

SECTION 2

Water Demands

Water demands were developed for existing and future conditions based on parcel-level land use information and water meter billing data. CH2M HILL worked extensively with Town of Cary staff to develop the base parcel information and a demand projection methodology which can easily be replicated in the future. The demands are the basis for the system hydraulic modeling which is used to evaluate the capacity of the Town's distribution system to meet existing and future demands within its urban service area. The total future water system demand is comprised of the existing demand, projected future demand, and future non-revenue water and bulk water sales. This report section presents a detailed summary of the demand projection development methodology and the projections for the future planning periods. Appendix G contains additional information about some of the topics presented in this section.

2.1 Existing Demands

Existing water demands were determined using the 2007 water meter billing data provided by the Town of Cary. These data were assumed to be the base year characteristic for existing water customers of all use classifications. The total annual consumption by individual account was used to determine the average annual day demand for each account, which is defined as the base water demand. The base water demand for each account was assumed to represent the typical usage pattern of the existing water customer and that this consumption pattern would remain constant in future years.

2.2 Future Demand Projection Methodology

The future demand projections were developed on a parcel-level basis following a projection methodology developed with the Town. This methodology can be repeated to easily update demands in the future. The methodology is described below.

2.2.1 Identification of Parcels in Urban Service Area

The digital 2008 Wake County parcel data layer was acquired from the Wake County Geographic Information System (GIS) Services Department. Using the Town's urban service area boundary GIS data layer all parcels contained within the service area were identified for the demand analysis. These parcels included those within the jurisdiction of the Towns of Cary and Morrisville, RTP South, and the RDU International Airport. Future water demand projections were developed for these parcels.

2.2.2 Parcel Classification

Each individual parcel was assigned a classification in order to calculate its future demand. Multiple data sources were used to aid in the classification of the parcels; these sources are shown in Table 2-1.

TABLE 2-1
Parcel Classification Data Layers

Data	Source	Format
2008 Wake County parcels	Wake County GIS Department	ArcGIS Shapefile
2007 Customer water meter/billing data	Town of Cary IT Department	ArcGIS Shapefile
Existing and future land use	Town of Cary Planning Department	ArcGIS Shapefile
Urban service area boundary	Town of Cary Engineering Department	ArcGIS Shapefile
2008 Permitted Development information for service area	Town of Cary Engineering Department	ArcGIS Shapefile
2008 Planned Development information for service area	Town of Cary Engineering Department	ArcGIS Shapefile
Vacant/Open Space parcels	Town of Cary Planning Department	ArcGIS Shapefile
Parcels with an occupied structure, but not connected to the water system	Town of Cary Engineering Department	ArcGIS Shapefile
RTP South Development Plan	The Wooten Company, 2008	ArcGIS Shapefile

The data layers provided by the Town were based on an original parcel data set from 2005; this data was used as the basis for the update to the most recent parcel data published by the Wake County GIS Services Department in December 2008 (Wake County, 2008).

2.2.2.1 Water Service Connection Categories

Each parcel was assigned a water service connection category which identified parcels with an existing water service connection (i.e. existing water demand) or that will have a connection in the future. The four water service connection categories are: Existing, Developing Permitted, Developing Unpermitted, and Vacant. Individual parcels assigned to these categories were in many cases further assigned to a sub-category. The categories and sub-categories are shown in Table 2-2 and are described in Table 2-3.

TABLE 2-2
Water Service Connection Categories and Sub-Categories

Water Service Connection Category	Water Service Connection Sub-Category
Existing	Existing
Existing	Existing-Unoccupied
Existing	Existing-Redevelopment
Existing	Existing-Airport Redeveloped
Existing	Existing-Built without Service (BWOS)
Developing Permitted	Developing Permitted
Developing Unpermitted	Developing Unpermitted
Vacant	Vacant-Cary
Vacant	Vacant-Morrisville
Vacant	Vacant-RTP Future
Vacant	Vacant-Open Space
Vacant	Vacant-Unclassified

Each water service connection category was determined by using ArcGIS to spatially overlay digital GIS data layers provided by the Town, identified in Table 2-1, with the 2008 Wake County parcel data.

The water service connection categories and sub-categories were used to define how the parcel would develop and contribute to the future demands. Table 2-3 shows a description of each of the water service connection categories and the method used to determine the categories.

TABLE 2-3
 Water Service Connection Categories, Description, and Method of Determination

Water Service Connection Category	Description	Method of Determination (for 2008 Wake County Parcel data)
Existing	These parcels contained an existing water meter that had an average day demand in 2007 greater than zero.	Spatial join with the 2007 Customer meter/billing data
Existing-Unoccupied	These parcels contained an existing water meter that had an average day demand in 2007 of zero. It was assumed that these parcels contained a residence that was not yet occupied and future demands would need to be assigned.	Spatial join with the 2007 Customer meter/billing data.
Existing-Redevelopment	These parcels contained an existing water meter that had an average day demand in 2007 greater than zero and which were identified by the Town as having the potential for future redevelopment and subsequently would have additional demand in the future above the existing demand.	Spatial join with the 2007 Customer meter/billing data and the manual interpretation of existing connections with planned future flows in the 2008 Permitted Development, 2008 Planned Development and the RTP South Development Plan data layers.
Existing-Airport Redeveloped	This parcel is the RDU Airport, which had an existing 2007 meter demand. This parcel was identified separately to assign additional future flows to the airport for redevelopment/expansion potential.	Manual identification of the main RDU Airport parcel.
Existing-Built without Service (BWOS)	These parcels were identified to be within the developed areas of the Town's service area but currently do not have a connection to the water system. These include parcels that are currently served by an individual or community well.	Spatial overlay with a data layer that contained parcels that have a structure but no existing water meter.
Developing Permitted	Parcels that were identified by the Town as not having a water meter present in 2007 but that had an approved site plan and an issued sewer permit.	Spatial overlay with 2008 Permitted Development data layer.
Developing Unpermitted	Parcels that were identified by the Town to be within a planned development and not having a water meter present in 2007, but that had a submitted site plan which may or may not have been approved by the Town.	Spatial overlay with the 2008 Planned Development data layer.
Vacant-Cary	Parcels that were within the jurisdiction of Cary and are currently vacant with no known development plans.	Spatial overlay with Cary-Vacant data layer.
Vacant-Morrisville	Parcels that were within the jurisdiction of Morrisville and are currently vacant with no known development plans.	Spatial overlay with Morrisville-Vacant data layer.
Vacant-RTP Future	These parcels were identified as having a future demand within RTP South where no existing water meter was identified.	Spatial overlay with the RTP South Development Plan data layer.

TABLE 2-3
Water Service Connection Categories, Description, and Method of Determination

Water Service Connection Category	Description	Method of Determination (for 2008 Wake County Parcel data)
Vacant-Open Space	These parcels were identified by the Town as not ever having a water service connection.	Spatial overlay with the open space data layer, as well as additional non-developable land identified in the parcel data (i.e. common open space, etc).
Vacant-Unclassified	Parcels that did not fall into any of the Town defined future development areas were compiled into an unclassified category.	These parcels were those that remained after all spatial overlays were completed.

2.2.2.2 Customer Classification

To attribute demands to an individual customer type each parcel was assigned a generalized customer type classification which included single family residential, multi-family residential, commercial, mixed-use, industrial, institutional, or open space. For existing accounts the generalized use type was assigned based on the 2007 billing data. The developing parcels were classified based on the information provided by the Town for each permitted or planned development. The vacant parcels within the Town of Cary were classified based on the Town's future land use plan. Vacant parcels within the Town of Morrisville were classified using land use information provided as part of the Wake County Public School System Long Range School Plan (CAMPO, 2006). Built without Service and Unclassified parcels were classified using each Town's respective land use planning data paired with the NC Department of Revenue codes contained in the Wake County parcel data to fill any data gaps and verify land use codes.

2.2.2.3 Build-out Rates

The rate at which a parcel would develop in the future varies based on its water service connection category. The build-out rates that were used to determine how each parcel would develop in the future is shown in Table 2-4. These values were used to determine the timing and extent of the water demand for each individual parcel for each planning period. Parcels identified as Existing-Redevelopment currently have an existing water demand and based on future development plans approved by the Town these parcels will have increased demands based on additional future development. The Vacant-RTP Future build-out rates were determined by individually assigned future flows in the RTP South Development Plan. The timing of this demand varied based on each individual parcels' redevelopment plan.

TABLE 2-4
Water Service Connection Category Parcel Build-out Rates

Water Service Connection Category	2007	2010	2015	2025	Build-out
Existing	100%	100%	100%	100%	100%
Existing-Unoccupied	0	100%	100%	100%	100%
Existing-Redevelopment ^a	100%	100%	100%	100%	100%
Existing-Airport Redeveloped	0%	100%	100%	100%	100%
Existing-Built without Service	0	0	10%	20%	100%
Developing Permitted	0	60%	100%	100%	100%
Developing Unpermitted	0	20%	100%	100%	100%
Vacant-Cary	0	6%	16%	36%	100%
Vacant-Morrisville	0	6%	16%	36%	100%
Vacant-RTP Future ^b	0	--	--	--	--
Vacant-Open Space	0	0	0	0	0
Vacant-Unclassified	0	6	16%	36%	100%

^a Existing-Redevelopment parcels currently have existing water demand, but based on redevelopment plans approved by the Town these parcels have additional future demands.

^b Vacant-RTP Future build-out rates were determined by individually assigned future flows in the RTP South Development Plan digital data layer.

2.2.3 Water Demand Unit Factors

Tables 2-5 and 2-6 identify the water demand unit factors, by customer classification, for Cary and Morrisville individually. These unit factors include both domestic indoor usage and outdoor irrigation usage, and are used to calculate the water demands.

The industrial/commercial/institutional (ICI) water demand unit factor of 0.1 gallons per day (gpd) per square foot of building space is the value used by the Town's Engineering Department for permitting sewer capacity for development projects within the Town's portion of the service area. An analysis of the 2007 ICI water meter demands per square foot of heated area, as identified in the 2008 Wake County parcel data, indicated that a water demand unit factor of 0.08 gpd/square foot most accurately represented the overall 2007 ICI demand for the Town. It was decided with the Town that the use of 0.1 gpd/square foot was the appropriate water demand unit factor for the ICI water demand analysis and would also assist in maintaining consistency between water and wastewater demand projection efforts. Although there are individual water demand unit factors for commercial (COM), industrial (IND) and institutional (INS) as shown in Table 2-5, the Town elected to use the ICI water demand unit factor for these classifications.

TABLE 2-5
Town of Cary Water Demand Unit Factors

Customer Classification and Abbreviation	Water Demand Unit Factor ^a	Data Source
Single Family Residential (SFR)	312 gpd/unit ^b	Town of Cary IWRMP (CH2M HILL, 2007)
Multi-Family Residential (MFR)	127 gpd/unit ^b	Town of Cary IWRMP (CH2M HILL, 2007)
Industrial/Commercial/ Institutional (ICI)	0.1 gpd/square foot of building	Town of Cary Engineering Department
Commercial (COM)	1740 gpd/acre	Town of Cary IWRMP (CH2M HILL, 2007)
Industrial (IND)	72 gpd/acre	Town of Cary IWRMP (CH2M HILL, 2007)
Institutional (INS)	34 gpd/acre	Town of Cary IWRMP (CH2M HILL, 2007)
Open Space (OS)	0 gpd/acre	No open space demand factors

^a Water demand unit factors include both domestic and outdoor usage.

^b Unit factors calculated based on the IWRMP (2007) reported gallons per capita day multiplied by the 2000 US Census person per household value.

TABLE 2-6
Town of Morrisville Water Demand Unit Factors

Customer Classification and Abbreviation	Water Demand Unit Factor ^a	Data Source
Single Family Residential (SFR)	265 gpd/unit ^b	Town of Cary IWRMP (CH2M HILL, 2007)
Multi-Family Residential (MFR)	106 gpd/unit ^b	Town of Cary IWRMP (CH2M HILL, 2007)
Commercial (COM)	436 gpd/acre	Town of Cary IWRMP (CH2M HILL, 2007)
Industrial (IND)	166 gpd/acre	Town of Cary IWRMP (CH2M HILL, 2007)
Institutional (INS)	6 gpd/acre	Town of Cary IWRMP (CH2M HILL, 2007)
Open Space (OS)	0 gpd/acre	No open space demand factors

^a Water demand unit factors include both domestic and outdoor usage.

^b Unit factors calculated based on the IWRMP (2007) reported gallons per capita day multiplied by the 2000 US Census person per household value.

2.3 Future Average Day Demands

The future demands were calculated using different methods dependent upon the water service connection category for an individual parcel. The calculation method for each water service connection category is described in the following sections.

2.3.1 Existing

Parcels within the Existing water service connection category were assigned to the sub-categories of Existing, Existing-Unoccupied, Existing-Redevelopment, Existing-Airport or

Existing-Built without Service as defined in Table 2-3. The Existing, Existing-Unoccupied, Existing-Redevelopment, and Existing-Airport Redeveloped sub-categories were determined to have an existing connection to the Town's water system. The Existing-Built without Service sub-category contains parcels that had an existing structure but which were not currently connected to the Town's water system.

2.3.1.1 Existing

Parcels identified as Existing were those that currently had an existing water meter with demands greater than zero gpd in 2007. The water demand for these parcels was obtained from the 2007 water meter data provided by the Town, as outlined in Section 2.1. These parcels were not included in any future demand calculations but were identified in the future parcel data set to isolate them from those parcels that had the potential for future development.

2.3.1.2 Existing-Unoccupied

Existing-Unoccupied parcels contained a structure and had an existing water meter but had demands of zero gpd in 2007. It was assumed that although these parcels were unoccupied in 2007 they would have future demands greater than zero gpd. Many of the Existing-Unoccupied parcels were identified within the Town's Permitted and Unpermitted Development data layers and these parcels were deducted from the development totals in each of those water service connection categories.

Existing-Unoccupied parcels were predominantly individual, subdivided single family residential parcels. Each of these parcels was assigned an appropriate unit demand factor. For parcels that were either multi-family residential or commercial the demand calculation was based on data from the 2008 Wake County parcel data, including the number of structures, number of units, deed acres and heated area. The calculation formulas for the Existing-Unoccupied parcels were the same as those used for the Existing-Built without Service parcels, described in Section 2.3.1.5. After the future demand was calculated for each parcel, the rate of demand accumulation was applied based on the build-out rates in Table 2-4.

2.3.1.3 Existing-Redevelopment

Existing-Redevelopment parcels had an existing water meter with demands greater than zero gpd in 2007 and were identified as having the potential for future redevelopment. Future redevelopment of these parcels would create an additional demand in the future and they were identified in either the RTP South Development Plan or the Town's Permitted Development layer.

For existing RTP South parcels, the future parcel demand values from the RTP South Development Plan were used to assign future demands. The rate of demand accumulation into the future was also identified in the RTP South Development Plan.

For those parcels located outside of RTP South, the future development of the parcel was identified within the Permitted Development data layer. The development numbers contained in that data layer were used and the demand calculation followed the same procedure as that for the Developing Permitted parcels described in Section 2.3.2.

2.3.1.4 Existing-Airport Redeveloped

The water service connection category of Existing-Airport Redeveloped was assigned to the RDU Airport. In 2007, the RDU Airport had a demand of approximately 195,000 gpd and in previous Town planning documents it had been estimated that the airport water demand would increase to 400,000 gpd (CH2M HILL, 2007). Therefore, the RDU Airport was assigned an additional flow of 205,000 gpd starting in 2010.

2.3.1.5 Existing-Built without Service

Existing-Built without Service parcels contained an existing structure but no existing metered connection to the Town's water system. The water sources for a majority of these parcels are individual or community groundwater wells. The water demand for these parcels was calculated as if they were to connect to the water system as is; these parcels were not considered for any redevelopment. The demand calculations were based on the 2008 Wake County parcel data, including number of structures, number of units, deed acres and heated area.

Based on the customer classification, as identified in Tables 2-5 and 2-6, assigned to each Existing-Built without Service parcel, the water demands were calculated as follows:

Single Family Residential (SFR)

$$\text{Demand}_{\text{SFR}} = \text{Number of Structures} * \text{gpd/unit}$$

The SFR gpd/unit values are shown in Tables 2-5 and 2-6.

Multi-Family Residential (MFR)

$$\text{Demand}_{\text{MFR}} = \text{Number of Units} * \text{gpd/unit}$$

The MFR gpd/unit values are shown in Tables 2-5 and 2-6.

Commercial (COM)

$$\text{For Cary only, Demand}_{\text{COM}} = \text{Heated Area} * \text{ICI gpd/square foot}$$

If no heated area data were available in the parcel data, or the parcel was located in Morrisville,

$$\text{Demand}_{\text{COM}} = \text{Deed Acres} * \text{COM gpd/acre}$$

The ICI gpd/square foot and the COM gpd/acre values are shown in Tables 2-5 and 2-6.

Industrial (IND)

$$\text{For Cary only, Demand}_{\text{IND}} = \text{Heated Area} * \text{ICI gpd/square foot}$$

If no heated parcel data were available in the parcel data, or the parcel was located in Morrisville,

$$\text{Demand}_{\text{IND}} = \text{Deed Acres} * \text{IND gpd/acre}$$

The IND gpd/acre values are shown in Tables 2-5 and 2-6.

Institutional (INS)

For Cary only, $\text{Demand}_{\text{INS}} = \text{Heated Area} * \text{ICI gpd/square foot}$

If no heated area data were available in the parcel data, or the parcel was located in Morrisville,

$\text{Demand}_{\text{INS}} = \text{Deed Acres} * \text{INS gpd/acre}$

The INS gpd/acre values are shown in Tables 2-5 and 2-6.

After the future demand was calculated for each parcel, the rate of demand accumulation was determined by the build-out rates as shown in Table 2-4.

2.3.2 Developing Permitted

Developing Permitted parcels are those 2008 Wake County parcels that were identified to be within the Town-provided Permitted Development data layer without a water meter present in 2007. The Town provided a Permitted Development data layer that was based upon approved site plans with sewer permits that have been issued. This layer was generated based on the 2005 Wake County parcel data; this data layer contained a total of 181 “parent” parcels (the terminology “parent” parcel is used in this report to differentiate between the 2005 parcels and the subdivided 2008 parcels identified within the 181 parcels). Using the 2008 parcel data, it was evident that the 181 “parent” parcels had been subdivided into a total of 7,998 smaller parcels. Therefore, many of the parcels within the Town-provided Permitted Development layer were a mixture of Existing, Existing-Unoccupied, and Developing Permitted parcels. The mixture of parcels with different water service connection categories were taken into account in calculating the parcel demands.

The Town-provided Permitted Development data layer included a permitted development project number, permitted development project name, sewer and water permit numbers, number of permitted single family lots, number of permitted multi-family units, and amount of permitted commercial square footage.

The water demand for the 2008 parcels within the Permitted Development data layer was calculated as described below. The unit demand factors referenced are shown in Tables 2-5 and 2-6 depending on the location of the parcel in either Cary or Morrisville. The rate of demand accumulation through the planning periods was determined by the build-out rates as shown in Table 2-4.

2.3.2.1 Unsubdivided Parcels

If a parcel within the Permitted Development data layer was identified to not have been subdivided in the 2008 parcel data (i.e. the 2005 parcel and 2008 parcel showed the same acreage), the following procedure was followed to calculate the demands:

- The number of single family lots, multi-family units, or commercial square footage for the permitted development was used as the basis for the demand calculation. This information was obtained from the site plan for each permitted development and was considered the most accurate source of data available to determine the realistic development for that parcel. Demands were calculated by multiplying the development

numbers (lots, units, square footage) by the appropriate unit demand factors, and the rate of demand accumulation through the planning periods was also applied.

2.3.2.2 Subdivided Parcels

Those parcels within the Permitted Development data layer that were identified to have been subdivided – represented by the presence of subdivided lots smaller than the “parent” parcel and including Existing, Existing-Unoccupied or Developing Permitted parcels – the following procedure was used to calculate demand for the Developing Permitted parcels:

- Parcels that had been subdivided into single family residential lots were assigned the appropriate water demand unit factor and the rate of demand accumulation through the planning periods was also applied.
- Commercial or multi-family residential parcels typically did not subdivide in the same manner as single family residential parcels. To calculate the water demand for these parcels, open space area was excluded and then the permitted development site plan information was divided based on the remaining land area of the developable parcels. The appropriate water demand unit factor was applied according to the site plan information (commercial or multi-family). The rate of demand accumulation through the planning periods was also applied.
- If a “parent” parcel within the Permitted Development data layer had only been partially subdivided, the development site plan information in the data layer was used to determine the number of lots, units, or square feet had been permitted for the entire development. These values were then subtracted from the values represented in the 2008 parcel data. For example, if a development within the permitted development data layer was permitted for 100 lots and 2008 parcel data showed that 50 lots had already been subdivided, then the remainder of the “parent” parcel still had the potential to develop into 50 more lots. Therefore the remaining portion of the “parent” parcel would be assigned a flow of 50 times the appropriate unit demand factors. Water demand for the already subdivided lots was calculated as described above in Section 2.3.2.1. The rate of demand accumulation through the planning periods was also applied.

2.3.3 Developing Unpermitted

Developing Unpermitted parcels are those parcels that were identified to be within the Town-provided planned development data layer without a water meter present in 2007. The planned development data layer represents developments with a submitted site plan that may or may not have been approved by the Town. Similar to the Developing Permitted parcels, within the planned development parcel there were both Existing and Existing-Unoccupied parcels.

The demand calculation for the Developing Unpermitted parcels followed the same procedure as that for the Developing Permitted parcels described in Section 2.3.2. The unit demand factors referenced are shown in Tables 2-5 and 2-6 depending on the location of the parcel in either Cary or Morrisville. The rate of demand accumulation through the planning periods was determined by the build-out rates as shown in Table 2-4.

2.3.4 Vacant

Vacant parcels are those parcels that were identified as currently undeveloped, with or without the potential to develop in the future. Those with the potential to develop in the future are in the categories of Vacant-Cary, Vacant-Morrisville, and Vacant-RTP Future. The Vacant-Open Space parcels will not develop in the future. The Vacant-Unclassified parcels were included in this category because these parcels were outside of all of the overlays provided by the Town, and it was agreed with the Town that these parcels would be categorized as Vacant for the purpose of calculating water demands.

2.3.4.1 Vacant-Cary

Vacant-Cary parcels are those parcels within the Town's jurisdiction that were in the Town-provided Vacant Parcels data layer. Each of these parcels was identified with a future land use code and designation in the Town's 2003 Land Use Plan (Town of Cary, 2003) which are shown in Table 2-7. The land use designation was then correlated with the appropriate development density factor also shown in Table 2-7.

TABLE 2-7
Town of Cary Land Use Codes, Development Density Factors, and Customer Classification Assignment

Land Use Code	Land Use Designation	Development Density Factor	Customer Classification Assignment ^a
AGR/FOR	Agriculture/Forestry	Not Applicable	Not Applicable
CB&R	Cottage Business and Residential	4 dwelling units/acre	100% SFR
CLI	Commercial - Light Industrial	10,000 square feet/acre	100% COM
COM	Commercial	10,000 square feet/acre	100% COM
HDR	High-Density Residential	12 dwelling units/acre	100% MFR
HDR Mid-Rise	High-Density Mid-Rise	35 dwelling units/acre	100% MFR
HMXD	High-Density Mixed-Use Development	30 dwelling units/acre & 30,000 square feet/acre	33% MFR/67% COM
INS	Institutional	2,500 square feet/acre	100% INS
IND	Industrial	10,000 square feet/acre	100% IND
LAK	Lake	Not Applicable	Not Applicable
LDR	Low-Density Residential	1 dwelling unit/acre	100% SFR
MDR	Medium-Density Residential	5.13 dwelling units/acre	100% SFR
MXD	Mixed Use	5.13 dwelling units/acre & 8,000 square feet/acre	33% SFR/67% COM
MXDR	Mixed-Use Residential	15 dwelling units/acre	100% MFR
OFC/IND	Office - Industrial	10,000 square feet/acre	100% COM
OFC/INS	Office - Institutional	10,000 square feet/acre	100% COM
PKS	Parkland	Not Applicable	100% OS
RDR	Rural Residential	0.475 dwelling units/acre	100% SFR
TRANS_OFC	Transportation - Office	10,000 square feet/acre	100% COM
ULDR	Ultra Low Density Residential	0.475 dwelling units/acre	100% SFR
UTL	Utility	Not Applicable	Not Applicable
VLDR	Very Low Density Residential	0.475 dwelling units/acre	100% SFR

^a Customer Classification Abbreviations defined in Table 2-5

For each vacant parcel, demands were calculated using the acreage of the parcel, the land use designation and percentage of the parcel planned for that land use, the appropriate land use development density factor shown in Table 2-7 and the appropriate water demand unit factor shown in Table 2-5. As described in Section 2.2.3, the ICI water demand unit factor was used for the COM, IND, and INS classifications. Future demands, based on customer classification assignment, were calculated for each parcel as follows:

Single Family Residential (SFR)

$\text{Demand}_{\text{SFR}} = \text{Deed acres} * \text{Percent Single Family Residential} * \text{Land use development density factor} * \text{SFR gpd/unit}$

The SFR gpd/unit value is shown in Table 2-5.

Multi-Family Residential (MFR)

$\text{Demand}_{\text{MFR}} = \text{Deed acres} * \text{Percent Multi-Family Residential} * \text{Land use development density factor} * \text{MFR gpd/unit}$

The MFR gpd/unit value is shown in Table 2-5.

Commercial (COM)

$\text{Demand}_{\text{COM}} = \text{Deed acres} * \text{Percent Commercial} * \text{Land use development density factor} * \text{ICI gpd/square foot}$

The ICI gpd/square foot value is shown in Table 2-5.

Mixed Use

$\text{Demand}_{\text{MIX}} = (\text{Deed acres} * \text{Percent Commercial} * \text{Land use development density factor} * \text{ICI gpd/square foot}) + (\text{Deed acres} * \text{Percent Single Family Residential} * \text{Land use development density factor} * \text{SFR gpd/unit})$

The ICI gpd/square foot and SFR gpd/unit values are shown in Table 2-5.

For a mixed use parcel with multi-family residential development rather than single family residential, the multi-family residential factors would be used in place of the single family factors shown in the equation above.

Industrial (IND)

$\text{Demand}_{\text{IND}} = \text{Deed acres} * \text{Percent Industrial} * \text{Land use development density factor} * \text{ICI gpd/square foot}$

The ICI gpd/square foot value is shown in Table 2-5.

Institutional (INS)

$\text{Demand}_{\text{INS}} = \text{Deed acres} * \text{Percent Institutional} * \text{Land use development density factor} * \text{ICI gpd/square foot}$

The ICI gpd/square foot value is shown in Table 2-5.

After the future demand was calculated for each parcel, the rate of demand accumulation was determined by the build-out rates as shown in Table 2-4.

2.3.4.2 Vacant–Morrisville

Vacant-Morrisville parcels are those parcels within Morrisville’s jurisdiction that were within the Town-provided vacant parcels data layer. Each of these parcels was identified with a future land use code and designation that was consistent with the codes and designations used in the Town of Cary’s 2003 Land Use Plan which are shown in Table 2-8.

Each of these parcels was identified with a future land use code and designation in the Town’s 2003 Land Use Plan (Town of Cary, 2003) which are shown in Table 2-7. The associated development density factors for each parcel were taken from information provided by the Town of Morrisville’s Planning Department for the Wake County Public Schools Long-Range School Plan [Capital Area Metropolitan Planning Organization (CAMPO), 2006]. The land use designations and the associated development density factors are shown in Table 2-8.

TABLE 2-8

Town of Morrisville Land Use Codes (consistent with Town of Cary Land Use Codes), Development Density Factors, and Customer Classification Assignment

Land Use Code	Land Use Designation	Development Density Factor	Customer Classification Assignment ^a
COM	Commercial	No Density Factor	100% COM
HDR	High-Density Residential	12 dwelling units/acre	100% MFR
IND	Industrial	No Density Factor	100% IND
INS	Institutional	No Density Factor	100% INS
LDR	Low-Density Residential	1.5 dwelling units/acre	100% SFR
MDR	Medium-Density Residential	6 dwelling units/acre	100% SFR
RDR	Rural Residential	0.25 dwelling units/acre	100% SFR
VLDR	Very Low Density Residential	0.75 dwelling units/acre	100% SFR

^a Customer Classification Abbreviations defined in Table 2-6

For each vacant parcel, demands were calculated using the acreage of the parcel, the land use designation and percentage of the parcel planned for that land use, the appropriate land use development density factor shown in Table 2-8 and the appropriate water demand unit factors shown in Table 2-6. Future demands, based on customer classification assignment, were calculated for each parcel as follows:

Single Family Residential (SFR)

$$\text{Demand}_{\text{SFR}} = \text{Deed acres} * \text{Percent Single Family Residential} * \text{Land use development density factor} * \text{SFR gpd/unit}$$

The SFR gpd/unit value is shown in Table 2-6.

Multi-Family Residential (MFR)

$$\text{Demand}_{\text{MFR}} = \text{Deed acres} * \text{Percent Multi-Family Residential} * \text{Land use development density factor} * \text{MFR gpd/unit}$$

The MFR gpd/unit value is shown in Table 2-6.

Commercial (COM)

$\text{Demand}_{\text{COM}} = \text{Deed acres} * \text{COM gpd/acre.}$

The COM gpd/acre value is shown in Table 2-6.

Industrial (IND)

$\text{Demand}_{\text{IND}} = \text{Deed acres} * \text{IND gpd/acre.}$

The IND gpd/acre value is shown in Table 2-6.

Institutional (INS)

$\text{Demand}_{\text{INS}} = \text{Deed acres} * \text{INS gpd/acre.}$

The INS gpd/acre value is shown in Table 2-6.

After the future demand was calculated for each parcel, the rate of demand accumulation was determined by the build-out rates as shown in Table 2-4.

2.3.4.3 Vacant-RTP Future

Vacant-RTP Future parcels were identified as those parcels within the RTP South Development Plan area data layer without an existing water meter. Information from the RTP South Development Plan was used to assign the future flows for these parcels as well as the rate of demand accumulation into the future.

2.3.4.4 Vacant-Open Space

No future flows were assigned to these parcels. The parcels will remain undeveloped into the future and will not ever have a water service connection.

2.3.4.5 Vacant-Unclassified

The Town's future land use plan was used to identify the planned land use for each individual Vacant-Unclassified parcel. These parcels were assigned future flows following the same calculation method as that for the Vacant parcels, and the rate of demand accumulation was determined by the build-out rates as shown in Table 2-4.

2.4 Future Maximum Day Demands

Based on discussions with the Town of Cary staff, a peaking factor of 1.64 was selected for use in this Master Plan to calculate the maximum day demand (MDD) as a function of annual average day demand (ADD).

This peaking factor is the value that the Town uses for its interbasin transfer reporting to the State of North Carolina and is near the average of the actual maximum day peaking factors for 1997 through 2007, shown in Table 2-9. The period from 2003 to 2007 shows a greater difference between the actual peaking factor and the selected peaking factor than during the period from 1997 to 2002. Yearly deviations from the selected peaking factor of 1.64 appear to be relatively consistent over time and it is assumed that this trend will continue through the defined planning periods.

TABLE 2-9

Town of Cary Maximum Day Water Demand (including Morrisville, RTP South. and RDU Airport)

Year	Annual Average Day Use (mgd)	Maximum Day Water Use (mgd)	Peaking Factor Ratio
1997	10.08	16.77	1.66
1998	10.31	16.96	1.65
1999	10.38	18.39	1.77
2000	11.06	18.14	1.64
2001	12.02	18.91	1.57
2002	12.38	20.99	1.70
2003	11.51	15.93	1.38
2004	12.25	22.21	1.81
2005	12.76	18.40	1.44
2006	12.90	20.00	1.55
2007	14.84	23.21	1.56
11-year Average Peaking Factor			1.61

Data Source: Town of Cary finished water pumping data

2.5 Non-Revenue Water

Non-revenue water represents the portion of finished water produced that is not billed. This typically includes meter errors, water lost to system leaks, hydrant flushing, fire flow and in-facility uses. It is necessary to add non-revenue water estimates to the projected demands to determine the total system demand.

Non-revenue water was calculated as 9 percent of the system demand for the Town's service area in 2007 as summarized in Table 2-10. The Town's historic non-revenue water percentage has ranged from 3 to 6 percent (CH2M HILL, 2007) while other utilities that are of similar size and age exhibit non-revenue water percentages of up to 10 percent. Morrisville's non-revenue water percentage has historically ranged from 9 to 16 percent (CH2M HILL, 2007). In 2006, the Town of Morrisville merged its system with the Town of Cary's system and the previously existing sub-metering of the Morrisville system was removed. As a result, the non-revenue water is now determined for the entire combined system. Based on the historically high percentage of Morrisville's non-revenue water, it is assumed that the 2007 non-revenue percentage of 9 percent determined for the Town of Cary's service area was reasonable to maintain through the planning periods.

The non-revenue factor was calculated based on the system's billed demand instead of the system's supply because the projected demands are calculated for the service area represent the projected billed consumption (or billed demand) and does not include non-revenue

water. The non-revenue water is added to the projected demands to determine the total system demand.

TABLE 2-10
Town of Cary 2007 Non-Revenue Water Summary (in million gallons)

	2007
Water Produced	6,714
Water Purchased	3
Total Water System Supply	6,717
Apex Usage	1,112
Cary Sales to Durham	181
Total Cary Service Area Supply	5,424
Cary Retail Sales	4,692
Cary Bulk Sales & RDU Airport	297
Total System Demand	4,989
Non-Revenue Water	435
% Non-Revenue Water (% of system demand)	9%

Information provided by the Town of Cary from its American Water Works Association (AWWA) water audits for fiscal years 2003 through 2008, excluding 2007, demonstrates that the average non-revenue water percentage is 8.9%. This includes unbilled authorized consumption, unauthorized consumption, meter inaccuracy and leakage. More details about these calculations are included in Appendix G.

Because the AWWA water audit value for non-revenue water is essentially the same as the value calculated above, the value of 9% for non-revenue water is used in this Master Plan.

2.6 Bulk Water Sales

Bulk water sales primarily include water sales for construction activities through hydrant meters. In 2007 the bulk water sales within the Town's system was approximately 500,000 gpd, and it was assumed that this demand would continue through the planning periods.

2.7 Water Demand Projections through Build-out

The ADD and MDD for existing conditions and for the defined planning periods were calculated using the methodologies described above and are summarized in this section. The year 2007 represents existing conditions.

2.7.1 Annual Average Day Demand

The ADD by pressure zone is summarized in Table 2-11. Table 2-12 and Table 2-13 show a summary of the ADD by customer type and water service connection category, respectively.

TABLE 2-11
Town of Cary Average Day Water Demand by Pressure Zone (units in mgd)

Pressure Zone	2007	2010	2015	2025	Build-out
Central	8.7	10.1	11.3	12.0	14.7
Southern	1.9	2.2	2.5	2.8	4.0
Western	2.9	5.2	7.4	8.3	10.2
Non-Revenue Water (9%)	1.2	1.6	1.9	2.1	2.6
Total Demand	14.7	19.1	23.1	25.1	31.5

Note: Numbers may not add exactly due to rounding.

TABLE 2-12
Town of Cary Average Day Water Demand by Customer Type (units in mgd)

Customer Type	2007	2010	2015	2025	Build-out
Single Family Residential	6.6	8.9	10.8	11.5	14.7
Multi-Family Residential	2.2	2.6	2.8	2.9	3.0
Commercial	3.5	4.7	5.9	6.7	8.5
Mixed Use	0.0	0.2	0.6	0.8	1.3
Industrial	0.3	0.3	0.4	0.4	0.5
Institutional	0.2	0.3	0.3	0.3	0.3
Bulk Water Sales	0.5	0.5	0.5	0.5	0.5
Non-Revenue Water (9%)	1.2	1.6	1.9	2.1	2.6
Total Demand	14.7	19.1	23.1	25.1	31.5

Note: Numbers may not add exactly due to rounding.

TABLE 2-13
Town of Cary Average Day Water Demand by Water Service Connection Category (units in mgd)

Water Service Connection	2007	2010	2015	2025	Build-out
Existing	12.9	12.9	12.9	12.9	12.9
Existing-Unoccupied	0.0	1.0	1.0	1.0	1.0
Existing-Redevelopment	0.0	0.2	0.5	0.7	0.8
Existing-Airport Redeveloped	0.0	0.2	0.2	0.2	0.2
Existing-Built without Service	0.0	0.0	0.2	0.4	2.1
Developing Permitted	0.0	1.7	2.9	2.9	2.9
Developing Unpermitted	0.0	0.3	1.4	1.4	1.4
Vacant-Cary	0.0	0.3	0.8	1.8	5.1
Vacant-Morrisville	0.0	0.0	0.1	0.2	0.6
Vacant-RTP Future	0.0	0.3	0.6	0.7	0.7
Vacant-Open Space	0.0	0.0	0.0	0.0	0.0
Vacant-Unclassified	0.0	0.0	0.1	0.2	0.6
Bulk Water Sales	0.5	0.5	0.5	0.5	0.5
Non-Revenue Water (9%)	1.2	1.6	1.9	2.1	2.6
Total Demand	14.7	19.1	23.1	25.1	31.5

Note: Numbers may not add exactly due to rounding.

2.7.2 Maximum Day Demand

As described in Section 2.4, a peaking factor of 1.64 was selected for use in this Master Plan to calculate the MDD as a function of ADD, based on discussions with Town of Cary staff. The MDD by pressure zone are summarized in Table 2-14.

TABLE 2-14
Town of Cary Maximum Day Water Demand by Pressure Zone (units in mgd)

Pressure Zone	2007	2010	2015	2025	Build-out
Central	14.2	16.6	18.5	19.7	24.1
Southern	3.1	3.7	4.2	4.5	6.5
Western	4.7	8.5	12.1	13.5	16.8
Non-Revenue Water (9%)	2.0	2.6	3.1	3.4	4.3
Total Demand	24.0	31.4	37.9	41.2	51.6

Note: Numbers may not add exactly due to rounding.

2.7.3 2009 Demands for Existing System Hydraulic Evaluation

As described in Section 6.1, the existing system hydraulic evaluation was conducted using projected 2009 demands derived by interpolating between the 2007 production and 2010 projected demands. 2009 demands were used for existing conditions in order to provide a model that is as accurate as possible to evaluate the Town's current system performance. The 2009 demands were linearly interpolated between the 2007 and 2010 demands and are shown in Table 2-15 for both average day and maximum day. The MDD was determined by using the peaking factor of 1.64 as described above.

TABLE 2-15
Town of Cary Interpolated 2009 Average and Maximum Day Demands (units in mgd)

Pressure Zone	2007	2009 (Interpolated)	2010
Average Day Demand	14.7	17.6	19.1
Maximum Day Demand	24.0	28.9	31.4

2.8 References

The following documents were referenced in this section:

Capital Area Metropolitan Planning Organization (CAMPO). 2007. Wake County School System Long Range School Plan 2005-2025. Completed in association with the Wake County School Board. Digital parcel data created for this study was utilized.

CH2M HILL. 2007. Town of Cary Integrated Water Resources Management Plan.

The Wooten Company. 2008. RTP South Development Plan. Microsoft Excel.

Town of Cary. 2003. Land Use Plan. Adopted in 1996, Amended in 2003.

Wake County. 2008. Wake County Geographic Information System (GIS) Services Department. <http://www.wakegov.com/gis/default.htm>. Accessed December 2008.