	0.33	0.64	0.63	0.70
Daily Maximum Temperature	0.36	0.65	0.64	0.70
Daily Precipitation Total	-0.12	-0.08	-0.08	-0.05
Days Since Last Rainfall (>0.1 inch)	0.46	0.26	0.25	0.22

Notes:

> = greater than

Figure 4-9 presents scatter plots for the comparison of 2013-2016 daily usage totals by SFR quartile range versus daily average and maximum temperature. Figure 4-10 presents the same comparison, but with the daily precipitation total and days since last rainfall (greater than 0.1 inch).

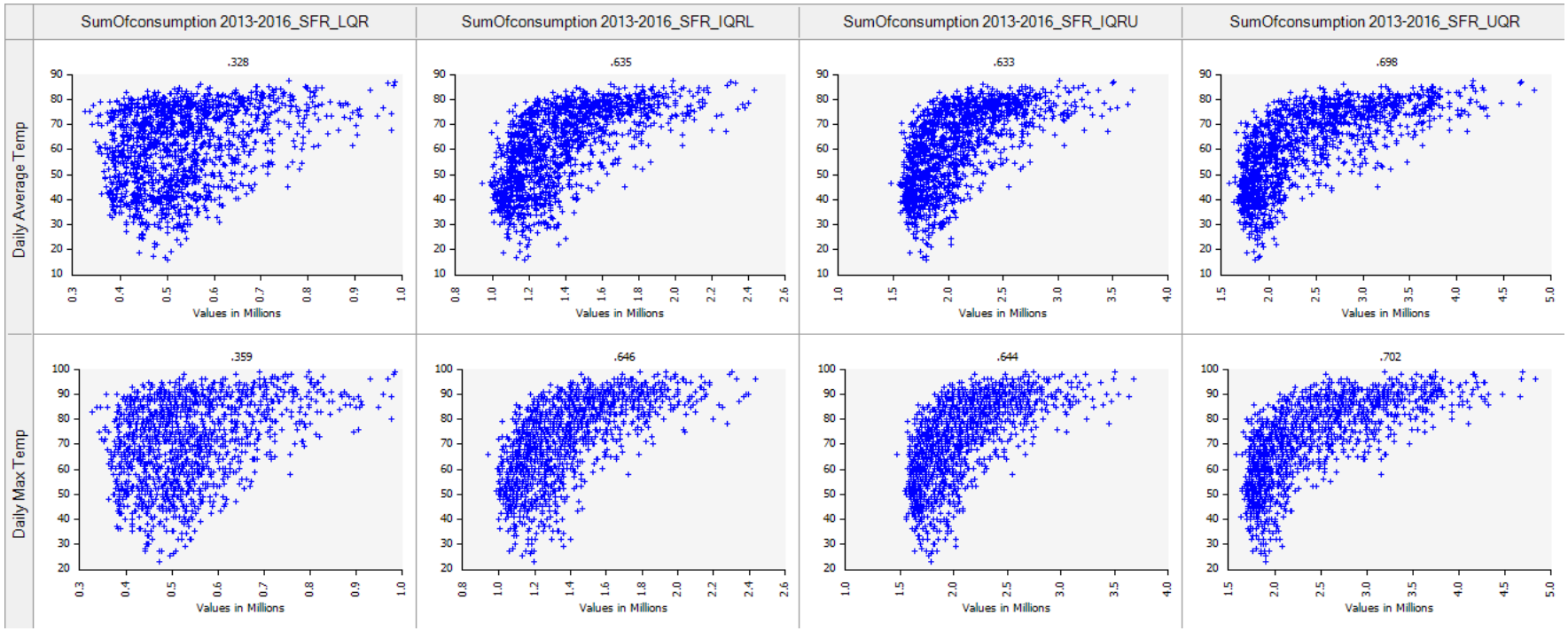


Figure 4-9. Scatter Plot of 2013-2016 Daily Usage Totals by Single-family Residential Quartile Range versus Daily Average and Maximum Temperature

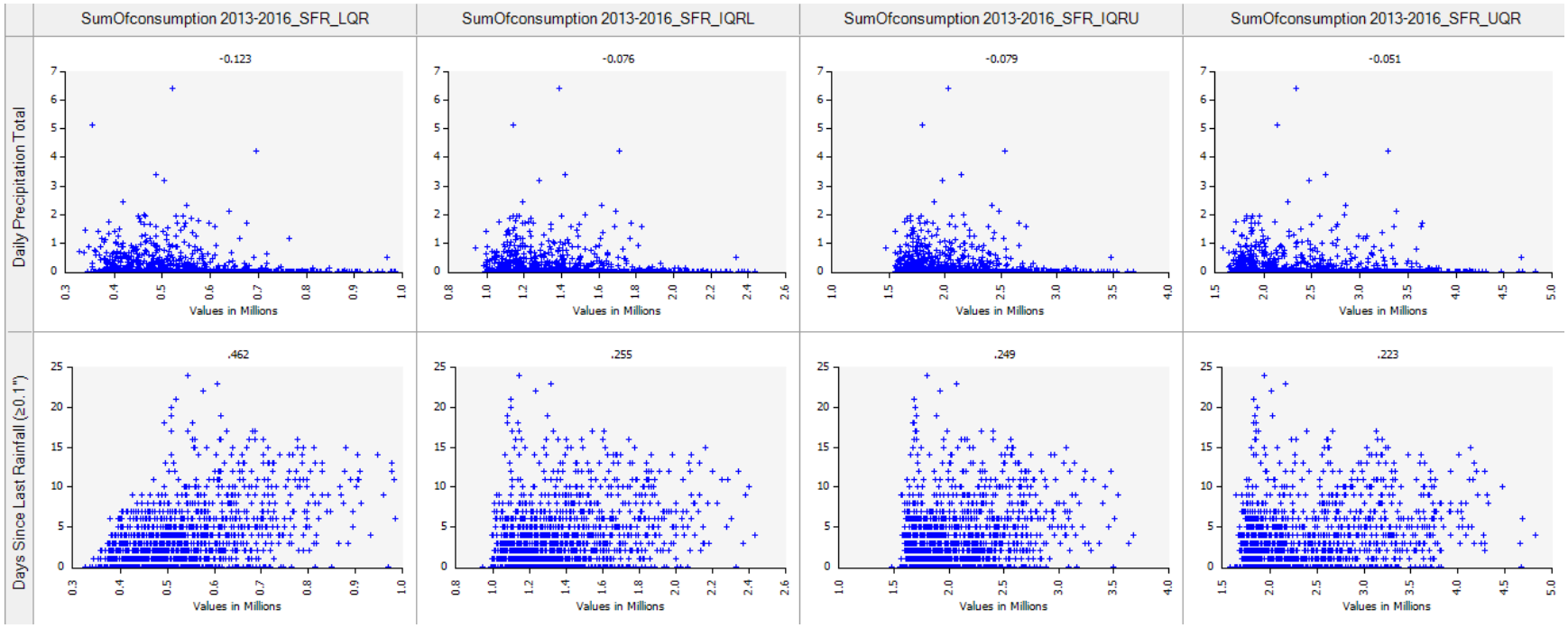


Figure 4-10. Scatter Plot of 2013-2016 Daily Usage Totals by Single-family Residential Quartile Range versus Daily Rainfall and Days Since Last Rainfall (greater than 0.1 inch)

SECTION 5

Monthly Water Use Analysis

The monthly water use analysis described in this section followed a method similar to that used in the 2010 Water Use Analysis, so aids in the understanding of the seasonal demand pattern over a year, as well as the long-term seasonal demand patterns.

5.1 Monthly Demand Patterns

Figure 5-1 presents the overall Town service area monthly average day potable water usage pattern from January 2001-December 2016. Figure 5-2 presents the average day potable water usage, by river basin, from January 2001-December 2016. Figure 5-3 presents the average day potable water usage, by customer type, from January 2001-December 2016. All data points from 2010-2012 have been estimated for each river basin based on the Finance Department' monthly summary data.

From Figures 5-1 through 5-3, it can be observed that there has been growth in water usage from 2001-2016. This growth has been most significant in the Cape Fear River basin, which supports the increasing trend in service locations and annual average daily potable water usage presented in Section 3; the Neuse River basin water usage growth has been predominantly flat. All customer types have increased in total water usage over this same period, which, again, supports the findings from the annual average daily potable water usage presented in Section 3. The SFR and COM customer types continue to be the largest proportion of the total monthly water usage and the major contributors to the strong seasonal demand profile for the water system.

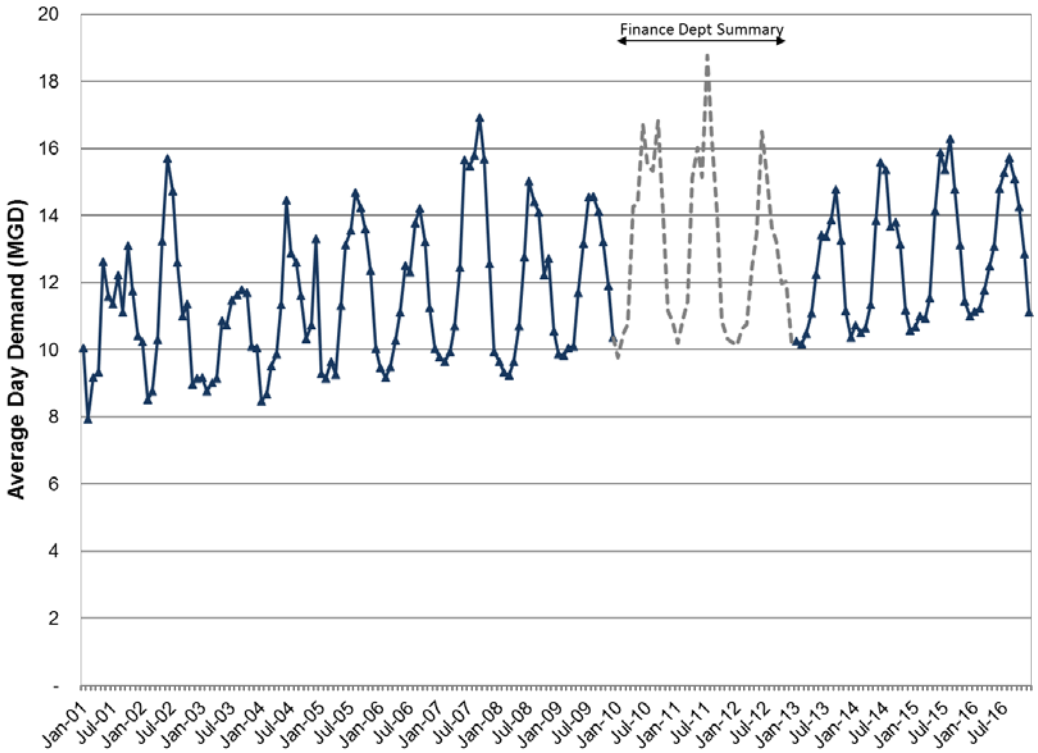


Figure 5-1. Monthly Average Day Potable Water Usage, January 2001-December 2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

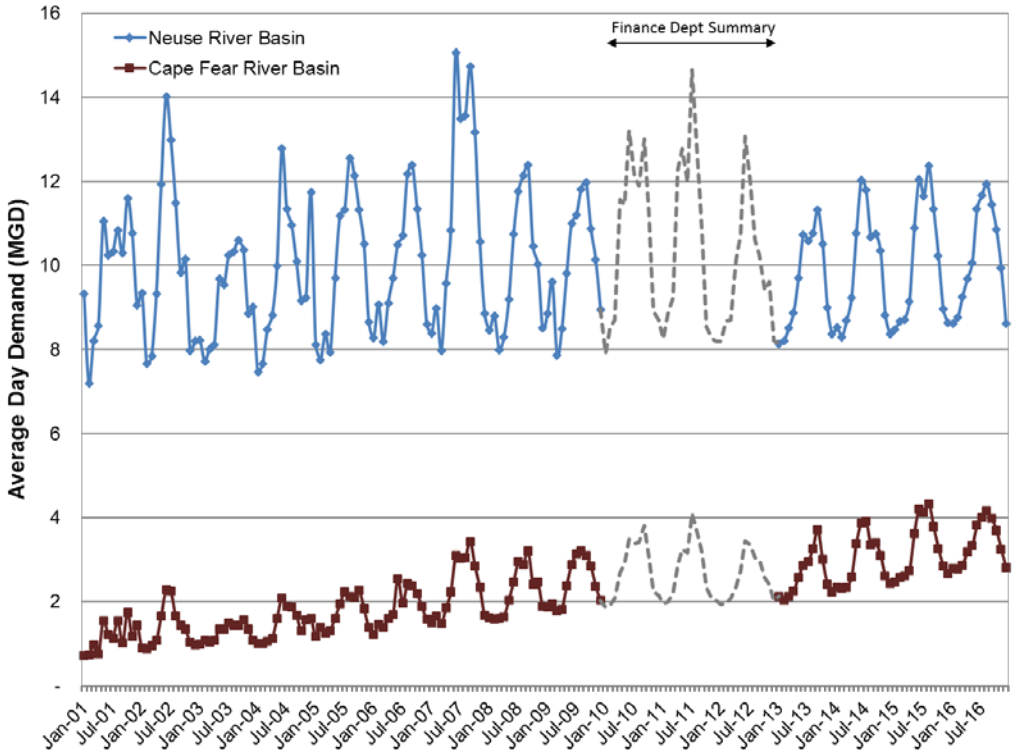


Figure 5-2. Monthly Average Day Potable Water Usage, by River Basin, January 2001-December 2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

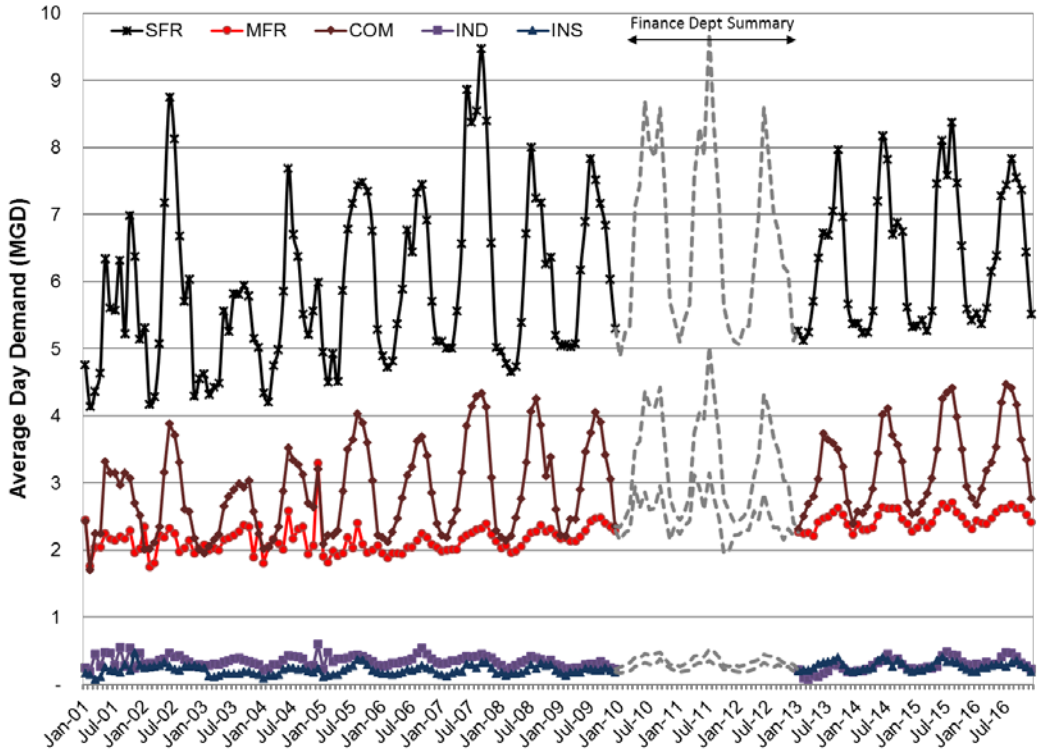


Figure 5-3. Monthly Average Day Potable Water Usage, by Customer Type, January 2001-December 2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

5.2 Seasonal Variation in Water Use

Water usage within the Town's service area is strongly influenced by the season of the year, as observed in previous sections. Figure 5-4 presents the overall average seasonal water usage pattern (seasonal index) from 2001-2009 (2010 Water Use Analysis data period) and 2001-2016. These overall seasonal profiles are very similar. The water usage data ranges from 100 to 120 percent of the annual average water usage for the months of May through September, and 80 to 100 percent for the months of January through April and October through December. The seasonal index was derived from the ratio of each month's average daily consumption to the 12-month moving average over the evaluation period.

Table 5-1 presents the seasonal index for all customer types from 2013-2016; this table also contains the overall seasonal index for 2013-2016, 2001-2016, and 2001-2009. The overall 2013-2016 seasonal index is most similar to the SFR and COM customer type seasonal index values, which reinforces the observations discussed in preceding sections that the total water usage of the SFR and COM customer types drive the seasonal water usage pattern for the service area. MFR has a relatively flat seasonal index, with average monthly variation from the annual average demand of only 7 to 8 percent, which is an intuitive result if billing accounts coded MFR are truly MFR, with water usage dominated by indoor water use.

In comparing the values in Table 5-1 to those presented in the 2010 Water Use Analysis (CH2M, 2010), all customer types' seasonal index values were similar, but IND and INS seasonal peak month values were greater, and IND and INS winter months' index values were lower. This indicates a greater seasonal peaking profile for these customer types in recent years, but the volume of the total usage for these customer types is not enough to affect the overall seasonal profile.

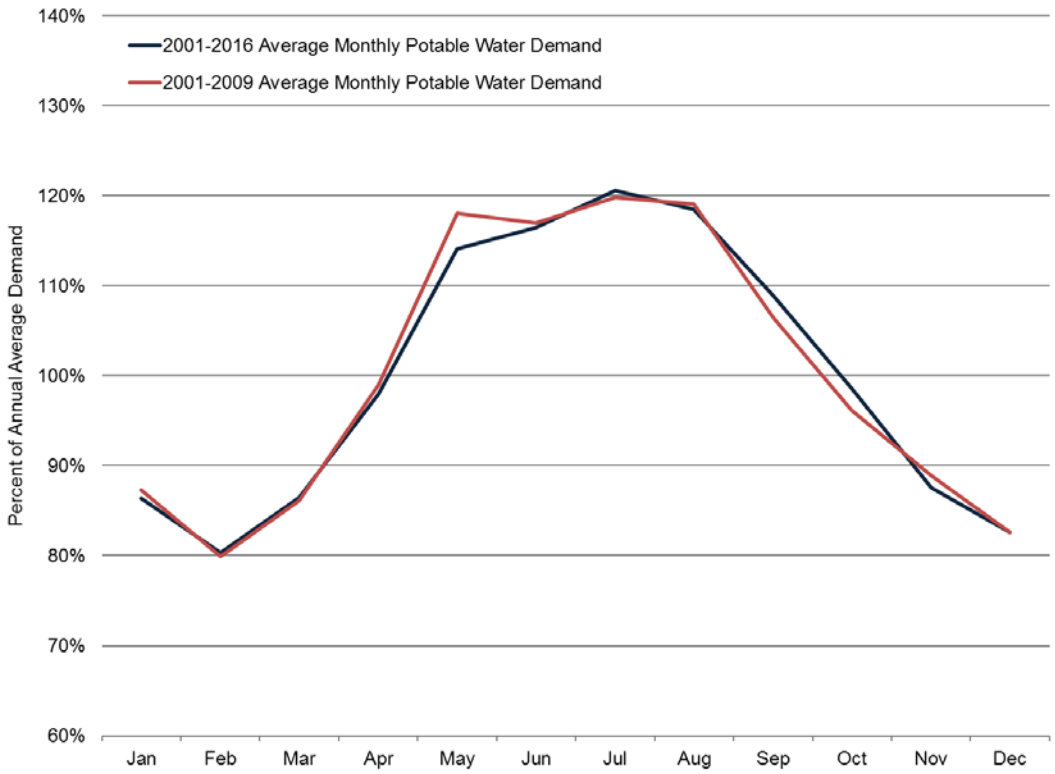


Figure 5-4. Monthly Average Day Potable Water Usage as a Percent of Total Annual Average Daily Potable Water Demand, 2001-2016

Includes the Town of Cary, Town of Morrisville, RTP South, and RDU Airport

Table 5-1. Seasonal Index by Customer Type (2013-2016) and Overall Seasonal Index Comparison

	SFR	MFR	COM	IND	INS	2013-2016 Overall	2001-2016 Overall	2001-2009 Overall
Month	***Index***	***Index***	***Index***	***Index***	***Index***	***Index***	***Index***	***Index***
Jan	0.85	0.95	0.80	0.78	0.71	0.85	0.86	0.87
Feb	0.83	0.95	0.82	0.76	0.80	0.85	0.80	0.80
Mar	0.84	0.94	0.87	0.85	0.85	0.87	0.87	0.86
Apr	0.90	0.97	0.93	0.85	0.96	0.92	0.98	0.99
May	1.09	1.03	1.04	0.94	1.21	1.06	1.14	1.18
Jun	1.22	1.07	1.23	1.22	1.31	1.18	1.17	1.17
Jul	1.16	1.05	1.26	1.36	1.23	1.17	1.21	1.20
Aug	1.16	1.07	1.21	1.36	1.14	1.16	1.19	1.19
Sep	1.17	1.06	1.14	1.30	1.29	1.15	1.10	1.07
Oct	1.06	1.01	1.04	1.01	1.03	1.04	0.99	0.96
Nov	0.88	0.97	0.86	0.81	0.79	0.91	0.88	0.89
Dec	0.84	0.92	0.80	0.77	0.67	0.84	0.83	0.83

5.3 Separately Metered Irrigation and Reclaimed Water Accounts

By the nature of the usage associated with separately metered irrigation and reclaimed water accounts, these accounts typically have a very strong seasonal usage pattern. This section provides an overview of the usage patterns of separately metered and reclaimed water accounts from 2001-2016.

5.3.1 Separately Metered Irrigation Accounts

Town residential customers who irrigate are required to have separate irrigation meters for all irrigation systems installed after August 2000. Many residential customers who had systems in place before August 2000 do not have a separate irrigation system meter. All commercial customers that irrigate are required to have a separate irrigation meter. The Town of Morrisville did not historically require irrigation meters; however, after the utility merger between the Towns of Cary and Morrisville in 2006, the Morrisville water customers have been subject to Cary's water system policies, including the requirement for separate irrigation meters.

Figure 5-5 shows the seasonal variation (2001-2009, 2013-2016) in domestic demand (inclusive of indoor demand and some seasonal outdoor nonirrigation demand), irrigation demand, and the combined domestic and irrigation water demand for all separately metered irrigation accounts. The variation in demand for these accounts is derived from the variation in irrigation demand over a year, with the demand for irrigation peaking in the summer months. Irrigation demand for these customers, since 2005, has seasonally exceeded that of the domestic demand for these select accounts.

Table 5-2 presents the annual average day irrigation demand by customer type from 2001-2009 and 2013-2016. Table 5-3 presents the annual average GPD per location for each year in the evaluation period, and Table 5-4 presents the percent of total potable water used for irrigation.

Tables 5-5 through 5-7 present the same information as Tables 5-2 through 5-4 for separately metered irrigation accounts within the Town of Morrisville's jurisdiction.

In Section 3, the number of separately metered irrigation accounts was presented and shows a modest amount of growth in these accounts, especially in 2008. In Figure 5-5, Table 5-2, and Table 5-5, total irrigation usage by separately metered accounts increased very slightly for most customer types, and unit demand values were smaller from 2013-2016 than from the 2010 Water Use Analysis.

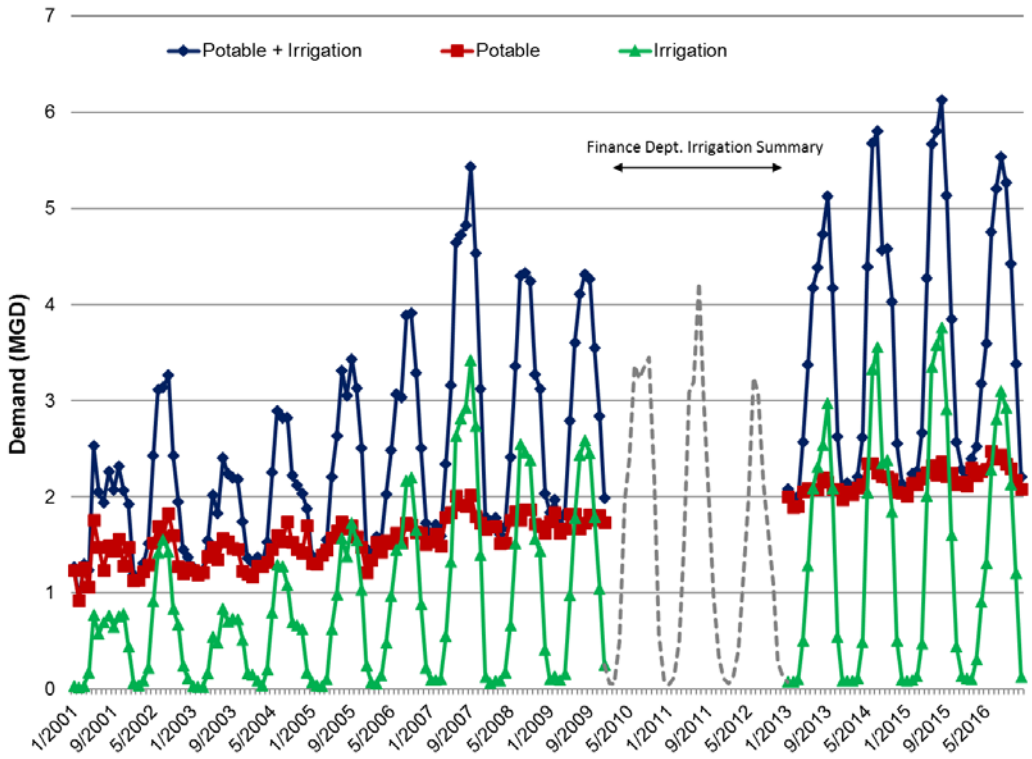


Figure 5-5. Seasonal Variation in Domestic and Irrigation Water Usage for Separately Metered Irrigation Accounts, 2001-2009 and 2013-2016

Includes the Town of Cary, Town of Morrisville, and RTP South

Table 5-2. Town of Cary Summary of the Annual Average Day Irrigation Demand by Customer Type, 2001-2009 and 2013-2016

Includes Only Town of Cary Separately Metered Irrigation Accounts

	Annual Average Day Irrigation Demand for Town of Cary (MGD)												
Customer Type	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		**2013**	**2014**	**2015**	**2016**
SFR	0.28	0.41	0.26	0.37	0.50	0.53	0.91	0.67	0.69		0.60	0.66	0.74	0.72
MFR	0.02	0.03	0.03	0.02	0.03	0.04	0.04	0.05	0.07		0.08	0.09	0.08	0.07
COM [a]	0.31	0.31	0.20	0.31	0.39	0.41	0.59	0.45	0.45		0.30	0.35	0.39	0.34
IND [a]	0.02	0.04	0.03	0.04	0.06	0.07	0.05	0.05	0.05		0.06	0.07	0.09	0.08
INS	0.03	0.03	0.02	0.04	0.05	0.04	0.05	0.04	0.03		0.06	0.06	0.05	0.03
Total	0.66	0.82	0.54	0.78	1.03	1.09	1.65	1.25	1.29		1.10	1.22	1.35	1.25

[a] IND separate meters can be in place for consumptive uses aside from irrigation, such as cooling towers.

Table 5-3. Town of Cary Summary of the Annual Average Day Irrigation Gallons per Day per Location by Customer Type, 2001-2009 and 2013-2016

Includes Only Town of Cary Separately Metered Irrigation Accounts

Customer Type	Annual Average Day Irrigation Demand for Town of Cary (GPD per Location)													
	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
SFR	148	180	100	126	155	123	186	117	119		97	104	116	112
MFR	270	438	327	278	318	397	373	399	568		369	411	401	371
COM [a]	870	843	558	773	878	853	1,116	793	809		621	677	707	655
IND [a]	1,789	4,305	2,550	3,676	3,838	6,296	5,869	4,358	6,518		9,650	9,474	12,467	11,923
INS	1,797	1,409	980	1,254	1,706	1,493	1,556	1,156	1,063		1,735	1,643	1,300	930
Overall	281	296	177	227	269	221	295	194	199		150	171	188	175

[a] IND separate meters can be in place for consumptive uses aside from irrigation, such as cooling towers.

Table 5-4. Town of Cary Percent of Total Use from Irrigation by Customer Type, 2001-2009 and 2013-2016

Includes Only Town of Cary Separately Metered Irrigation Accounts

Customer Type	Irrigation Demand as a Percent of Total Account Usage for Town of Cary (%)													
	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
SFR	45	50	37	41	47	45	54	46	45		39	41	44	43
MFR	33	52	47	37	36	53	49	47	55		55	58	57	52
COM	19	20	14	21	24	33	38	32	31		31	34	36	32
IND	75	47	40	32	42	12	16	21	26		31	29	34	32
INS	46	52	35	42	51	47	45	33	35		54	55	48	39
Overall	30	35	26	31	37	38	46	39	39		37	39	41	39

Table 5-5. Town of Morrisville Summary of the Annual Average Day Irrigation Demand by Customer Type, 2001-2009 and 2013-2016

Includes Only Town of Morrisville Separately Metered Irrigation Accounts

Customer Type	Annual Average Day Irrigation Demand for Town of Morrisville (MGD)													
	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
SFR	0.04	0.06	0.04	0.06	0.07	0.09	0.09	0.06	0.06		0.05	0.05	0.05	0.06
MFR	0.05	0.04	0.02	0.02	0.02	0.04	0.04	0.02	0.02		0.02	0.03	0.02	0.02
COM [a]	0.15	0.17	0.12	0.15	0.17	0.12	0.16	0.12	0.14		0.11	0.11	0.13	0.12
IND [a]	0.001	0.001	0.001	0.003	0.002	0.001	0.002	0.002	0.001		[b]	[b]	[b]	[b]
INS	0.003	0.003	0.001	0.002	0.004	0.003	0.002	0.001	0.001		0.006	0.001	0.002	0.002
Total	0.24	0.28	0.18	0.23	0.27	0.24	0.29	0.20	0.22		0.18	0.19	0.21	0.20

[a] IND separate meters can be in place for consumptive uses aside from irrigation, such as cooling towers.
[b] Data sets for these years are too small to develop meaningful percentages.

Table 5-6. Town of Morrisville Summary of the Annual Average Day Irrigation Gallons per Day per Location by Customer Type, 2001-2009 and 2013-2016

Includes Only Town of Morrisville Separately Metered Irrigation Accounts

Customer Type	Annual Average Day Irrigation Demand for Town of Morrisville (GPD per Location)												
	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
SFR	182	229	157	189	213	228	195	122	125		94	94	107	111
MFR	3,239	2,663	1,717	1,414	1,229	1,682	1,419	920	713		572	754	660	486
COM [a]	1,353	1,594	1,060	1,374	1,433	873	1,278	945	1,002		754	713	863	802
IND [a]	1,625	1,305	783	790	960	1,077	613	382	324		[b]	[b]	[b]	[b]
INS	328	487	73	1,421	699	65	398	501	294		1,432	181	612	449
Overall	677	693	461	547	572	443	479	328	339		274	273	299	284

[a] IND separate meters can be in place for consumptive uses aside from irrigation, such as cooling towers.

[b] Data sets for these years are too small to develop meaningful percentages.

Table 5-7. Town of Morrisville Percent of Total Use from Irrigation by Customer Type, 2001-2009 and 2013-2016

Includes Only Town of Morrisville Separately Metered Irrigation Accounts

	Irrigation Demand as a Percent of Total Account Usage for Town of Morrisville (%)													
Customer Type	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
SFR	51	56	44	50	55	48	55	44	45		37	38	41	41
MFR	84	76	61	62	56	74	72	62	50		64	70	64	54
COM	47	53	44	42	42	32	40	38	40		44	41	43	39
IND	[a]	47	0	45	86	78	41	26	23		[a]	[a]	[a]	[a]
INS	[a]	[a]	[a]	[a]	83	6	45	28	18		68	23	45	45
Overall	55	57	46	48	49	43	49	42	42		44	43	44	40

[a] Data sets for these years are too small to develop meaningful percentages.

5.3.2 Reclaimed Water Accounts

The Town of Cary's reclaimed water system began operation in June 2001. To date, the Town of Morrisville does not receive any reclaimed water. Figure 5-6 shows the seasonal variation in domestic potable water demand (inclusive of indoor demand and some seasonal outdoor nonirrigation demand), reclaimed water irrigation demand, and the combined domestic potable demand and reclaimed water irrigation demand for all reclaimed water accounts, from 2002-2009 and 2013-2016. The seasonal variation in demand for these accounts is derived from the variation in reclaimed water demand, similar to the irrigation trend identified on Figure 5-5. During the entire evaluation period, reclaimed water demands exceed those of the domestic potable demands during the summer months. Reclaimed water values do not include reclaimed water used onsite at a WRF, for bulk use, or by single meter users. Tables 5-8 through 5-10 present the same information as Tables 5-2 through 5-4 for the Town's reclaimed water accounts.

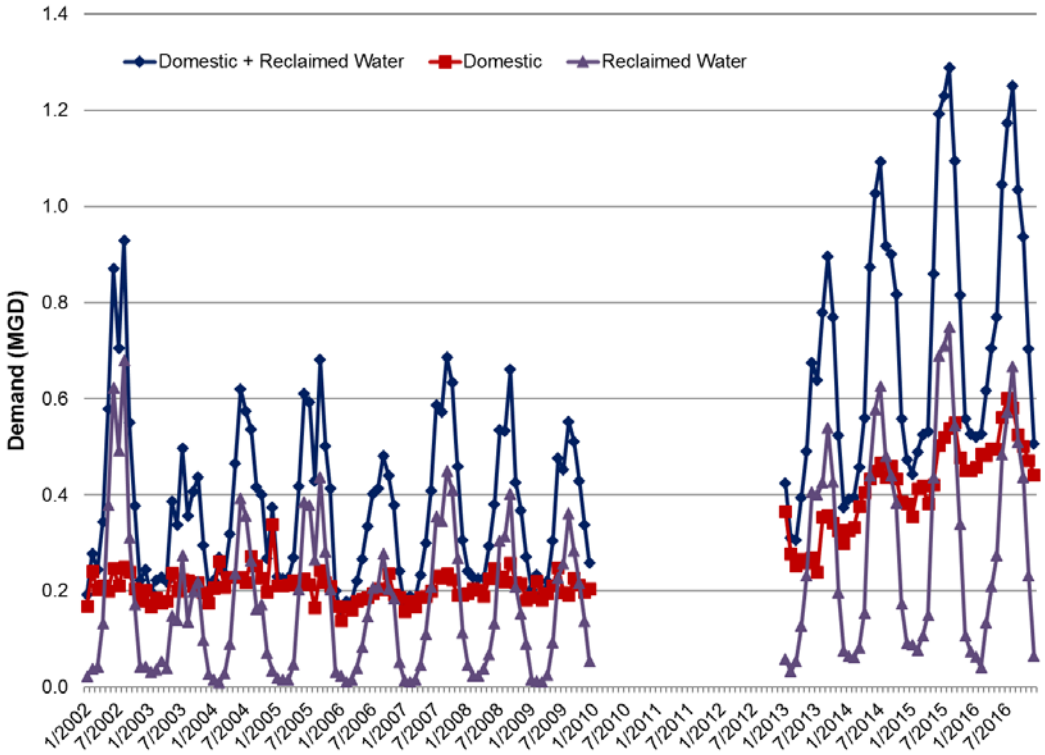


Figure 5-6. Seasonal Variation in Domestic and Reclaimed Water Usage for Reclaimed Water Accounts, 2001-2009 and 2013-2016

Includes the Town of Cary Reclaimed Water Accounts Only

Table 5-8. Summary of the Annual Average Day Reclaimed Water Demand by Customer Type, 2001-2009 and 2013-2016

Includes Town of Cary Reclaimed Water Accounts

	Annual Average Day Irrigation Demand (MGD)													
Customer Type	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		**2013**	**2014**	**2015**	**2016**
SFR	0.02	0.04	0.02	0.03	0.03	0.03	0.1	0.08	0.07		0.06	0.06	0.07	0.07
MFR	0.001	0.004	0.001	0.002	0.001	0.002	0.003	0.011	0.004		0.01	0.01	0.01	0.01
COM	0.06	0.15	0.09	0.11	0.14	0.1	0.15	0.09	0.10		0.16	0.21	0.24	0.19
IND	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
INS	0.01	0.04	0.01	0.01	0.01	0.02	0.01	0.01	0.01		0.02	0.02	0.02	0.03
Total	0.09	0.24	0.13	0.15	0.19	0.16	0.27	0.19	0.19		0.25	0.30	0.34	0.31

Notes:

< = less than

Table 5-9. Summary of the Annual Average Day Reclaimed Water Gallons per Day per Location, 2001-2009 and 2013-2016

Includes Town of Cary Reclaimed Water Accounts Only

Customer Type	Annual Average Day Irrigation Demand (GPD per Location)													
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		**2013**	**2014**	**2015**	**2016**
SFR	88	149	83	99	140	118	213	170	146		111	115	128	124
MFR	433	995	507	387	740	795	469	1,630	499		536	438	738	734
COM	1,609	3,015	1,813	2,219	2,663	2,168	2,586	1,710	1,842		2,165	2,698	2,527	2,177
IND	1,346	4,099	876	2,136	2,484	2,296	2,101	836	169		1,392	1,474	1,271	1,286
INS	3,328	8,390	1,350	2,229	2,908	5,494	6,808	2,484	4,332		2,657	2,852	2,612	4,026
Overall	365	742	400	471	620	449	509	357	343		404	487	510	466

Table 5-10. Percent of Total Use from Reclaimed Water by Customer Type, 2001-2009 and 2013-2016

Includes Town of Cary Reclaimed Water Accounts Only

	Irrigation Demand as a Percent of Total Account Usage (%)													
Customer Type	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		**2013**	**2014**	**2015**	**2016**
SFR	34	53	36	36	43	40	60	54	50		42	43	47	46
MFR	19	67	52	17	20	31	40	40	24		70	67	81	81
COM	23	49	37	39	49	36	41	31	32		56	58	55	45
IND	27	56	24	33	46	44	42	24	6		3	2	2	1
INS	19	96	75	85	82	65	65	49	63		66	68	67	77
Overall	24	56	38	39	48	39	50	41	41		53	48	48	42

SECTION 6

Unit Consumption Analysis

6.1 Annual Average Daily Unit Consumption Statistics

6.1.1 Single-family Residential Statistics

SFR unit consumption values were estimated for the Towns of Cary and Morrisville based on the annual average GPD per service location (or residence) for each location for 2001-2009 and 2013-2016, individually. Account service location IDs were used to identify individual residences, then an individual service location calculated annual average GPD per residence value was divided by the USCB persons per household value to generate the SFR GPCD. Before 2010, the 2000 Census data were used; after that, the 2010 Census data were used. The 2010 USCB persons per household value was also used in the 2017 Imagine Cary Plan (USCB, 2017). The USCB persons per household values used were:

- Cary:
  - 2000 Census: 2.86 persons per household
  - 2010 Census: 2.61 persons per household
- Morrisville:
  - 2000 Census: 2.43 persons per household
  - 2010 Census: 2.43 persons per household

Table 6-1 presents the GPD per residence and GPCD for all SFR accounts in the Towns of Cary and Morrisville. The Towns of Cary and Morrisville unit consumption values are very similar each year and follow the same annual variations. Overall, there has been a general declining trend in the annual average unit consumption values from 2001-2016, with 2008-2016 the most stable period, with 57 to 60 GPCD for both towns.

Figures 6-1 and 6-2 provide a cumulative distribution of all SFR annual average GPD per residence values for the Towns of Cary and Morrisville, respectively, for 2013-2016. These figures show that the towns have a similar distribution of unit consumption values, with very similar consumption values in 2013-2016 for SFR accounts. Appendix B contains a detailed statistical summary of the GPD per residence for 2001-2009 and 2013-2016; one primary additional observation can be made from these data that is similar to the declining annual average values from 2001-2016: the variability in the annual average SFR GPD per residence values has also declined from 2001-2016.

Figure 6-3 provides a cumulative distribution of all SFR annual average GPD per residence values for the Town of Cary comparing the years of 2001, 2005, 2007, 2009, and 2016, providing a comparison of 2016 to other years in the evaluation period that are reflective of drought periods and early years of the evaluation. The significance of this comparison is that the measures of central tendency (average and median) for the GPD per residence values have a range of 40 to 50 GPD per residence.

Table 6-1. Single-family Residential Annual Average Gallons per Day per Residence and Gallons per Capita per Day, 2001-2009 and 2013-2016

Includes All Single-family Residential Accounts from the Towns of Cary and Morrisville

Jurisdiction	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
GPD per Residence														
Cary	203	214	183	195	196	174	202	165	168		149	149	150	149
Morrisville	181	189	153	162	169	145	168	143	145		141	140	142	145
GPCD														
Cary	71	75	64	68	69	61	70	58	59		57	57	58	57
Morrisville	74	78	63	67	69	60	69	59	60		58	57	58	60

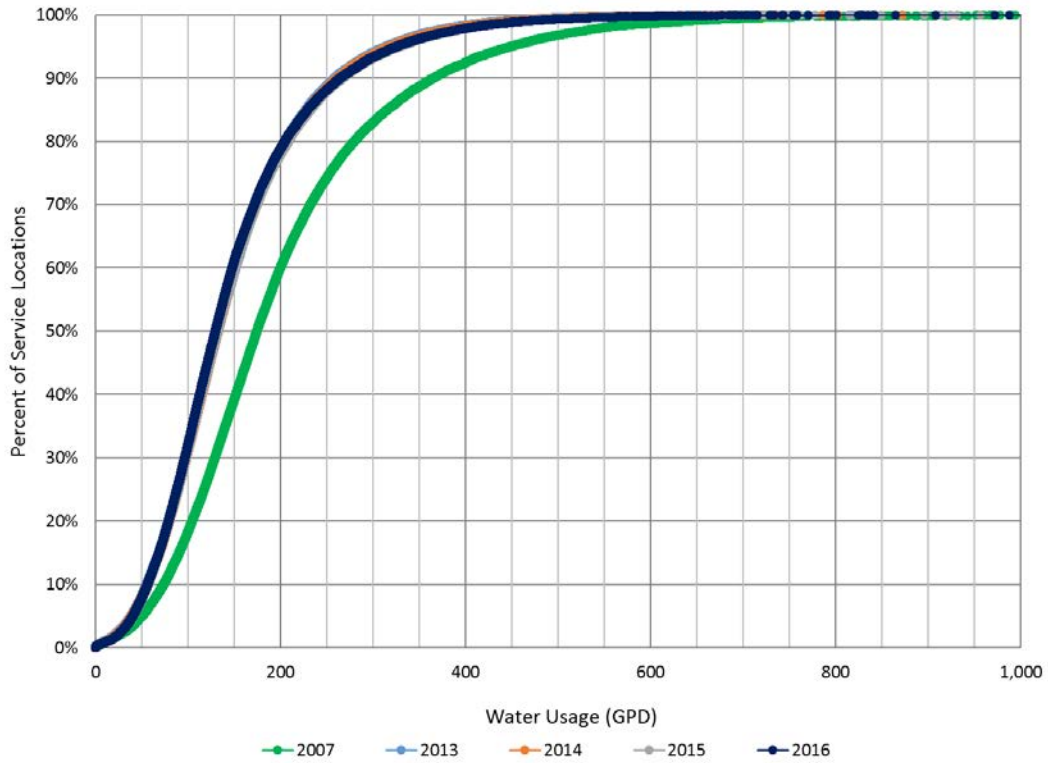


Figure 6-1. Town of Cary Cumulative Distribution of Single-family Residential Annual Average Gallons per Day per Service Location (Residence) Values, 2007 and 2013-2016

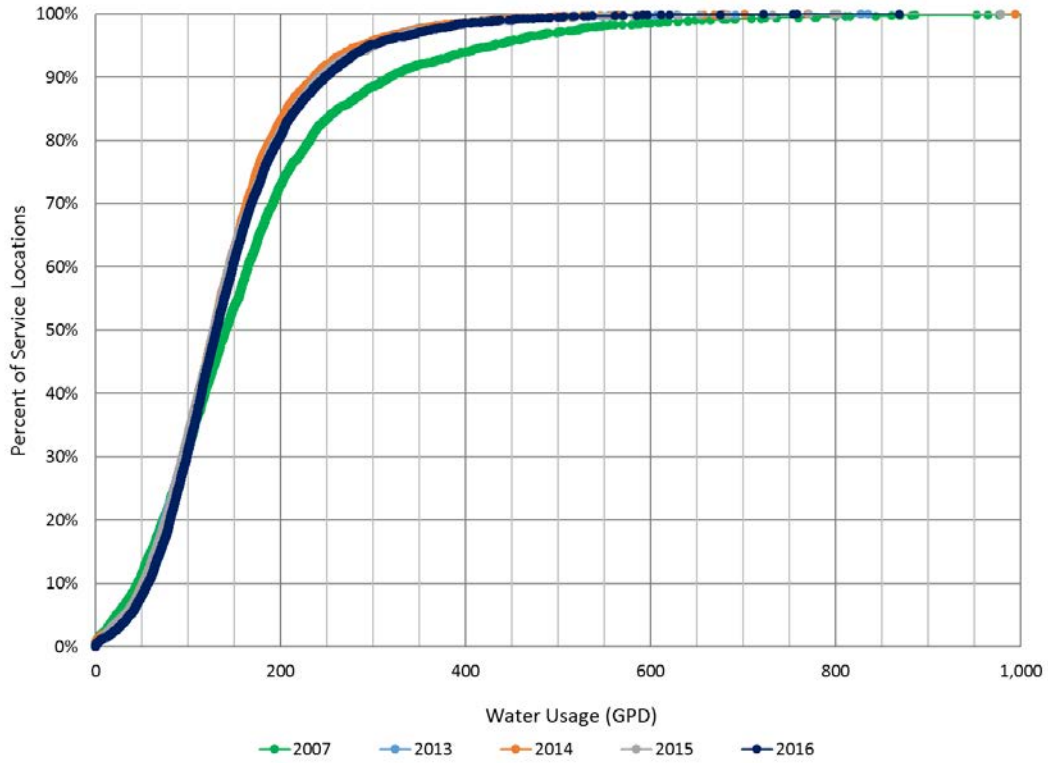


Figure 6-2. Town of Morrisville Cumulative Distribution of Single-family Residential Annual Average Gallons per Day per Service Location (Residence) Values, 2007 and 2013-2016

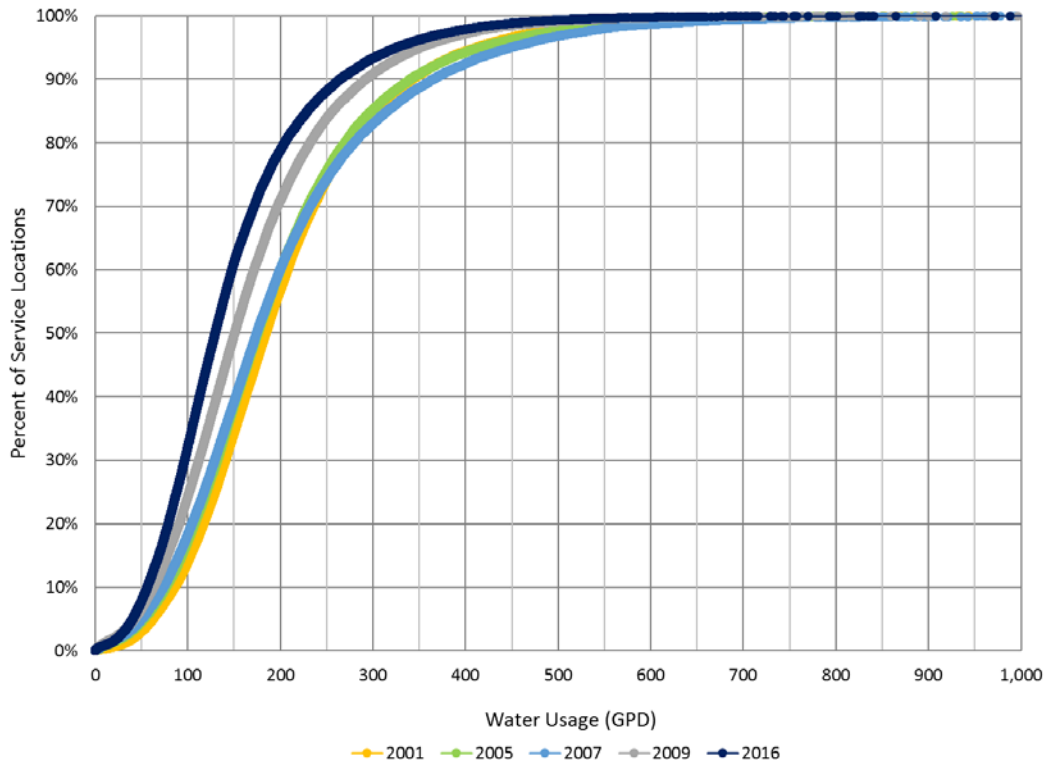


Figure 6-3. Town of Cary Cumulative Distribution of Single-family Residential Annual Average Gallons per Day and Service Location (Residence) Values, 2001, 2005, 2007, 2009, and 2016

6.1.2 Multifamily Residential Statistics

An estimate of the MFR unit consumption required an estimation of the MFR population by year, as the same method used for SFR accounts is not accurate for MFR accounts, since many MFR locations are not individually metered, and a single meter account can include multiple residences (that is, master meter for an apartment complex). MFR populations were estimated by deducting the estimated SFR population from the total residential population. Appendix C provides a breakout of the MFR population. Unit consumption values were estimated separately for the Towns of Cary and Morrisville from the total annual MFR usage divided by the estimated MFR population.

Table 6-2 presents the GPD per location and GPCD for all MFR accounts in the Towns of Cary and Morrisville. The Towns of Cary and Morrisville unit consumption values are very similar and follow the same annual variations. Appendix B contains a detailed statistical summary of the GPD per location for 2001-2009 and 2013-2016. Figures 6-4 and 6-5 provide a cumulative distribution of all MFR GPD per location values for the Towns of Cary and Morrisville, respectively, for 2013-2016. The towns have a similar distribution of unit consumption values, and the consumption values in 2013-2016 were very similar for MFR.

Table 6-2. Multifamily Residential Annual Average Gallons per Day per Location and Gallons per Capita per Day, 2001-2009 and 2013-2016

Includes All Multifamily Residential Accounts from the Towns of Cary and Morrisville

Jurisdiction	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
GPD per Location														
Cary	309	295	295	301	282	248	277	248	251		231	226	216	208
Morrisville	239	233	204	205	206	207	224	212	210		198	201	203	200
GPCD														
Cary	63	57	54	57	57	50	56	50	50		42	41	39	39
Morrisville	57	60	54	57	54	52	54	50	54		41	41	42	41

Notes:

MFR accounts, in many cases, are not individually metered, providing a higher per location consumption total than SFR.

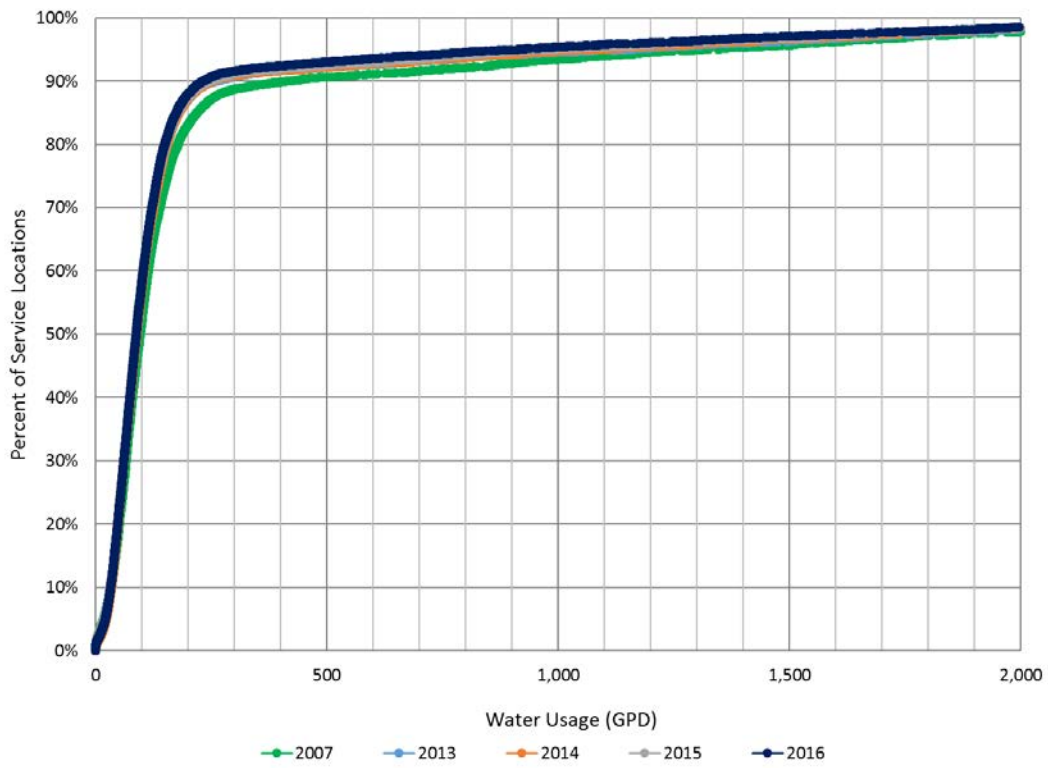


Figure 6-4. Town of Cary Cumulative Distribution of Multifamily Residential Annual Average Gallons per Day per Service Location Values, 2007 and 2013-2016

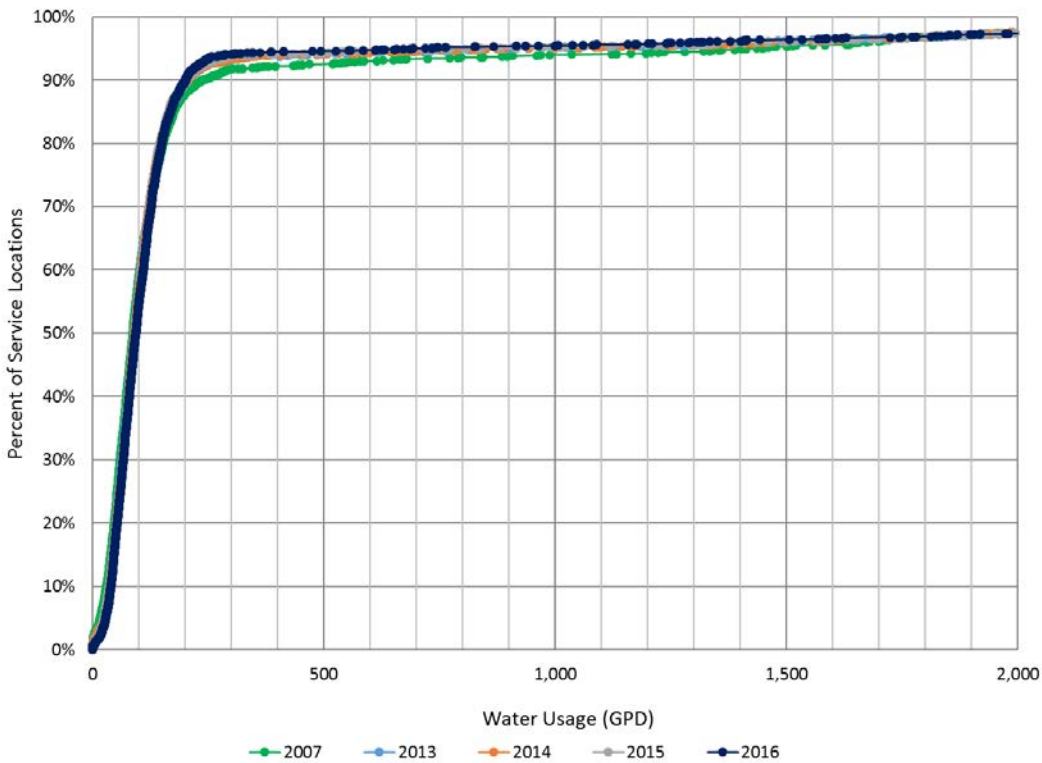


Figure 6-5. Town of Morrisville Cumulative Distribution of Multifamily Residential Annual Average Gallons per Day per Service Location Values, 2007 and 2013-2016

6.1.3 Commercial Statistics

COM unit consumption values were estimated for the Towns of Cary and Morrisville using each individual commercial account service location ID and GPD usage divided by building square footage. The GPD per square foot was the unit consumption basis used in the 2013 LRWRP (CH2M and Brown and Caldwell, 2013). Building square footage was obtained from the Wake County building database that was spatially linked to the Town's meter data using the Town's meter point geographic information system (GIS) data layer for the 2001-2009 data, and the coordinate in the Aquastar system for the 2013-2016 data.

Table 6-3 presents the annual average and median GPD per square foot for all COM accounts. Appendix B contains a detailed statistical summary of the GPD per square foot for 2001-2009 and 2013-2016. Figures 6-6 and 6-7 present the cumulative distribution of COM GPD per square foot values for the Towns of Cary and Morrisville, respectively, for 2013-2016.

Table 6-3. Commercial Annual Average Gallons per Day per Square Foot, 2001-2009 and 2013-2016
Includes All Commercial Residential Accounts from the Towns of Cary and Morrisville

Jurisdiction	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
Average GPD/ft^2														
Cary	0.17	0.17	0.16	0.16	0.17	0.15	0.18	0.15	0.15		0.12	0.12	0.13	0.12
Morrisville	0.06	0.07	0.08	0.09	0.10	0.13	0.15	0.13	0.13		0.14	0.14	0.16	0.17
Median GPD/ft^2														
Cary	0.05	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04		0.04	0.04	0.04	0.04
Morrisville	0.04	0.05	0.04	0.04	0.05	0.04	0.04	0.03	0.03		0.03	0.03	0.04	0.04

Note:
ft^2 = square foot (feet)

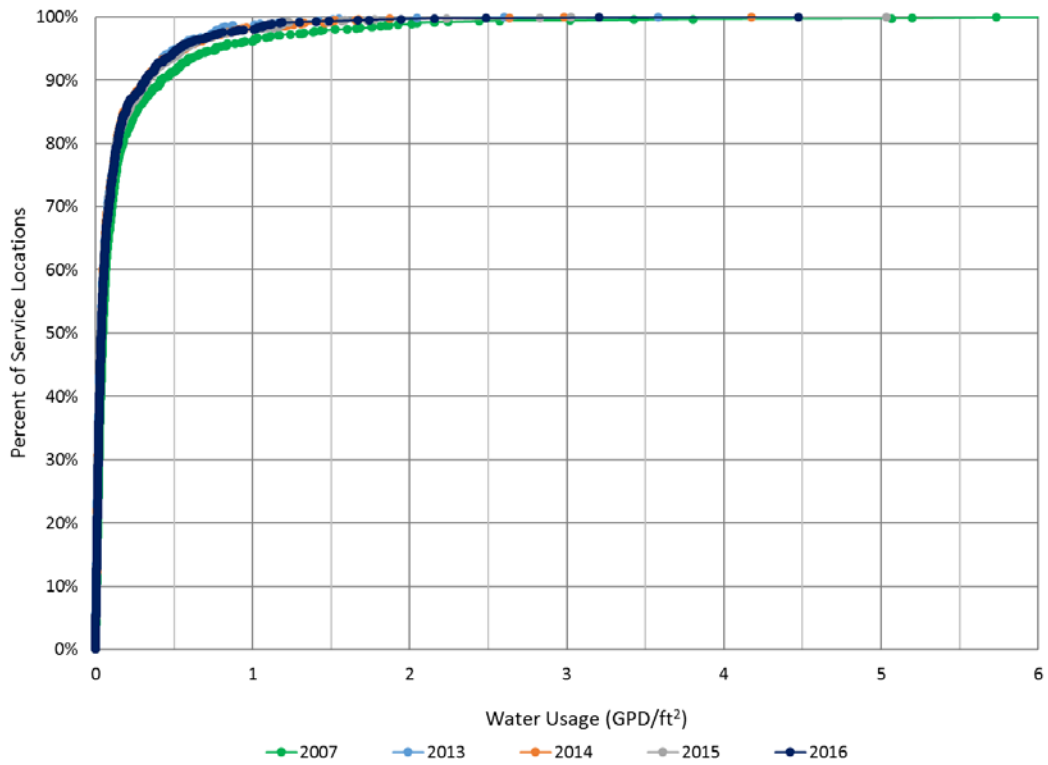


Figure 6-6. Town of Cary Cumulative Distribution of Commercial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

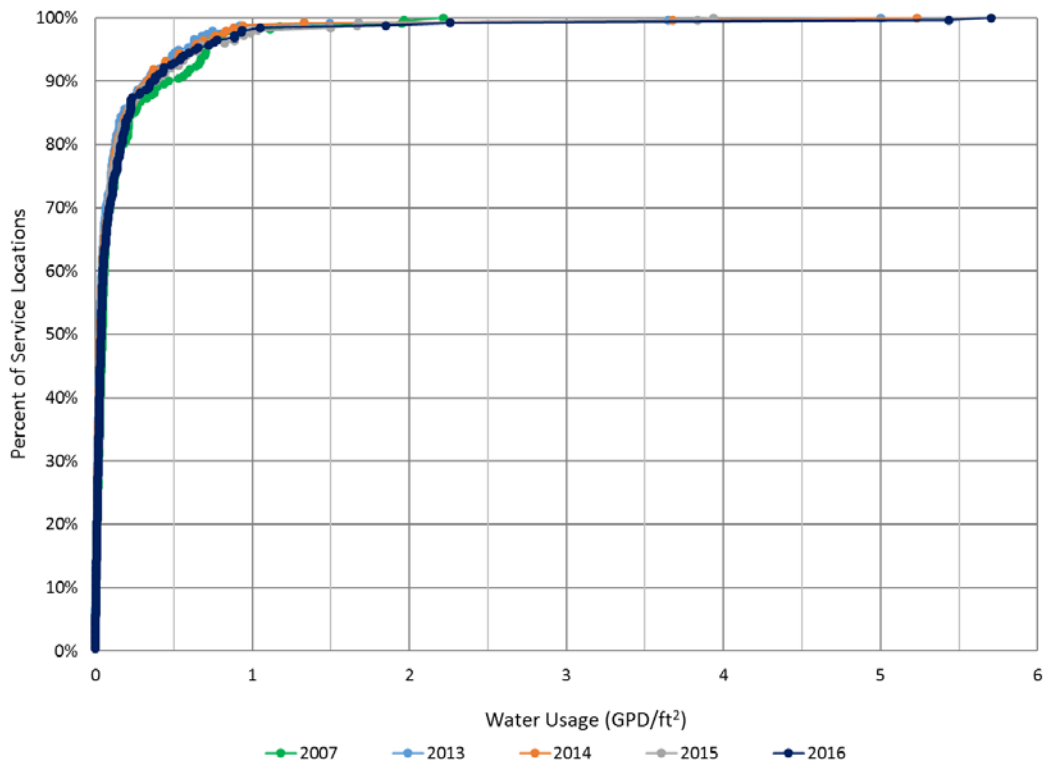


Figure 6-7. Town of Morrisville Cumulative Distribution of Commercial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

6.1.4 Industrial Statistics

IND unit consumption values were estimated for the Towns of Cary and Morrisville based on an individual industrial account's service location using the same method as the COM unit consumption values discussed in Section 6.1.3. Table 6-4 presents the annual average and median GPD per square foot for all COM accounts. Appendix B contains a detailed statistical summary of the GPD per square foot for 2001-2009 and 2013-2016. Figures 6-8 and 6-9 present the cumulative distribution of IND GPD per square foot values for the Towns of Cary and Morrisville, respectively, for 2013-2016.

Table 6-4. Industrial Annual Average Gallons per Day per Square Foot, 2001-2009 and 2013-2016
Includes All Industrial Residential Accounts from the Towns of Cary and Morrisville

Jurisdiction	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
Average GPD/ft^2														
Cary	0.34	0.27	0.33	0.35	0.27	0.27	0.23	0.19	0.11		0.19	0.29	0.32	0.29
Morrisville	-	-	-	-	0.06	0.43	0.52	0.22	0.24		0.02	0.06	0.06	0.08
Median GPD/ft^2														
Cary	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01		0.01	0.01	0.01	0.01
Morrisville	-	-	-	-	0.06	0.01	0.02	0.01	0.01		0.01	0.01	0.01	0.01

Notes:

Morrisville data prior to Cary's infrastructure purchase are not included in the analysis.

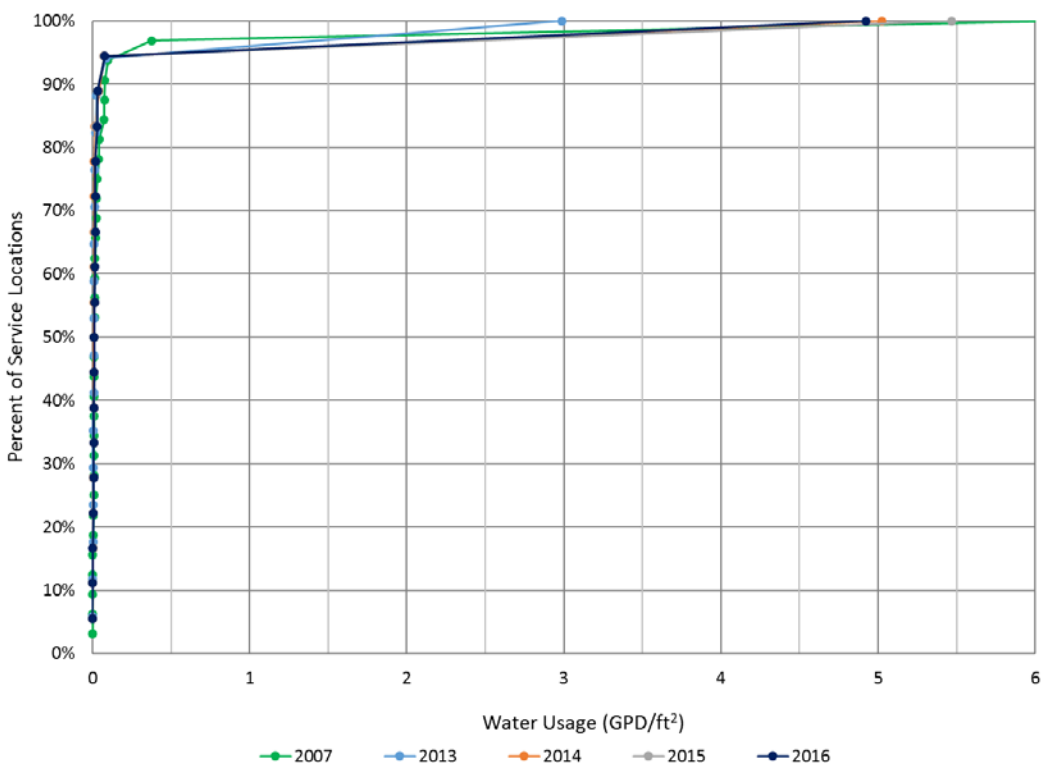


Figure 6-8. Town of Cary Cumulative Distribution of Industrial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

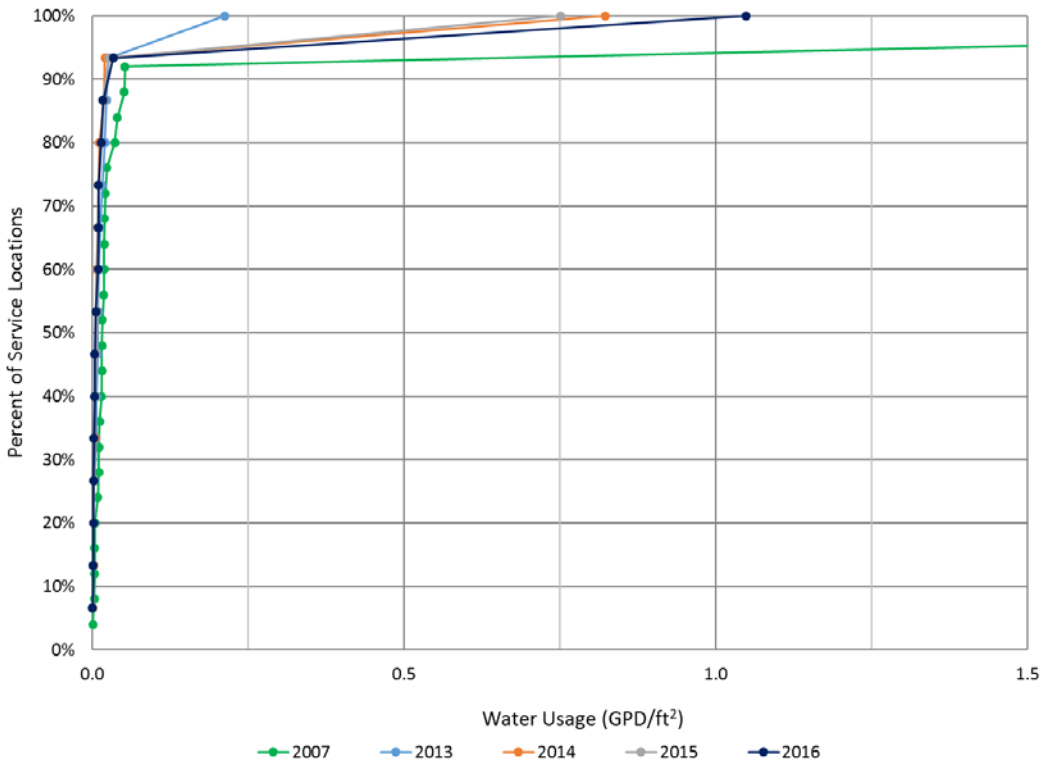


Figure 6-9. Town of Morrisville Cumulative Distribution of Industrial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

6.1.5 Institutional Statistics

INS unit consumption values were estimated for the Towns of Cary and Morrisville based on each individual institutional account's service location using the same method as the COM unit consumption values discussed in Section 6.1.3. Table 6-5 presents the annual average and median GPD per square foot for all INS accounts. Appendix B contains a detailed statistical summary of the GPD per square foot for 2001-2009 and 2013-2016. Figures 6-10 and 6-11 present the cumulative distribution of INS GPD per square foot values for the Town of Cary and Morrisville, respectively, for 2013-2016.

Table 6-5. Institutional Annual Average Gallons per Day per Square Foot, 2001-2009 and 2013-2016
Includes All Institutional Residential Accounts from the Towns of Cary and Morrisville

Jurisdiction	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
Average GPD/ft²														
Cary	0.21	0.20	0.09	0.15	0.21	0.13	0.34	0.25	0.17		0.10	0.12	0.11	0.10
Morrisville	0.13	0.17	0.18	0.58	0.42	0.07	0.05	0.04	0.05		0.06	0.05	0.04	0.04
Median GPD/ft²														
Cary	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03		0.02	0.02	0.02	0.03
Morrisville	0.15	0.21	0.15	0.21	0.21	0.02	0.02	0.04	0.04		0.03	0.02	0.02	0.02

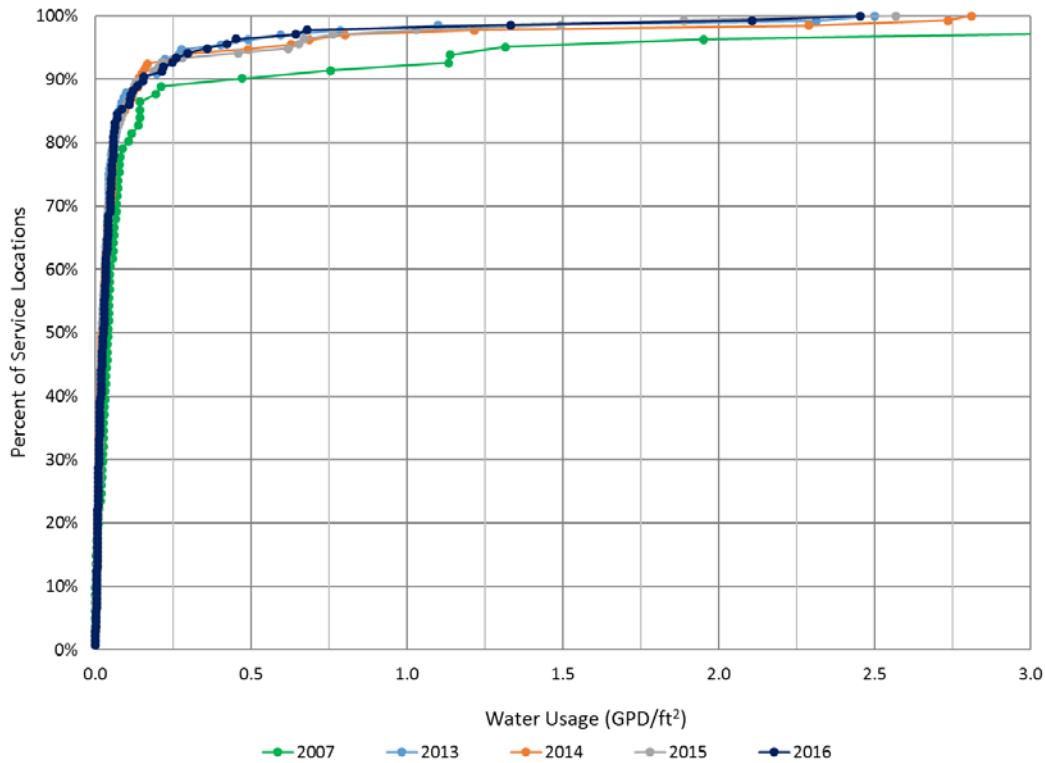


Figure 6-10. Town of Cary Cumulative Distribution of Institutional Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

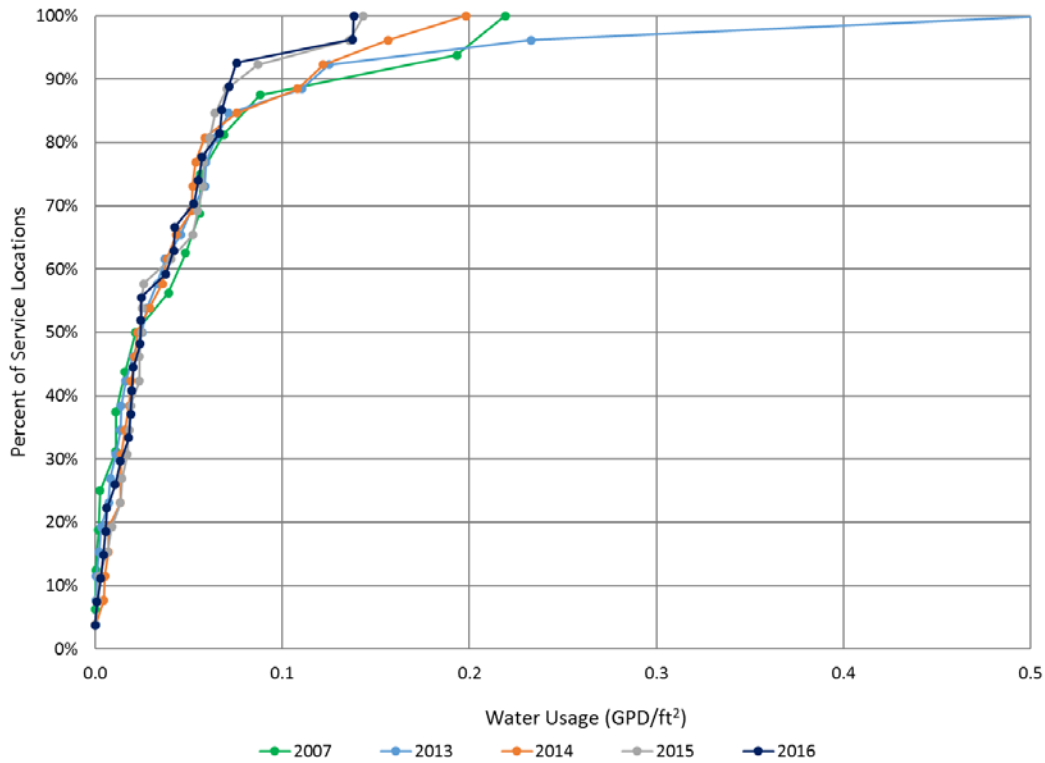


Figure 6-11. Town of Morrisville Cumulative Distribution of Institutional Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

6.2 Seasonal Indoor and Outdoor Usage Profile

A seasonal indoor and outdoor use profile was developed to identify the difference in seasonal variation for total demand, indoor demand, and outdoor and irrigation demand for separate meter accounts (with separately metered irrigation) and single meter account types. This section presents an indoor and outdoor use profile for SFR and COM accounts, the two primary customer types that drive the seasonal demand pattern for the Town's service area.

To estimate the indoor and outdoor use profile, two distinct methods were necessary: one for separately metered irrigation accounts and one for single meter accounts (all accounts that do not have a separate irrigation meter).

The indoor and outdoor use profile was estimated for separately metered irrigation accounts using the following methodology:

- These accounts have dual meters: one to measure domestic potable water consumption for all uses excluding irrigation, and one meter to measure just irrigation consumption.
- Aquastar meter data for each account's dual meter were used to estimate the annual average domestic indoor GPD per residence, which likely includes a small seasonal outdoor demand that is not irrigation, and irrigation GPD per residence values.

The indoor and outdoor use profile was estimated for all SFR accounts that do not have a separate meter to track outdoor and irrigation usage using the following methodology:

- Seasonality of monthly SFR account water usage for the evaluation period was estimated from variations in customer account billing data.
- Average water usage for the months of December-March was assumed to be representative of indoor water demand, since outdoor and irrigation demand does not normally occur in these months (or occurs minimally).
- Indoor demand is defined as all end-uses inside a residence (for example, toilet flushing, washing machines, and showers).
- The December-March average water demand was subtracted from all other months of the year to estimate the monthly volume of outdoor and irrigation demand. This demand is assumed to be dominated, in general, by irrigation.

The data set used for the estimation of the indoor and outdoor use profile included the January 2013-December 2016 Aquastar meter data for all SFR accounts summarized by month and year for both the separate and single meter accounts.

Figure 6-12 presents the monthly average day GPD per residence for SFR single meter and separately metered accounts. These data have been broken out by total demand, and outdoor and irrigation demand. The separately metered account irrigation data are actual metered data, while the single meter outdoor and irrigation unit demands are the estimated values based on the method described. The demand profiles from April from November shown on Figure 6-12 identify a significantly higher seasonal profile for the separately metered accounts than for the single meter accounts. The demand profile during the winter months (December-March) is similar between the two account types (separate versus single meter), with separately metered accounts consuming 15 to 20 percent more during the winter on a unit basis.

Figure 6-13 presents similar data as Figure 6-12, except the total demand data have been replaced by the indoor demand. The indoor demand profile between the separate and single meter accounts is similar; again, showing about 20 percent increased demand from separately metered accounts. The single meter indoor demand is estimated based on the period average December-March demand and is intended to only represent indoor water demands.

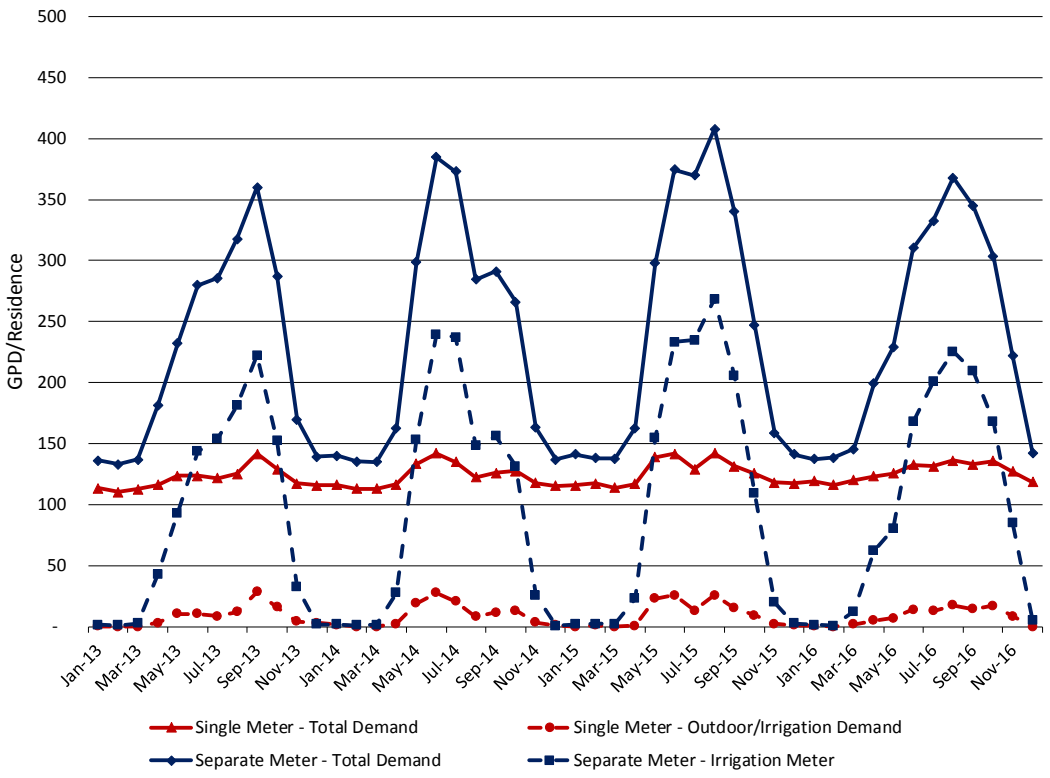


Figure 6-12. 2013–2016 Monthly Average Day Single-family Residential Gallons per Day per Residence, Total, and Outdoor and Irrigation Demand

Includes All Accounts from the Towns of Cary and Morrisville

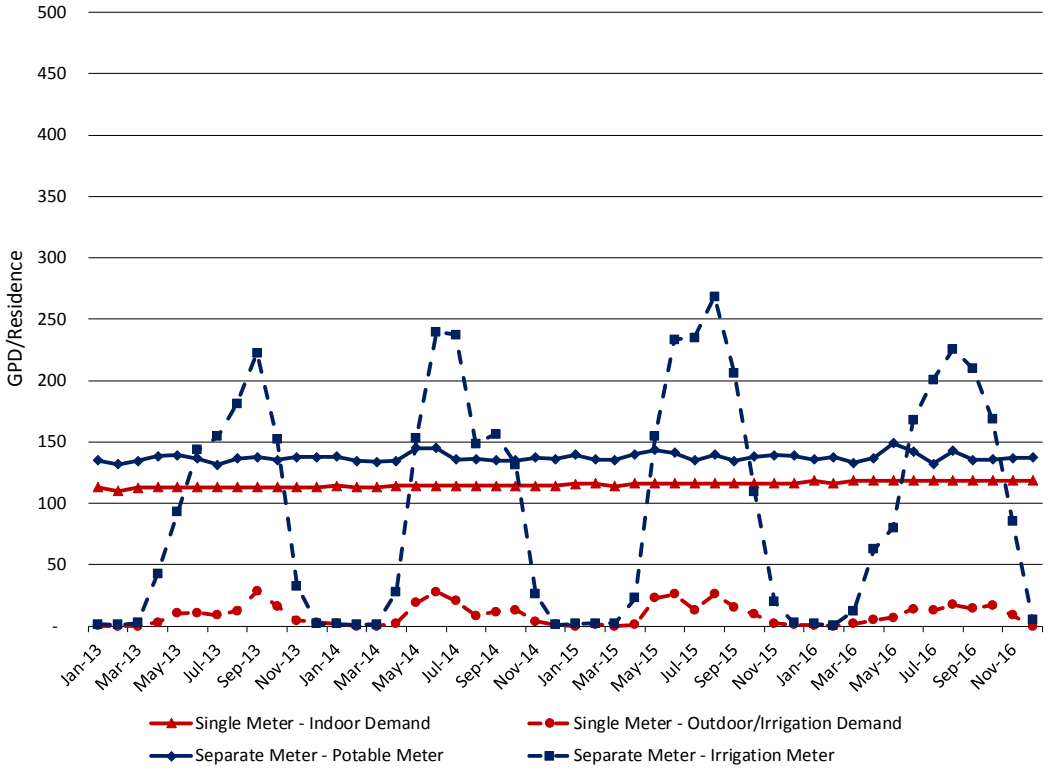


Figure 6-13. 2013–2016 Monthly Average Day Single-family Residential Gallons per Day per Residence, Indoor, and Outdoor and Irrigation Demand

Includes All Accounts from the Towns of Cary and Morrisville

Figures 6-14 and 6-15 present the monthly average day GPD per location for COM single meter and separately metered accounts. The methodology for estimating indoor and outdoor usage is the same as described for the SFR analysis. The data in Figure 6-14 have been broken out by total demand, and outdoor and irrigation demand. The April through November demand profiles shown on Figure 6-15 identify a significantly higher seasonal profile for the separately metered accounts than for the single meter accounts, same as was observed in the SFR analysis. The demand profile during the winter months (December-March), however, is not as similar as it was for the SFR analysis, with separately metered accounts consuming twice the volume of single metered accounts during the winter.

Figure 6-15 presents similar data as Figure 6-14, except the total demand data have been replaced by the indoor demand. Figure 6-15 shows in more detail the differences between indoor demand for single metered COM accounts and separately metered COM accounts. Separately metered accounts exhibit a fairly significant seasonal pattern in their indoor usage, requiring as much as two to three times the volume, on a unit basis, as single metered accounts during peak summer months.

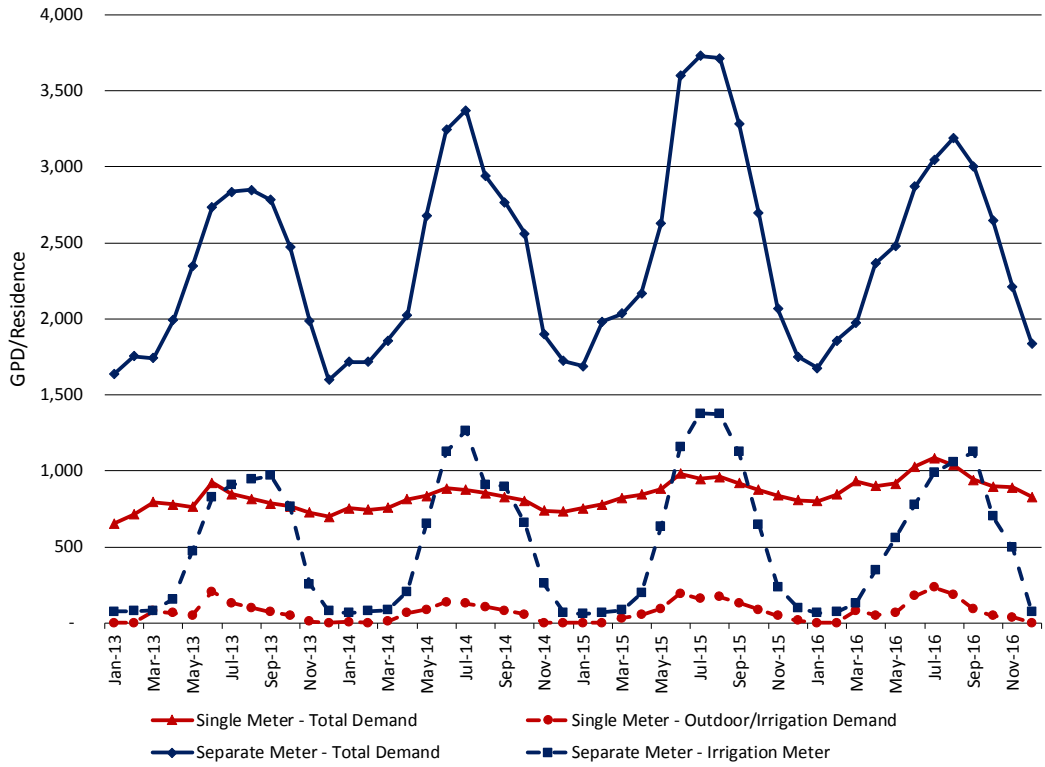


Figure 6-14. 2013–2016 Monthly Average Day Gallons per Day per Location for Commercial Accounts, Total, and Outdoor and Irrigation Demand

Includes All Accounts from the Towns of Cary and Morrisville

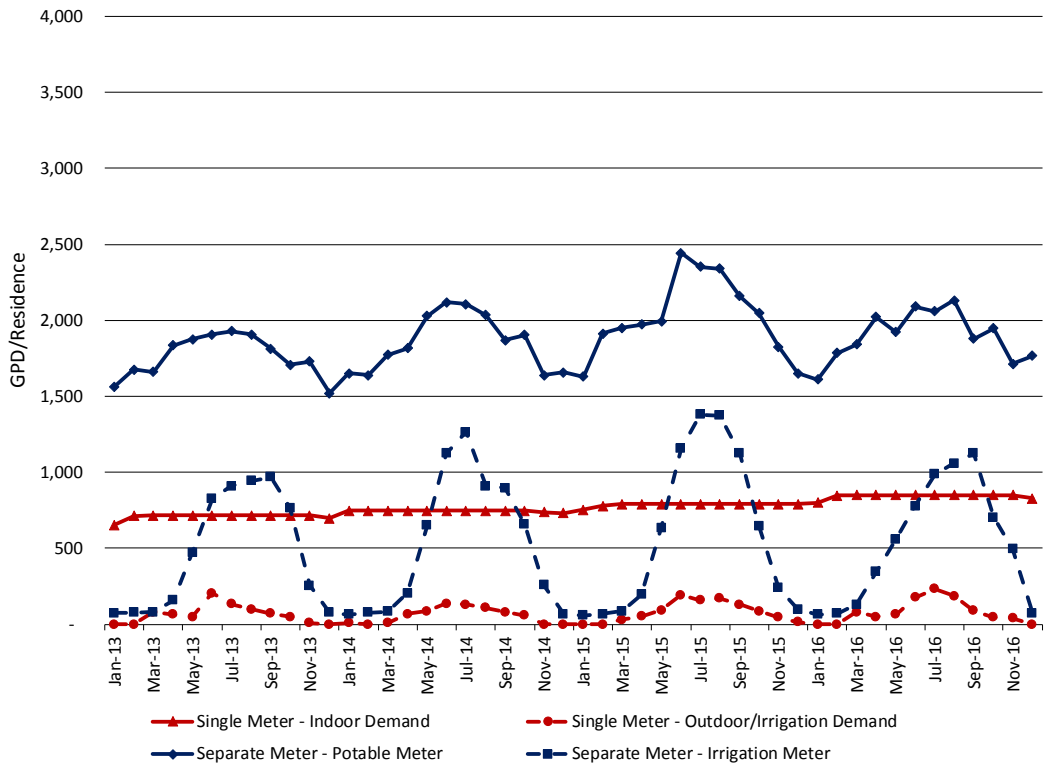


Figure 6-15. 2013–2016 Monthly Average Day Gallons per Day per Location for Commercial Accounts, Indoor, and Outdoor and Irrigation Demand

Includes All Accounts from the Towns of Cary and Morrisville

6.3 Maximum Monthly and Daily Peaking Profiles

Monthly and daily peaking ratios measure the magnitude of customers' seasonality and also provide an indication for what may be expected from a treatment perspective during a worst-case scenario. Significantly increased usage is generally associated with outdoor and irrigation usage; therefore, will likely occur during the summer. Peaking ratios were calculated by comparing the maximum monthly or daily average GPD in a given year to the annual average GPD for that year, for each SFR and COM location. Because these maximum peaking ratios are determined on a customer-by-customer basis, they do not necessarily occur in the same month or on the same day. The proportion of each customer type within different peaking ratio ranges are shown in the following bar charts.

6.3.1 Single-family Residential Peaking Profiles

Figures 6-16, 6-17, and 6-18 present SFR maximum monthly peaking ratio distributions for 2013-2016. Figure 6-16 incorporates all SFR customers, while Figure 6-17 shows separately metered irrigation accounts only, and Figure 6-18 shows single meter accounts. Figure 6-16 shows that for each of the past 4 years, around 90 percent of all customers have a maximum monthly GPD that peaks less than 2.5 times their annual GPD. Half of all customers consistently have a peaking factor less than 1.5 times their annual GPD. However, those separately metered customers exhibit higher maximum monthly peaking ratios, with over half of customers between 1.6 and 2.5, and notably with a significant decrease in the lowest category (Figure 6-17). The profile for single meter customers, presented on Figure 6-18, much more closely resembles the overall profile on Figure 6-16, with most single metered customers exhibiting a peaking factor of less than 1.5. This is because there are approximately 2.6 times more single meter customers than separately metered customers.

The peaking factor is magnified when analyzing the daily peaking ratio, primarily due to outdoor usage. Figure 6-19 presents maximum SFR daily peaking ratio distributions for 2016 only. Separately metered customers frequently use automated irrigation systems that use water on a regular basis, driving up their peak monthly use, as reflected on Figure 6-17, and creating a significant difference in daily usage between days of no watering and days of watering. Single meter customers who are also using water outdoors are more likely to complete outdoor watering activities on an as-needed basis, in reaction to warm weather trends. This also creates a significant difference in daily usage between days of no watering and days of watering. This is why, when looking at daily peaking ratios on Figure 6-19, both separately metered and single meter customers are more likely to use over 10 times as much as their annual average.

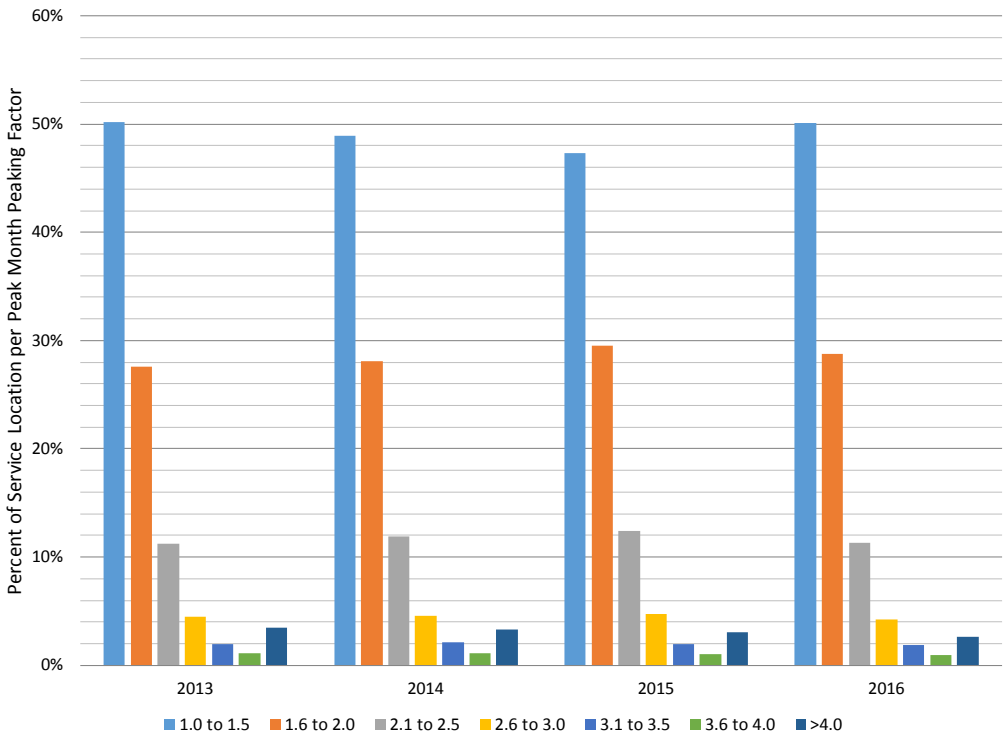


Figure 6-16. Single-family Residential Maximum Monthly Peaking Factor Distribution, 2013-2016

Includes All Accounts from the Towns of Cary and Morrisville

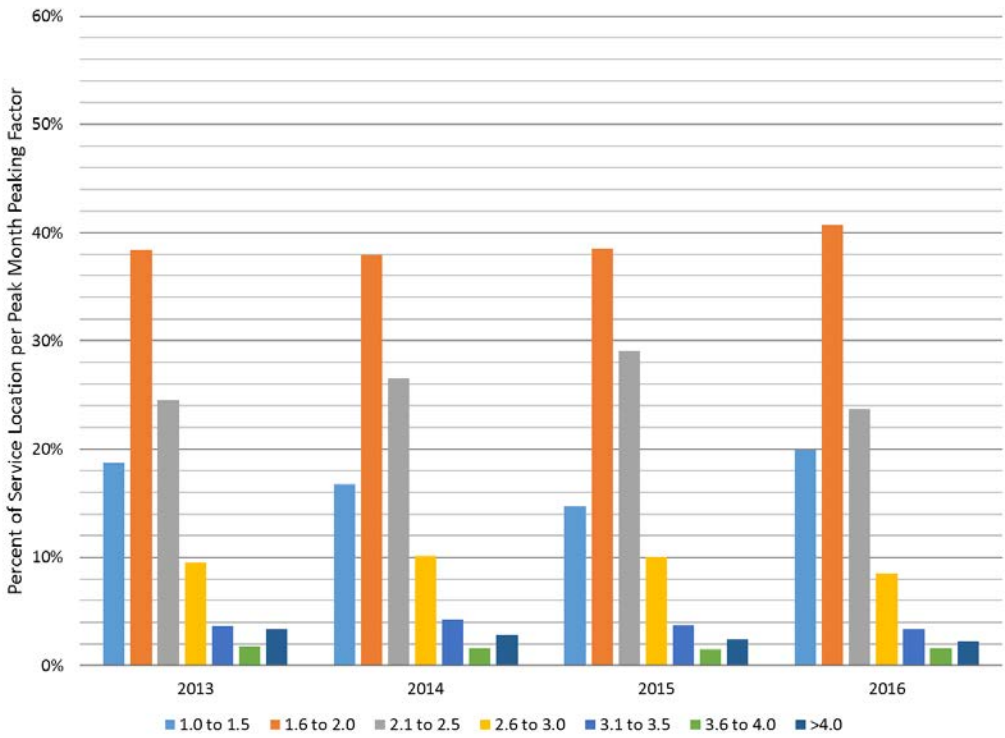


Figure 6-17. Single-family Residential Maximum Monthly Peaking Factor Distribution, 2013-2016

Includes Only Separately Metered Irrigation Accounts from the Towns of Cary and Morrisville

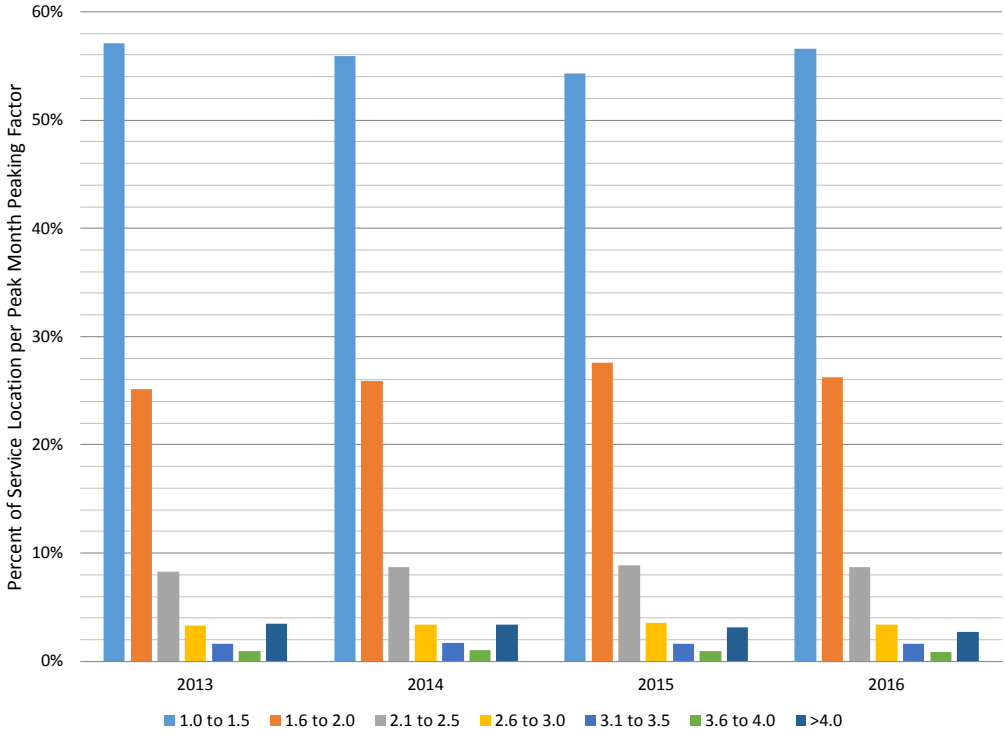


Figure 6-18. Single-family Residential Maximum Monthly Peaking Factor Distribution, 2013-2016

Includes Only Single Meter Accounts from the Towns of Cary and Morrisville

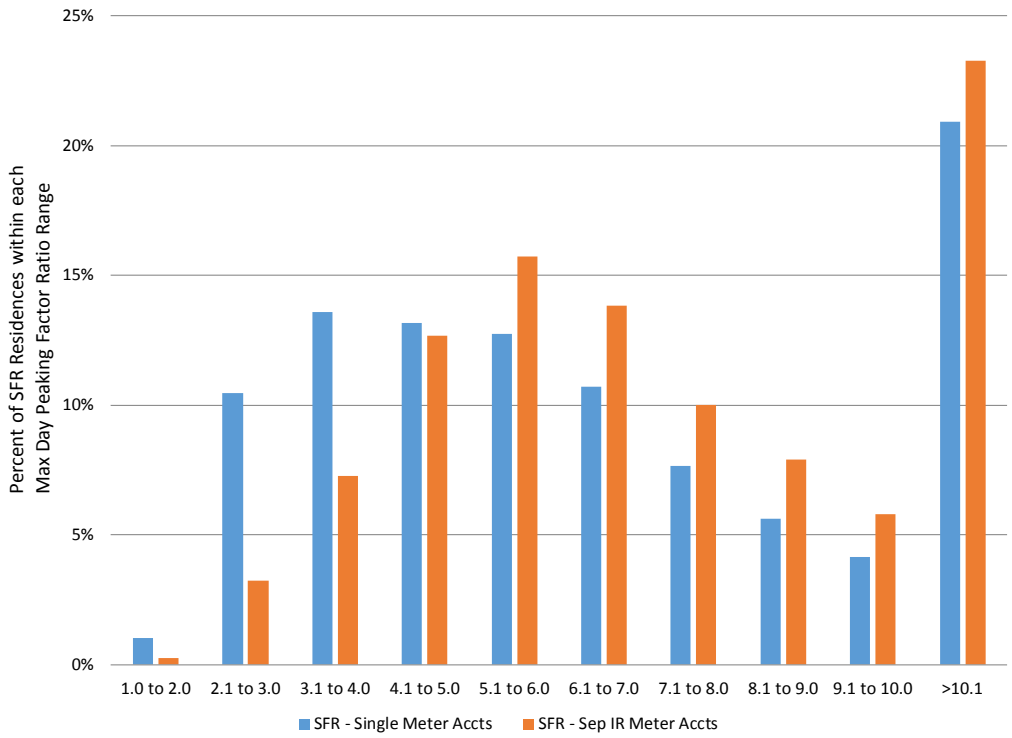


Figure 6-19. Single-family Residential Maximum 2016 Daily Peaking Factor Distribution, Comparing Single and Separately Metered Accounts

Includes All Accounts from the Towns of Cary and Morrisville

6.3.2 Commercial Peaking Profiles

Figures 6-20, 6-21, and 6-22 present maximum COM monthly peaking ratio distributions for 2013-2016. Figure 6-20 incorporates all COM customers, while Figure 6-21 shows data for separately metered irrigation accounts only, and Figure 6-22 shows single meter accounts. Unlike SFR, COM customers exhibit higher monthly peaking factors, with the majority having a peaking factor less than 2.0. The next largest group, at around 15 percent, exhibits a peaking factor greater than 4.0. Again, there are more single meter COM customers than those with separately metered irrigation systems, so the trends seen on Figure 6-22 are also observed on Figure 6-20. The profile for separately metered locations presented on Figure 6-21 is relatively flat, indicating there is no significant trend amongst this group.

Daily COM peaking ratios are similar to the patterns shown for SFR on Figure 6-19. Figure 6-23 presents maximum COM daily peaking ratio distributions for 2016 only. The COM single meter locations are shifted lower than separately metered locations, except for the lowest ranges of peaking factors. However, counter to the trend of single metered locations using less than separately metered locations in SFR accounts, Figure 6-23 shows that single metered locations are more likely to fall into the highest maximum day peak ratio category than separately metered locations. This shows that COM indoor usage drives their water use profile, with most facilities showing a peaking factor less than 1.5, and no outdoor irrigation.

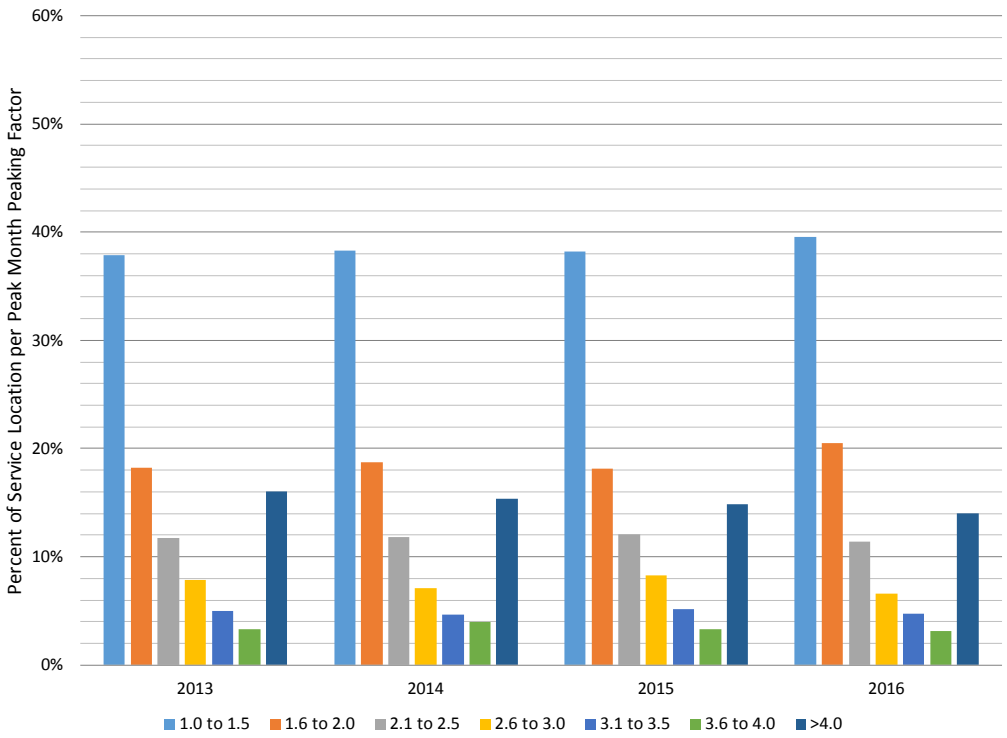


Figure 6-20. Commercial Maximum Monthly Peaking Factor Distribution, 2013-2016

Includes All Accounts from the Towns of Cary and Morrisville

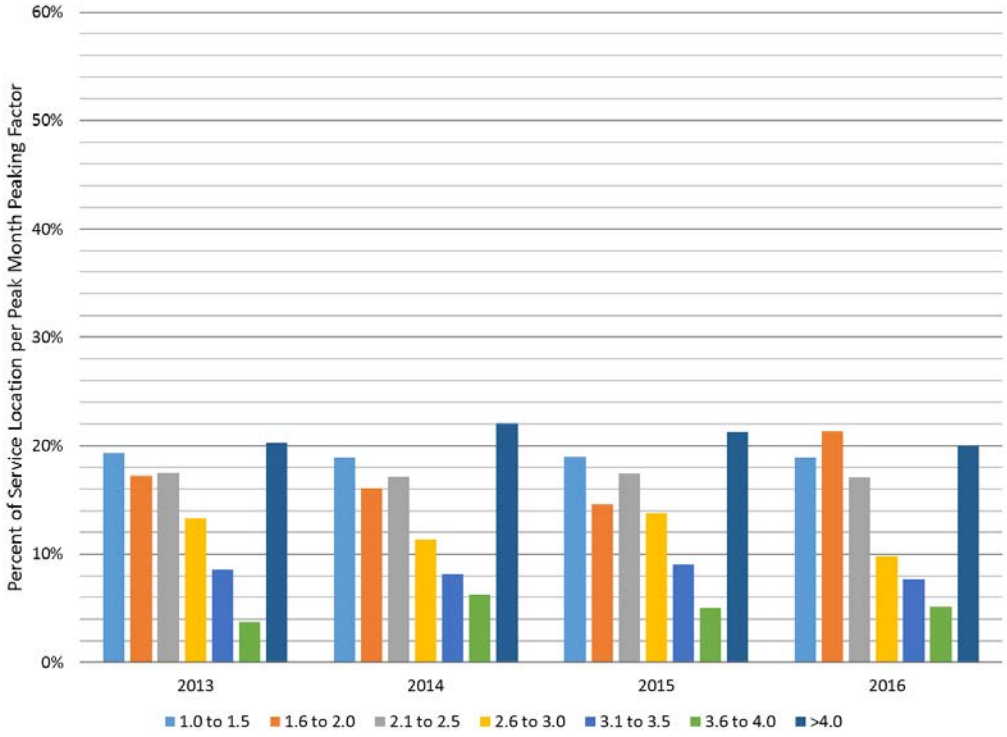


Figure 6-21. Commercial Maximum Monthly Peaking Factor Distribution, 2013-2016

Includes Only Separately Metered Irrigation Accounts from the Towns of Cary and Morrisville

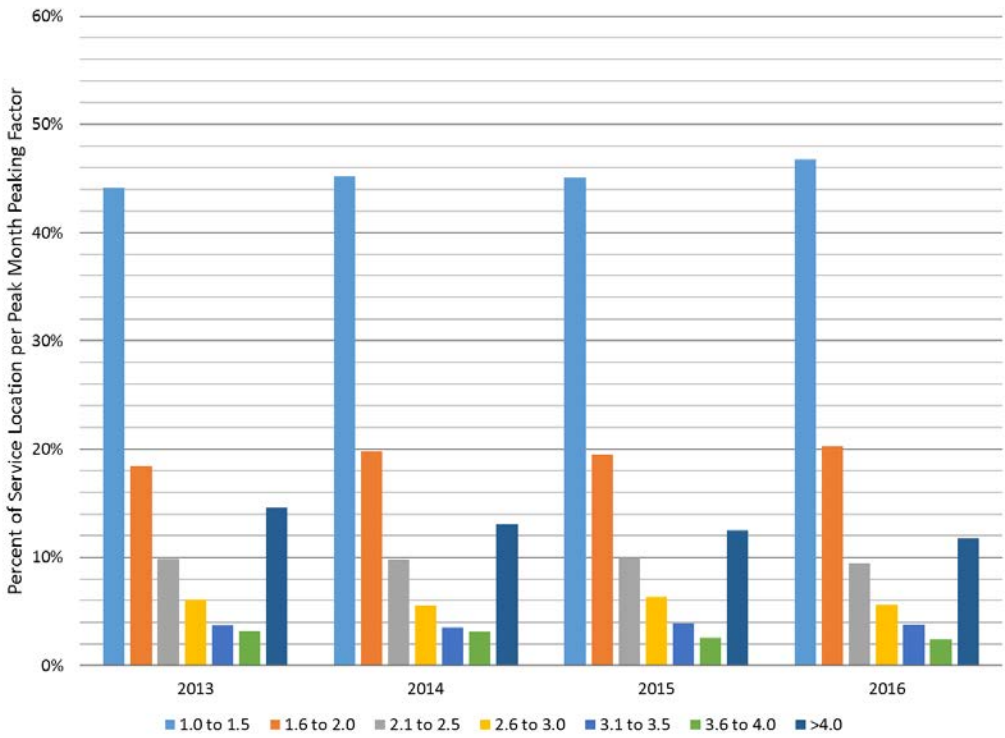


Figure 6-22. Commercial Maximum Monthly Peaking Factor Distribution, 2013-2016

Includes Only Single Meter Accounts from the Towns of Cary and Morrisville

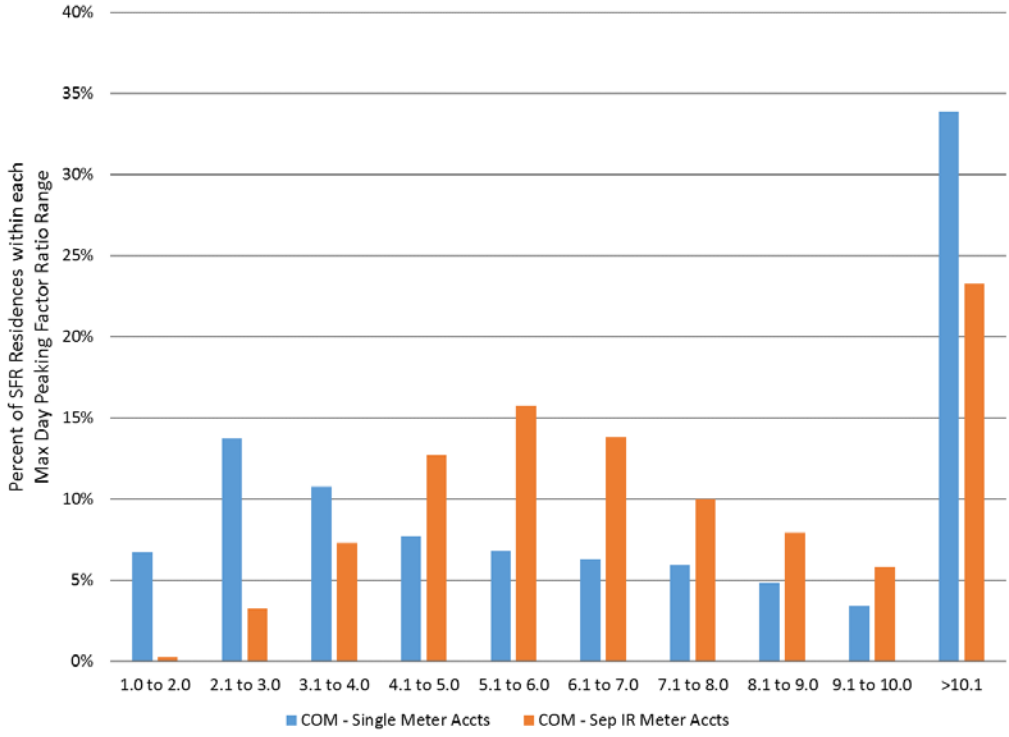


Figure 6-23. Commercial Maximum 2016 Daily Peaking Factor Distribution, Comparing Single and Separately Metered Accounts

Includes All Accounts from the Towns of Cary and Morrisville

6.4 Single-family Residential Water Use Trends

The intent of this section is to review the SFR billing data for the Towns of Cary and Morrisville to identify the usage trends from 2001-2016. A key finding of the both 2007 IWRMP (CH2M, 2007) and the 2010 Water Use Analysis (CH2M, 2010) was that newer SFRs within the Town of Cary service area used water more than older homes. As shown in this section, this pattern exhibits a reversal for the newer homes.

6.4.1 Single-family Residence Age Water Use Profile

For this analysis, SFR homes were grouped into age blocks based on the year the residence was constructed, as identified in the Wake County parcel data. The residence age blocks are as follows:

- Before 1975
- 1975-1994
- 1995-2000
- 2001-2005
- 2006-2010
- After 2010

The SFR residence age blocks were selected in an attempt to provide the best representation of specific time periods relevant to the Town. Time periods, including before and after the full implementation of the National Energy Policy Act of 1992, which required plumbing code changes and the availability of higher-efficiency toilets, urinals, faucets, and showerheads by 1994. In addition, the Town started requiring separate irrigation meters starting in August 2000 for all new in-ground irrigation systems. The age blocks also provide a grouping to identify the oldest homes in Cary (before 1975), as well as incrementally subdividing the newest homes within the Town's service area into four blocks (1995-2000, 2001-2005, 2006-2010, and after 2010).

Figure 6-24 presents the average monthly GPD for all SFR residences within Town's service area. This figure also presents the monthly GPD for each residence age block. From 2001-2009, the residences in the 1975-1994 and 1995-2000 age blocks comprised the greatest proportion of the total SFR demand. From 2013-2016, these two age blocks continue to comprise the greatest proportion of the total SFR demand.

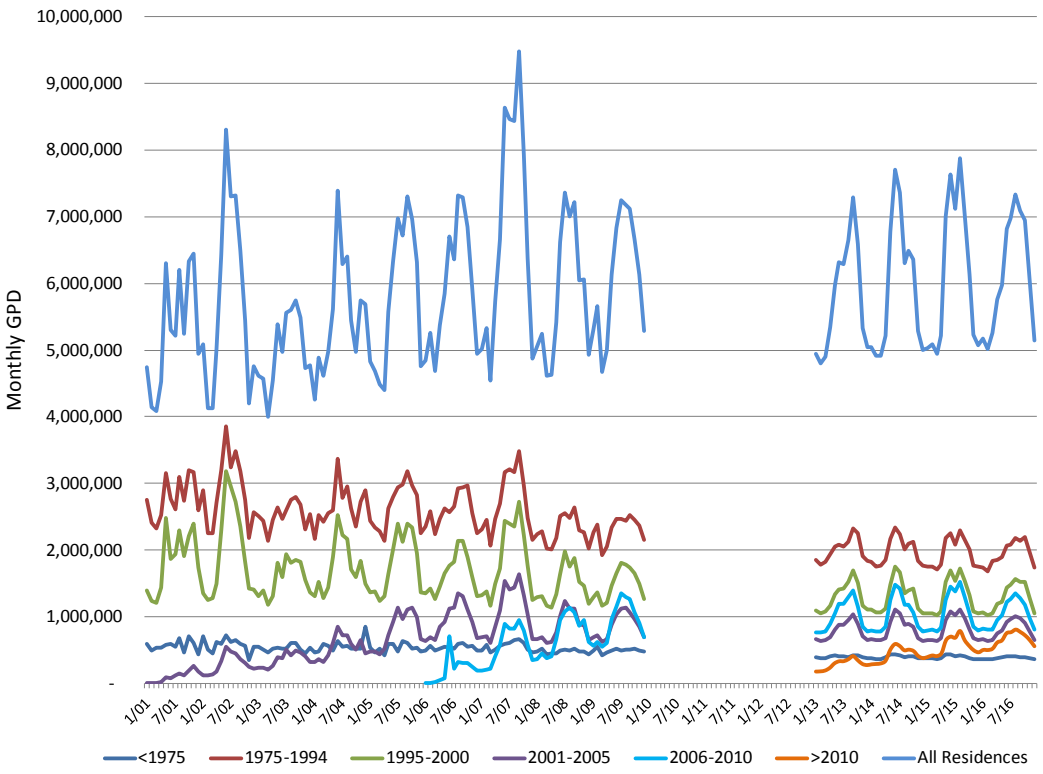


Figure 6-24. Monthly Single-family Residential Gallons per Day, by Residence Age Block, 2001-2016

Includes All Accounts from the Towns of Cary and Morrisville

Figure 6-25 presents the average monthly GPD per residence by residence age block for all SFR residences in the Towns of Cary and Morrisville, and Figure 6-26 presents the same data as Figure 6-25, but only includes those accounts that have a single meter; thereby, excluding separately metered irrigation accounts. A reduced seasonal variability in GPD per residence values is identified for the single meter accounts when comparing Figures 6-25 and 6-26. This reduced variability is most apparent for the three newest age blocks, 2001-2005, 2006-2010, and after 2010, with a similarity in seasonal profile for single meter accounts for all residence age blocks on Figure 6-26. Less outdoor irrigation is occurring at these newer residences.

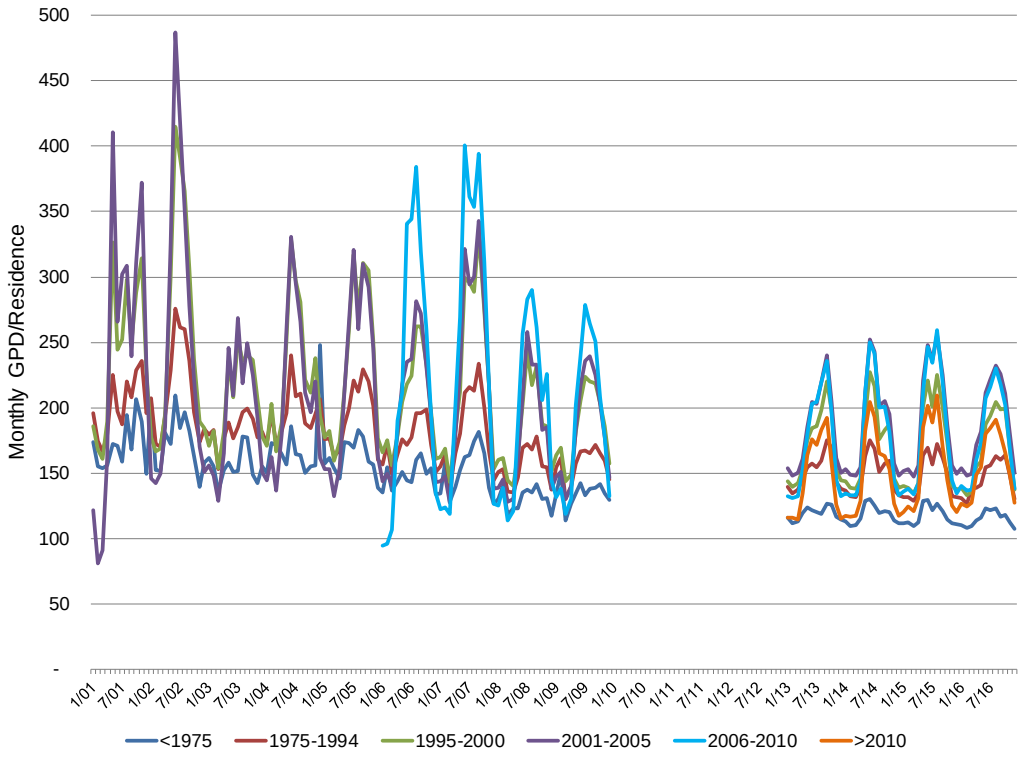


Figure 6-25. Monthly Average Single-family Residential Gallons per Day per Residence, by Residence Age Block, 2001-2016

Includes All Accounts from the Towns of Cary and Morrisville

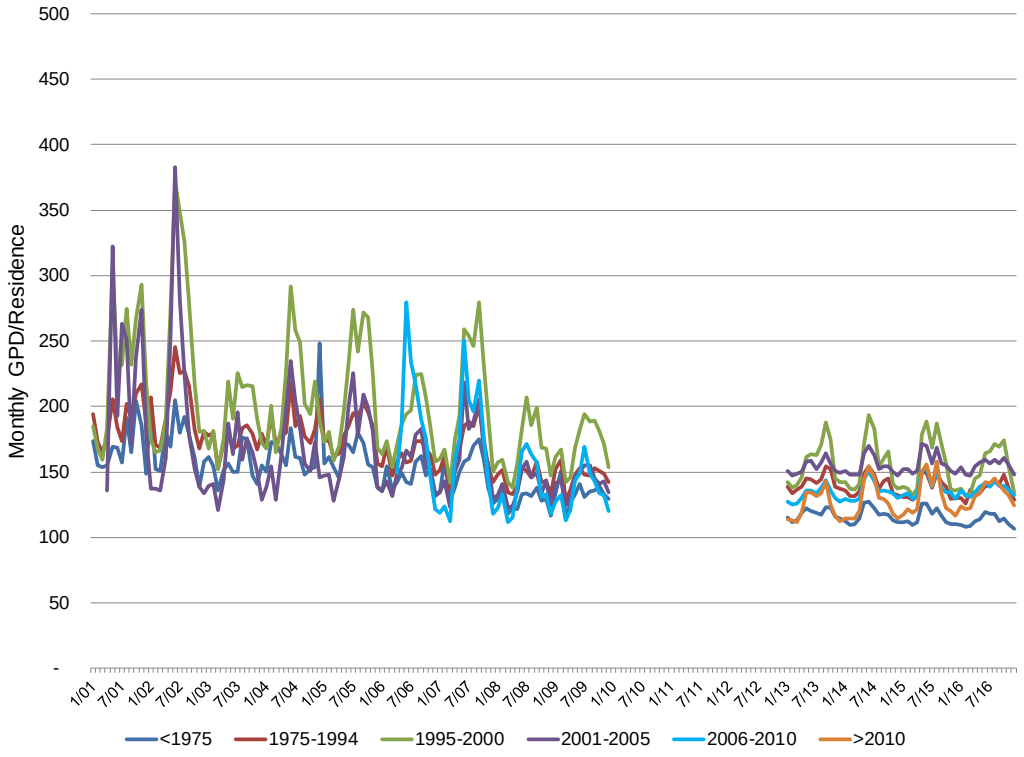


Figure 6-26. Monthly Average Single-family Residential Gallons per Day per Residence, by Residence Age Block, 2001-2016

Includes Only Single Meter Accounts from the Towns of Cary and Morrisville

Table 6-6 presents the annual average GPD per residence data for 2001-2016 by residence age. The prevailing trend by residence age discussed in the 2010 LRWRP is that newer homes use more water; however, a shift has occurred. From 2013-2016, this trend has reversed for the newest residence age block, homes built after 2010. This decrease can also be observed on Figure 6-25. The annual variations in the unit demands can be attributed to environmental (drought years versus wet years) and economic (recent economic recession) factors that have a strong influence on residential consumption patterns. From 2013-2016, there is little variation and per-residence usage is down from the 2001-2009 average. This is partially due to the past 4 years experiencing consistently normal weather patterns, with average precipitation amounts slightly higher than the 30-year average (State Climate Office of North Carolina, 2017).

Table 6-6. Single-family Residential Annual Average Day Water Use Variation with Residence Age, January 2001–December 2016

Includes All Accounts from the Towns of Cary and Morrisville

	Annual Average GPD per Residence												
Age Block	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		**2013**	**2014**	**2015**	**2016**
<1975	171	175	156	170	163	148	154	132	134		117	116	115	113
1975 - 1994	201	213	182	196	193	174	183	156	156		148	146	144	144
1995 - 2000	242	258	207	229	233	202	227	185	185		167	167	168	165
2001 - 2005	226	252	197	214	222	199	225	181	183		176	180	185	182
2006 - 2010	-	-	-	-	-	196	249	195	194		168	172	178	174
>2010	-	-	-	-	-	-	-	-	-		116	125	136	145

The lowest unit demands occurred in 2008 and later; this can likely be attributed to the economic recession, cooler temperature, and higher rainfall amounts during this period. Table 6-7 presents the same information as Table 6-6, but only includes the accounts within the Towns of Cary and Morrisville that have a single meter; thereby, excluding separately metered irrigation accounts. The most significant difference for the individual residence age blocks between the GPD per residence values in Table 6-6 (all accounts) and Table 6-7 (single meter accounts only) is for residences constructed after 2000. This coincides with the initiation year for Cary's separate irrigation meter ordinance put in place in August 2000; therefore, all in-ground irrigation systems, required to be separately metered, are not included in the data in Table 6-7. In comparing these two tables, there is a much smaller difference in the unit demand values between the before 1975, 1975-1994, and 1995-2000 age blocks; this coincides with the significantly lower percentage of separately metered irrigation accounts identified on Figure 6-27 for each of these age blocks as compared to the 2001-2005 and 2006-2010 age blocks.

Table 6-7. Single-family Residential Annual Average Day Water Use Variation with Residence Age, January 2001–December 2016

Includes Only Single Meter Accounts from the Town of Cary and Town of Morrisville

	Annual Average GPD per Residence												
Age Block	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		**2013**	**2014**	**2015**	**2016**
<1975	169	173	155	169	160	146	150	128	134		115	115	113	110
1975-1994	190	199	175	186	180	161	167	145	147		139	137	135	135
1995-2000	229	239	193	212	213	186	204	168	171		154	154	153	151
2001-2005	181	193	156	169	172	153	163	138	143		150	151	153	152
2006-2010	-	-	-	-	-	142	167	138	136		131	134	137	136
>2010	-	-	-	-	-	-	-	-	-		94	104	115	124

Table 6-8 presents the annual average GPD per residence for separately metered irrigation accounts. Comparing the Table 6-8 values to Tables 6-6 and 6-7, the unit demand values for separately metered irrigation accounts are much higher than the system average for all accounts (Table 6-6) and the single meter accounts (Table 6-7). Table 6-8 also shows that residences with separately metered irrigation accounts do not exhibit the same decrease in usage for the after 2010 age block when looking at all accounts.

Table 6-8. Single-family Residential Annual Average Day Water Use Variation with Residence Age, January 2001–December 2016

Includes Only Separately Metered Irrigation Accounts from the Towns of Cary and Morrisville

	Annual Average GPD per Residence												
Age Block	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2013**	**2014**	**2015**	**2016**
<1975	313	340	251	281	309	254	338	261	232	194	209	237	252
1975-1994	311	345	260	298	316	301	343	262	259	224	226	230	230
1995-2000	322	371	287	331	354	302	366	270	270	229	233	240	236
2001-2005	336	386	299	332	363	307	364	266	271	223	231	241	235
2006-2010	-	-	-	-	-	280	345	274	265	220	225	235	227
>2010	-	-	-	-	-	-	-	-	-	220	235	263	281

Figure 6-27 presents the percentage of single meter accounts and separately metered accounts per residence age block for 2016. A significant drop-off in separately metered irrigation accounts is observed for the after 2010 age block. This trend reversal is likely caused by the recent economic recession. The irrigation systems and meters require additional cost to install, maintain, and inspect. As a result, developers were more reluctant to install them unless requested by the home buyer.

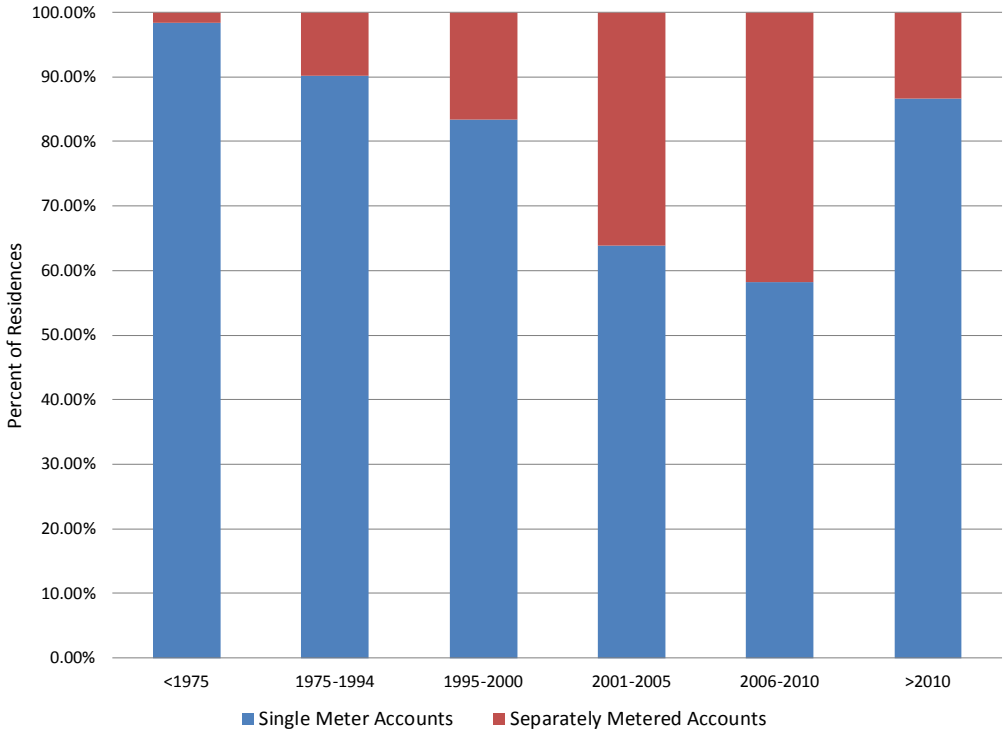


Figure 6-27. 2016 Comparison of the Percent of Single Meter Account Single-family Residences and Separately Metered Account Single-family Residences, by Residence Age Block

Includes All Accounts from the Towns of Cary and Morrisville

6.4.2 Single-family Residential Indoor and Outdoor Use Profile

Section 6.2 presented the overall seasonality for all SFR accounts' indoor and outdoor usage from January 2013-December 2016. This section breaks the same data down into residence age block, presenting a comparison of average GPCD for indoor versus outdoor usage on Figure 6-28, and presents the variability of monthly usage by each age block group using box and whisker plots for two time periods, 2005-2009 and 2013-2016. The results from the 2013-2016 water usage data set are compared to the same analysis performed on usage data spanning 2005-2009, which were previously presented in the 2010 Water Use Analysis. The USCB value for persons per household for the Town of Cary presented earlier in Section 6 was used in this analysis.

Each box and whisker chart provides the range of monthly GPCD values, the average GPCD, the median GPCD, as well as the 25th and 75th percentile monthly GPCD range by residence age block. Generally, statistics for the 2001-2009 water use data set show greater variability. This variability may be attributed to weather variability, including the significant droughts of 2002 and 2007.

Figure 6-28 presents a breakdown of indoor and outdoor usage for each residence age block, showing indoor and outdoor usage for single meter accounts (Data Set ID 1), separately metered irrigation accounts (Data Set ID 2), and for all accounts (Data Set ID 3). The following observations can be made:

- Accounts with separately metered irrigation have a significantly higher unit demand than single meter accounts; this is true across all age blocks.
- SFR indoor GPCD values are similar within the residence age blocks for each data set.
- For both time periods, the newest and oldest age blocks have the least indoor usage by GPCD.
- For the 2005-2009 data set, this pattern showing the newest and oldest age blocks have the least indoor usage is also reflected in outdoor and irrigation use. However, from 2013-2016, separately metered irrigation accounts tend to use the same amount per person independent of age block, with the exception of homes built after 2010, which have the highest GPCD of any age block during either data set period.

Figure 6-29 presents the variability and average for overall GPCD for all SFR accounts. The more recent 2013-2016 data set shows an increasing trend of usage with home age block with the newest homes, reversing in those homes built after 2010, which use less on average than the next three newest home age blocks, as mentioned before. Comparing the 2001-2009 data with the 2013-2016 data, there is less variability and lower peak usage months from 2013-2016. The is likely due to the 2001-2009 data set capturing outdoor usage during the significant drought years of 2002 and 2007.

Figure 6-30 presents the variability and average for outdoor and irrigation GPCD for all SFR accounts. The more recent 2013-2016 data set shows an increasing trend of usage with home age block, with the newest homes reversing with those built after 2010, using less on average than the next three newest home age blocks, as mentioned before. Comparing the 2001-2009 data with the 2013-2016 data, there is less variability and lower peak usage months from 2013-2016. The is likely due to the 2001-2009 data set capturing outdoor usage during the significant drought years of 2002 and 2007.

Figure 6-31 presents the variability and average for overall GPCD for only single metered SFR accounts. The more recent 2013-2016 data set shows a decreasing trend of usage with home age block for the newest three age blocks, 2001-2005, 2006-2010, and after 2010. The larger variability shown in the 2001-2009 data set likely reflects water usage during droughts.

Figure 6-32 presents the variability and average for outdoor and irrigation GPCD for only single metered SFR accounts. The more recent 2013-2016 data set shows little trend by home age block. Comparing the 2001-2009 data with the 2013-2016 data, there is less variability and lower peak usage months from 2013-2016. The newest age block, homes built after 2010, shows a significant increase over the 2001-2005 and 2006-2010 age blocks. This pattern is not seen for any other grouping of these data.

Considering the drop-off in percentage of separately metered accounts for this age block shown on Figure 6-27, this usage is likely from customers who should have separately metered irrigation accounts.

Figure 6-33 presents the variability and average for irrigation GPCD for only separately metered SFR accounts. These data were only available from 2013-2016. When observing GPCD results, a downward trend with home age is observed, except for an increase for homes built after 2010. The decreasing trend is reflective of the increase in service locations with separately metered irrigation accounts. In terms of total gallons used, newer homes are irrigating more than older homes; however, the increase in separately metered accounts pulls down the GPCD.

For all box and whisker charts describing outdoor and irrigation usage, the minimum and 25th percentile marks have been overridden to be zero. For single meter accounts, the assumption is made that there is no usage during the winter; however, when observing the usage for separately metered accounts, there is a minimal amount of outdoor usage being recorded during the winter months. This usage has been determined to be negligible and is ignored for this analysis to facilitate comparison of time periods.

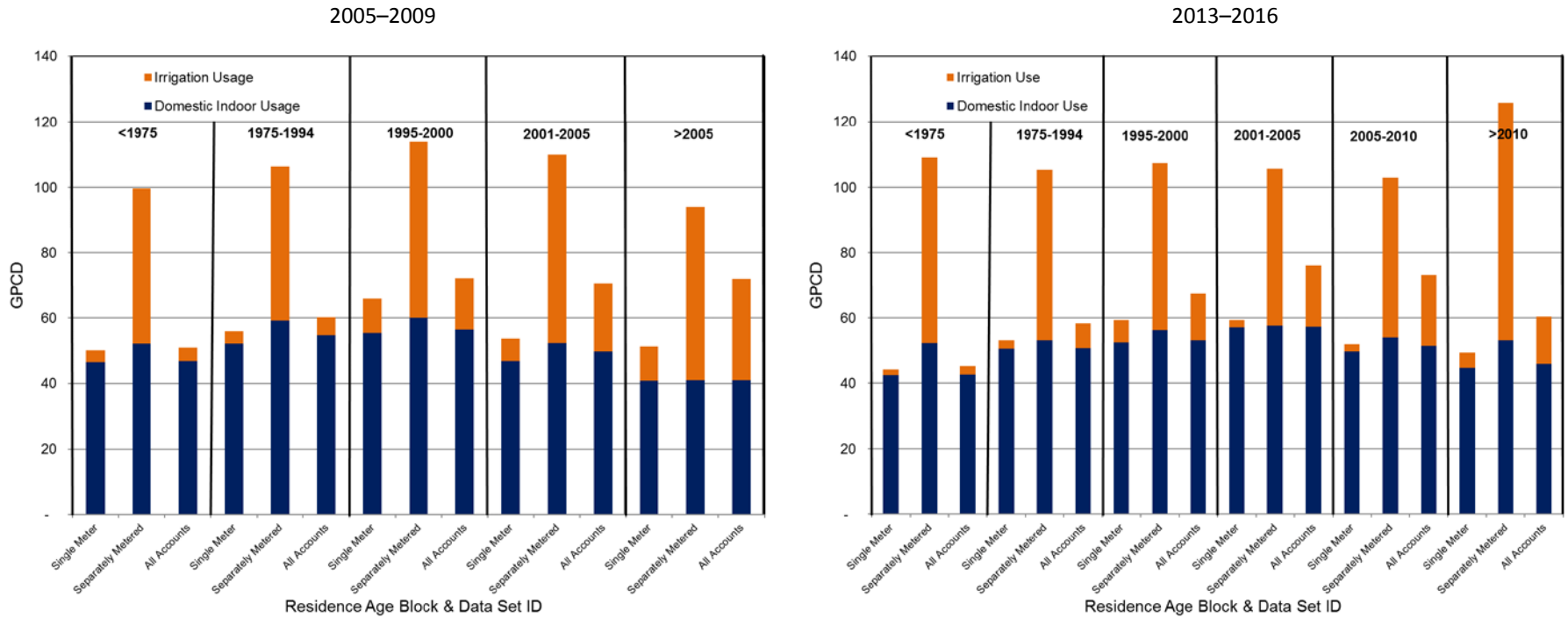


Figure 6-28. Period Average Single-family Residential Gallons per Capita per Day, by Residence Age Block

Includes All Accounts from the Towns of Cary and Morrisville

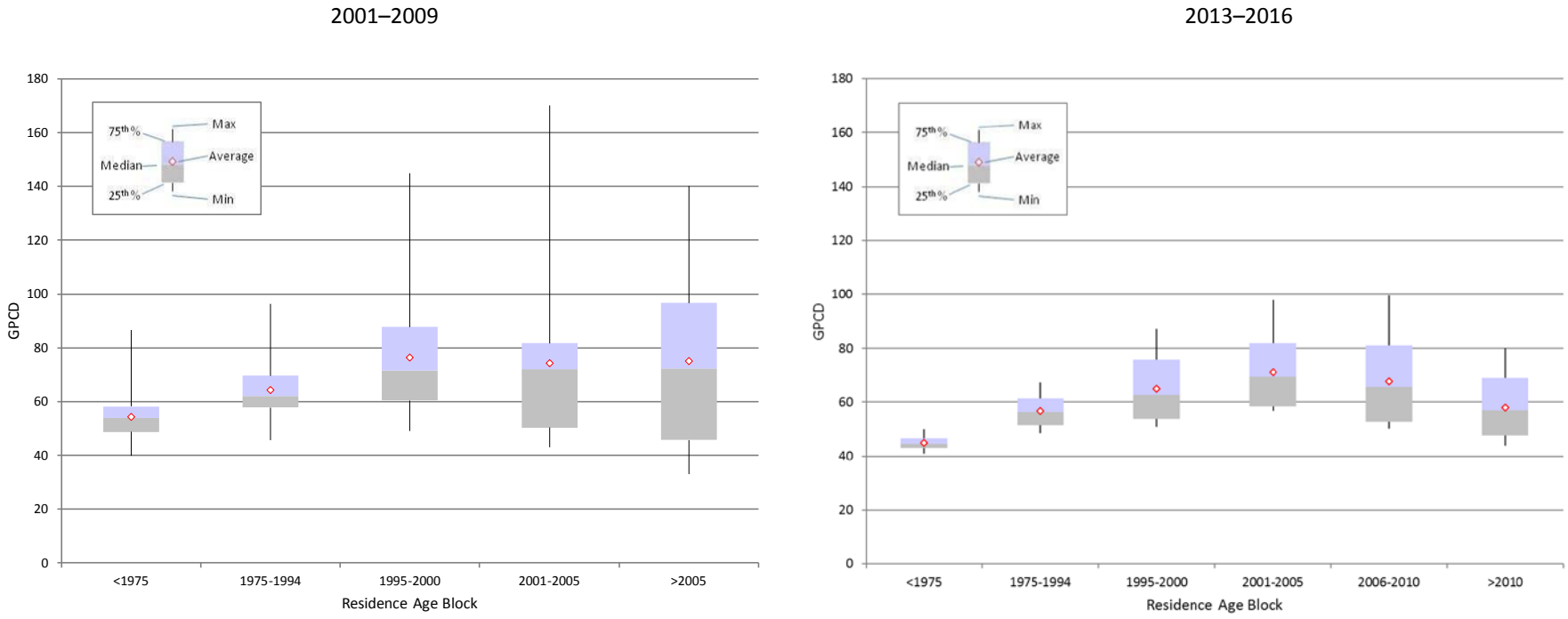


Figure 6-29. Monthly Average Day Total Use for Single-family Residential Gallons per Capita per Day Box Plot, by Residence Age Block

Includes All Accounts from the Towns of Cary of Morrisville

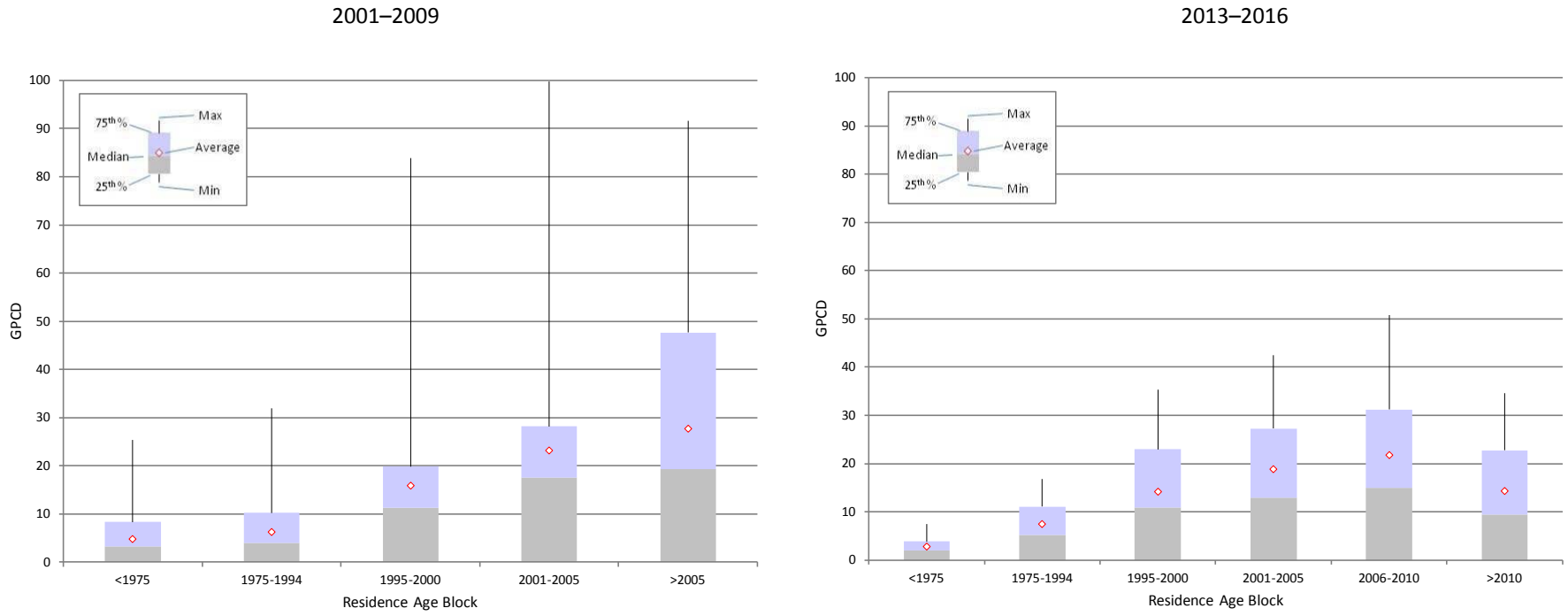


Figure 6-30. Monthly Average Day Outdoor and Irrigation Use for Single-family Residential Gallons per Capita per Day Box Plot, by Residence Age Block

Includes All Accounts from the Town of Cary and Town of Morrisville

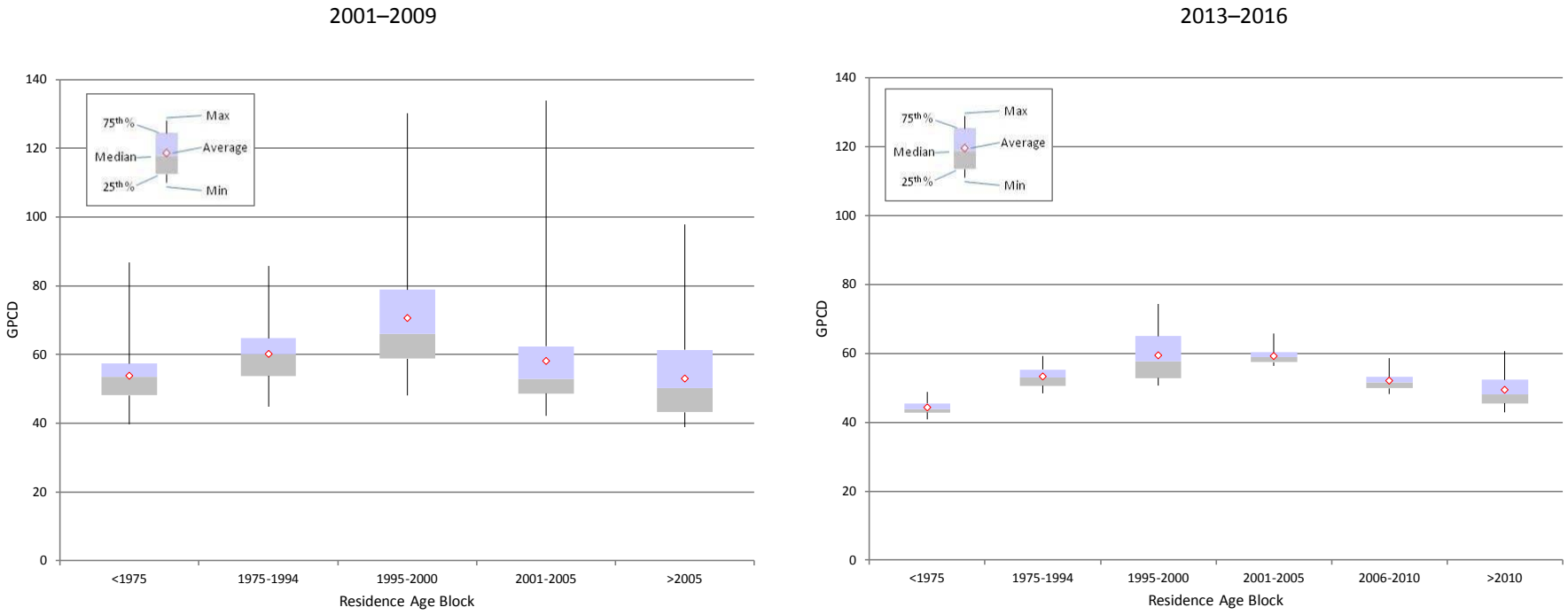
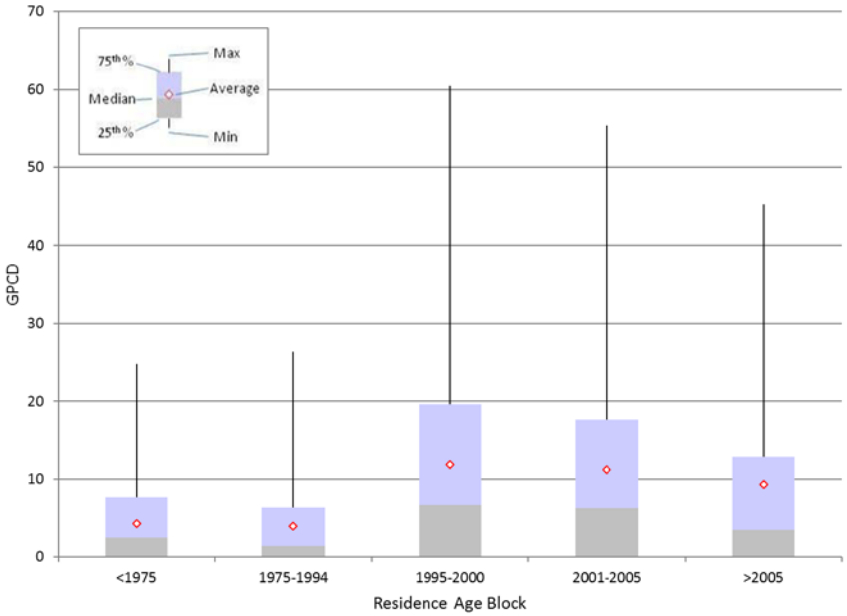


Figure 6-31. Monthly Average Day Total Use for Single-family Residential Gallons per Capita per Day Box Plot, by Residence Age Block

Includes Only Single Meter Accounts from the Towns of Cary and Morrisville

2001–2009



2013–2016

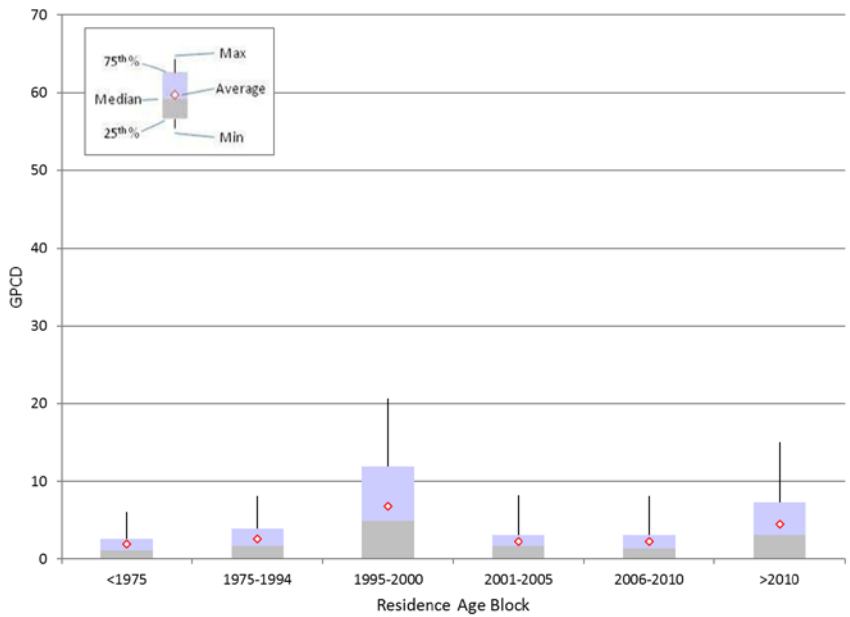


Figure 6-32. Monthly Average Day Outdoor and Irrigation Use for Single-family Residential Gallons per Capita per Day Box Plot, by Residence Age Block

Includes Only Single Meter Accounts from the Towns of Cary and Morrisville

2013–2016

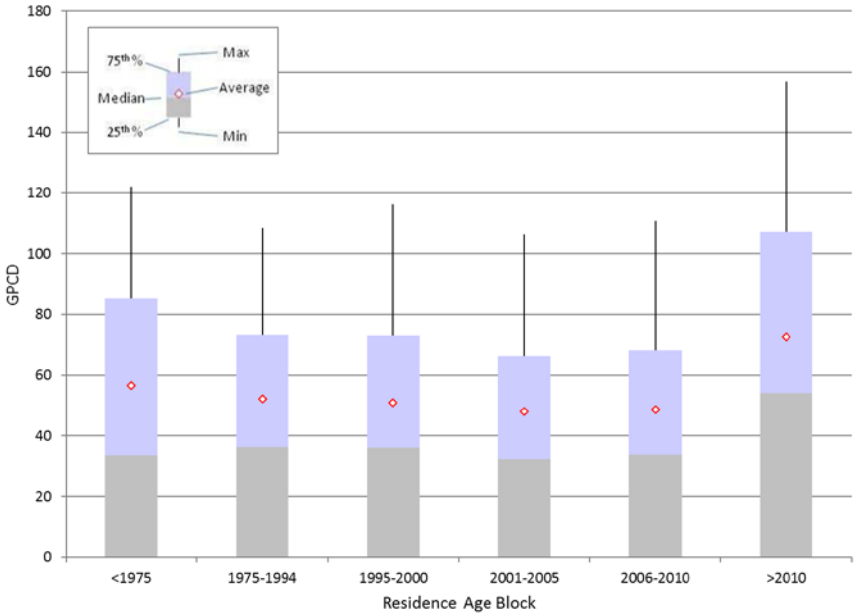


Figure 6-33. Monthly Average Day Outdoor and Irrigation Use for Single-family Residential Gallons per Capita per Day Box Plot, by Residence Age Block

Includes Only Irrigation usage from Separately Metered Accounts from the Towns of Cary and Morrisville

6.4.3 Single-family Residence Parcel and Building Characteristic Use Profile

The Wake County parcel database and the Town's building database both contain useful information about parcel and building characteristics. This information supplements the billing data as a means of understanding water consumption patterns. As expected, water consumption patterns differ as a result of residence age, residential lot size, residence square footage, residence tax value, and the number of bathrooms. Water consumption patterns by residence age were evaluated in detail in Section 6.4.1. To understand the variation in consumption by residence age and the other parcel and building characteristics listed, the water consumption evaluation developed for this section was completed by the residence age blocks identified in Section 6.4.1.

Table 6-9 presents the average parcel and building characteristics by residence age block for SFR residences.

Table 6-9. Single-family Residential Parcel and Building Characteristics by Residence Age Block, 2016
Includes All Accounts from the Towns of Cary and Morrisville

Age Block	Lot Size (acres)	Home Size (square footage)	No. Bathrooms	Tax Valuation ($)	% of Residences
<1975	0.48	1,917	2.1	126,665	9
1975-1994	0.35	2,322	2.5	207,140	34
1995-2000	0.35	2,871	2.7	290,916	19
2001-2005	0.30	3,073	2.9	317,824	11
2006-2010	0.24	3,284	3.0	344,665	15
>2010	0.22	3,335	3.2	366,670	11
Overall	0.32	2,737	2.7	267,446	100

Notes:

No. = number

Tables 6-10 through 6-13 summarize the data available through the combination of the billing, parcel, and building data for each account from 2016.

Table 6-10. Single-family Residential Period Average Gallons per Day per Residence by Residence Lot Size and Age, 2013-2016
Includes All Accounts from the Towns of Cary and Morrisville

Lot Size (acres)	Annual Average Day GPD per Residence by Residence Age Block					
	<1975	1975-1994	1995-2000	2001-2005	2006-2010	>2010
<=0.10	329[a]	88	97	94	100	82
0.11-0.30	105	129	146	160	162	118
0.31-0.50	115	147	181	221	225	179
0.51-0.75	124	172	204	244	277	290
>0.75	127	357	253	364	323	281

[a] Only one account

Table 6-11. Single-family Residential Period Average Gallons per Day per Residence by Residence Square Footage and Age, 2013-2016

Includes All Accounts from the Towns of Cary and Morrisville

	Annual Average Day GPD per Residence by Residence Age Block					
Square Footage	**<1975**	**1975-1994**	**1995-2000**	**2001-2005**	**2006-2010**	**>2010**
<2000	106	129	123	151	118	83
2000-3000	125	145	155	155	141	106
3000-4000	155	176	187	196	177	131
>4000	189	223	238	236	246	181

Table 6-12. Single-family Residential Period Average Gallons per Day per Residence by Residence Tax Value and Age, 2013-2016

Includes All Accounts from the Towns of Cary and Morrisville

Tax Value ($)	Annual Average Day GPD per Residence by Residence Age Block					
	<1975	**1975-1994**	**1995-2000**	**2001-2005**	**2006-2010**	**>2010**
<100,000	81	--[a]	--[a]	--[a]	--[a]	--[a]
101,000-200,000	102	109	105	102	94	87
201,000-300,000	119	124	126	124	124	85
301,000-400,000	126	145	154	155	144	110
401,000-500,000	136	170	179	183	171	120
>500,000	171	209	226	240	236	174

[a] No residences included in this combination of parcel and building characteristics.

Table 6-13. Single-family Residential Period Average Gallons per Day per Residence for Winter Months (December-March) by Residence Number of Bathrooms and Age, 2013-2016

Includes All Accounts from the Towns of Cary and Morrisville

	Annual Average Day GPD per Residence by Residence Age Block					
No. of Bathrooms	**<1975**	**1975-1994**	**1995-2000**	**2001-2005**	**2006-2010**	**>2010**
1	89	86	173	161	119	--[a]
1.5	96	106	183	--[a]	86	--[a]
2	107	108	103	91	103	76
2.5	120	128	136	138	123	111
3	127	128	146	140	131	123
3.5 or More	140	143	156	163	146	140

[a] No residences included in this combination of parcel and building characteristics.

The following observations regarding GPD trends are made based on the data presented in Tables 6-9 through 6-13:

- SFR development trends appear to be towards larger residences, with higher tax values, more bathrooms, and on smaller lot sizes as compared to homes developed before 1995.
- As residential lot size increases, the unit consumption increases.
- As residential home square footage increases, the unit consumption increases. A parallel with square footage is tax value; the greater the tax value, the greater the unit consumption.
- As a home's number of bathrooms increases, there is an increase in the indoor unit consumption.
- Tables 6-10 through 6-13 identify a general trend of increasing consumption for homes built before 2005, while a decreasing trend is observed for homes built after 2005.

6.4.4 Future Considerations of Single-family Residential Trends

The SFR use classification has historically comprised 50 percent or greater of the total annual average daily demand for the Town of Cary water system. Due to this large percentage, the SFR use class has great influence on the overall demand trends for the Town's water system. Some SFR usage statistics have changed since the 2010 Water Use Analysis was performed, and these statistics are driving shifts in the system's overall water usage. Data in this document have been presented by home age to characterize the difference in water use statistics in homes built in 2010 and later.

The shift in water use statistics is due to a combination of factors including climate, the use of more efficient indoor appliances, changing trends home construction, and changing trends in conservation habits. The Town is expecting that construction trends will continue, with smaller lot sizes and a growing proportion of MFR housing. Housing costs are also increasing. Another behavior change that may that while the overall number of separately metered irrigation accounts may increase into the future, the Town has also seen a significant number of disconnections of separate water meters Depending on future development trends within the Town's service area, the future water demands could also be affected by development policies. With newer homes having a different water use profile than older homes, it will be important to monitor GPD usage and irrigation use statistics to examine if these trends are continuing.

SECTION 7

Development of Unit Water Demand Factors

Unit consumption factors were developed for each land use category (SFR, MRF, COM, IND, and INS) and for facility capacity to move forward to the forecasting effort to be conducted in Phase Two of this project. Statistics were calculated separately for the Towns of Cary and Morrisville, as was done in the 2013 LRWRP (CH2M and Brown and Caldwell, 2013). Statistics for the Town of Cary include RTP South and RDU. Unit factor profiles were developed using a full review of the water use analysis data back to 2001. Profile documentation, including a description of the development of the unit factor distribution, is included as Appendix D.

Table 7-1 presents a summary comparison by land use category for both the 2013 LRWRP and this 2017 Water Use Analysis. All unit factors have decreased, which aligns with the water use analysis discussion presented in preceding sections. Less variability is seen between the Towns of Cary and Morrisville in the more recent water use data from 2013-2016; and as such, the same residential unit factors are presented for this 2017 water use analysis. These unit factors will be reviewed along with available water demand information from the 2017 calendar year at the start of Phase II of this LRWRP update in early 2018. The unit factors, with any needed revisions, will then be approved for use in the forecast.

Table 7-1. Unit Demand Factor Summary
Includes All Accounts from the Towns of Cary and Morrisville

	Cary		Morrisville	
Customer Type (units)	**2013 LRWRP Forecast**	**2017 Water Use Analysis**	**2013 LRWRP Forecast**	**2017 Water Use Analysis**
SFR (GPCD)	76	58	76	58
MFR (GPCD)	52	40	64	40
COM (GPD/ft^2)	0.1	0.06	0.1	0.05
IND (GPD/ft^2)	0.1	0.09	0.1	0.09
INS (GPD/ft^2)	0.1	0.06	0.1	0.06

The SFR unit factor is a GPD statistic by residence and is based on data for homes built since 2010, assuming that usage trends for this block of homes will continue in the future. The methodology used in the 2013 LRWRP was carried forward.

$$New\ SFR\ GPCD = a + (b*c) + [d * (1-c)] \quad \text{(Eq. 2)}$$

Where:
a = SFR domestic indoor usage
b = Separately metered outdoor and irrigation usage
c = Percent of SFR accounts with separately metered irrigation accounts
d = Outdoor use for single meter SFR accounts

Using the same methodology as the 2013 LRWRP, the MFR unit factor was developed as GPD per unit; and the COM, IND, and INS unit factors were developed as GPD per square foot.

SECTION 8

System Profiles for Forecast

The Town's metering and Aquastar data support the calculation of system profile factors to carry forward in the forecast. The Aquastar system is geospatially categorized, allowing for water billing data to be tied to wastewater collection systems and treatment facilities. The following system profiles were developed from 2013-2016 data.

8.1 Water System Profile

To consider treatment facility production needs, a ratio is needed to understand the potential raw water demand from Jordan Lake. Raw water is treated at the Cary/Apex WTP, and some water is lost to the treatment process. That unit factor was developed using raw water and finished water metered values as provided by the Town, minus water sold to Chatham County. Data used are included in Table 8-1. The average ratio of raw water to treated water is 1.17, consistent with the ratio used in the 2013 LRWRP (CH2M and Brown and Caldwell, 2013).

Table 8-1. Cary/Apex WTP Production Data, 2013-2016

Year	Raw Water to WTP (MGD)	Water Process Losses (MGD)	Finished Water Produced (MGD)	Ratio of Raw Water to Finished Water
2013	18.54	2.26	16.28	1.14
2014	19.27	2.11	17.17	1.12
2015	21.46	3.36	18.10	1.19
2016	22.26	3.95	18.31	1.22
Average Ratio of Raw Water to Finished Water				1.17

Of the treated water distributed throughout the Town of Cary's service area, a portion stays in the Cape Fear River basin, and a portion is used in the Neuse River basin. Table 8-2 includes statistics for accounts in each river basin for years 2013 and 2016. Development is increasing in the Cape Fear River basin portion of the service area; this is reflected in the greater increase in the number of accounts in this basin. Operational data were not included in the data used to develop Table 8-2.

Table 8-2. Metered Accounts by River Basin

Use Type	2013 Accounts River Basin		2016 Accounts River Basin	
	Neuse	Cape Fear	Neuse	Cape Fear
SFR	29,420	10,554	29,885 (2%)[a]	12,090 (15%)
MFR	8,483	2,860	8,961 (6%)	4,166 (46%)
COM	2,219	154	2,385 (7%)	257 (67%)
IND	32	2	33 (3%)	2 (0%)
INS	178	22	202 (13%)	27 (23%)
Total:	**40,332**	**13,592**	**41,466 (3%)**	**16,542 (22%)**
Percent of Total:	**75**	**25**	**71**	**29**

[a] Percent increase in number of metered accounts from 2013-2016

8.2 Wastewater System Profiles

A portion of finished water is collected after use and treated at the Town's water reclamation facilities. To estimate future baseline wastewater flows, flow metering data were used to develop ratios of finished water to wastewater collected. This list now includes the WWRWRF, which was not yet operational when the 2013 LRWRP was completed. A comparison of these wastewater flows and water billing data was performed to develop wastewater return factors specific to each water reclamation facility, as presented in Table 8-3.

Table 8-3 presents the percent wastewater return for the years 2013-2016, for which detailed billing data are available. For the NCWRF and SCWRF, the total potable water demand, including water accounts and separately metered irrigation accounts for a given year within a given water reclamation facility's sewer basin, was compared to the annual influent flow of that facility.

The influent flow at WWRWRF incorporates sanitary flows from the Town of Apex; therefore, the percent return for connections within the Town of Cary, the Town of Morrisville, and RTP South is calculated using upstream flow meters. All service connections for the Town of Cary, the Town of Morrisville, and RTP South within the WWRWRF sewer basin are located upstream of the Green Level Interceptor and the White Oak Interceptor. The annual flows measured at the Green Level Interceptor (flow monitor site 30) and the White Oak Interceptor (flor monitor site 26) were used as the "influent" flow to calculate the percent return from the service area. During 2013 and 2014, the sewer subbasins that now feed into WWRWRF were flowing into the Durham County WWTP; therefore, the potable water demand in these sewer subbasins during 2013 and 2014 did not impact the percent return calculations for NCWRF or SCWRF.

Table 8-3. Water Reclamation Facilities' Percent Return, 2013-2016

Facility	2013 (%)	2014 (%)	2015 (%)	2016 (%)	Average (%)
NCWRF	120	123	119	111	**118**
SCWRF	125	119	120	119	**121**
WWRWRF	--[a]	--[a]	93	97	**95**

[a] WWRWRF came online in 2014

In 2010, the percent return for the NCWRF was 124 percent, SCWRF was 103 percent, and the Kit Creek meter (then to the Durham County WWTP, now upstream of the Green Level Interceptor) was 72 percent (CH2M, 2010). The percent return for the NCWRF has lowered to 118 percent. This may be, in part, due to the methodology used in this analysis. The recycle stream is captured at the influence flow meter; in this analysis, that recycle stream volume was estimated and removed from the calculation (Personal communication, Sarah Braman, 2017). The percent return has also decreased at the SCWRF. The sewer basin feeding into the WWRWRF generally has newer infrastructure than basins feeding into NCWRF and SCWRF; therefore, the percent return is lower than for the other two facilities. Details by subbasin are included in Appendix E.

Each facility exhibits a unique peaking factor, a ratio of maximum to average day flows. The peaking factors by subbasin and facility are presented in the following tables. Tables 8-4 through 8-6 present the annual average and maximum month flow values, as well as the average peaking factor by facility.

Table 8-4. North Cary Water Reclamation Facility Service Area Maximum Month Average Day to Annual Average Peaking Factor Ratio

Year	Annual Average Wastewater Flow (MGD)	Maximum Month Wastewater Flow (MGD)	Peaking Factor Ratio
2010	6.33	7.43	1.18
2011	6.09	6.31	1.04
2012	6.19	6.61	1.07
2013	6.37	6.84	1.07
2014	6.55	7.26	1.11
2015	6.62	7.19	1.08
2016	6.21	7.32	1.18
		5-year Average Peaking Factor (2012-2016):	**1.10**

Table 8-5. South Cary Water Reclamation Facility Service Area Maximum Month Average Day to Annual Average Peaking Factor Ratio

Year	Annual Average Wastewater Flow (MGD)	Maximum Month Wastewater Flow (MGD)	Peaking Factor Ratio
2010	5.03	6.15	1.22
2011	5.02	5.45	1.09
2012	5.26	5.59	1.06
2013	5.33	6.27	1.18
2014	5.39	6.93	1.29
2015	5.47	6.28	1.15
2016	5.48	6.52	1.19
		5-year Average Peaking Factor (2012-2016):	**1.17**

Table 8-6. Western Wake Regional Water Reclamation Facility Service Area Maximum Month Average Day to Annual Average Peaking Factor Ratio

Year	Annual Average Wastewater Flow (MGD)	Maximum Month Wastewater Flow (MGD)	Peaking Factor Ratio
2015	4.61	5.41	1.17
2016	4.89	5.43	1.11
		2-year Average Peaking Factor (2015-2016):	**1.14**

NCWRF had the lowest average peaking factor, at 1.10. This is slightly lower than that included in the 2013 LRWRP of 1.12 for 2008–2010. The SCWRF had a 5-year (2006-2010) average peaking factor of 1.20, which is very close to the most recent 5-year average of 1.17. The Kit Creek Pump Station, which now sends flows to the WWRWRF, had a 5-year average peaking factor of 1.22.

SECTION 9

Ongoing Monitoring

The water use statistics presented herein are benchmarks of current Town water use behaviors, and can be used for ongoing monitoring of the Town's customer base. Benefits of monitoring these statistics include development of targeted water conservation programs and measurement of their effectiveness, evaluation of water use trends against facility capacities, and use in rate structure scenario evaluations. These benchmarks can also be used to compare the Town's water use trends against other utilities. Ongoing monitoring recommendations are derived from *A Guide to Customer Water-Use Indicators for Conservation and Financial Planning* (AWWA, 2013).

The first benchmark, SFR customer average use, is presented with the U.S. Geologic Survey (USGS) national home average of 98 GPCD, 2016 WRF REU Study indoor usage of 58 GCPD, and national high-efficiency home value of 35 GPCD on Figure 9-1 (AWWA, 2013; WRF, 2016). In comparison to these national benchmarks, the Town's newer homes (built since 2010) are using less water than the national average. A major finding of the second version of the REU Study was that from 1999-2016, average indoor water use decreased by 22 percent for the 23 utilities evaluated (WRF, 2016). This trend is also seen in the Town of Cary's data and supports the reduced unit factors proposed in this analysis compared to the 2010 Water Use Analysis (CH2M, 2010).

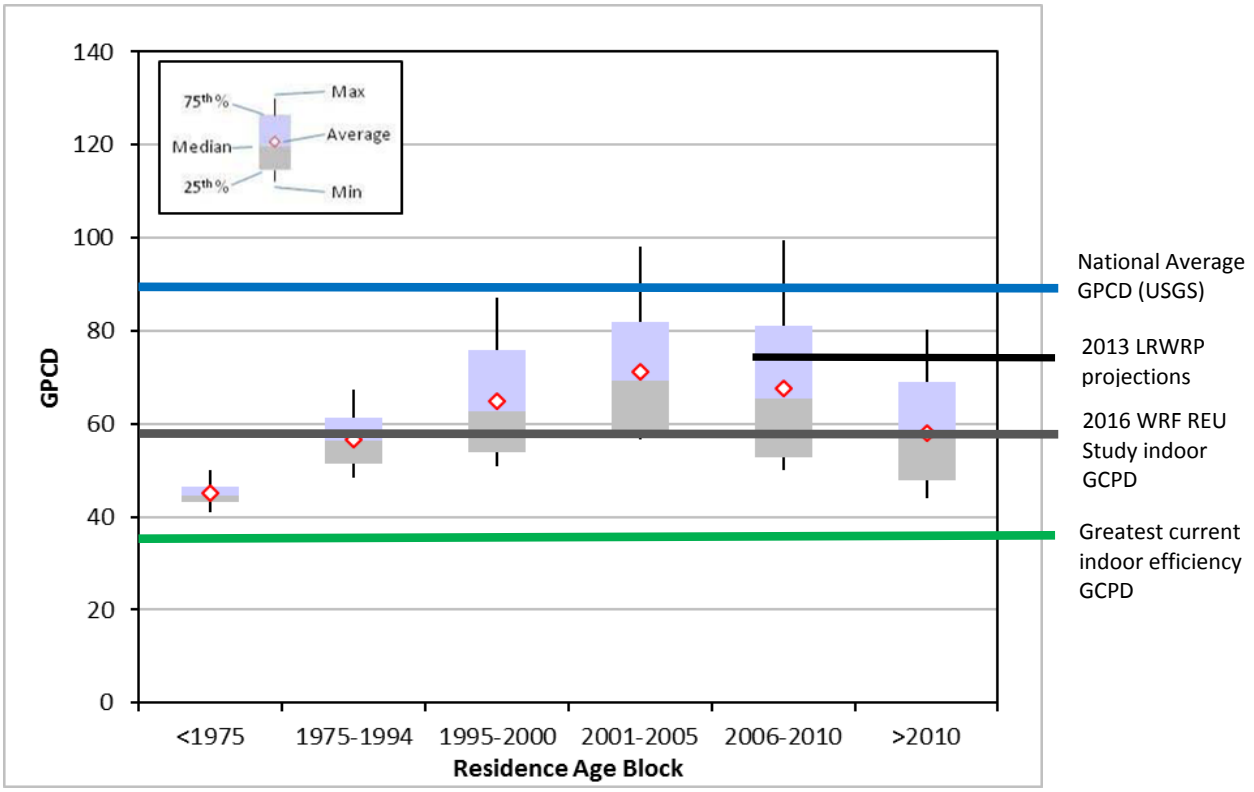


Figure 9-1. Single-family Residential Gallons per Capita per Day Customer Average Use Metric

The Town should continue monitoring a subset of these metrics on a seasonal and annual basis. The ability to distinguish trend variation will occur annually. Other financial metrics using billing data are being used in the Finance Department to detect meter issues, such as leaks or seasonal customers. This subset is divided into two categories: conservation and financial factors. Some metrics can be used to inform planning efforts in both subsets. Conservation metrics include:

- Customer Average Use
- Rank of Customer Average Use

- Percentile of Customer Average Use
- Customer Baseline Demand
- Customer Maximum Demand
- Customer Use Profile
- "Hidden" Irrigation Accounts

These metrics are most useful when aggregating data by customer type. In particular, separating SFR and MFR trends is useful in monitoring per capita usage trends against changing Town population demographics. These conservation metrics may also be helpful in evaluating the effectiveness of current Town policies and programs, such as the Water Shortage Response Plan (Town of Cary, 2015). Implementation of this Plan includes water use reduction targets. Understanding the customer baseline demand, for example, can be helpful to understand how effective water restrictions may be.

Financial metrics that may be helpful in detecting meter issues, seasonal residents, peaking factor variability, or those with outdoor demands that should have separate irrigation meters include:

- Zero- and Low Use Accounts
- Customer Baseline Demand
- Customer Peaking Ratio
- Customer Use Profile
- "Hidden" Irrigation Accounts

Tracking the financial metrics that can be linked to water rates can be useful in evaluating potential rate structure scenarios and their impact on water usage. Water rates, to some extent, influence behavior towards water usage, which then, in turn, affects revenue generation. This response to water cost may be lessened in the Town due to the relatively high household income compared to other portions of the state.

For ongoing monitoring to be most effective, other data, including population demographics, weather, and changes in Town codes and policies, need to be tracked and documented so that trends and influences can be detected. Suggested information to track along a timeline include:

- Housing and demographics: Current and projected trends
- Code changes to plumbing fixture and appliance water efficiency requirements
- Weather patterns: Rainfall, temperature, drought status, and Jordan Lake data
- Numbers of customer participants in each conservation program measure, including:
  - Actual (reported audits, ordinance violations)
  - Estimates (compliance with local ordinances and national codes)
  - Survey results
- Customer attitudes, including:
  - 2017 survey participants' responses compared to their actual metered billing usage
  - Track by rate tier, percentile, indoor and outdoor usage, and housing and demographic characteristics
- Costs of conservation programs to estimate benefits compared to water usage reductions

The primary benefit of ongoing monitoring is the ability to update the forecasted demands (or evaluate scenarios) when trend shifts in water use are detected. Other benefits of these programs include the potential to continue to reduce SFR and MFR GPCD usage, delay potential capital expenditures for capacity expansions, and stretch the Town's portion of Jordan Lake allocation farther into the future.

SECTION 10

References

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Appendix A
Analysis Logic Technical Memorandum

Water Use Analysis Database Methodology

PREPARED FOR:	Town of Cary (Town)
PREPARED BY:	CH2M HILL North Carolina, Inc. (CH2M)
DATE:	November, 2017; revised December 2017
PROJECT NUMBER:	692605

In preparing the Water Use Analysis to update the Town's Long Range Water Resources Plan, CH2M has used Town-provided data, including meter records and geographic information system (GIS) data for analytical use. The objective of this technical memorandum (TM) is to document the methodology used to identify water use trends and summarize water use statistics for the Town.

The following sections detail the individual queries found in the Microsoft Access database that produce the analytical results relating to water use in the main TM and walks through the steps involved in executing these queries. These sections are ordered and titled to mirror the organization of the Water Use Analysis TM. Often, a series of queries is necessary to perform the correct calculations. When this is the case, the titles of the queries match and are appended with "Qry1, Qry2, etc". In Access, it is not necessary to execute all queries in the series, only the final query.

2.0 Water Use Analysis Objective and Approach

2.2 Analysis Approach

2.2.1 Water Usage and Utility Account Data

The data used to define the water consumption patterns for the water use analysis include, by time period:

- 2001-2005: The 2007 Integrated Water Resources Management Plan (IWRMP) [CH2M, 2007] (this information was summarized in the 2010 Water Use Analysis [CH2M, 2010])
- 2006-2009: The 2010 Water Use Analysis; the analysis results from the 2010 Water Use Analysis have been incorporated into the analysis results presented in this document
- 2013-2016: Aquastar data provided by the Town for each utility account

The Aquastar data provided by the Town, as direct exports from the SAS Institute Inc. (SAS) database, included two different data sets: daily usage data for 2013-2106, identified by meter record, and a water meter information table containing account information. These databases were provided by the Town in May 2017. An updated version of the water meter information containing account information by basin was provided by the Town on August 1, 2017.

One data gap exists: during the period of transition to the Aquastar system, specifically, from 2010-2012, no water usage data were available for this analysis. Where appropriate, water consumption summaries from the Town's Finance Department were used; these summaries only provide consumption data for the service area and not for individual water meters.

In 2016, the Town added 9 service types to better categorize water use. These categories were included in the analysis and assigned to a general service category as shown in Table A-1. General service types used in this study include potable water (WA), potable water used for irrigation (IR) and reclaimed water (RW).

Table A-1. New Service Types and Alignment to General Service Types

Service Category Added in 2016	Town Definition	General Service Type
RW	Reclaim/Irrigation	RW
RF	Reclaim-Future/Irrigation	-[a]
RA	Reclaimed/Sewer-Toilet	RW
RT	Reclaim Cooling Tower/Stream	RW
RS	Reclaim Colling Tower/Sewer	RW
WW	Wholesale Water	-[a]
WN	Water No Sewer	WA
WT	Water Cooling Tower/Stream	WA
WC	Water Cooling Tower/Sewer	WA

[a] RF and WW service categories are not present in current Billing Database

The database provided by the Town categorizes customers into 34 different customer types. For the purposes of this analysis, these were generalized into six broader categories:

1. Single Family Residential (SFR)
2. Multifamily Residential (MFR)
3. Commercial (COM)
4. Industrial (IND)
5. Institutional (INS)
6. Operational (OPS)

The mapping from the specific categories used by the Town to the generalized categories was performed based on guidance provided by the Town. Table A-2 summarizes these instructions. Shown are four detailed categories used by the Town (Class, Cycle Route, Jurisdiction, and Detailed Customer Type) and how they were sorted into the Generalized Customer Type, which was created for the purposes of this analysis. The table is structured in such a way to communicate the hierarchy of categorization. For example, all records with Class B are assigned the generalized customer type of MFR, despite what their cycle route or detailed customer type may be.

Table A-2. Instructions for Generalizing Customer Types

Class	Cycle Route	Jurisdiction	Detailed Customer Type	Generalized Customer Type
A	-	-	-	SFR
B	-	-	-	MFR
C	7720, 7721, 7722, 7723	-	-	OPS
	All Other Cycle Routes	CU, CG, MG	-	INS
		All Other Jurisdiction Codes	CC, IE, IG, CT	INS
			IP, IW	IND
	All Remaining Records			COM

After executing the sorting as defined in Table A-2, the Generalized Customer Type of some records was altered based on interpretation, outliers, or identified errors in the database. One important change was that residential attached (RA) housing was considered MFR rather than SFR. Further refinement was done based on identifying erroneously categorized meters. These records were identified by observing meters with outlying water demand values and meter size values based on expected values for the category. For the OPS customer type an additional 20 records, with cycle routes other than the 4 listed in Table A-2, occurred at the same Location IDs as some of the records with the specified cycle routes. These were determined to be pump stations or flushing meters located at public facilities, and were also assigned to the OPS generalized customer type.

Some sections of this analysis required additional information pertaining to the building and parcel for a given account. The individual meter information, building characteristics (for example, square footage, home age, and number of bathrooms) and parcel characteristic (for example, acreage and tax valuation) were provided in three separate databases. Each database contained geographical location data. These data were imported into GIS and used to link meters to their respective building and parcel characteristics. Because location coordinates may not match exactly between data sets, a buffer of 15 inches was established, capturing over 98 percent of the linkages. Parcel PIN numbers were mapped over to the meters database and then used to link meters to building and parcel data. The remaining linkages that could be confirmed were done manually.

This process was also used to update river basin information for records without an assigned river basin.

2.2.3 Database Query Development

Service locations were used as the base analysis unit for much of the effort. To summarize meter account records by service location, the following steps were performed:

1. Each account has a unique LocationID and CustomerID; the combination of these two identifications (IDs) was used to define an individual account, and the LocationID was used to define the service location.
2. Service location was selected in this analysis to define consumption patterns, since the CustomerID has the potential to change multiple times over the analysis period for an individual service location.
3. Service location data were then summarized by jurisdiction as Town of Cary, Town of Morrisville, the Wake County portion of Research Triangle Park (RTP South), or Raleigh-Durham International (RDU)

Airport using the General_Ju field showing TC, TM, RTP, and RD, respectively. Similar fields were used to sum data by river basin.

3.0 Water System Overview

The tables and figures in this section provide a high-level review of overall water system demands.

3.2 Population and Service Locations

Table 3-2. Annual Average Day Total Water Demand Profile (including reclaimed water)

- Open (execute) query titled *AnnualGPD_Summary_Qry2*
- Pull data into Microsoft Excel to sum Town of Cary, RTP South, and Town of Morrisville results by Customer Type, and separate RDU

3.5 Annual Average Daily Potable Water Usage

Table 3-9. Summary of the Annual Average Daily Potable Water Usage by River Basin, in million gallons per day

- Open *Annual_GPD_Breakdown_Qry2RiverBasin*

Table 3-10. Summary of the Annual Average Daily Potable Water Usage by Jurisdiction and Customer Type, in million gallons per day

- Open *AnnualGPD_Breakdown_Qry2*

4.0 Daily Water Use Trends

The tables and figures in this section summarize a daily view of potable water demand in the service area.

4.1 Daily Demand Patterns

Figure 4-3. Comparison of Daily Finished Water Production and Aquastar Usage Data, by Customer Type, 2013-2016

- Open the four queries:
  1. Daily_Cons_by_CustType_2013_Qry
  2. Daily_Cons_by_CustType_2014_Qry
  3. Daily_Cons_by_CustType_2015_Qry
  4. Daily_Cons_by_CustType_2016_Qry
- Copy into Excel, separate by Customer Types, and concatenate years

Figure 4-4. Percent of Total Aquastar Daily Usage Data, by Customer Type for 2013-2016

- Start with Excel dataset created for Figure 4-3
- Calculate total sum by day
- Calculate percentages per day per customer type

5.0 Monthly Water Use Analysis

The table and figures in this section detail monthly potable and nonpotable water demand to aid in understand seasonal and long-term patterns.

5.1 Monthly Demand Patterns

Figure 5-1. Monthly Average Day Potable Water Usage, January 2001 - December 2016

- Open *MonthlyGPD_Summary_Qry2Total*

Figure 5-2. Monthly Average Day Potable Water Usage, by River Basin, January 2001 - December 2016

- *MonthlyGPD_Summary_Qry2RiverBasin*

Figure 5-3. Monthly Average Day Potable Water Usage, by Customer Type, January 2001 - December 2016

- *MonthlyGPD_Summary_Qry2CustomerType*

5.3 Separately Metered Irrigation and Reclaimed Water Accounts

5.3.1 Separately Metered Irrigation Accounts

Figure 5-5. Seasonal Variation in Domestic and Irrigation Water Usage for Separately Metered Irrigation Accounts, 2001-2009 and 2013-2016

- Open *MonthlyGPD_WA_IR_Qry*
- Copy into Excel
- Sum by Service Type
- Calculate Total Sum

Table 5-2. Town of Cary Summary of the annual Average Day Irrigation Demand by Customer Type, 2001-2009 and 2013-2016

- Open *Annual_TC_TM_IR_Qry2Sum*
- Record results for Jurisdiction TC

Table 5-3. Town of Cary Summary of the annual Average Day Irrigation Gallons per Day per Account by Customer Type, 2001-2009 and 2013-2016

- Open *Annual_TC_TM_IR_Qry2Avg*
- Record results for Jurisdiction TC

Table 5-5. Town of Morrisville Summary of the annual Average Day Irrigation Demand by Customer Type, 2001-2009 and 2013-2016

- Open *Annual_TC_TM_IR_Qry2Sum*
- Record results for Jurisdiction TM

Table 5-6. Town of Morrisville Summary of the annual Average Day Irrigation Gallons per Day per Account by Customer Type, 2001-2009 and 2013-2016

- Open *Annual_TC_TM_IR_Qry2Avg*
- Record results for Jurisdiction TM

5.3.2 Reclaimed Water Accounts

Figure 5-6. Seasonal Variation in Domestic and Reclaimed Water Demand for Reclaimed Water Accounts, 2001-2009 and 2013-2016

- Open *MonthlyGPD_WA_RW_Qry*
- Copy into Excel
- Sum by Service Type
- Calculate Total Sum

Table 5-8. Summary of the Annual Average Day Reclaimed Water Demand by Customer Type, 2001-2009 and 2013-2016

- Open *AnnualGPD_RW_Qry2Sum*

Table 5-9. Summary of the Annual Average Day Reclaimed Water Gallons per Day per Account, 2001-2009 and 2013-2016

- Open *AnnualGPD_RW_Qry2Avg*

6.0 Unit Consumption Analysis

6.1 Annual Average Daily Unit Consumption Statistics

6.1.1 Single-family Residential Statistics

Table 6-1. Single-family Residential Annual Average Gallons per Day per Residence and Gallons per Capita per Day, 2001-2009 and 2013-2016

- Open *SFR_TC_TM_AnnualGPD_Summary_Qry2*
- For per capita value, divide by SFR people per household value reported in main TM

Figure 6-1. Town of Cary Cumulative Distribution of Single-family Residential Annual Average Gallons per Day per Service Location (Residence) Values, 2007 and 2013-2016

- Open *SFR_TC_TM_AnnualGPD_Summary_Qry1*
- Copy in Excel
- Sort by Jurisdiction, and separate TC and TM locations
- Separate year columns, and sort ascending

Figure 6-2. Town of Morrisville Cumulative Distribution of Single-family Residential Annual Average Gallons per Day per Service Location (Residence) Values, 2007 and 2013-2016

- Open *SFR_TC_TM_AnnualGPD_Summary_Qry1*
- Copy in Excel
- Sort by Jurisdiction, and separate TC and TM locations
- Separate year columns, and sort ascending

6.1.2 Multifamily Residential Statistics

Table 6-2. Multifamily Residential Annual Average Gallons per Day per Residence and Gallons per Capita per Day, 2001-2009 and 2013-2016

- Open *MFR_TC_TM_AnnualGPD_Summary_Qry2*
- For per capita value, divide by MFR people per household values reported in Appendix C

Figure 6-4. Town of Cary Cumulative Distribution of Multifamily Residential Annual Average Gallons per Day per Service Location (Residence) Values, 2007 and 2013-2016

- Open *MFR_TC_TM_AnnualGPD_Summary_Qry1*
- Copy in Excel
- Sort by Jurisdiction, and select TC locations
- Separate year columns, and sort ascending

Figure 6-5. Town of Morrisville Cumulative Distribution of Mutlifamily Residential Annual Average Gallons per Day per Service Location (Residence) Values, 2007 and 2013-2016

- Open M*FR_TC_TM_AnnualGPD_Summary_Qry1*
- Copy in Excel
- Sort by Jurisdiction, and select TM locations

- Separate year columns, and sort ascending

6.1.3 Commercial Statistics

Table 6-3. Commercial Annual Average Gallons per Day per Square Foot, 2001-2009 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry3*
- To calculate median values, follow steps for Figures 6-6 and 6-7, and then use Excel to calculate median of list of locations' annual usage

Figure 6-6. Town of Cary Cumulative Distribution of Commercial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry2*
- Copy in Excel
- Divide annual usage columns by square footage column, producing four more columns
- Sort by Customer Type, and select COM locations
- Then sort by Jurisdiction, and select TC locations
- Separate year columns, and sort ascending

Figure 6-7. Town of Morrisville Cumulative Distribution of Commercial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry2*
- Copy in Excel
- Divide annual usage columns by square footage column, producing four more columns
- Sort by Customer Type, and select COM locations
- Then sort by Jurisdiction, and select TM locations
- Separate year columns, and sort ascending

6.1.4 Industrial Statistics

Table 6-4. Industrial Annual Average Gallons per Day per Square Foot, 2001-2009 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry3*
- To calculate median values, follow steps for Figures 6-6 and 6-7, and then use Excel to calculate median of list of locations' annual usage

Figure 6-8. Town of Cary Cumulative Distribution of Industrial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry2*
- Copy in Excel
- Divide annual usage columns by square footage column, producing four more columns
- Sort by Customer Type, and select IND locations
- Then sort by Jurisdiction, and select TC locations
- Separate year columns, and sort ascending

Figure 6-9. Town of Morrisville Cumulative Distribution of Industrial Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry2*
- Copy in Excel
- Divide annual usage columns by square footage column, producing four more columns
- Sort by Customer Type, and select IND locations
- Then sort by Jurisdiction, and select TM locations

- Separate year columns, and sort ascending

6.1.5 Institutional Statistics

Table 6-5. Institutional Annual Average Gallons per Day per Square Foot, 2001-2009 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry3*
- To calculate median values, follow steps for Figures 6-6 and 6-7, and then use Excel to calculate median of list of locations' annual usage

Figure 6-10. Town of Cary Cumulative Distribution of Institutional Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry2*
- Copy in Excel
- Divide annual usage columns by square footage column, producing four more columns
- Sort by Customer Type, and select INS locations
- Then sort by Jurisdiction, and select TC locations
- Separate year columns, and sort ascending

Figure 6-11. Town of Morrisville Cumulative Distribution of Institutional Annual Average Gallons per Day per Square Foot Values, 2007 and 2013-2016

- Open *ICI_AnnualGPD_Summary_Qry2*
- Copy in Excel
- Divide annual usage columns by square footage column, producing four more columns
- Sort by Customer Type, and select INS locations
- Then sort by Jurisdiction, and select TM locations
- Separate year columns, and sort ascending

6.2 Seasonal Indoor and Outdoor Usage Profiles

This section presents an indoor and outdoor use profile for SFR and COM accounts, the two primary customer types that drive the seasonal demand pattern for the Town's service area.

See data analysis description for Section 6.4.2 of the Water Use Analysis TM.

6.3 Peaking Profiles

See data analysis description for Section 6.4.2 of the Water Use Analysis TM.

6.4 Single-family Residential Water Use Trends

6.4.1 Single-family Residence Age Water Use Profile

Figure 6-24. Monthly Single-family Residential Gallons per Day, by Residence Age Block, 2001 - 2016

- Open *SFR_MonthlyGPD_Summary_Qry2Sum*

Figure 6-25. Monthly Average Single-family Residential Gallons per Day per Residence, by Residence Age Block, 2001 - 2016

- Open *SFR_MonthlyGPD_Summary_Qry2Avg*

Figure 6-26. Monthly Average Single-family Residential Gallons per Day per Residence, by Residence Age Block, 2001 - 2016

- Open *SFR_MonthlyGPD_Breakdown_Qry2SingleMeter*

Table 6-6. Single-family Residential Annual Average Day Water Use Variation with Residence Age, January 2001 – December 2016

- Open *SFR_AnnualGPD_Summary_Qry2*

Table 6-7. Single-family Residential Annual Average Day Water Use Variation with Residence Age, January 2001 – December 2016 (includes only Single Meter Accounts)

- Open *SFR_AnnualGPD_Breakdown_Qry2*
- Record values from rows where "Sep IR_Acct" cell is blank

Table 6-8. Single-family Residential Annual Average Day Water Use Variation with Residence Age, January 2001 – December 2016 (includes only Separately Metered Irrigation Accounts)

- Open *SFR_AnnualGPD_Breakdown_Qry2*
- Record values from rows where "Sep IR_Acct" cell contains "Y"

6.4.2 Single-family Residential Indoor and Outdoor Use Profile

Most this section of the analysis is performed in Excel. The query providing the raw data is *SFR_MonthlyGPD_Breakdown_Qry1*. From this point, the outdoor water demand of single metered residences is calculated using the procedure detailed in the main TM (finding average of winter months to establish baseline indoor usage). Figures 6-28 through 6-33 are produced using these data.

These same data are used to produce Figures 6-12 through 6-14 in Section 6.2 of the Water Use Analysis TM.

In addition, these data are used to produce Figures 6-16 through 6-18 in Section 6.3.1 of the Water Use Analysis TM.

6.4.3 Single-family Residence Parcel and Building Characteristics Use Profile

Table 6-10. Single-family Residential Period Average Gallons per Day per Residence by Residence Lot Size and Age, 2013 - 2016

- Open *SFR_Cross_LotSize*

Table 6-11. Single-family Residential Period Average Gallons per Day per Residence by Residence Square Footage and Age, 2013 - 2016

- Open *SFR_Cross_SqFt*

Table 6-12. Single-family Residential Period Average Gallons per Day per Residence by Residence Tax Value and Age, 2013 - 2016

- Open *SFR_Cross_TaxValue*

Table 6-13. Single-family Residential Period Average Gallons per Day per Residence for Winter Months (December - March) by Residence Number of Bathrooms and Age, 2013 - 2016

- Open *SFR_Cross_WinterBathrooms*

8.0 System Profiles for Forecast

The Aquastar system is geospatially categorized, allowing for water billing data to be tied to wastewater collection systems and treatment facilities.

8.1 Water System

Of the treated water distributed throughout the Town's service area, a portion stays in the Cape Fear River basin, and a portion is used in the Neuse River basin. Data were tabulated using the river basin field RiverBas2.

8.2 Wastewater System

A portion of finished water is collected after use and treated at the Town's water reclamation facilities. This update now includes the Western Wake Regional Water Reclamation Facility (WWRWRF), which was not yet operational when the 2013 LRWRP was completed. The Town's other two treatment facilities are the North Cary WRF (NCWRF) and the South Cary WRF (SCWRF). Records were summarized by sewer basin.

10.0 References

CH2M HILL (CH2M). 2007. *Integrated Water Resources Management Plan (IWRMP)*. Prepared for the Town of Cary.

CH2M HILL (CH2M). 2010. *Water Use Analysis*. Prepared for the Town of Cary.

Appendix B
Detailed Unit Consumption Value Statistical Summary

StatTools Report

Title: Cary SFR Unit Consumption (GPD/Residence)

Analysis: One Variable Summary
Performed By: Sharpe, Adam/RAL
Date: Monday, July 10, 2017

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR	TC_SFR
Mean	203	214	183	195	196	174	202	165	168	149	149	150	149
Variance	12,195	14,873	9,051	11,211	12,953	12,222	17,119	11,857	10,615	17,736	7,865	8,462	10,241
Std. Dev.	110	122	95	106	114	111	131	109	103	133	89	92	101
Skewness	1	1	1	1	1	2	3	0	3	80	2	2	16
Kurtosis	8	7	6	6	7	34	47	240	63	11,468	9	9	1,203
Median	184	191	169	178	176	159	174	147	150	133	132	132	130
Mode	170	163	149	161	134	149	192	153	122	100	98	101	81
Minimum	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.03	0.00	0.00	0.00	0.00
Maximum	1,361	1,150	999	1,159	1,427	3,032	4,221	3,397	3,542	19,270	1,320	1,221	8,506
Range	1,361	1,150	999	1,159	1,427	3,032	4,221	8,521	3,542	19,270	1,320	1,221	8,506
Count	25,271	25,721	26,061	26,683	27,658	30,784	30,802	32,543	33,520	37,074	37,932	38,415	38,851
1st Quartile	129	132	118	124	120	104	117	99	101	90	89	89	88
3rd Quartile	253	268	230	246	248	225	253	209	213	188	188	189	186
Interquartile Range	124	136	112	122	128	121	136	110	111	98	99	100	98
1.00%	29	25	21	19	14	3	12	11	8	9	11	12	13
2.50%	46	43	40	41	34	8	32	28	25	24	26	27	27
5.00%	62	62	56	58	52	22	50	42	42	38	39	41	40
10.00%	86	86	78	81	76	53	74	61	63	55	56	57	56
25.00%	129	132	118	124	120	104	117	99	101	90	89	89	88
75.00%	253	268	230	246	248	225	253	209	213	188	188	189	186
90.00%	342	372	303	328	340	307	365	287	292	258	261	267	264
95.00%	412	449	358	393	415	370	448	347	351	314	317	328	325
97.50%	480	520	413	458	490	435	529	408	409	367	373	388	385
99.00%	571	620	494	543	578	525	638	496	493	440	447	462	463

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	25,018	25,464	25,800	26,416	27,381	30,476	30,494	32,218	33,185	36,703	37,553	38,031	38,462
2.50%	24,639	25,078	25,409	26,016	26,967	30,014	30,032	31,729	32,682	36,147	36,984	37,455	37,880
5.00%	24,007	24,435	24,758	25,349	26,275	29,245	29,262	30,916	31,844	35,220	36,035	36,494	36,908
10.00%	22,744	23,149	23,455	24,015	24,892	27,706	27,722	29,289	30,168	33,367	34,139	34,574	34,966
25.00%	18,953	19,291	19,546	20,012	20,744	23,088	23,102	24,407	25,140	27,806	28,449	28,811	29,138
75.00%	6,318	6,430	6,515	6,671	6,915	7,696	7,701	8,136	8,380	9,269	9,483	9,604	9,713
90.00%	2,527	2,572	2,606	2,668	2,766	3,078	3,080	3,254	3,352	3,707	3,793	3,842	3,885
95.00%	1,264	1,286	1,303	1,334	1,383	1,539	1,540	1,627	1,676	1,854	1,897	1,921	1,943
97.50%	632	643	652	667	691	770	770	814	838	927	948	960	971
99.00%	253	257	261	267	277	308	308	325	335	371	379	384	389

StatTools Report

Title: Morrisville SFR Unit Consumption (GPD/Residence)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Monday, July 10, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR	TM_SFR
Mean	181	189	153	162	169	145	168	143	145	141	140	142	145
Variance	27,544	34,650	21,646	20,621	24,787	135,896	17,267	10,624	12,944	7,359	6,930	7,708	7,330
Std. Dev.	166	186	147	144	157	369	131	103	114	86	83	88	86
Skewness	4	3	5	6	7	41	2	4	5	2	2	2	2
Kurtosis	38	21	53	76	122	2,007	12	70	72	11	11	11	9
Median	143	148	123	136	137	113	141	125	127	128	128	128	131
Mean Abs. Dev.	109	120	85	87	94	93	90	69	73	61	60	63	62
Mode	4	121	163	139	0	6	0	55	0	129	82	81	51
Minimum	0.27	0.27	0.55	0.27	0.27	0.05	0.03	0.03	0.05	0.00	0.00	0.00	0.01
Maximum	2,435	2,034	2,191	2,872	3,679	18,475	1,422	2,300	2,267	835	994	979	869
Range	2,434	2,034	2,190	2,872	3,678	18,475	1,422	2,300	2,267	835	994	979	869
Count	1,103	1,404	1,752	2,044	2,308	3,087	2,884	3,016	3,174	3,303	3,507	3,734	3,827
1st Quartile	81	75	77	83	82	58	85	80	78	85	86	86	90
3rd Quartile	229	230	184	199	202	177	207	180	185	178	174	181	181
Interquartile Range	148	155	107	116	120	119	122	100	107	92	89	95	92
1.00%	2	2	2	3	2	2	1	2	1	3	2	5	5
2.50%	8	5	7	9	7	4	11	12	7	15	16	15	21
5.00%	18	13	18	21	19	7	22	26	19	33	33	31	37
10.00%	35	31	39	45	42	17	46	45	41	52	52	52	57
25.00%	81	75	77	83	82	58	85	80	78	85	86	86	90
75.00%	229	230	184	199	202	177	207	180	185	178	174	181	181
90.00%	366	392	280	296	324	270	318	257	259	238	236	243	248
95.00%	478	516	367	407	433	371	429	323	327	292	288	299	296
97.50%	587	675	507	512	552	457	522	402	416	346	345	364	363
99.00%	748	889	692	658	705	580	665	480	502	440	427	439	446

# of Locations per Percentile (Percentile consumption level and above)

1.00%	1,092	1,390	1,734	2,024	2,285	3,056	2,855	2,986	3,142	3,270	3,472	3,697	3,789
2.50%	1,075	1,369	1,708	1,993	2,250	3,010	2,812	2,941	3,095	3,220	3,419	3,641	3,731
5.00%	1,048	1,334	1,664	1,942	2,193	2,933	2,740	2,865	3,015	3,138	3,332	3,547	3,636
10.00%	993	1,264	1,577	1,840	2,077	2,778	2,596	2,714	2,857	2,973	3,156	3,361	3,444
25.00%	827	1,053	1,314	1,533	1,731	2,315	2,163	2,262	2,381	2,477	2,630	2,801	2,870
75.00%	276	351	438	511	577	772	721	754	794	826	877	934	957
90.00%	110	140	175	204	231	309	288	302	317	330	351	373	383
95.00%	55	70	88	102	115	154	144	151	159	165	175	187	191
97.50%	28	35	44	51	58	77	72	75	79	83	88	93	96
99.00%	11	14	18	20	23	31	29	30	32	33	35	37	38

StatTools Report

Title: Cary MFR Unit Consumption (GPD/Account)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Monday, July 10, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR	TC_MFR
Mean	309	295	295	301	282	248	277	248	251	231	226	216	208
Variance	1,433,841	1,063,018	1,005,148	1,128,026	1,030,334	913,696	1,095,287	804,933	762,156	681,887	640,017	609,004	549,549
Std. Dev.	1,197	1,031	1,003	1,062	1,015	956	1,047	897	873	826	800	780	741
Skewness	25	23	20	20	23	24	21	20	19	20	22	25	27
Kurtosis	957	817	599	659	822	929	649	600	590	660	825	1,007	1,285
Median	110	107	102	103	98	87	96	87	89	88	90	87	88
Mean Abs. Dev.	348	329	337	346	323	288	321	287	289	257	245	233	217
Mode	55	110	90	75	63	1	65	73	0	25	1,699	0	0
Minimum	0.03	0.02	0.03	0.05	0.03	0.05	0.03	0.03	0.03	0.00	0.00	0.00	0.00
Maximum	55,378	45,633	40,304	44,579	45,705	46,197	44,318	37,992	37,248	37,332	39,595	41,680	43,606
Range	55,378	45,633	40,304	44,579	45,705	46,197	44,318	37,992	37,248	37,332	39,595	41,680	43,606
Count	5,594	5,718	5,845	5,984	6,188	7,305	6,944	7,510	7,912	8,845	9,192	9,738	10,358
1st Quartile	70	65	63	63	61	47	59	52	53	55	55	54	55
3rd Quartile	178	177	169	171	161	147	155	142	143	137	139	135	134
Interquartile Range	109	111	105	108	99	100	96	89	90	82	83	81	79
1.00%	3	2	1	1	2	1	2	1	1	2	2	1	1
2.50%	13	10	6	8	9	2	6	4	3	10	13	6	9
5.00%	29	24	21	20	20	4	18	14	11	21	23	18	21
10.00%	43	40	38	36	35	10	33	29	27	33	35	32	33
25.00%	70	65	63	63	61	47	59	52	53	55	55	54	55
75.00%	178	177	169	171	161	147	155	142	143	137	139	135	134
90.00%	559	606	595	496	462	326	421	329	343	260	255	247	233
95.00%	1,452	1,397	1,467	1,469	1,363	1,212	1,320	1,196	1,235	1,149	1,074	978	917
97.50%	1,993	1,950	1,952	2,080	1,969	1,856	1,893	1,848	1,863	1,795	1,740	1,687	1,636
99.00%	2,893	2,690	2,781	3,048	2,940	2,720	3,050	2,511	2,779	2,462	2,301	2,267	2,295

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	5,538	5,661	5,787	5,924	6,126	7,232	6,875	7,435	7,833	8,757	9,100	9,641	10,254
2.50%	5,454	5,575	5,699	5,834	6,033	7,122	6,770	7,322	7,714	8,624	8,962	9,495	10,099
5.00%	5,314	5,432	5,553	5,685	5,879	6,940	6,597	7,135	7,516	8,403	8,732	9,251	9,840
10.00%	5,035	5,146	5,261	5,386	5,569	6,575	6,250	6,759	7,121	7,961	8,273	8,764	9,322
25.00%	4,196	4,289	4,384	4,488	4,641	5,479	5,208	5,633	5,934	6,634	6,894	7,304	7,769
75.00%	1,399	1,430	1,461	1,496	1,547	1,826	1,736	1,878	1,978	2,211	2,298	2,435	2,590
90.00%	559	572	585	598	619	731	694	751	791	885	919	974	1,036
95.00%	280	286	292	299	309	365	347	376	396	442	460	487	518
97.50%	140	143	146	150	155	183	174	188	198	221	230	243	259
99.00%	56	57	58	60	62	73	69	75	79	88	92	97	104

StatTools Report

Title: Morrisville MFR Unit Consumption (GPD/Account)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Monday, July 10, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR	TM_MFR
Mean	239	233	204	205	206	207	224	212	210	198	201	203	200
Variance	465,939	328,898	244,019	208,990	217,636	294,685	299,512	230,996	227,627	204,613	221,533	230,299	226,594
Std. Dev.	683	573	494	457	467	543	547	481	477	452	471	480	476
Skewness	11	7	7	5	5	6	5	4	4	5	5	5	5
Kurtosis	188	83	84	31	36	56	43	24	20	28	30	30	31
Median	88	88	81	85	87	78	87	83	84	91	91	94	94
Mean Abs. Dev.	271	260	223	215	217	236	247	235	232	198	203	204	197
Mode	0	30	2	89	87	0	73	93	1	40	72	48	118
Minimum	0.27	0.27	0.27	0.27	0.27	0.00	0.03	0.03	0.03	0.00	0.00	0.00	0.00
Maximum	13,958	9,212	8,598	5,620	5,797	8,305	6,624	5,221	3,750	5,154	5,172	4,985	5,078
Range	13,957	9,211	8,598	5,620	5,797	8,305	6,624	5,221	3,750	5,154	5,172	4,985	5,078
Count	1,505	1,677	1,925	2,049	2,104	2,117	2,016	2,073	2,203	2,841	2,916	2,998	3,118
1st Quartile	52	53	48	56	55	46	54	50	49	58	58	59	60
3rd Quartile	138	139	127	132	131	125	137	130	130	133	133	134	137
Interquartile Range	86	87	79	76	76	79	83	81	82	75	75	76	76
1.00%	1	2	1	2	1	0	1	1	1	2	2	4	5
2.50%	4	5	3	7	4	1	5	3	2	12	10	16	19
5.00%	13	11	11	25	16	4	17	11	7	25	25	26	29
10.00%	32	27	24	36	32	18	31	25	23	37	37	37	40
25.00%	52	53	48	56	55	46	54	50	49	58	58	59	60
75.00%	138	139	127	132	131	125	137	130	130	133	133	134	137
90.00%	362	267	217	217	224	212	239	232	222	206	205	201	201
95.00%	1,302	1,413	1,341	1,319	1,322	1,403	1,446	1,432	1,533	906	999	840	719
97.50%	1,709	1,762	1,770	1,804	1,857	1,890	1,990	1,884	1,971	2,010	1,983	2,039	2,085
99.00%	2,112	2,266	2,202	2,186	2,201	2,492	2,687	2,396	2,449	2,478	2,551	2,690	2,680

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	1,490	1,660	1,906	2,029	2,083	2,096	1,996	2,052	2,181	2,813	2,887	2,968	3,087
2.50%	1,467	1,635	1,877	1,998	2,051	2,064	1,966	2,021	2,148	2,770	2,843	2,923	3,040
5.00%	1,430	1,593	1,829	1,947	1,999	2,011	1,915	1,969	2,093	2,699	2,770	2,848	2,962
10.00%	1,355	1,509	1,733	1,844	1,894	1,905	1,814	1,866	1,983	2,557	2,624	2,698	2,806
25.00%	1,129	1,258	1,444	1,537	1,578	1,588	1,512	1,555	1,652	2,131	2,187	2,249	2,339
75.00%	376	419	481	512	526	529	504	518	551	710	729	750	780
90.00%	151	168	193	205	210	212	202	207	220	284	292	300	312
95.00%	75	84	96	102	105	106	101	104	110	142	146	150	156
97.50%	38	42	48	51	53	53	50	52	55	71	73	75	78
99.00%	15	17	19	20	21	21	20	21	22	28	29	30	31

StatTools Report

Title: Cary COM Unit Consumption (GPD/Square Foot)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Tuesday, July 11, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM	TC_COM
Mean	0.170	0.166	0.155	0.161	0.166	0.155	0.183	0.150	0.150	0.117	0.125	0.127	0.124
Variance	0.165	0.154	0.129	0.123	0.173	0.142	0.258	0.158	0.177	0.061	0.079	0.089	0.080
Std. Dev.	0.406	0.393	0.359	0.351	0.417	0.377	0.508	0.397	0.421	0.247	0.282	0.298	0.282
Skewness	6.737	6.482	5.882	5.092	7.019	6.526	8.511	7.411	8.737	6.023	6.412	7.464	7.028
Kurtosis	70.962	64.470	52.340	40.691	75.455	61.877	106.893	78.018	108.142	59.976	65.428	91.723	79.051
Median	0.046	0.045	0.040	0.044	0.043	0.043	0.046	0.038	0.039	0.036	0.036	0.036	0.038
Mean Abs. Dev.	0.198	0.193	0.184	0.187	0.197	0.182	0.219	0.178	0.178	0.130	0.141	0.145	0.139
Mode	0.015	0.016	0.000	0.000	0.000	0.011	0.000	0.019	0.013	0.000	0.000	0.000	0.000
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	5.901	5.609	4.429	4.239	6.204	5.052	8.745	5.725	6.842	3.579	4.175	5.034	4.475
Range	5.901	5.609	4.429	4.239	6.204	5.052	8.745	5.725	6.842	3.579	4.175	5.034	4.475
Count	962.000	999.000	1,024.000	1,041.000	1,067.000	1,125.000	1,147.000	1,195.000	1,198.000	1,029.000	1,051.000	1,077.000	1,089.000
Sum	163.740	165.393	158.970	168.094	177.598	174.272	209.422	179.333	179.713	120.261	130.883	137.090	134.928
1st Quartile	0.019	0.018	0.016	0.017	0.016	0.016	0.017	0.015	0.016	0.013	0.014	0.014	0.014
3rd Quartile	0.128	0.123	0.114	0.125	0.126	0.116	0.128	0.115	0.112	0.106	0.109	0.110	0.109
Interquartile Range	0.109	0.104	0.099	0.108	0.111	0.100	0.111	0.100	0.096	0.092	0.096	0.096	0.094
1.00%	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.50%	0.001	0.001	0.000	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001
5.00%	0.004	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.003	0.002
10.00%	0.007	0.007	0.006	0.007	0.007	0.006	0.007	0.007	0.007	0.005	0.006	0.006	0.005
25.00%	0.019	0.018	0.016	0.017	0.016	0.016	0.017	0.015	0.016	0.013	0.014	0.014	0.014
75.00%	0.128	0.123	0.114	0.125	0.126	0.116	0.128	0.115	0.112	0.106	0.109	0.110	0.109
90.00%	0.451	0.435	0.441	0.468	0.431	0.409	0.418	0.341	0.343	0.327	0.320	0.328	0.320
95.00%	0.701	0.692	0.722	0.756	0.721	0.682	0.765	0.656	0.625	0.533	0.575	0.556	0.531
97.50%	1.304	1.305	1.138	1.199	1.232	1.124	1.384	1.103	1.130	0.761	0.842	0.862	0.812
99.00%	1.767	1.721	1.549	1.770	2.021	1.552	2.047	1.792	1.774	1.166	1.458	1.217	1.189

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	952	989	1,014	1,031	1,056	1,114	1,136	1,183	1,186	1,019	1,040	1,066	1,078
2.50%	938	974	998	1,015	1,040	1,097	1,118	1,165	1,168	1,003	1,025	1,050	1,062
5.00%	914	949	973	989	1,014	1,069	1,090	1,135	1,138	978	998	1,023	1,035
10.00%	866	899	922	937	960	1,013	1,032	1,076	1,078	926	946	969	980
25.00%	722	749	768	781	800	844	860	896	899	772	788	808	817
75.00%	241	250	256	260	267	281	287	299	300	257	263	269	272
90.00%	96	100	102	104	107	113	115	120	120	103	105	108	109
95.00%	48	50	51	52	53	56	57	60	60	51	53	54	54
97.50%	24	25	26	26	27	28	29	30	30	26	26	27	27
99.00%	10	10	10	10	11	11	11	12	12	10	11	11	11

StatTools Report

Title: Morrisville COM Unit Consumption (GPD/Square Foot)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Tuesday, July 11, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM	TM_COM
Mean	0.061	0.068	0.075	0.090	0.100	0.131	0.153	0.128	0.131	0.139	0.145	0.156	0.169
Variance	0.004	0.007	0.014	0.014	0.016	0.066	0.094	0.074	0.071	0.188	0.194	0.172	0.296
Std. Dev.	0.067	0.086	0.118	0.119	0.128	0.258	0.307	0.271	0.266	0.434	0.441	0.415	0.544
Skewness	1.453	2.200	3.095	2.044	2.078	3.943	3.991	4.940	3.869	8.498	8.660	6.537	8.207
Kurtosis	4.025	8.211	13.710	6.700	6.952	22.987	22.597	35.292	22.206	87.522	91.994	55.370	80.075
Median	0.041	0.046	0.043	0.044	0.049	0.036	0.045	0.034	0.033	0.032	0.032	0.036	0.037
Mean Abs. Dev.	0.050	0.055	0.071	0.083	0.088	0.153	0.178	0.150	0.158	0.169	0.173	0.188	0.207
Mode	0.000	0.011	0.001	0.003	0.002	0.002	0.010	0.000	0.017	0.000	0.000	0.000	0.000
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	0.217	0.357	0.534	0.435	0.476	1.888	2.214	2.387	2.112	5.000	5.233	3.935	5.703
Range	0.217	0.357	0.534	0.435	0.476	1.888	2.214	2.387	2.112	5.000	5.233	3.935	5.703
Count	23.000	24.000	23.000	25.000	27.000	218.000	220.000	229.000	226.000	237.000	246.000	252.000	255.000
Sum	1.411	1.623	1.730	2.256	2.712	28.512	33.759	29.285	29.651	32.958	35.568	39.235	43.117
1st Quartile	0.018	0.004	0.015	0.014	0.018	0.011	0.016	0.014	0.013	0.015	0.015	0.016	0.015
3rd Quartile	0.069	0.069	0.094	0.109	0.113	0.114	0.124	0.095	0.090	0.102	0.112	0.105	0.126
Interquartile Range	0.051	0.065	0.078	0.095	0.095	0.103	0.108	0.081	0.077	0.088	0.097	0.089	0.111
1.00%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.50%	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.001	0.000	0.000
5.00%	0.000	0.000	0.000	0.004	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
10.00%	0.001	0.002	0.002	0.004	0.003	0.003	0.005	0.004	0.006	0.006	0.006	0.006	0.006
25.00%	0.018	0.004	0.015	0.014	0.018	0.011	0.016	0.014	0.013	0.015	0.015	0.016	0.015
75.00%	0.069	0.069	0.094	0.109	0.113	0.114	0.124	0.095	0.090	0.102	0.112	0.105	0.126
90.00%	0.192	0.193	0.144	0.267	0.267	0.409	0.466	0.379	0.422	0.336	0.342	0.386	0.379
95.00%	0.210	0.246	0.282	0.414	0.472	0.668	0.706	0.591	0.671	0.592	0.636	0.655	0.654
97.50%	0.217	0.357	0.534	0.435	0.476	0.850	0.950	0.639	0.867	0.747	0.819	0.986	0.932
99.00%	0.217	0.357	0.534	0.435	0.476	1.024	1.953	1.299	1.234	1.495	1.332	1.675	2.259

# of Locations per Percentile (Percentile consumption level and above)

1.00%	23	24	23	25	27	216	218	227	224	235	244	249	252
2.50%	22	23	22	24	26	213	215	223	220	231	240	246	249
5.00%	22	23	22	24	26	207	209	218	215	225	234	239	242
10.00%	21	22	21	23	24	196	198	206	203	213	221	227	230
25.00%	17	18	17	19	20	164	165	172	170	178	185	189	191
75.00%	6	6	6	6	7	55	55	57	57	59	62	63	64
90.00%	2	2	2	3	3	22	22	23	23	24	25	25	26
95.00%	1	1	1	1	1	11	11	11	11	12	12	13	13
97.50%	1	1	1	1	1	5	6	6	6	6	6	6	6
99.00%	0	0	0	0	0	2	2	2	2	2	2	3	3

StatTools Report

Title: Cary IND Unit Consumption (GPD/Square Foot)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Tuesday, July 11, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND	TC_IND
Mean	0.342	0.266	0.331	0.349	0.268	0.268	0.226	0.192	0.114	0.189	0.292	0.318	0.289
Variance	2.369	1.349	2.279	2.840	1.762	1.590	1.185	0.821	0.225	0.520	1.396	1.653	1.337
Std. Dev.	1.539	1.161	1.510	1.685	1.327	1.261	1.088	0.906	0.474	0.721	1.181	1.286	1.156
Skewness	5.162	5.150	5.172	5.374	5.555	5.453	5.623	5.615	5.536	4.118	4.241	4.241	4.241
Kurtosis	29.745	29.656	29.823	31.916	33.903	32.814	34.728	34.659	34.004	19.970	20.991	20.993	20.990
Median	0.019	0.016	0.015	0.017	0.014	0.017	0.012	0.013	0.013	0.010	0.010	0.012	0.012
Mean Abs. Dev.	0.582	0.442	0.562	0.604	0.461	0.450	0.382	0.320	0.174	0.329	0.526	0.572	0.515
Mode	0.004	0.012	0.000	0.000	0.000	0.001	0.012	0.011	0.000	0.004	0.009	0.012	0.001
Minimum	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maximum	8.028	6.061	7.874	9.105	7.415	6.935	6.179	5.144	2.693	2.986	5.026	5.469	4.922
Range	8.028	6.061	7.874	9.105	7.415	6.934	6.179	5.144	2.693	2.986	5.026	5.469	4.922
Count	27.000	27.000	27.000	29.000	31.000	30.000	32.000	32.000	32.000	17.000	18.000	18.000	18.000
Sum	9.233	7.176	8.928	10.118	8.294	8.028	7.231	6.159	3.658	3.211	5.262	5.732	5.202
1st Quartile	0.008	0.005	0.006	0.005	0.003	0.007	0.009	0.009	0.008	0.004	0.006	0.005	0.008
3rd Quartile	0.030	0.029	0.031	0.032	0.033	0.047	0.030	0.028	0.029	0.016	0.012	0.018	0.019
Interquartile Range	0.022	0.024	0.025	0.027	0.029	0.040	0.021	0.019	0.021	0.012	0.006	0.013	0.011
1.00%	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.50%	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.00%	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
10.00%	0.003	0.002	0.001	0.000	0.001	0.002	0.002	0.001	0.002	0.000	0.000	0.000	0.000
25.00%	0.008	0.005	0.006	0.005	0.003	0.007	0.009	0.009	0.008	0.004	0.006	0.005	0.008
75.00%	0.030	0.029	0.031	0.032	0.033	0.047	0.030	0.028	0.029	0.016	0.012	0.018	0.019
90.00%	0.156	0.160	0.216	0.142	0.097	0.087	0.080	0.078	0.077	0.085	0.074	0.073	0.078
95.00%	0.508	0.438	0.381	0.301	0.251	0.348	0.378	0.357	0.318	2.986	5.026	5.469	4.922
97.50%	8.028	6.061	7.874	9.105	7.415	6.935	6.179	5.144	2.693	2.986	5.026	5.469	4.922
99.00%	8.028	6.061	7.874	9.105	7.415	6.935	6.179	5.144	2.693	2.986	5.026	5.469	4.922

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	27	27	27	29	31	30	32	32	32	17	18	18	18
2.50%	26	26	26	28	30	29	31	31	31	17	18	18	18
5.00%	26	26	26	28	29	29	30	30	30	16	17	17	17
10.00%	24	24	24	26	28	27	29	29	29	15	16	16	16
25.00%	20	20	20	22	23	23	24	24	24	13	14	14	14
75.00%	7	7	7	7	8	8	8	8	8	4	5	5	5
90.00%	3	3	3	3	3	3	3	3	3	2	2	2	2
95.00%	1	1	1	1	2	2	2	2	2	1	1	1	1
97.50%	1	1	1	1	1	1	1	1	1	0	0	0	0
99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0

StatTools Report

Title: Morrisville IND Unit Consumption (GPD/Square Foot)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Tuesday, July 11, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009		2013	2014	2015	2016
	TM_IND	TM_IND	TM_IND	TM_IND	TM_IND	TM_IND	TM_IND	TM_IND	TM_IND		TM_IND	TM_IND	TM_IND	TM_IND
Mean					0.0639	0.4345	0.5234	0.2230	0.2388		0.0242	0.0618	0.0577	0.0779
Variance						3.0658	4.7607	0.6591	0.8523		0.0028	0.0444	0.0368	0.0723
Std. Dev.						1.7510	2.1819	0.8119	0.9232		0.0527	0.2106	0.1919	0.2688
Skewness						4.7172	4.8044	4.3103	4.5964		3.7286	3.8681	3.8643	3.8662
Kurtosis						26.0091	26.5011	22.2935	24.7835		17.1937	17.9732	17.9520	17.9623
Median					0.0639	0.0129	0.0162	0.0098	0.0094		0.0097	0.0062	0.0075	0.0058
Mean Abs. Dev.					-	0.7727	0.9292	0.3836	0.4156		0.0255	0.1015	0.0924	0.1295
Mode					0.0639	0.0001	0.0155	0.0066	0.0097		0.0018	0.0061	0.0016	0.0031
Minimum					0.0639	0.0000	0.0008	0.0000	0.0002		0.0006	0.0012	0.0014	0.0004
Maximum					0.0639	8.8861	10.8548	3.9413	4.5368		0.2126	0.8229	0.7510	1.0491
Range					-	8.8861	10.8540	3.9413	4.5366		0.2120	0.8217	0.7496	1.0487
Count					1.0000	27.0000	25.0000	26.0000	25.0000		15.0000	15.0000	15.0000	15.0000
Sum					0.0639	11.7305	13.0848	5.7979	5.9696		0.3624	0.9271	0.8654	1.1684
1st Quartile					0.0639	0.0042	0.0106	0.0060	0.0040		0.0036	0.0023	0.0027	0.0023
3rd Quartile					0.0639	0.0265	0.0236	0.0224	0.0213		0.0207	0.0111	0.0149	0.0146
Interquartile Range					-	0.0223	0.0131	0.0164	0.0173		0.0171	0.0089	0.0122	0.0122
1.00%					0.0639	0.0000	0.0008	0.0000	0.0002		0.0006	0.0012	0.0014	0.0004
2.50%					0.0639	0.0000	0.0008	0.0000	0.0002		0.0006	0.0012	0.0014	0.0004
5.00%					0.0639	0.0001	0.0032	0.0012	0.0011		0.0006	0.0012	0.0014	0.0004
10.00%					0.0639	0.0001	0.0040	0.0016	0.0021		0.0024	0.0022	0.0014	0.0017
25.00%					0.0639	0.0042	0.0106	0.0060	0.0040		0.0036	0.0023	0.0027	0.0023
75.00%					0.0639	0.0265	0.0236	0.0224	0.0213		0.0207	0.0111	0.0149	0.0146
90.00%					0.0639	0.1049	0.0524	0.0816	0.0492		0.0266	0.0201	0.0264	0.0339
95.00%					0.0639	2.4140	1.8072	1.4913	1.1357		0.2126	0.8229	0.7510	1.0491
97.50%					0.0639	8.8861	10.8548	3.9413	4.5368		0.2126	0.8229	0.7510	1.0491
99.00%					0.0639	8.8861	10.8548	3.9413	4.5368		0.2126	0.8229	0.7510	1.0491

of Locations per Percentile (Percentile consumption level and above)

1.00%	-	-	-	-	1	27	25	26	25		15	15	15	15
2.50%	-	-	-	-	1	26	24	25	24		15	15	15	15
5.00%	-	-	-	-	1	26	24	25	24		14	14	14	14
10.00%	-	-	-	-	1	24	23	23	23		14	14	14	14
25.00%	-	-	-	-	1	20	19	20	19		11	11	11	11
75.00%	-	-	-	-	0	7	6	7	6		4	4	4	4
90.00%	-	-	-	-	0	3	3	3	3		2	2	2	2
95.00%	-	-	-	-	0	1	1	1	1		1	1	1	1
97.50%	-	-	-	-	0	1	1	1	1		0	0	0	0
99.00%	-	-	-	-	0	0	0	0	0		0	0	0	0

StatTools Report

Title: Cary INS Unit Consumption (GPD/Square Foot)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Tuesday, July 11, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS	TC_INS
Mean	0.2055	0.2041	0.0903	0.1457	0.2121	0.1324	0.3383	0.2518	0.1681	0.0984	0.1229	0.1086	0.0995
Variance	0.3047	0.3041	0.0285	0.1039	0.3784	0.1266	1.6200	0.8463	0.2780	0.1025	0.1689	0.1061	0.0950
Std. Dev.	0.5520	0.5514	0.1687	0.3223	0.6151	0.3557	1.2728	0.9199	0.5273	0.3201	0.4110	0.3258	0.3082
Skewness	3.7886	4.4076	5.4332	4.1031	5.2929	4.9966	6.4568	6.6555	5.5863	6.1948	5.4594	5.3655	6.0127
Kurtosis	16.5284	22.7086	38.6539	21.7210	34.2943	30.7948	50.2622	52.9835	38.2706	44.5635	34.0034	35.3325	42.3936
Median	0.0535	0.0531	0.0463	0.0469	0.0458	0.0417	0.0409	0.0363	0.0345	0.0210	0.0217	0.0230	0.0258
Mean Abs. Dev.	0.2735	0.2594	0.0834	0.1697	0.2814	0.1614	0.5188	0.3679	0.2282	0.1274	0.1674	0.1431	0.1265
Mode	0.0104	0.0074	0.0366	0.0004	0.0004	0.0000	0.0000	0.0001	0.0001	0.0058	0.0203	0.0461	0.0085
Minimum	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Maximum	2.5848	3.2034	1.2507	2.0226	4.3386	2.4980	10.2358	7.4455	3.9234	2.4993	2.8105	2.5682	2.4535
Range	2.5848	3.2034	1.2507	2.0224	4.3385	2.4980	10.2358	7.4455	3.9234	2.4992	2.8105	2.5682	2.4535
Count	64.0000	64.0000	65.0000	72.0000	73.0000	81.0000	81.0000	78.0000	79.0000	132.0000	133.0000	136.0000	136.0000
Sum	13.1509	13.0627	5.8689	10.4890	15.4851	10.7243	27.3986	19.6433	13.2808	12.9855	16.3451	14.7642	13.5309
1st Quartile	0.0162	0.0193	0.0178	0.0211	0.0205	0.0159	0.0184	0.0182	0.0186	0.0109	0.0097	0.0100	0.0102
3rd Quartile	0.0759	0.0957	0.0827	0.0811	0.0927	0.0739	0.0781	0.0757	0.0681	0.0444	0.0538	0.0514	0.0531
Interquartile Range	0.0597	0.0763	0.0650	0.0600	0.0722	0.0580	0.0597	0.0575	0.0494	0.0336	0.0441	0.0414	0.0430
1.00%	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0009
2.50%	0.0003	0.0002	0.0001	0.0004	0.0002	0.0000	0.0000	0.0001	0.0001	0.0013	0.0015	0.0006	0.0012
5.00%	0.0023	0.0032	0.0013	0.0021	0.0008	0.0001	0.0001	0.0005	0.0005	0.0025	0.0025	0.0023	0.0028
10.00%	0.0083	0.0071	0.0059	0.0084	0.0101	0.0015	0.0020	0.0023	0.0022	0.0058	0.0053	0.0042	0.0050
25.00%	0.0162	0.0193	0.0178	0.0211	0.0205	0.0159	0.0184	0.0182	0.0186	0.0109	0.0097	0.0100	0.0102
75.00%	0.0759	0.0957	0.0827	0.0811	0.0927	0.0739	0.0781	0.0757	0.0681	0.0444	0.0538	0.0514	0.0531
90.00%	0.3154	0.3720	0.2028	0.2712	0.4325	0.2199	0.4714	0.3353	0.2986	0.1489	0.1420	0.1562	0.1555
95.00%	1.4744	0.4627	0.2949	0.9682	1.0447	0.6058	1.3152	1.5249	0.8415	0.4033	0.6280	0.6524	0.4226
97.50%	2.5798	2.5718	0.3956	1.3159	2.6397	1.2245	3.4790	2.3648	2.0028	0.7855	1.2171	1.0287	0.6796
99.00%	2.5848	3.2034	1.2507	2.0226	4.3386	2.4980	10.2358	7.4455	3.9234	2.3132	2.7351	1.8888	2.1067

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	63	63	64	71	72	80	80	77	78	131	132	135	135
2.50%	62	62	63	70	71	79	79	76	77	129	130	133	133
5.00%	61	61	62	68	69	77	77	74	75	125	126	129	129
10.00%	58	58	59	65	66	73	73	70	71	119	120	122	122
25.00%	48	48	49	54	55	61	61	59	59	99	100	102	102
75.00%	16	16	16	18	18	20	20	20	20	33	33	34	34
90.00%	6	6	7	7	7	8	8	8	8	13	13	14	14
95.00%	3	3	3	4	4	4	4	4	4	7	7	7	7
97.50%	2	2	2	2	2	2	2	2	2	3	3	3	3
99.00%	1	1	1	1	1	1	1	1	1	1	1	1	1

StatTools Report

Title: Morrisville INS Unit Consumption (GPD/Square Foot)

Analysis: One Variable Summary
Performed By: Bromby, William/RAL
Date: Tuesday, July 11, 2017
Updating: Live

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2013	2014	2015	2016
	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS	TM_INS
Mean	0.1269	0.1720	0.1790	0.5827	0.4150	0.0707	0.0521	0.0429	0.0470	0.0597	0.0456	0.0403	0.0384
Variance	0.0094	0.0218	0.0053	0.6286	0.2700	0.0155	0.0044	0.0014	0.0021	0.0112	0.0025	0.0014	0.0014
Std. Dev.	0.0971	0.1477	0.0728	0.7929	0.5196	0.1245	0.0662	0.0379	0.0457	0.1057	0.0497	0.0378	0.0371
Skewness	(1.0657)	(1.1216)	1.5873	1.6447	1.5216	3.0580	1.7872	1.5782	2.0730	3.5714	1.7982	1.4426	1.4566
Kurtosis						13.1621	5.6113	6.5323	9.1651	17.3287	5.9580	4.9507	5.0741
Median	0.1514	0.2117	0.1473	0.2117	0.2050	0.0229	0.0216	0.0392	0.0448	0.0251	0.0226	0.0245	0.0244
Mean Abs. Dev.	0.0714	0.1090	0.0555	0.6069	0.3945	0.0700	0.0461	0.0255	0.0296	0.0584	0.0359	0.0293	0.0284
Mode	0.0245	0.0157	0.1308	0.0796	0.0576	0.0002	0.0007	0.0482	0.0009	0.0005	0.0144	0.0011	0.0243
Minimum	0.0198	0.0085	0.1274	0.0434	0.0332	0.0001	0.0001	0.0003	0.0004	0.0004	0.0001	0.0000	0.0000
Maximum	0.2094	0.2959	0.2622	1.4931	1.0068	0.4877	0.2192	0.1504	0.1896	0.5135	0.1982	0.1432	0.1383
Range	0.1896	0.2873	0.1348	1.4497	0.9736	0.4876	0.2191	0.1500	0.1893	0.5131	0.1981	0.1432	0.1383
Count	3.0000	3.0000	3.0000	3.0000	3.0000	15.0000	16.0000	16.0000	16.0000	26.0000	26.0000	26.0000	27.0000
Sum	0.3806	0.5161	0.5369	1.7481	1.2450	1.0606	0.8332	0.6866	0.7518	1.5516	1.1847	1.0475	1.0379
1st Quartile	0.0198	0.0085	0.1274	0.0434	0.0332	0.0017	0.0025	0.0092	0.0103	0.0080	0.0136	0.0143	0.0106
3rd Quartile	0.2094	0.2959	0.2622	1.4931	1.0068	0.0660	0.0564	0.0503	0.0619	0.0592	0.0537	0.0580	0.0571
Interquartile Range	0.1896	0.2873	0.1348	1.4497	0.9736	0.0643	0.0539	0.0411	0.0516	0.0511	0.0401	0.0437	0.0465
1.00%	0.0198	0.0085	0.1274	0.0434	0.0332	0.0001	0.0001	0.0003	0.0004	0.0004	0.0001	0.0000	0.0000
2.50%	0.0198	0.0085	0.1274	0.0434	0.0332	0.0001	0.0001	0.0003	0.0004	0.0004	0.0001	0.0000	0.0000
5.00%	0.0198	0.0085	0.1274	0.0434	0.0332	0.0001	0.0001	0.0003	0.0004	0.0005	0.0045	0.0012	0.0009
10.00%	0.0198	0.0085	0.1274	0.0434	0.0332	0.0002	0.0003	0.0008	0.0010	0.0005	0.0052	0.0020	0.0029
25.00%	0.0198	0.0085	0.1274	0.0434	0.0332	0.0017	0.0025	0.0092	0.0103	0.0080	0.0136	0.0143	0.0106
75.00%	0.2094	0.2959	0.2622	1.4931	1.0068	0.0660	0.0564	0.0503	0.0619	0.0592	0.0537	0.0580	0.0571
90.00%	0.2094	0.2959	0.2622	1.4931	1.0068	0.1775	0.1933	0.0932	0.0816	0.1250	0.1218	0.0870	0.0755
95.00%	0.2094	0.2959	0.2622	1.4931	1.0068	0.4877	0.2192	0.1504	0.1896	0.2329	0.1567	0.1360	0.1377
97.50%	0.2094	0.2959	0.2622	1.4931	1.0068	0.4877	0.2192	0.1504	0.1896	0.5135	0.1982	0.1432	0.1383
99.00%	0.2094	0.2959	0.2622	1.4931	1.0068	0.4877	0.2192	0.1504	0.1896	0.5135	0.1982	0.1432	0.1383

# of Locations per Percentile (Percentile consumption level and above)													
1.00%	3	3	3	3	3	15	16	16	16	26	26	26	27
2.50%	3	3	3	3	3	15	16	16	16	25	25	25	26
5.00%	3	3	3	3	3	14	15	15	15	25	25	25	26
10.00%	3	3	3	3	3	14	14	14	14	23	23	23	24
25.00%	2	2	2	2	2	11	12	12	12	20	20	20	20
75.00%	1	1	1	1	1	4	4	4	4	7	7	7	7
90.00%	0	0	0	0	0	2	2	2	2	3	3	3	3
95.00%	0	0	0	0	0	1	1	1	1	1	1	1	1
97.50%	0	0	0	0	0	0	0	0	0	1	1	1	1
99.00%	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix C
Single-family Residential and Multifamily Residential Population Estimates

Town of Cary GPCD

Person per household (pph)

	from 2000 Census	from 2010 Census
SFR	2.86	2.61
MFR	2.23	2.22

Single Family Residential

SF_{05} = SFR Accounts * pph

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2013	2014	2015	2016		
# of Service Locations		25,271	25,721	26,061	26,683	27,658	29,230	30,802	32,542	33,520		37,074	37,932	38,415	38,851		Service Location (LOCTID)
SFR Population		72,275	73,562	74,534	76,313	79,102	83,598	88,094	93,070	95,867		96,763	99,003	100,263	101,401		
																Average	
TOTAL GPD	SFR	5,131,069	5,497,963	4,768,770	5,209,703	5,427,252	5,371,053	6,206,655	5,362,723	5,622,910		5,513,030	5,643,013	5,778,855	5,779,100		
GPCD	SFR	71	75	64	68	69	64	70	58	59		57	57	58	57	66	
GPD/Account	SFR	203	214	183	195	196	184	202	165	168		149	149	150	149	190	

Multi Family Residential

MF_{05} = Total Population (Cary Planning Dept.) - SF_{05}

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2013	2014	2015	2016		
Total Population		99,798	103,260	106,715	108,152	108,846	115,854	122,643	130,716	135,955	136,590	144,982	149,859	153,868	157,259		Provided by Town of Cary
# of Service Locations		5,594	5,718	5,845	5,984	6,188	6,566	6,944	7,510	7,912		8,845	9,192	9,738	10,358		Service Location (LOCTID)
MFR Population		27,523	29,698	32,181	31,839	29,744	32,256	34,549	37,646	40,088	136,590	48,219	50,857	53,604	55,858		
MFR persons per location		4.92	5.19	5.51	5.32	4.81	4.91	4.98	5.01	5.07		5.45	5.53	5.50	5.39		
																Average	
TOTAL GPD	MFR	1,726,470	1,686,756	1,722,852	1,801,196	1,746,655	1,625,953	1,926,038	1,864,650	1,989,757		1,989,761	1,989,762	1,989,763	1,989,764		
GPCD	MFR	63	57	54	57	57	50	56	50	50		42	41	39	39	50	
GPD/Account	MFR	309	295	295	301	282	248	277	248	251		231	226	216	208	261	

Town of Morrisville GPCD

Person per household (pph)

SFR	2.43	2.43	2.86
MFR	1.96	2.18	2.34
	from 2000 Census	from 2010 Census	from 2015 Special Census

Single Family Residential

SF_{05} = SFR Accounts * pph

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2013	2014	2015	2016	
# of Service Locations	1,103	1,404	1,752	2,044	2,308	2,596	2,884	3,016	3,174		3,303	3,507	3,734	3,827	Service Location (LOCTID)
SFR Population	2,680	3,412	4,257	4,967	5,164	6,308	7,008	7,329	7,713		8,026	8,522	9,074	9,300	

Multi Family Residential

MF_{05} = Total Population (Morr. Planning Dept.) - SF_{05}

	2000 Census	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2013	2014	2015	2016	
Total Population	5,208	8,973	9,976	11,464	12,371	13,827	14,800	15,393	16,102	16,292	18,084	21,696	22,962	23,682	24,456	Provided by Town of Cary
# of Service Locations		1,505	1,677	1,925	2,049	2,104	2,116	2,016	2,073	2,203		2,841	2,916	2,998	3,118	Service Location (LOCTID)
MFR Population		6,293	6,564	7,207	7,404	7,488	8,492	8,385	8,773	8,579		13,670	14,440	14,608	15,156	
MFR persons per location		4.18	3.91	3.74	3.61	3.56	4.01	4.16	4.23	3.89		4.81	4.95	4.87	4.86	
																Average
TOTAL GPD	MFR	359,605	390,602	392,108	420,920	432,951	439,225	451,547	440,249	462,993		562,842	587,494	607,341	624,196	
GPCD	MFR	57	60	54	57	54	52	54	50	54		41	41	42	41	51
GPD/Account	MFR	239	233	204	205	206	208	224	212	210		198	201	203	200	211

Appendix D
Unit Factor Analysis

New SFR Account Unit Demand Assumptions

Note: Cary PPH = 2.61, Morrisville PPH = 2.43 (2010 US Census)

Average & Median values are for the monthly averages for the period of time from 2013-2016 for SFR residences constructed after 2010
5th and 95th percentile values were selected based on a full review of the Water Use Analysis data back to 2001

a **Indoor Unit Demand (GPD/Residence)**

	Average	Median (50th Perc.)	5th Percentile	95th Percentile
Cary	117	115	91	157
Morrisville	109	107	85	146
GPCD Check				
Cary & Morrisville	45	44	35	60

Unit Factor Assumption Basis:

Average & Median — based on the average GPCD for the population of SFR residences constructed after 2010 for the time period from 2013-2016

5th — 35 GPCD is current the most efficient indoor GPCD for a residential home, based on current technology

95th — based on the highest annual average indoor demand for SFR residences w/ a single meter for the time period from 2001-2009 (Source: 2010 Water Use Analysis)

b **Separately Metered Irrigation Unit Demand (GPD/Residence)**

	Average	Median (50th Perc.)	5th Percentile	95th Percentile
Cary	191	154	131	209
Morrisville	177	143	122	194
GPCD Check				
Cary & Morrisville	73	59	50	80

note: 59 GPCD was used for the 2013 LRWRP forecast

Unit Factor Assumption Basis:

Average & Median — based on the annual average GPCD for the population of SFR residences with a separately metered irrigation systems

5th — 50 GPCD is reflective of the irrigation demand for SFR residences w/ sep. meter IR constructed before 2010 for the time period from 2013-2016

95th — based on a review of the percentiles for separately metered irrigation for SFR residences constructed after 2010 for the time period from 2013-2016

c **% of New SFR accounts with a Seprate Irrigation Meter**

	Average	Median (50th Perc.)	5th Percentile	95th Percentile
Cary & Morrisville	13%	13%	5%	35%

Assumption Basis:

Average & Median — % separately metered irrigation accounts for SFR residence constructed after 2010 (as of 2016)

5th — Assumed minimum level of separately metered irrigation accounts

95th — based on the % for SFR residences with separately metered irrigation systems for homes constructed between 2001 and 2010, % used in 2013 LRWRP forecast (Source: 2010 Water Use Analysis)

d **Outdoor/Irrigation Demand (GPD/Residence)**

	Average	Median (50th Perc.)	5th Percentile	95th Percentile
Cary	10	8	0	26
Morrisville	10	7	0	24
GPCD Check				
Cary & Morrisville	4	3	0	10

Unit Factor Assumption Basis:

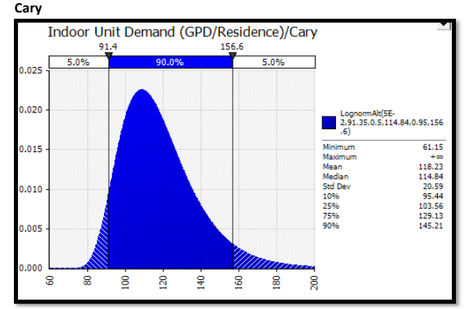
50th — based on the annual average outdoor demand for SFR residences w/ a single meter constructed after 2010 for the time period from 2013-2016

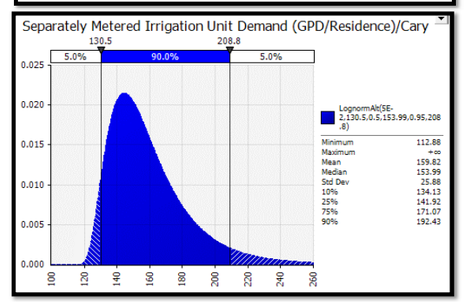
5th — Minimum irrigation level = 0

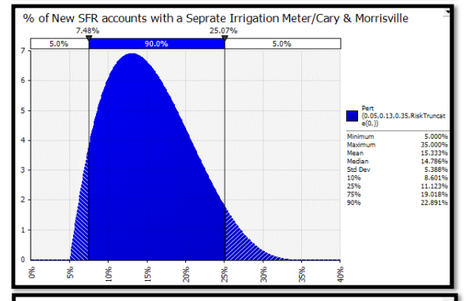
95th — based on the annual average outdoor demand for SFR residences w/ a single meter constructed after 2005 for the time period from 2001-2009 (Source: 2010 Water Use Analysis)

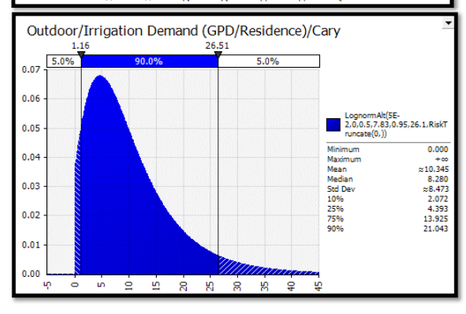
Probability Density Function

Cary

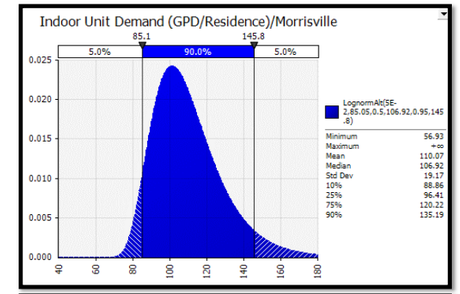


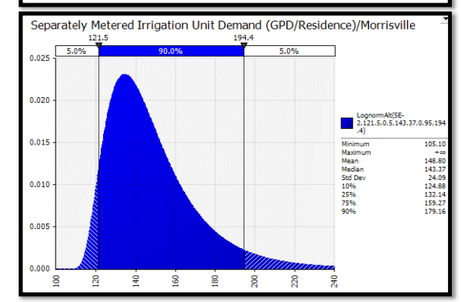


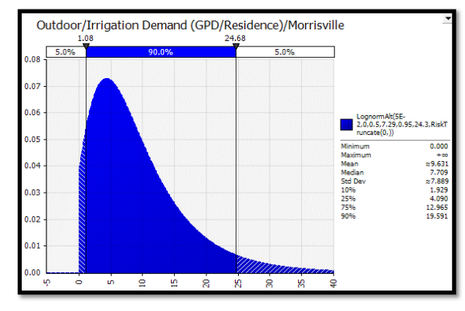




Morrisville







SFR Unit Demand (GPD/Residence)

Calculated as: New SFR GPCD = a + (b*c) + [d * (1-c)]

a = Indoor Unit Demand (GPD/Residence)

b = Separately Metered Irrigation Unit Demand (GPD/Residence)

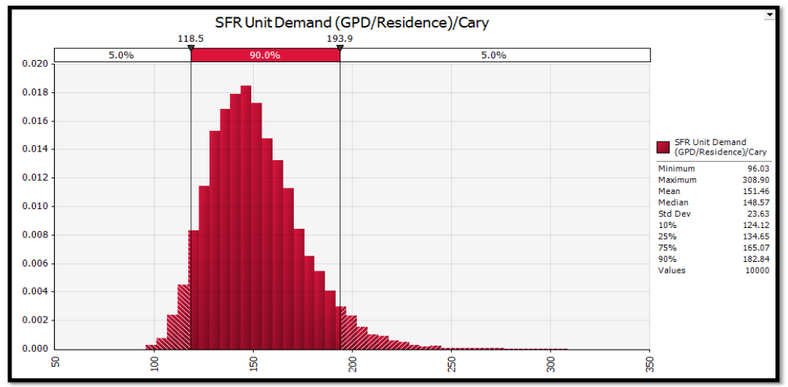
c = % of New SFR accounts with a Seprate Irrigation Meter

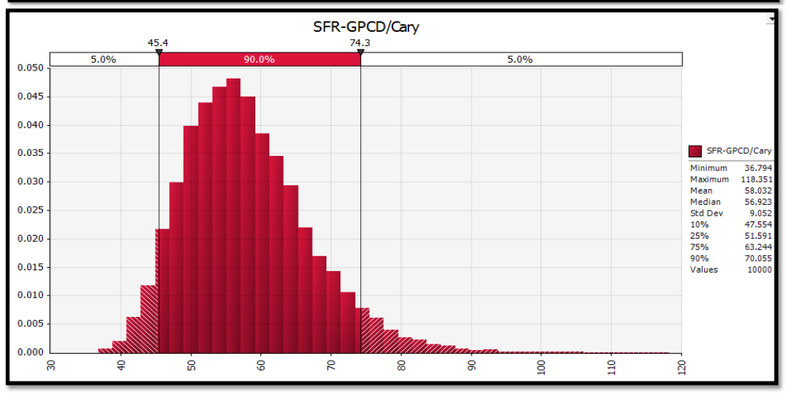
d = Outdoor/Irrigation Demand (GPD/Residence)

	Average	Median (50th Perc.)	5th Percentile	95th Percentile	
Cary	151	142	98	247	*for visual of overall unit demand*
Morrisville	141	132	91	230	*for visual of overall unit demand*
GPCD Check					
Cary	58	54	38	95	
Morrisville	58	54	38	95	

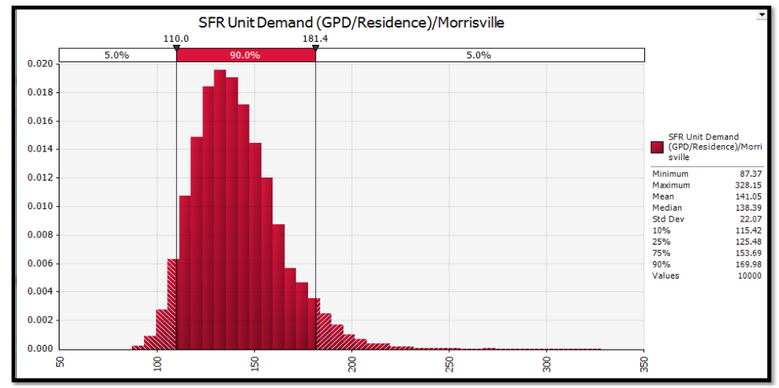
Output Distribution:

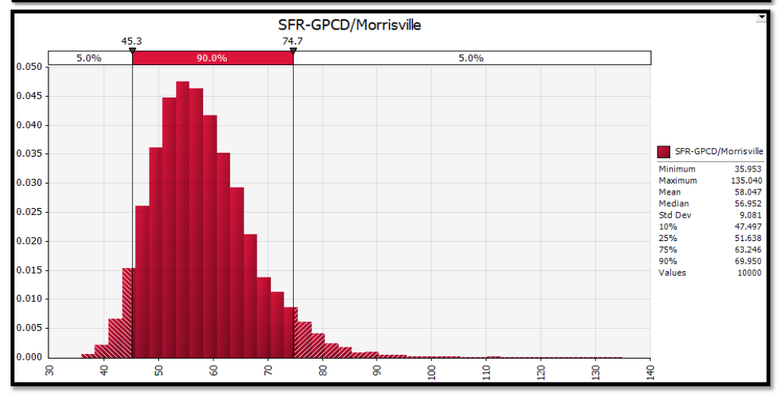
Cary





Morrisville





New MFR Account Unit Demand Assumptions

Average & Median values are for the monthly averages for the period of time from 2013-2016 for MFR accounts

5th and 95th percentile values were selected based on a full review of the Water Use Analysis data back to 2001

Note: Cary PPH = 2.22, Morrisville PPH = 2.18 (2010 US Census)

MFR Unit Demand (GPD/Unit)

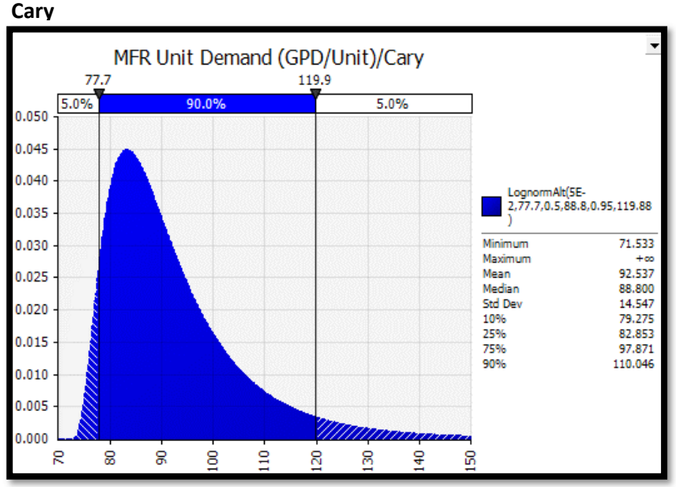
	Average	Median (50th Perc.)	5th Percentile	95th Percentile	Variable Value
Cary	89	38	78	120	
Morrisville	87	35	76	120	
GPCD Check					
Cary	40	17	35	54	
Morrisville	40	16	35	55	

Unit Factor Assumption Basis:

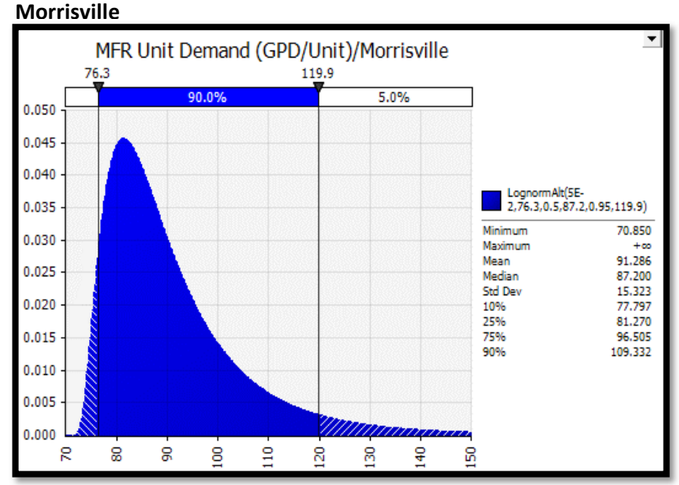
50th	based on the annual average demand for all MFR accounts for the time period from 2013-2016
5th	35 GPCD is current the most efficient indoor GPCD for a residential home, based on current technology
95th	based on the annual average demand for all MFR accounts for the time period from 2001-2009

Probability Density Function

Cary



Morrisville



New COM Account Unit Demand Assumptions

Average & Median values are for the monthly averages for the period of time from 2013-2016 for COM accounts

5th and 95th percentile values were selected based on a full review of the Water Use Analysis data back to 2001

COM Unit Demand (GPD/Square Foot)

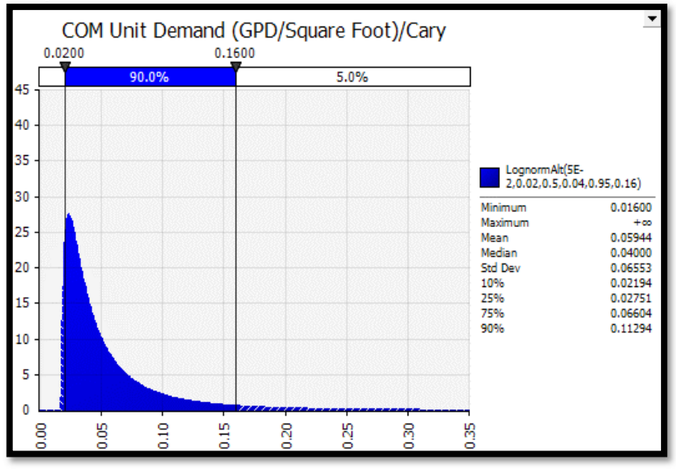
	Average	Median (50th Perc.)	5th Percentile	95th Percentile	Variable Value
Cary	0.12	0.04	0.020	0.16	
Morrisville	0.15	0.03	0.015	0.16	

Unit Factor Assumption Basis:

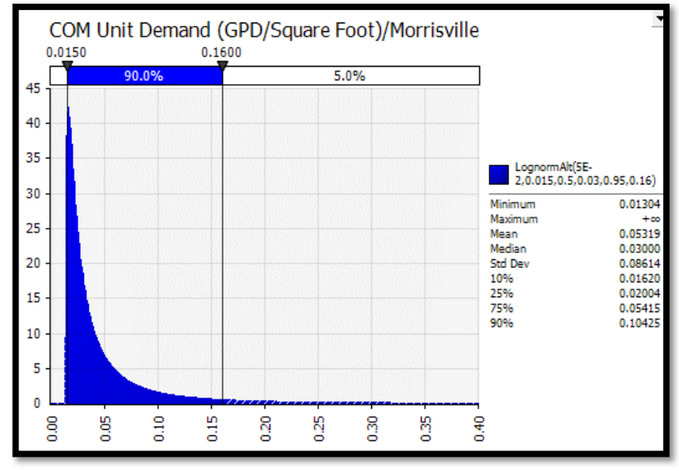
Average & Median	based on the annual average GPD/Square Foot for all COM accounts
5th	assumed no less than half the median value for 2013-2016
95th	based on the average for the 2001 to 2009 period, for Cary COM accounts

Probability Density Function

Cary



Morrisville



New IND Account Unit Demand Assumptions

Average & Median values are for the monthly averages for the period of time from 2013-2016 for IND accounts

5th and 95th percentile values were selected based on a full review of the Water Use Analysis data back to 2001

Unit Demand (GPD/Square Foot)

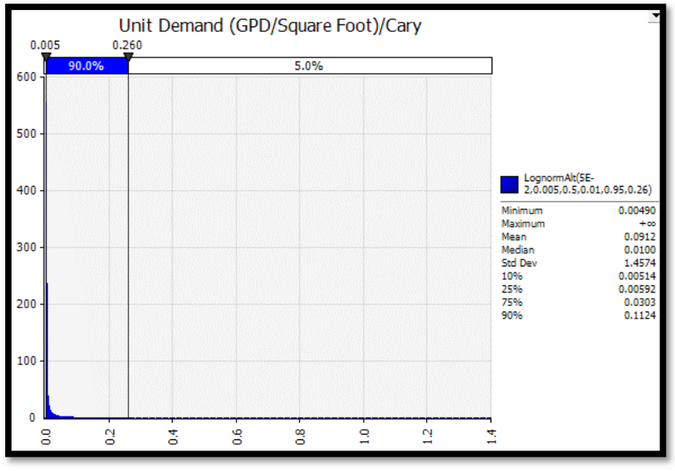
	Average	Median (50th Perc.)	5th Percentile	95th Percentile	Variable Value
Cary	0.27	0.01	0.005	0.26	
Morrisville	0.06	0.01	0.005	0.26	

Unit Factor Assumption Basis:

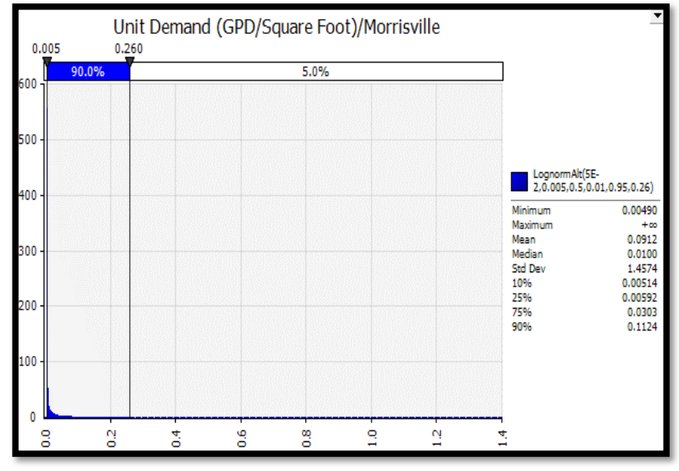
Average & Median	based on the annual average GPD/Square Foot for all IND accounts
5th	assumed no less than half the median value for 2013-2016
95th	based on the average for the 2001 to 2009 period, for Cary IND accounts

Probability Density Function

Cary



Morrisville



New INS Account Unit Demand Assumptions

Average & Median values are for the monthly averages for the period of time from 2013-2016 for INS accounts

5th and 95th percentile values were selected based on a full review of the Water Use Analysis data back to 2001

INS Unit Demand (GPD/Square Foot)

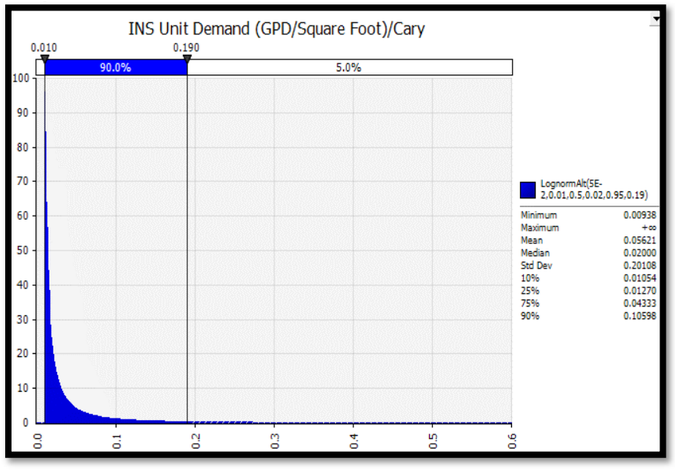
	Average	Median (50th Perc.)	5th Percentile	95th Percentile	Variable Value
Cary	0.11	0.02	0.01	0.19	
Morrisville	0.05	0.02	0.01	0.19	

Unit Factor Assumption Basis:

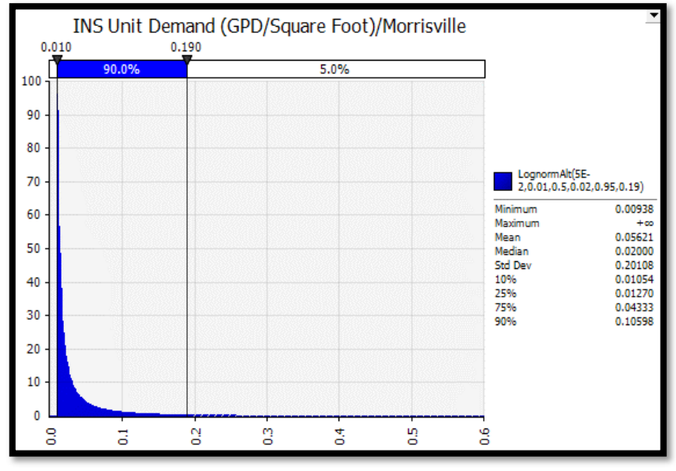
Average & Median	based on the annual average GPD/Square Foot for all INS accounts
5th	assumed no less than half the median value for 2013-2016
95th	based on the average for the 2001 to 2009 period, for Cary INS accounts (Morrisville 2001-2009 avg. is the same)

Probability Density Function

Cary



Morrisville



Appendix E
Wastewater System Profile Analysis

Table E1. Wastewater Flow Monitor Location Percent Returns for 2013-2016, and 2016 Max Month Peaking Factor

Site No.	Flow Monitor Location	Percent Return 2013	2014	2015	2016	4-year Average	2016 Max Month Peaking Factor
North Cary Water Reclamation Facility Sewer Basin							
1	Black Creek	98	114	113	115	**110**	**1.08**
3	Crabtree Creek	93	93	93	81	**90**	**1.24**
8	Carpenter	149	103	100	94	**111**	**1.15**
11	Upper Preston	126	118	124	120	**122**	**1.15**
12	Black Creek	152	144	140	131	**142**	**1.17**
13	Jenks Carpenter	12	153	140	138	**139**	**1.13**
16	Crabtree Creek	109	111	100	98	**104**	**1.14**
22	Indian Creek	61	68	81	104	**79**	**1.11**
23	York	126	96	94	100	**104**	**1.08**
24	Aviation Parkway	81	229	254	220	**196**	**1.16**
25	Brier Creek	133	146	142	127	**137**	**1.11**
27	Harrison Oaks	22	185	153	157	**179**	**1.14**
28	Medfield Road	101	87	152	198	**135**	**1.18**
South Cary Water Reclamation Facility Sewer Basin							
2	Lynn's Branch	203	130	136	126	**149**	**1.20**
4	Walnut Creek	136	120	157	158	**143**	**1.29**
5	MacDonald Woods	508	180	172	166	**256**	**1.21**
6	Upper Swift Creek	119	135	134	128	**129**	**1.15**
7	Upper Swift Creek	132	113	128	121	**124**	**1.23**
9	Lower Wyndfall	93	79	83	79	**84**	**1.07**
10	Long Branch	122	142	143	132	**135**	**1.21**
15	Camp Branch	134	121	110	116	**120**	**1.08**
17	Speight Branch	58	104	108	92	**90**	**1.19**
31	Lower Swift Creek	--	103	114	117	**111**	**1.11**
32	Lower Swift Creek	--	72	79	81	**77**	**1.09**
33	Lochmere	--	125	147	134	**136**	**1.19**
Western Wake Regional Water Reclamation Facility							
14	Panther Creek	349	216	122	130	**204**	**1.29**
18	Kit Creek	98	100	110	116	**106**	**1.04**
26	White Oak	115	115	112	120	**116**	**1.18**
29	Nancy Branch	141	110	117	123	**123**	**1.03**
30	Green Level	--	13	82	88	**61**	**1.03**
54	West Reedy Branch	--	--	89	93	**91**	**1.07**

Notes:

Max = maximum

No. = number