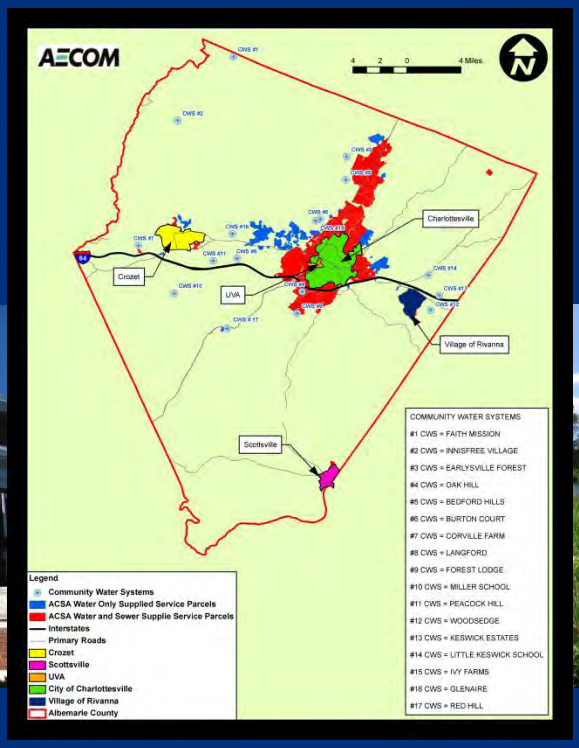
Rivanna Water and Sewer Authority
Regional Water Demand Forecasts



In conjunction with:
City of Charlottesville
Albemarle County
Albemarle County Service Authority
Town of Scottsville

Prepared by:

AECOM

August 24, 2011

Executive Summary

The Rivanna Water and Sewer Authority is developing a Regional Water Supply Plan on behalf of the City of Charlottesville, Albemarle County and the Town of Scottsville. The Regional Water Supply Plan is required under the Virginia Local and Regional Water Supply Planning regulations (9 VAC 25-780).

One element of the Regional Water Supply Plan is the water demand analysis, which estimates the future drinking water needs for residential and employment uses. This document outlines the methodology for the water demand forecasts, the historical data evaluated and used in the analysis, and the resulting water demand forecasts. This water demand analysis meets the regulatory requirements (9 VAC 25-780-100) as summarized in Table ES-1 below.

Table ES-1. Addressing the Requirements of the Virginia Local and Regional Water Supply Planning Regulations for Water Demand Analysis

Requirement	Supporting Text
Use of appropriate data sources and documented methodology	Methodology Section
Forecast demands for a minimum of 30 years and a maximum of 50 years	Water Demand Forecasts Section
Estimate the water demands for each decade (2010, 2020, 2030, etc.)	Water Demand Forecasts Section and Appendix A
Include projections for community water systems	Water Demand Forecasts Section
Include self-supplied water demands (private non-farm wells)	Water Demand Forecasts Section
Include self-supplied agricultural demand	N/A
Consider the reduction in future water demands associated with water conservation and leak detection programs	Water Demand Forecasts Section: • Water Conservation: Continue Implementation of Existing Programs • Additional Water Conservation Initiatives – New Mandatory Programs

Based on the analysis outlined in this report, the Regional Water Supply Planning area which includes the City of Charlottesville, Albemarle County, Town of Scottsville, the Community Water Systems, and self-supplied population should plan for 22.02 MGD of total off-stream (human use) water demand. This water demand is estimated by area as follows:

- Urban Service Area should plan for 16.96 MGD
- Crozet Service Area should plan for 0.99 MGD
- Scottsville Service Area should plan for 0.09 MGD
- The Community Water Systems should plan for 0.22 MGD
- The self-supplied area should plan for 3.78 MGD

The forecasted water demands will be considered in the Regional Water Supply Plan with the goal of planning for sufficient water to meet the community's long-term needs.

This report also identifies potential variations from these water demand forecasts, such as the adoption/implementation of enhanced water conservation measures or changes in planned population and employment. These water demand forecasts should be revised if data is collected that demonstrates a significant change in water demand patterns. In fact, the Regional Water Supply Plan (including the water demand forecasts) must be reviewed every 5 years and must be updated and submitted to the Virginia Department of Environmental Quality for approval every 10 years.

Background

The Rivanna Water & Sewer Authority (RWSA) is a wholesale water provider that produces and distributes potable water to two customers; the City of Charlottesville through the Charlottesville Public Utilities Division and the Albemarle County Service Authority (ACSA). These two customers receive wholesale water then directly retail the water to end users (i.e., residential, commercial and industrial water customers). The City of Charlottesville provides water service to the City of Charlottesville and the Grounds of the University of Virginia (UVA)[1]. The ACSA provides water service to the urban areas in Albemarle County surrounding the City of Charlottesville, as well as Crozet, the Town of Scottsville, and the Village of Rivanna. ACSA also serves a research park and some other off-Grounds facilities owned by UVA or its foundations. Figure 1 shows the location of the service areas within Albemarle County.

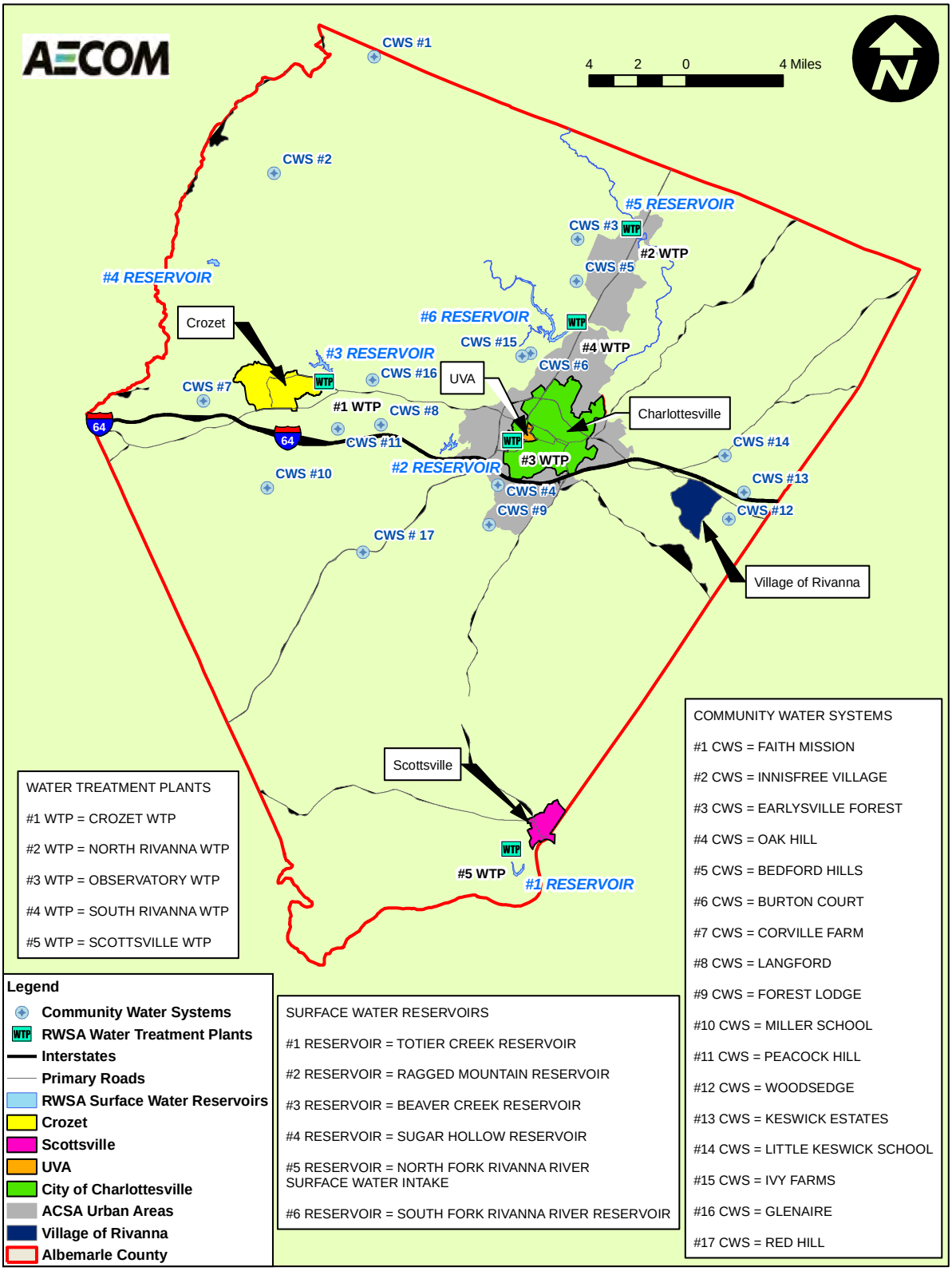
In addition to the RWSA, there are a number of smaller Community Water Systems (CWS) in Albemarle County that produce and distribute drinking water. In 2009, there were 17 CWS including; Bedford Hills, Burton Court Apartments, Earlysville Forest, Faith Mission Home, Forest Lodge Water Company, Glenaire Subdivision, Innisfree Village, Ivy Farms Water Company, Keswick Estates, Langford Subdivision, Little Keswick School, Miller School, Oak Hill Trailer Park, Peacock Hill Subdivision, Corville Farm Subdivision, Woods Edge Subdivision, and Red Hill. Also within Albemarle County, there is a segment of the population that is considered "self-supplied" which means they have a private well to supply their individual home.

For the purposes of this report, the water services were grouped into four distinct character areas; Urban, Crozet, Town of Scottsville, and CWS/self-supplied areas. These areas are defined below.

- **Urban** – City of Charlottesville, University of Virginia, urban portions of the ACSA
- **Crozet** – ACSA rural areas, in and around the Crozet area
- **Town of Scottsville** – area served by ACSA within the town limits
- **Community Water Systems (CWS)** – 16 independently-operated water systems, plus Red Hill (operated by ACSA) and the self-supplied population

[1] All of the buildings on grounds of UVA are served by the City of Charlottesville, even the portions outside of the City limits.

Figure 1. Location Map of RWSA service area



Regulatory Basis

The Virginia Local and Regional Water Supply Planning regulations (9 VAC 25-780) form the basis for the Water Demand Forecasts outlined in this document as well as the larger Regional Water Supply Plan being developed by RWSA. This section outlines these requirements.

Regional Water Supply Plan

The RWSA Regional Water Supply Plan will include all of the water users both in the RWSA service area and the CWS/self-supplied areas, which is defined as the "planning area" in 9 VAC 25-780. By regulation, the Regional Water Supply Plan shall contain the following elements:

- Description of existing water sources (9 VAC 25-780-70)
- Description of existing water use (9 VAC 25-780-80)
- Description of existing water resource conditions (9 VAC 25-780-90)
- Assessment of projected water demand (9 VAC 25-780-100)
- Description of water management actions (9 VAC 25-780-110 & 120)
- Statement of need (9 VAC 25-780-130)
- Maps identifying important elements (e.g., environmental resources, existing water sources, existing significant water uses, proposed new sources, etc.) of the Water Supply Program
- Copies of local ordinances or amendments that incorporate elements of the Water Supply Program
- Copies of resolutions from the local governments in the planning area approving the Water Supply Plan
- Records of local public hearing

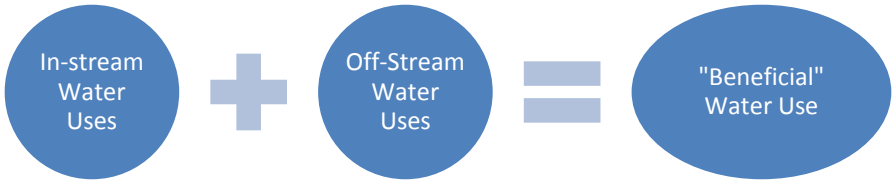
The Regional Water Supply Plan must be submitted by November 2, 2011 for review by the Virginia Department of Environmental Quality and for approval by the Virginia State Water Control Board. The Regional Water Supply Plan must be reviewed every 5 years. If circumstances upon which the Plan was based change, or new information indicates that water demands cannot be met by the alternatives contained in the Regional Water Supply Plan, then the Plan must be updated and re-submitted to the Virginia Department of Environmental Quality for approval. Even if no changes have occurred that would change the conclusions of the Regional Water Supply Plan, it must be updated and submitted to the Virginia Department of Environmental Quality for approval every 10 years.

The Virginia Regional Water Supply Planning regulations require consideration of both in-stream and off-stream beneficial uses for water as defined below and illustrated in Figure 2:

- In-stream beneficial uses include "the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values".

- Off-stream beneficial uses include "domestic (including public water supply), agricultural, electric power generation, and commercial and industrial uses".

Figure 2. Total Water Use Considerations for the Regional Water Supply Plan



While the Regional Water Supply Plan will include both in-stream and off-stream uses, this memorandum only addresses the future off-stream water use or, those uses associated with human water demands. The in-stream uses will be considered within the Regional Water Supply Plan.

Water Demand Analysis

The Local and Regional Water Supply Planning regulations also contain specific requirements for the water demand analysis (9 VAC 25-780-100) described in this document. These requirements, in summary, include:

- Use of appropriate data sources and documented methodology
- Forecast demands for a minimum of 30 years and a maximum of 50 years
- Estimate the water demands for each decade (2010, 2020, 2030, etc.)
- Include projections for community water systems
- Include self-supplied water demands (private non-farm wells)
- Include self-supplied agricultural demand
- Consider the reduction in future water demands associated with water conservation and leak detection programs

Stakeholder and Public Involvement

Stakeholders, advocacy groups, and citizen involvement played a major role throughout the water demand forecasting process. Stakeholders include elected officials, planning staff, community water systems in the region, and representatives from the University of Virginia. Advocacy groups and citizens included other individuals and groups interested in the outcome of the water demand forecasts.

Public interest in water supply planning is high in the City of Charlottesville and Albemarle County planning area. Several opportunities were provided for stakeholders and the public to provide input and data to support the water demand forecasts. These opportunities included:

- Stakeholders Data Collection Meetings – Individual meetings were held with the key stakeholders to engage them in the process and secure the best available data needed to develop the water demand forecasts. Meetings were held as needed to secure additional data throughout the water demand forecasting process.

- Methodology Workshop – The proposed methodology for estimating the future water demands was presented at a public meeting on May 26, 2011. Feedback was provided during the public meeting and at the subsequent "office hours" (individual meetings with citizens and public interest groups).
- Draft Water Demand Forecast Workshop - The draft water demand forecasts were presented during a series of three public meetings held on July 11-12, 2011. Feedback was provided during these three public meetings and at the subsequent "office hours".
- RWSA website – The website was updated by RWSA throughout the project to provide stakeholders and the public with access to data used to support the reports and documents for review.
- Presentation of Final Water Demand Forecasts – The final water demand forecasts included in this report will be presented to the elected boards and councils on September 12 and 13, 2011.

The additional data and information regarding community values provided by stakeholders and the public improved the water demand forecasts. The public dialogue also increased the understanding of the future challenges and provided a forum for larger policy debates such as; the importance of planning for the continued economic success of the region, the value of long-term water conservation to the community, and the value in protecting natural resources.

Overview of this Report

This document is organized in the following sections:

- Methodology – presents an overview of the methodology used to forecast the future water demands.
- Historical Water Use Data – presents historical water use and production data and how the water is used for off-stream purposes; including, use by customer category, per capita/per employee water use, water use by end use, and estimates for non-revenue water.
- Normalized Water Use – presents an evaluation of climate data, economic data, and historical water use to determine whether the 2006 to 2010 disaggregated water use data is likely to be representative of future trends.
- Population and Employment Data – summarizes the future population and employment used for the water demand forecasts.
- Baseline Water Demands – presents the baseline future water demands, which reflect current water use trends continuing into the future.
- Water Demand Forecasts – presents the likely future water demands. Starting from the baseline water demand forecasts, several different scenarios were evaluated to determine the most representative future water demands.

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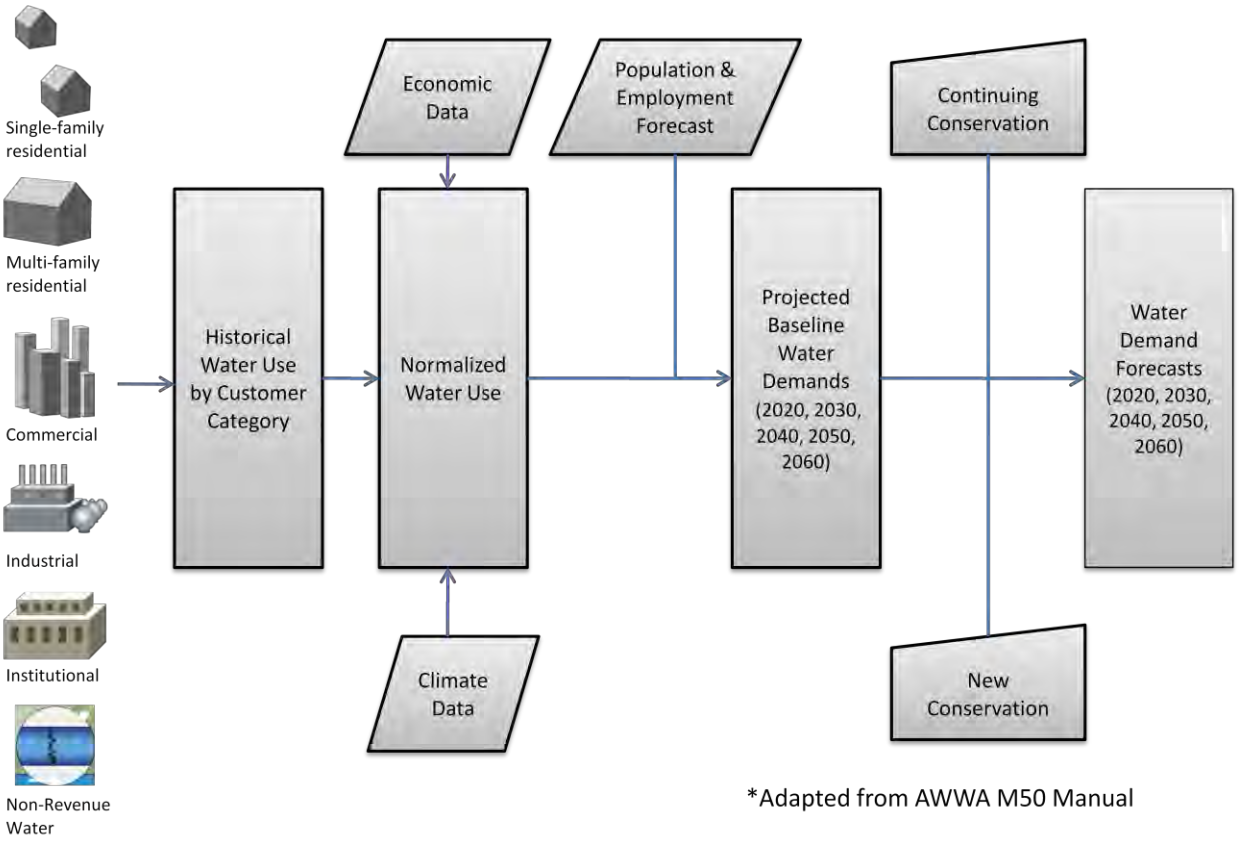
Methodology

Two different methods were used to develop the water demand forecasts, both methods are outlined in the American Water Works Association (AWWA) *M50: Water Resources Planning Manual* (AWWA M50 Manual). The methodology used for the Urban, Crozet, and Scottsville character areas is the "Disaggregate Water Use Model", as shown in Figure 3. The Disaggregate Water Use Model considers the different water use patterns for each customer type and applies these water use patterns to the future customers within that specific water use category (e.g., residential). The data evaluated following this methodology is presented in the following sections.

Figure 3: Process for Developing Water Demand Forecasts



*Adapted from AWWA M50 Manual

Disaggregated historical water use data was not available for the CWS character areas; therefore, the "Per Capita" method was used for the CWS areas. The per capita method multiplies the average per capita demand by future population to determine future water demands. The overall per capita demand was applied to the future population served by CWS as well as the self-supplied population. The demands calculated for the CWS and self-supplied populations were summed with the demands for the Urban, Crozet, and Scottsville character areas to determine the regional water demand.

Historical Water Use Data

Historical water use data (i.e., billing and production data) was provided by RWSA for the City of Charlottesville including UVA and ACSA service area (ACSA urban, Crozet, and Town of Scottsville). The RWSA historical urban water production data (Charlottesville and ACSA urban) was provided for the period from 1983 to 2010. The historical water use by customer category, needed to use the disaggregate water use method, was provided by both the City of Charlottesville and the ACSA from FY2006 to FY2010[2]. The RWSA also compiled and provided water use data for the CWS providers from 2008 to 2009. The historical water production and total use data is presented in million gallons per day (MGD) in Table 1.

Table 1. Historical Water Production and Use by Character Area for FY2006 – FY2010 (in MGD)

Character Areas	FY2006	FY2007	FY2008	FY2009	FY2010
RWSA Production	11.12	10.93	10.04	9.80	9.85
Urban Water Use	8.87	8.95	8.33	8.47	8.35
Crozet Water Use	0.35	0.37	0.36	0.36	0.37
Town of Scottsville Water Use	0.07	0.08	0.06	0.06	0.05
Community Water Systems Use			1.29	1.18	
Total Consumption	**9.29**	**9.4**	**10.04**	**10.07**	**8.77**

Note 1: RWSA production data was provided by RWSA, the water use was provided by the City of Charlottesville and the ACSA, and the Community Water System data was derived from the Virginia Department of Health data sheets. RWSA Production serves the Urban Water Users, the Crozet Water Users and the Town of Scottsville. Water provided by the CWS is not included in the RWSA Production numbers.

This water use data was disaggregated to provide a foundation for the water demand forecasts and also to provide a better understanding of current water use patterns to guide some of the water conservation analysis presented later in this document. The analysis presented in this section, except where noted otherwise, is based on the historical water use and water production data from FY2006 to FY2010. The larger historical record was used as part of the normalization step, described later in this document.

Water Use by Customer Category

The water use by customer category for the City of Charlottesville and ACSA is presented in Table 2 and Figure 4. Using the average of all of the water use for the areas where disaggregated water use data was available, single-family residential water use was highest with multi-family, institutional, and

[2] FY = fiscal year which is from July through June

commercial use sharing a very similar percentage of the total water use. Most of the CWS and self-supplied customer water use is considered to be single-family residential.

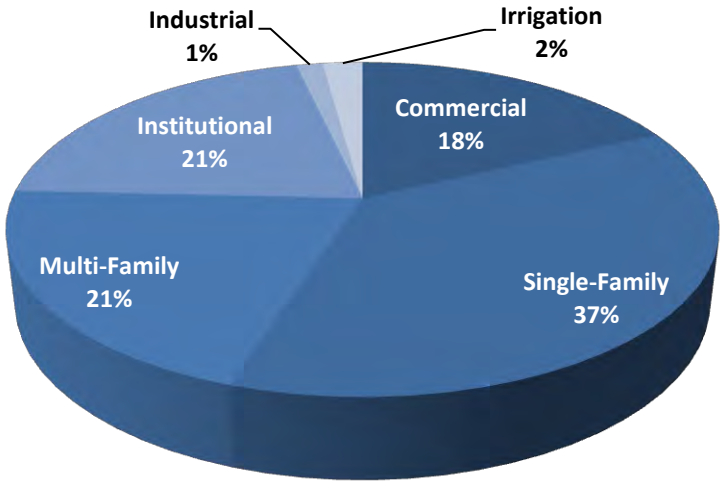
Table 2. Percentage of Total Water User by Customer Type by Service Area

Character Area	Single-Family	Multi-Family	Commercial	Institutional	Industrial	Irrigation[1]
City of Charlottesville (Urban)	30%	19%	18%	32%	1%	0%
ACSA Urban	42%	24%	20%	8%	1%	5%
Crozet	73%	5%	6%	9%	4%	3%
Town of Scottsville	33%	4%	21%	5%	37%	0%
Total[2]	37%	21%	18%	21%	1%	2%

Notes:

1. Irrigation only includes properties with a separate irrigation meter that only tracks water use for irrigation.
2. The total represents an average percentage based on the dividing the sum of water use for each customer category for all four character areas by the sum of the total water use for all four character areas. The total reflects water use for the character areas with disaggregated data.

Figure 4. Percentage of Total Water Use by Customer Type for Urban, Crozet, and Scottsville



Per Capita and Per Employee Water Use

The per capita and per employee water use was calculated based on the historical water use data (presented in Table 1), the 2010 population based on the 2010 U.S. Census,[3] and the 2010 employment

[3] http://quickfacts.census.gov/qfd/states/51/51003.html and http://quickfacts.census.gov/qfd/states/51/51540.html

based on the 2010 Quarterly Census on Economics and Wages (QCEW)[4] from the U.S. Department of Labor: Bureau of Labor Statistics. To be consistent with the population and employment data (presented later in this document), the customer were grouped into three categories; residential, employment, and irrigation. The irrigation category does not represent all outdoor water use, only outdoor water use associated with separate irrigation meters. Irrigation use that is not specifically billed by a separate meter is reflected in the residential and employment categories, as that is how the water usage is billed. The total outdoor water use is calculated and presented in the Water Use by End Use section that follows. Table 3 presents the average gallons per capita per day (gpcd) and gallons per employee per day (gped) water use based on data from FY2006 to FY2010.

Table 3. Average Per Capita and Per Employee Water Demand by Service Area for FY2006 to FY2010

Character Area	Total Overall System[1] (gpcd)	Overall[2] (gpcd)	Residential (gpcd)	Employment (gped)	Irrigation[3] (gpcd)
RWSA	99.8				
City of Charlottesville (Urban)		93.7	45.3	66.5	0.04
UVA[4]					
Student On-Grounds			65.3		
Faculty/Staff				69.6	
Hospital				50.8	
ACSA Urban		81.9	54.8	24.4	3.82
Crozet		68.3	53.3	43.7	1.99
Town of Scottsville		108.1	39.9	204.8	n/a
Average[5]		86.9	50.1		
CWS[6]	83.6				

Notes:

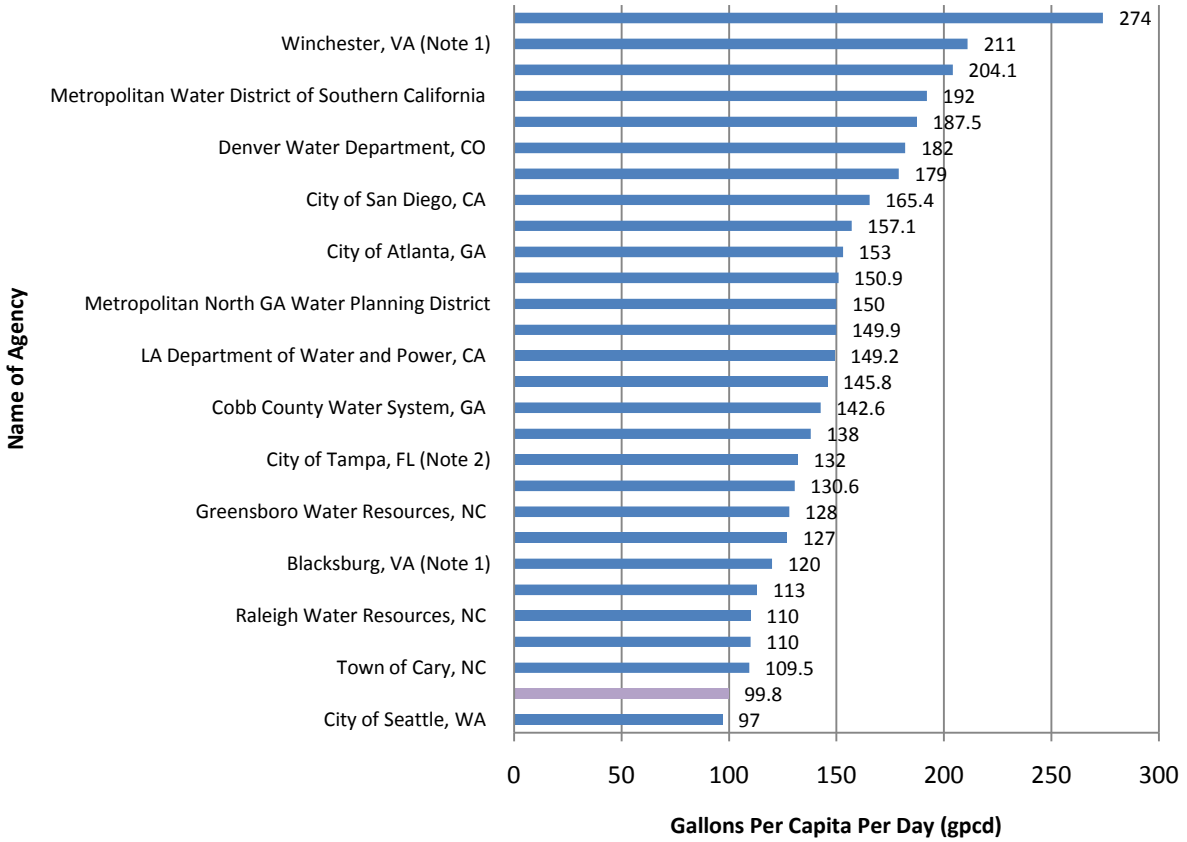
1. The total overall system per capita use reflects all of the water produced and therefore includes non-revenue water
2. The overall per capita water use reflects the water used divided by the total population and therefore is influenced by the extent and type of employment in the community.
3. Irrigation includes only usage associated with separate irrigation meters and does not represent all outdoor use
4. The Off-Grounds UVA students are included in the residential per capita water use for the City of Charlottesville and ACSA Urban areas based on their location as outlined in the population section of this document.
5. Calculated based on the overall residential water use divided by the overall population for Urban, Crozet, and Scottsville.
6. Calculated based on the overall water produced by CWS systems divided by the CWS population served. This information was listed on the Virginia Department of Health data sheets.

[4] http://beta.bls.gov/maps/cew/VA?period=2010-Q1&industry=10&pos_color=blue&negcolor=orange &Update=Update&chartData=3&ownerType=0&distribution=Quantiles

The RWSA total overall system per capita water use of 99.8 is low. However, it is important to understand that the per capita water use reflects the nature of the community and that use will vary based on employment, climate, geography, water source, cost of water, availability of water, and a host of other factors. For example, the Town of Scottsville has a higher overall per capita water use and the lowest residential per capita use, because of a large manufacturing facility.

While it is important to use care when comparing overall per capita water demands, it is a common method for comparing communities. Figure 5 shows 2009 per capita water use data from 27 other communities across the United States, including several communities (Cary, NC and Spartanburg, SC) that are similar to Albemarle County and the City of Charlottesville as well as other communities in the Commonwealth (Blacksburg, Staunton, and Winchester). For the communities listed, the RWSA has the second lowest overall per capita water use, next to the City of Seattle, Washington. The relatively low per capita water use is in part due to the strong water conservation ethic practiced within the Regional Water Supply study area.

Figure 5. Comparison of Per Capita Water Use across the United States



Notes:

1. These values were obtained as part of this study. All other values were obtained from: *Catawba-Wateree Water Management Group Benchmarking Survey of Current Successful Water Demand Management Programs.* JJ&G. 2010. Final report.
2. This per capita water use only reflects the City of Tampa and not the Tampa Bay Water District, which is the wholesale water provider for the City and several other communities.

Water Use by End Use

An "end use" reflects how water is used by a customer and includes outdoor water use (i.e., irrigation) as well as indoor water uses (i.e., toilets, showers, sinks, washing machines, etc.). The water use by each specific end use category was estimated to guide some of the water conservation analysis, presented later in this document.

Outdoor Water Use

A small portion of outdoor water use (less than 5-percent) in the Regional Water Supply Planning Area is metered separately from other domestic water uses (i.e., these homes have two meters, one for irrigation and one for household uses). The remaining irrigation use is accounted for in the residential and employment water use categories (i.e., customers with one meter for all uses - greater than 95-percent of all customers).

To estimate the total outdoor water use, the average water use during winter months was compared to the average annual water use. Typically, there is little or no irrigation during the winter months (November through February) and therefore the winter average is considered to reflect indoor usage only (see Figure 6). Therefore, any water use in excess of the winter average water use is considered to be outdoor water use. Table 4 presents the percent of indoor versus outdoor water use for the Urban, Crozet, and Scottsville character areas. Table 4 also presents a weighted average calculated as the total outdoor water use divided by the total water use for these three character areas.

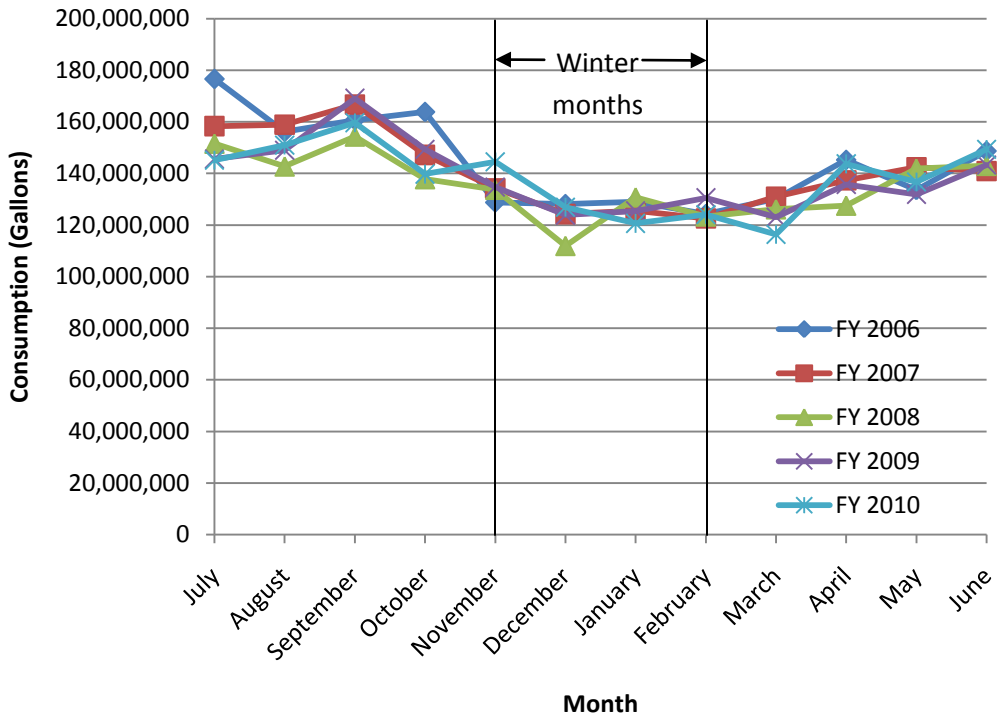
Outdoor water use typically ranges from 10-percent to 20-percent of total water use in the mid-Atlantic. In arid areas of the United States, such as Nevada and Florida, the outdoor water use can climb to as high as 6o-percent of overall demand. At 12-percent, the Urban, Crozet, and Scottsville character areas are within the typical range. The City of Charlottesville and ACSA have several ongoing education programs to increase awareness and present alternatives for water used for irrigation.

Table 4. Average Indoor versus Outdoor Water Use by Service Area for 2006 to 2010

Character Area	% Indoor Water Use	% Outdoor Water Use
City of Charlottesville (Urban)	90%	10%
ACSA Urban	86%	14%
Crozet	88%	11%
Town of Scottsville	87%	13%
AVERAGE	**88%**	**12%**

Note: This is a weighted average calculated as the outdoor water use divided by the total water use for all three character areas.

Figure 6. Example Determination of Outdoor versus Indoor Water Use (City of Charlottesville)



The average flow-weighted residential per capita water use is approximately 50.1 gpcd[5] and includes indoor and outdoor water use. Based on the average percent of indoor water use of 88-percent, from Table 4, the average indoor per capita water use is approximately 44.1 gpcd[6]. The indoor water use was sub-divided into the various end uses for residential properties based on the AWWA Research Foundation (AWWARF) Residential End Uses Report[7]. This 1999 study identifies the average percentage of water use by end use within the home, shown in Figure 7. The average residential per person water use by end use category is presented in Table 5 for the combined Urban, Crozet, and Scottsville character areas was calculated by applying these percentages to the calculated indoor water use of 44.1 gpcd. This information was used for some of the water conservation analysis performed later in this memorandum, and is important given that residential customers comprise the largest portion of water use.

[5] Calculated based on the overall residential water use divided by the overall population for Urban, Crozet, and Scottsville.
[6] Calculated by multiplying the residential per capita of 53 gpcd by the 88-percent indoor water use
[7] *Residential End Uses of Water*. AWWA Research Foundation. Peter W. Mayer, William B. DeOreo. 1999.

Figure 7. Percent of Residential Water Use by End Use

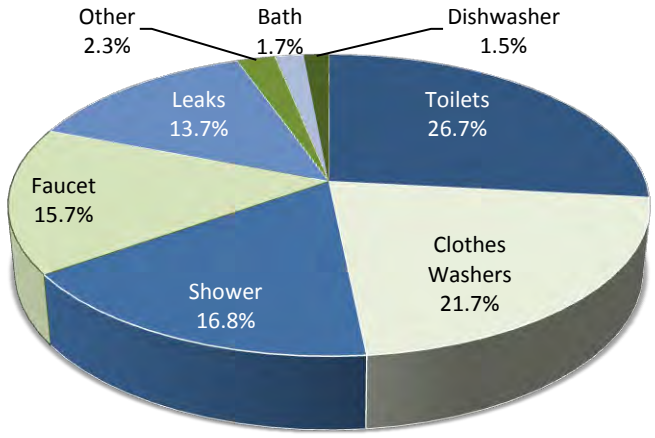


Table 5. Average Residential Indoor Per Capita Use for Urban, Crozet, and Scottsville Character Areas

End Use	Residential Use by End Use (%)[1]	Calculated Indoor Per Person Water Use (gpcd)[2]
Toilets	26.7%	11.8
Clothes Washers	21.7%	9.6
Shower	16.8%	7.4
Faucet	15.7%	6.9
Leaks	13.7%	6.0
Other	2.3%	1.0
Bath	1.7%	0.75
Dishwasher	1.5%	0.66
Total	**100%**	**44.1**

Notes:

1. The residential use by end use category is based on the *Residential End Uses of Water*, AWWA Research Foundation paper.

2.The average indoor per person water use is based on the weighted average per capita use multiplied by the weighted average indoor water use of 88-percent for Urban, Crozet, and Scottsville character areas.

Non-Revenue Water

Non-revenue water (NRW) is water that enters the water distribution system but is not billed to a customer account. As defined by the AWWA, NRW includes unbilled authorized consumption (i.e., fire fighting, line flushing, etc.), apparent losses (i.e., water not billed through clerical error, metering inaccuracies, or unauthorized uses), and real losses (i.e., leaks, main breaks) as shown in Figure 8. Since NRW includes unbilled authorized consumption and real losses (AWWA methods confirm that all water systems will have an unavoidable level of leakage), it is rare to see a system with less than 10-percent NRW[8]. NRW above 20-percent is typically considered high and programs would be needed to target the highest areas of NRW.

Figure 8. International Water Standard Water Balance (adapted from AWWA M50)

<table>
<tr><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="8">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Systematic Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage on Overflows at Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to Customer Meters</td></tr>
</table>

The NRW, shown in Table 6, was calculated for each character area by subtracting the water billed to customers from the water produced by RWSA. The NRW for the urban area cannot be divided between the ACSA service area and the City of Charlottesville service area because the water plants send flows to both systems. The NRW for the Urban area and Crozet are low. The NRW for the Town of Scottsville is

[8] International Benchmarking Network for Water and Sanitation Utilities, and the World Bank *Water Supply and Sanitation Sector Board Discussion Paper Series. Paper No. 8.* December 2006.

higher than the normal range and should be investigated to determine that all accounts are being properly metered and billed and that there aren't any unresolved water leaks.

Table 6. Average Non-Revenue Water by Character Area for FY2006 to FY2010

Character Area	NRW (%)
Urban	13
Crozet	13[9]
Town of Scottsville	31
CWS	NA

[9] The actual average NRW for FY2006 to FY2010 was 9%, however in FY2006 the NRW was 14% and FY2010 the NRW was 13%. The intermediate years had overly low NRW and that data was not considered in the average due to irregularities in the data that appear to have been addressed.

Normalized Water Use

Weather and economic conditions can have a dramatic effect on water use patterns; therefore, it is important to analyze the data trends for any anomalies. The normalization process considered unusual circumstances including irregularities in climate, economic conditions, and historical water use that may have impacted "normal" water use during the time period evaluated.

One of the goals of the Regional Water Supply Plan is to "ensure that adequate and safe drinking water is available to all citizens of the Commonwealth" (9VAC 25-750-20). Normalization is an important step in the analysis, as using a lower than normal baseline water use could result in insufficient water to meet the regional water supply planning area needs. Conversely, forecasting future water demands based on higher than normal conditions could result in building additional water supply capacity in advance of demands.

Climate Data

Historical rainfall patterns were reviewed to identify years with irregular weather patterns. Typically, during "wet" years, outdoor watering levels decline as ample rainfall decreases outdoor water needs and during "dry" years, there are often watering restrictions that can reduce typical consumption levels.

The historical rainfall analysis is based on published monthly precipitation data from the National Weather Service. There are several rainfall gages in the region. The gage with the most complete records (at Observatory Hill on UVA's campus) was primarily used. If data was not recorded for a particular month due to an interruption, then monthly data from the other gage stations (Free Union and Charlottesville 1) was used to get a complete record for that year, as shown in Figure 9.

Years with rainfall below the average are considered to be "dry" years and above this level are "wet" years. Rainfall from 2006 to 2010 was about 6.7-percent below the historical average and the rainfall in 2007 was significantly below the historical average, more than 25-percent below normal (see Table 7). Water use restrictions were in place in 2007, which is the year with the lowest rainfall total since 1977.

One important reason for weather normalization is to determine the impacts, if any, of emergency drought water use restrictions on normal water use. From the AWWA M50, "Long-run demand forecasts do not account for occasional droughts that are accompanied by restrictions and short-run pricing programs." It is not prudent to plan for future water use by assuming that reduced water use during periods of temporary restrictions will continue long-term into the future.

Table 7 shows that the per capita water use was almost 6-percent higher in 2007 than the average for FY2006 to FY2010, despite the mandatory watering restrictions. The overall range of per capita water use from FY2006 to FY2010 was considered reflective of current water use and therefore no normalization for weather conditions was recommended.

Figure 9. Historical Rainfall Data for the City of Charlottesville

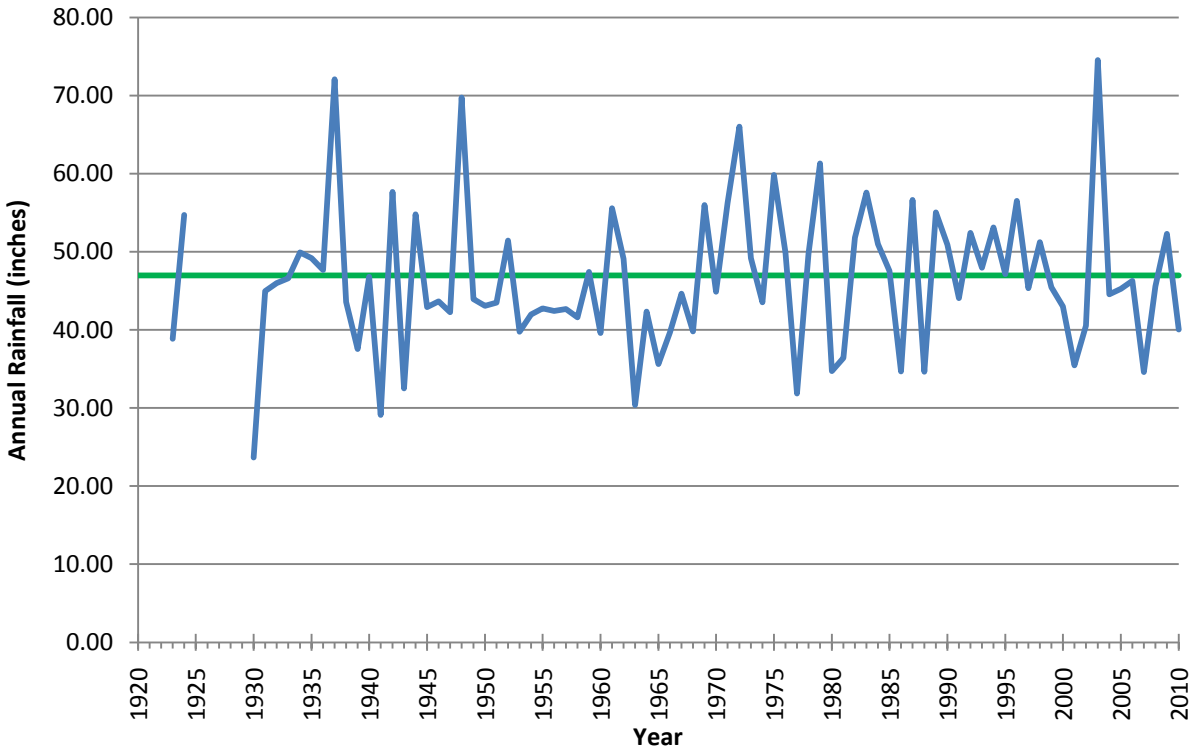


Table 7. Percent Variation in Annual Rainfall Compared to Average for FY2006 to FY2010

Fiscal Year	Rainfall (inches)	% of Normal	Average Consumption Per Capita
2006	46.26	-3%	89.8
2007	34.61	-27%	92.4
2008	45.57	-4%	85.1
2009	52.27	+10%	85.1
2010	40.03	-16%	82.0
5-year Average	**43.75**	**-8%**	**86.9**

Concerns were raised during the May 27, 2011 "Office Hours" meetings with interested citizens and advocacy groups following the methodology meeting on May 26, 2011, regarding global climate change and the increasing changes in normal weather patterns. The following reports regarding global climate change and the impacts on water supply and availability in the region were reviewed:

- *Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations*. Chesapeake Bay Program Science and Technical Advisory Committee (STAC). September 2008. This source states that "Climate models have, in general, been unable to simulate this long-term change in precipitation in the northeast United States.[10]"
- *Governor's Commission on Climate Change Final Report: A Climate Change Action Plan*. Governor's Commission on Climate Change. December 2008. This source states that "more research to determine the specific effects [of climate change] is needed. The lack of specific information on the impacts hinders Virginia's ability to adapt and prepare for these changes."
- *Are Climate Variations Reducing the Reliability of Our Water Supplies*. Robert R. Osborne, Pamela Kenel, and Hope Walker. Proceedings of the 2009 Georgia Water Resources Conference. April 2009.

While these reports all indicate there are uncertainties and that future rainfall patterns will become increasingly irregular, there is not a precise impact that has been identified to account for the future variations. As the Regional Water Supply Plan will be reviewed and updated (as needed) every 5 years and resubmitted every 10 years, the recommendation at this time is to continue to watch the trends and revise the water demands as needed.

Economic Trends

The number of unemployed persons from 2001 to 2010 for the Charlottesville Metropolitan Statistical Area (MSA), presented in Figure 10, shows a steady rise in unemployment from 2007 to 2010. The highest period of unemployment was January 2010 and the lowest period was January 2001. While the Charlottesville MSA unemployment remains much lower than the national average, the change is noteworthy.

The unemployment for the period of 2006 to 2010 was compared to per capita water use to see if there was a noticeable decline in water use, shown in Table 8. While there is a small (2-percent) decrease in per capita water use between 2009 and 2010, the difference is not definitively tied to unemployment or the economy. This water demand forecast covers a 50-year planning horizon. Undoubtedly, during the 50-years there will be several periods of slower economic growth and periods of higher economic growth. Maintaining employment forecasts with steady growth allows the region to plan for future water needs without requiring adjustments to current employment use as part of the normalization process. Instead of adjusting the per capita water use to respond to a decline in employment, the forecasts are based on steady and continued employment.

[10] Hayhoe et al., 2007; Najjar et al., 2008.

Figure 10. Historical Unemployment Data for the Charlottesville MSA[11]

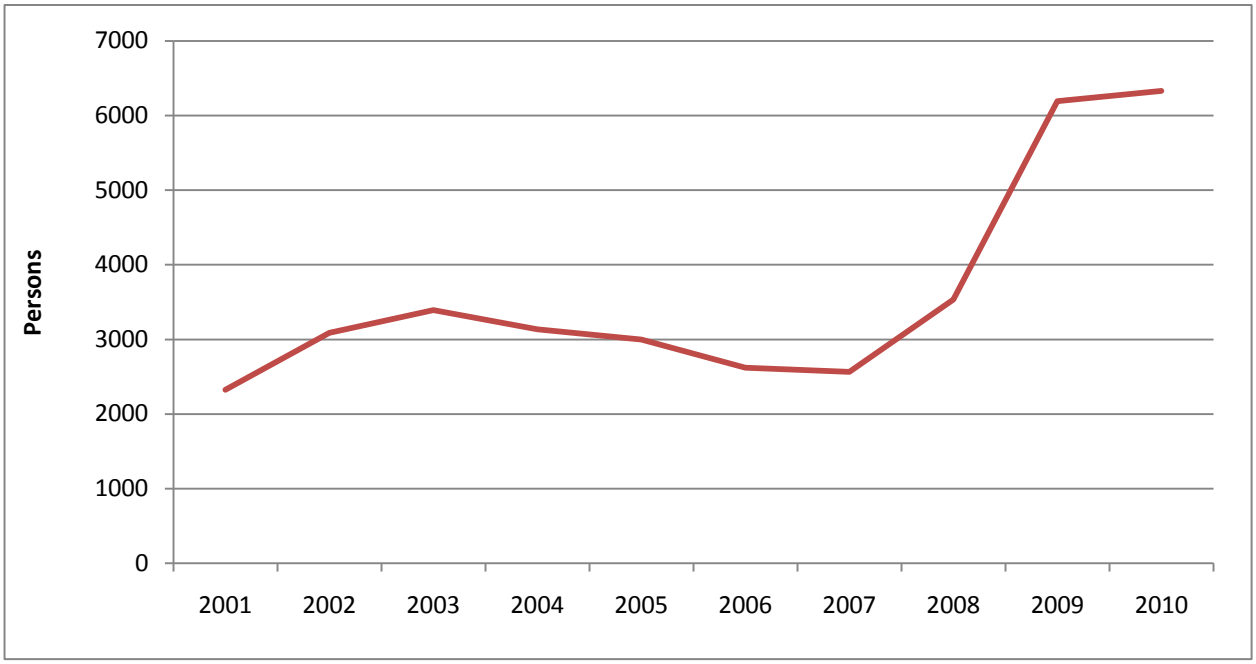


Table 8. Unemployment Data and Per Capita Water Use for FY2006 - FY2010

Fiscal Year	Unemployment (Persons)	Average Consumption Per Capita
2006	2,619	89.8
2007	2,563	92.4
2008	3,532	85.1
2009	6,193	85.1
2010	6,333	82.0

Based on the comparison of weather and economic conditions to the per capita water use, normalization of the actual data is not considered necessary at this time.

Historical Water Use Patterns

Disaggregated water use data was only available from FY2006 to FY2010. Water production and total water use data for the urban area was available from FY1983 to FY2010. The historical data (prior to

[11] U.S. Bureau of Labor Statistics trends for the Metropolitan Statistical Area from http://www.bls.gov/ro3/charlottesville.pdf

FY2006) was compared to the data from FY2006 to FY2010 to confirm that planning based on the smaller data set was appropriate. The historical water use and production data is shown in Table 9 along with the calculated average for both the historical record as well as for the FY2006 to FY2010 period.

Table 9. Historical Urban Water Production and Water Use Data for FY1983 to FY2010

Year	Total Urban Water Produced (MGD)	Total Urban Water Consumed (MGD)	Urban Area Consumption Per Capita (gpcd)
FY 1983	8.56	7.50	115.3
FY 1984	9.01	7.92	120.8
FY 1985	8.82	8.07	120.8
FY 1986	9.82	8.18	122.8
FY 1987	9.91	8.41	124.0
FY 1988	10.27	8.78	126.9
FY 1989	10.41	8.89	126.3
FY 1990	10.16	9.04	126.7
FY 1991	10.28	9.18	126.4
FY 1992	9.55	8.89	121.3
FY 1993	10.22	8.80	117.1
FY 1994	11.32	9.42	123.7
FY 1995	10.91	9.37	121.3
FY 1996	11.27	9.72	124.6
FY 1997	10.79	9.31	118.3
FY 1998	11.32	9.88	124.2
FY 1999	11.92	10.33	128.3
FY 2000	11.21	9.89	120.9
FY 2001	11.17	9.55	114.9
FY 2002	10.75	9.88	117.7
FY 2003	9.19	8.20	96.4
FY 2004	9.64	8.24	95.2
FY 2005	9.93	8.29	95.0
FY 2006	10.60	8.77	90.0
FY 2007	10.43	8.81	91.7
FY 2008	9.57	8.14	84.0
FY 2009	9.34	8.45	85.9
FY 2010	9.35	8.22	81.6
Average	10.20	8.86	112.9
Average FY06-FY10	9.86	8.48	86.6

Note: Historical urban area water production data was provided by RWSA and urban consumption data provided by the City of Charlottesville and ACSA.

Table 9 shows that there is approximately a 20-percent decline in per capita water use from FY2002 to FY2003. The decline in per capita water use does not appear strongly correlated to any one factor

including; data reviewed in this section (weather patterns, economic conditions, outdoor water use, and non-revenue water), and other information provided by stakeholders (timing of drought restrictions, water conservation, rate adjustments). The drop in per capita water use is likely associated with some combination of these factors. Although the per capita water use from FY2003 to FY2010 is significantly lower than the previous 20 years of data, the per capita water use has remained low for a period of 8 years. Based on the recent records, this analysis assumes that the per capita water use will remain at the reduced rate. The circumstances that caused this change are unknown based on data provided, and therefore we cannot assess the likelihood that these conditions may be reversed in the future. The uncertainty surrounding the shift in per capita water use highlights the importance of the review required by the state every 5 years and the resubmission every 10 years.

Population and Employment Data

The current and future forecasts for population and employment play an integral role in this water demand analysis. As the population and employment decisions are established by the City and County through the comprehensive land use planning process, these forecasts are based on the currently adopted land use plans and discussions with these stakeholders. Available population and employment data were used to generate and verify population to employment through 2060 as described below.

Population

Current population data for the City of Charlottesville and Albemarle County was obtained from the 2010 U.S. Census. Future population projections were compiled based on data primarily provided by each jurisdiction as outlined by character area below.

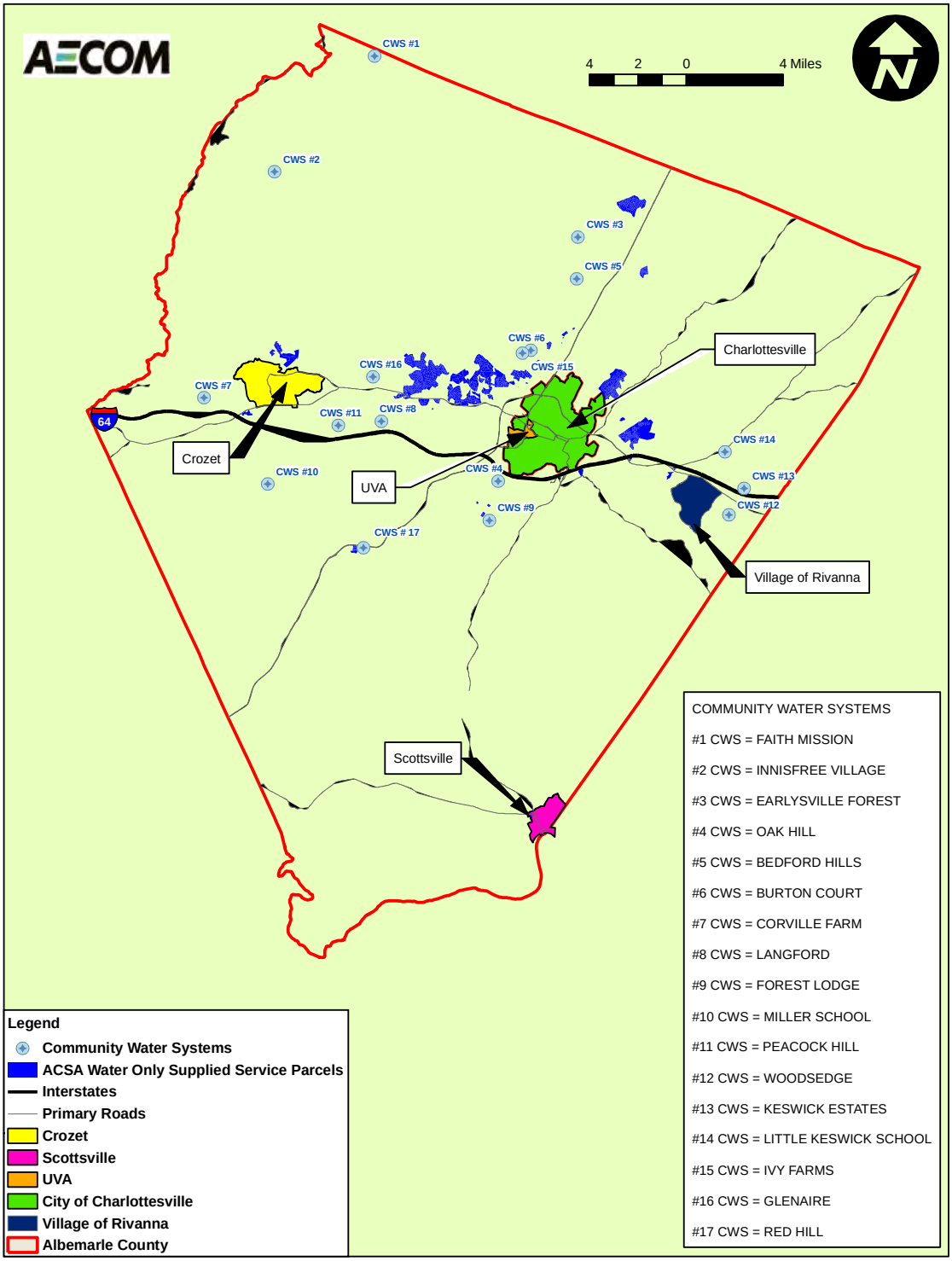
Basis for Urban Area Population:

- The City of Charlottesville water service area population projections were developed based on the historic growth rate over the last 15 years and discussions with the City's Neighborhood Development Services department. The population over the past 15 years has included periods of slower and higher growth and is considered representative of future trends.

- The population projections for the urbanized area of Albemarle County were obtained from the Albemarle County Planning Division. The Albemarle County Planning Division recently estimated the future population growth through 2060 based on the development potential of the County, in support of the 2008 Rivanna Water & Sewer Authority's Comprehensive Sanitary Sewer Interceptor Study. The Albemarle County Planning Division recommended using these population forecasts for the water demand forecasts, which were based on the development potential in accordance with the Comprehensive Land Use Plan and zoning classifications for each parcel.

  All of the parcels included in this study were assumed to have water service as well as wastewater service. There are additional areas that receive water service but do not receive sewer service from RWSA. The Village of Rivanna has its own sewer system and there are several water-only parcels in and around the urban area that were not included in the 2008 sewer study, as shown in Figure 11. The population for the Village of Rivanna was based on the Comprehensive Land Use Plan, assuming that the 80-percent of the average future development potential was reached by 2060. The population associated with buildout for other parcels was calculated based on zoning information provided by the Albemarle County Planning Division. As timing for buildout of these parcels is not known, it was assumed that 80-percent of the buildout would occur by 2060, consistent with guidance from County staff and as defined in the Crozet Master Plan (outlined below).

Figure 11. Water-Only Service Parcels



Basis for Crozet Population:

- Crozet's population information was obtained from the Crozet Master Plan which was developed by the Albemarle County Planning Division and adopted on October 13, 2010. This document projected the population through buildout based on the zoning outlined in the Master Plan. The County staff estimated that 80-percent of this buildout development would occur by 2060.

  Similar to the Urban Area, there are a small number of undeveloped water-only parcels located just outside of the Crozet area that would be served by the same source of water. Of these undeveloped parcels, 80-percent were assumed to be developed by 2060 to remain consistent with the Crozet Master Plan. The current water-only population (approximately 60 people) was added to the Crozet Master Plan population to determine the total Crozet water service population.

Basis for Town of Scottsville Population:

- The Town of Scottsville population forecasts were based on the Scottsville 2008 Comprehensive Plan and information provided by the Town's Planning Commission.

Basis for CWS and self-supplied Population:

- The population served by a CWS was based on the Virginia Department of Health (VDH) and Virginia Department of Environmental Quality (DEQ) records. As CWS water systems are designed based on a specific demand, the population served by the existing CWS systems is not expected to increase in the future.

- The current self-supplied population was calculated as the difference between the existing population in Albemarle County according to the 2010 US Census and the population that is served in one of the other character areas (Urban, Crozet, Scottsville, or CWS). Albemarle County is encouraging new development within the urban growth areas (i.e., areas with water service). Currently, approximately 36-percent of the population in Albemarle County is self-supplied. This percentage was considered to decline to 26-percent of the total population in Albemarle County (including on-grounds students) by 2060.

Basis for University of Virginia: The basis for the student enrollment at UVA is outlined in the text box on the following page and shown in Table 10.

The resulting population forecasts used for the water demand forecasts are presented in Table 11 for the City of Charlottesville and Table 12 for Albemarle County, including ACSA Urban, Crozet, Scottsville, CWS, and Self-Supplied. Tables 11 and 12 also show the relationship between the demographic population and the water service area population. Figure 12 shows the population and employment forecasts for the entire Regional Water Supply Planning area.

University of Virginia

UVA presented several unique challenges in terms of estimating future population and employment. The UVA students live both on-grounds and off-grounds as described below.

Student Enrollment: The number of students enrolled at UVA is expected to increase from 21,000 students in 2010 to 31,000 students in 2060 based on discussions with the UVA Academic Facilities Planning Department. The timing of the increases in enrollment are unknown, so a linear growth rate was forecasted.

On-grounds UVA Students: The majority of the on-grounds UVA students actually live in Albemarle County but receive their water service exclusively from the City of Charlottesville. These students are counted in both the City of Charlottesville and the Albemarle County Census numbers but are considered part of the City of Charlottesville Water Service population for the purpose of this report. Only 450 of the current 6,600 on-grounds students are estimated to live in the City of Charlottesville. These 450 students in the City of Charlottesville reside in University Gardens, French House, Russian House, Shea House, Spanish House, and Bice. The remaining students (6,150 students) are estimated to live in Albemarle County. No new on-grounds dormitories in the City of Charlottesville are planned at this time.

Off-grounds UVA Students: Off-grounds students live both within the City of Charlottesville and in Albemarle County (assumed within the Urban Water Service Area). A UVA Parking and Transportation Department conducted a study in 2007 identified the number of students living on-grounds and the number of students living off-grounds within the City of Charlottesville limits. The remaining enrolled students are assumed to live in Albemarle County.

Employment: The UVA employment includes faculty, staff, and the UVA hospital. The number of faculty and staff employed by UVA in 2010 was provided by the UVA Academic Facilities Planning Department. The future employment numbers of faculty and staff were calculated based on maintaining the existing faculty and staff to student ratio (1 faculty or staff to every 3 students). The number of persons employed by the UVA hospital in 2010 was provided by the UVA Health Systems Facility Planning staff. The UVA Health Systems Facility Planning staff also advised that the hospital is planning on adding 150 beds by 2030. The current staff to bed ratio (10.9 hospital staff per bed) was applied to these new beds.

Comparison of Population Forecasts

The population projections for the water demand forecasts were compared to the projections developed by the Virginia Employment Commission (VEC). The VEC develops population projections for the Commonwealth, and the most recent projections are through 2030.

According to a long-established VEC internal policy (dating from August 13, 1976), the VEC acknowledges the difficulties with long-range population forecasting. A table in this policy outlines the "permissible deviation" from the state forecasts for eleven different population ranges. In general, the permissible deviation decreases with increasing population. According to VEC, the permissible deviation based on the 2030 population is 10-percent for Albemarle County and 16-percent for the City of Charlottesville.

VEC's 2010 population projections were developed prior to the release of the 2010 Census data and were lower than the actual 2010 Census data. VEC's forecasts were adjusted to start at the 2010 Census numbers, which resulted in a population increase of 2,836 for the City of Charlottesville and 2,723 for Albemarle County over the VEC's 2010 population projections. The rate of growth from the VEC projections was held constant to provide a 2030 VEC-forecasted population of 45,114 for the City of Charlottesville and 123,179 for Albemarle County using the actual 2010 Census population numbers as a starting point.

A majority of the on-grounds students (93-percent) live in Albemarle County but receive water from the City of Charlottesville (see University of Virginia text box on the previous page). The comparison to the VEC projections uses the population based on where students live. Therefore, the population numbers for this comparison shows the on-grounds students in Albemarle County in the Albemarle County population.

The 2030 population projections for the City of Charlottesville and Albemarle County were compared to the 2030 VEC population forecasts (adjusted based on the 2010 census). The City of Charlottesville's projection of 50,583 in 2030 was 11.4-percent higher than these VEC's projections, which is within the 16-percent allowable deviation contained in the VEC 1976 Policy. The population for Albemarle County in 2030 is 132,868, or 7.6-percent above the VEC forecasts, which is also within the allowable 10-percent deviation. This comparison confirmed that the population projections used for the water demand forecasts are within the reliable range as defined by the VEC.

Employment

Current employment data was based on the 2010 U.S. Department of Labor Quarterly Census of Employment and Wages (QCEW). Employment forecasts were not available through 2060. Most of the employment forecasts completed by the Virginia Employment Commission (VEC) and Weldon Cooper were for the near-term future (2018) and included a wider geographic extent than the Regional Water Supply Plan. Most of the comprehensive land use plans; however, included a ratio of jobs per household and/or jobs per capita. Therefore, this ratio was used to project the future employment based on the future population forecasts.

- **Urban area**: The City of Charlottesville's Comprehensive Land Use Plan did not include a ratio of employment per household or employment per capita, so one was developed. As the unemployment rate in 2010 is high at 7.7-percent, the ratio was based on an average of the employment per household for 2005 and the employment per household in 2010. The employment for 2005 and 2010 was based on the QCEW data and the 2005 and 2010 population was from the U.S. Census data. The resulting ratio was 1.95 jobs per household for the City. The 2010 Crozet Master Plan included the population per household ratios for both the Crozet area and for Albemarle County. The Albemarle County ratio of 1.22 jobs per household was used for the ACSA urban area.
- **Crozet**: The 2010 Crozet Master Plan ratio of 0.74 jobs per household was used.
- **Town of Scottsville**: An average historical employment rate of 175 employees was used for this analysis based on discussion with staff. This assumes that the tire manufacturing facility will be re-purposed at the average historical employment levels.
- **CWS and self-supplied**: The water demands for the population served by these systems were calculated using the per capita method and therefore future employment was not needed for this analysis.
- **University of Virginia:** The basis for the UVA employment is outlined in the text box presented previously.

The results are presented in Table 13 and were submitted to and reviewed for reasonableness by the stakeholders.

Table 10: University of Virginia Student Population Breakdown (2010-2060)

Character Area [1]	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
UVA Students Total[2]	**21,000**	**22,000**	**23,000**	**24,000**	**25,000**	**26,000**	**27,000**	**28,000**	**29,000**	**30,000**	**31,000**
On-Grounds[3]	**6,600**	**6,820**	**7,130**	**7,440**	**7,750**	**8,060**	**8,370**	**8,680**	**8,990**	**9,300**	**9,610**
Charlottesville	450	450	450	450	450	450	450	450	450	450	450
Albemarle County	6,150	6,370	6,680	6,990	7,300	7,610	7,920	8,230	8,540	8,850	9,160
Off-Grounds[4]	**14,400**	**15,180**	**15,870**	**16,560**	**17,250**	**17,940**	**18,630**	**19,320**	**20,010**	**20,700**	**21,390**
Charlottesville	9,300	9,680	10,120	10,560	11,000	11,440	11,880	12,320	12,760	13,200	13,640
Albemarle County	5,100	5,500	5,750	6,000	6,250	6,500	6,750	7,000	7,250	7,500	7,750

Note:

1. The “On-Grounds” and “Off-Grounds” student totals are the sum of the “Charlottesville” and “Albemarle County” values.
2. Current and future projections provided by the UVA Academic Facilities Planning Department.
3. “On-Grounds Students” includes all students living on-grounds. 2010 data was provided by the UVA Academic Facilities Planning Department. Percentage of students living on-grounds was assumed to remain constant through 2060.
4. “Off-Grounds Students” includes off-grounds students living in the City of Charlottesville and Albemarle County. The number of students living off-grounds in the City of Charlottesville was provided by the UVA Parking and Transportation Department. The percentage of students living off-grounds in the City of Charlottesville was assumed to remain constant through 2060.

Table 11. City of Charlottesville Population Forecasts (2010 – 2060): City Population and City Water Service Area Population

Character Area [1, 2, 3]	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
City Population	**43,475**	**45,152**	**46,894**	**48,704**	**50,583**	**52,534**	**54,561**	**56,666**	**58,853**	**61,123**	**63,482**
On-Grounds Students	450	450	450	450	450	450	450	450	450	450	450
Off-Grounds Students	9,300	9,680	10,120	10,560	11,000	11,440	11,880	12,320	12,760	13,200	13,640
Residents	33,725	35,022	36,324	37,694	39,133	40,644	42,231	43,896	45,643	47,473	49,392
City Population + On-Grounds Students living in Albemarle County (see Table 12) = City Water Service Area Population											
City Water Service Area Population	**49,625**	**51,522**	**53,574**	**55,694**	**57,883**	**60,144**	**62,481**	**64,896**	**67,393**	**69,973**	**72,642**
On-Grounds Students	6,600	6,820	7,130	7,440	7,750	8,060	8,370	8,680	8,990	9,300	9,610
Off-Grounds Students	9,300	9,680	10,120	10,560	11,000	11,440	11,880	12,320	12,760	13,200	13,640
Residents	33,725	35,022	36,324	37,694	39,133	40,644	42,231	43,896	45,643	47,473	49,392

Notes:

1. 2010 population is based on the U.S. Census data.
2. Population forecasts are based on data provided by the stakeholders during meetings held in Summer 2011.
3. "**City Population**" and "**City Water Service Area Population**" totals are the sum of the respective "On-Ground Students" + "Off-Ground Students" + "Residents" values.

Table 12: Albemarle County Population Forecasts (2010 – 2060): County Population and County Water Population

Character Area [1, 2]	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
County Population[3]	**98,970**	**107,445**	**115,919**	**124,394**	**132,868**	**141,343**	**149,818**	**158,292**	**166,767**	**175,242**	**183,716**
ACSA Urban[4]	**57,245**	**63,658**	**70,070**	**76,483**	**82,895**	**89,308**	**95,720**	**102,133**	**108,545**	**114,958**	**121,370**
On-Grounds Students	**6,150**	**6,370**	**6,680**	**6,990**	**7,300**	**7,610**	**7,920**	**8,230**	**8,540**	**8,850**	**9,160**
Off-Grounds Students	5,100	5,500	5,750	6,000	6,250	6,500	6,750	7,000	7,250	7,500	7,750
Residents	45,995	51,788	57,640	63,493	69,345	75,198	81,050	86,903	92,755	98,608	104,460
Crozet	5,562	6,366	7,170	7,973	8,777	9,581	10,385	11,189	11,992	12,796	13,600
Scottsville	618	649	680	712	743	774	806	837	868	900	931
CWS	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611
Self-Supplied	32,934	34,161	35,388	36,615	37,842	39,069	40,296	41,523	42,750	43,977	45,204
ACSA Urban Population – On-Grounds UVA Students living in Albemarle County = ACSA Urban Water Population											
County Water Population[5]	**92,820**	**101,075**	**109,239**	**117,404**	**125,568**	**133,733**	**141,898**	**150,062**	**158,227**	**166,392**	**174,556**
ACSA Urban Water[4]	**51,095**	**57,288**	**63,390**	**69,493**	**75,595**	**81,698**	**87,800**	**93,903**	**100,005**	**106,108**	**112,210**
On-Grounds Students	0	0	0	0	0	0	0	0	0	0	0
Off-Grounds Students	5,100	5,500	5,750	6,000	6,250	6,500	6,750	7,000	7,250	7,500	7,750
Residents	45,995	51,788	57,640	63,493	69,345	75,198	81,050	86,903	92,755	98,608	104,460
Crozet	5,562	6,366	7,170	7,973	8,777	9,581	10,385	11,189	11,992	12,796	13,600
Scottsville	618	649	680	712	743	774	806	837	868	900	931
CWS	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611
Self-Supplied	32,934	34,161	35,388	36,615	37,842	39,069	40,296	41,523	42,750	43,977	45,204

Notes:

1. 2010 population is based on the U.S. Census data.
2. Population forecasts are based on data provided by the stakeholders during meetings held in Summer 2011.
3. County Population equals the sum of "ACSA Urban", "Crozet", "Scottsville", "CWS", and "Self-Supplied" populations.
4. The ACSA Urban Population equals the sum of "On-Grounds Students", "Off-Grounds Students", and "Residents"
5. County Water Population equals the sum of "ACSA Urban Water", "Crozet", "Scottsville", "CWS", and "Self-Supplied" populations.

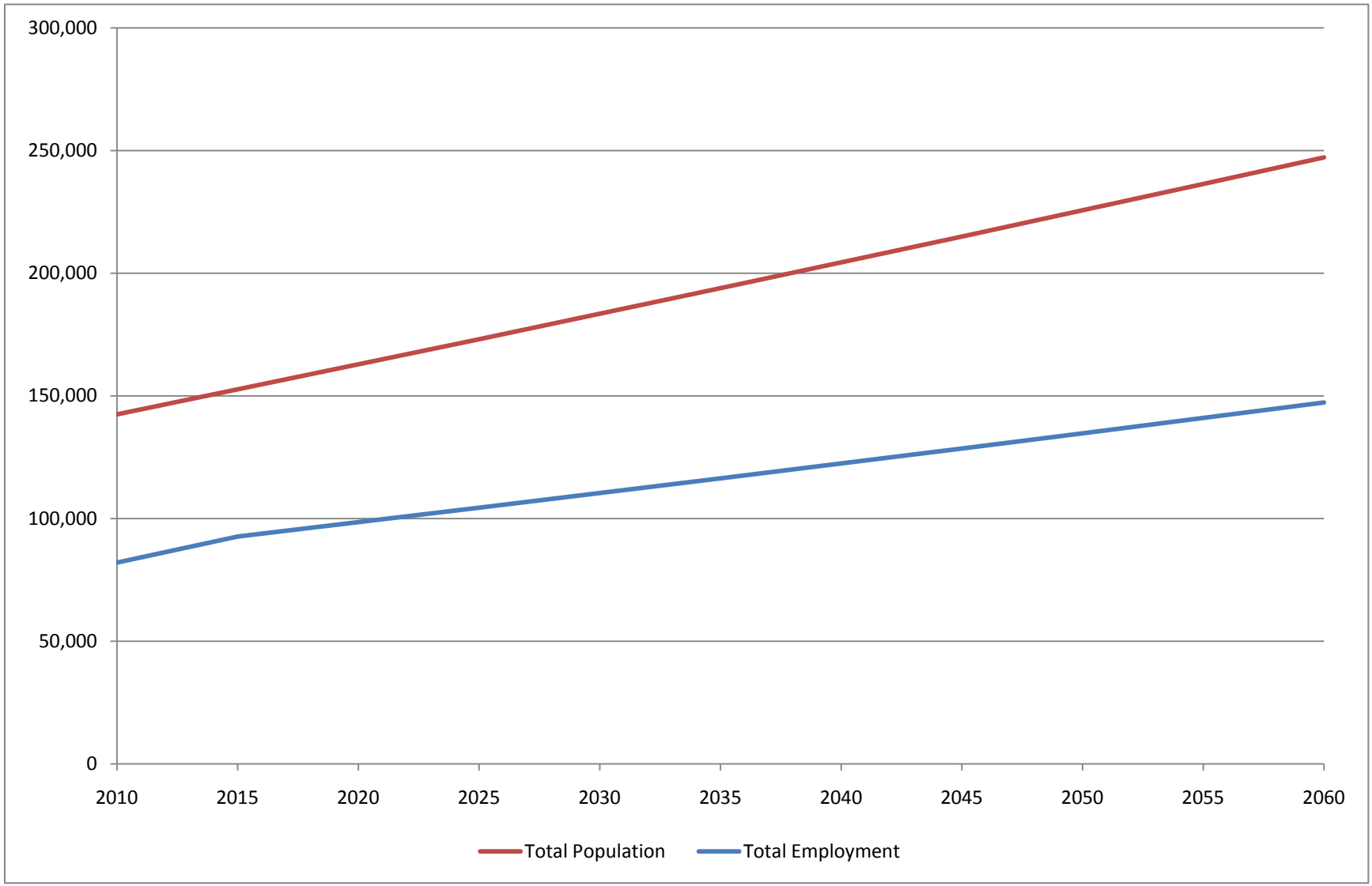
Table 13. Employment Forecasts by Water Area (2010 – 2060)

Character Area [1, 2]	E:H Ratio[3]	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
TOTAL		**81,997**	**92,672**	**98,512**	**104,403**	**110,350**	**116,353**	**122,415**	**128,537**	**134,724**	**140,976**	**147,297**
City of Charlottesville (Urban)	1.95	34,644	40,199	41,800	43,453	45,161	46,926	48,749	50,633	52,581	54,594	56,676
Albemarle County		47,353	52,473	56,712	60,950	65,189	69,427	73,666	77,904	82,143	86,382	90,621
ACSA Urban	1.22	45,540	50,293	54,279	58,264	62,250	66,235	70,221	74,206	78,192	82,178	86,163
Crozet	0.74	1,638	2,005	2,258	2,511	2,764	3,017	3,270	3,523	3,776	4,029	4,283
Town of Scottsville	N/A	175	175	175	175	175	175	175	175	175	175	175
University of Virginia[4]												
UVA– Total		13,000	13,741	14,482	15,223	15,963	16,297	16,630	16,963	17,297	17,630	17,963
UVA Faculty/Staff		7,000	7,333	7,667	8,000	8,333	8,667	9,000	9,333	9,667	10,000	10,333
UVA Hospital		6,000	6,408	6,815	7,223	7,630	7,630	7,630	7,630	7,630	7,630	7,630

Notes:

1. 2010 employment is based on the U.S. Department of Labor Quarterly Census of Employment and Wages data.
2. Employment forecasts are based on data provided by RWSA and the stakeholders during meetings held in Spring 2011.
3. E:H Ratio is the employment: housing ratio used.
4. The employment for the University of Virginia is included in the City of Charlottesville and ACSA Urban area.

Figure 12. Population and Employment Forecasts for the Regional Water Supply Planning Area (2010 – 2060)



Baseline Water Demands

The baseline water demands represent the future water need if the existing trends remain constant into the future. The projected baseline demands were calculated by multiplying the population and employment from the previous section by the residential per capita water use and per employee water use in Table 3, respectively, as shown in Figure 13. The volume of non-revenue water (determined as a percent non-revenue factor multiplied by the demand sub-total) was added to yield the total baseline water demand. The water demands were developed for each of the four character areas; Urban, Crozet, Scottsville, and CWS. The Urban baseline water demand was further disaggregated into the City of Charlottesville, ACSA urban, and UVA areas.[12] The draft baseline water demands are shown in Table 14.

Figure 13. Baseline Water Demand Forecast Calculation

[12] The number of persons served by the ACSA was calculated by multiplying the total number of residential accounts by 2.35, the average number of people per household for the City of Charlottesville based on the U.S. Census American Community Survey as a five-year average from 2006 to 2009.The number of persons served by the City of Charlottesville is assumed to be the total population in the City.

Table 14. Baseline Water Demands by Character Area for 2010 through 2060 (in MGD)

Character Area	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
City of Charlottesville	5.13	5.65	5.87	6.10	6.34	6.59	6.85	7.11	7.39	7.67	7.96
ACSA Urban	4.63	5.17	5.68	6.20	6.71	7.22	7.73	8.25	8.76	9.27	9.79
Urban Total	9.76	10.82	11.55	12.3	13.05	13.81	14.58	15.36	16.15	16.94	17.75
Crozet	0.43	0.50	0.56	0.62	0.68	0.75	0.81	0.87	0.93	1.00	1.06
Town of Scottsville	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.10
Urban + Crozet + Scottsville Total	10.27	11.4	12.19	13.01	13.82	14.65	15.48	16.32	17.17	18.04	18.91
CWS	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Self Supplied	2.75	2.85	2.96	3.06	3.16	3.26	3.37	3.47	3.57	3.68	3.78
Regional Water Supply Plan Total[1]	13.24	14.47	15.37	16.29	17.2	18.13	19.07	20.01	20.96	21.94	22.91
UVA[2]	2.17	2.28	2.39	2.50	2.61	2.70	2.78	2.87	2.96	3.04	3.13

Notes:

1. Regional Water Supply Plan Total equals the sum of "Urban + Crozet + Scottsville Total", "CWS" and "Self Supplied"
2. The UVA water demands are included in the City of Charlottesville and ACSA Urban water demands.

Water Demand Forecasts

The baseline water demands represent an extension of current trends and are a starting point for other considerations. Starting from the baseline water demand forecasts, several different scenarios were evaluated to determine the most representative future water demands. The scenarios evaluated in this section include:

- Water Conservation: Continue Implementation of Existing Programs – reflects continued demand reductions associated with the existing water conservation program as well as the demand reductions associated with the Energy Policy Act of 1992.
- Additional Water Conservation Initiatives: New Mandatory Programs – reflects additional water conservation programs to reflect a best-in-class conservation program.
- Increase in Population/ Employment – recognizes a potential increase in forecasted population and employment. An increase of 5-percent in 2060 was used.
- Decrease in Population/ Employment - recognizes a potential decrease in forecasted population and employment. A decrease of 5-percent in 2060 was used.
- Other Changes in Water Use Patterns – includes a discussion of changes that were considered but not calculated as part of the draft forecasts.

These scenarios are described in greater detail below followed by the resulting forecasted water demands.

Water Conservation: Continue Implementation of Existing Programs

This scenario includes continued demand reductions associated with the existing water conservation program as well as demand reductions associated with "passive" conservation through implementation of the National Energy Policy Act of 1992. This scenario also addresses future improvements in water efficiency associated with future mandates of more efficient fixtures.

The National Energy Policy Act includes provisions for plumbing fixtures, such a toilets, faucets, and showerheads. The National Energy Policy Act does not include conditions for appliances, such as clothes washers. The State of Virginia Plumbing Code (Section 604.4) adopted these fixtures standards within the Commonwealth, also referenced in the Virginia Uniform Statewide Building Code.

Although more efficient showerheads and faucets are included in the National Energy Policy Act and the Virginia Plumbing Code, the replacement of these fixtures and the potential savings are less certain than the savings associated with toilet fixtures. Therefore, the savings for these fixtures (e.g., faucets and showerheads) were not explicitly calculated as part of the water conservation analysis. The assumptions for the conversion of toilets provided some allowance for the anticipated savings from showerheads and faucets, as described in the National Energy Policy Act description on the following pages.

National Energy Policy Act

The National Energy Policy Act limits the sale of fixtures (showerheads, faucets, and toilets) to higher efficiency fixtures. By law, anyone choosing to update these fixtures is limited to fixtures that meet or exceed these standards. There have been some challenges with implementation of this act, as described below.

Showerheads: The National Energy Policy Act limits the sale of showerheads to 2.5 gallons per minute (gpm) at a pressure of 80 pounds per square inch (psi). If the system pressure is greater than 80 psi, the fixture will operate at a higher flow rate and the water savings will be reduced. Despite the Federal requirements, there are a number of new showerheads sold today that are non-conforming. In some cases, fixtures are knowingly sold at higher flow rates, in some cases they are incorrectly tested and/or labeled, and in some cases the flow rate is adjustable so that only the lowest setting is in conformance but the user could adjust to higher, non-conforming settings.

In addition to the availability of non-conforming fixtures, there is an increasing trend of the installation of multiple showerheads in a single stall (not illegal) and non-compliant showerheads due to tampering (removing the flow restrictor disk) to increase the flow rate. These challenges are also noted by the Alliance for Water Efficiency website; "Water savings will only be achieved if the new showerhead is retained and not altered to excessive flows." Without the inspection and testing of a representative and random sampling of shower fixtures in Albemarle County and the City of Charlottesville, the impacts of non-conforming and non-compliant fixtures on current and future water demand reductions cannot be reasonably estimated.

It should also be noted that installing showerheads with flow rates less than 2.5 gpm is not recommended due to safety concerns. From the Alliance for Water Efficiency website; "As showerhead flow rates have decreased, the incidents of accidental scalding have increased; caused by the loss of thermal buffering in water volume when water supply temperatures change suddenly. Thermostatic mixing valves prevent this problem… to date, thermostatic mixing valves are only tested and certified for flows of 2.5 gpm or greater."

Continued on following page

National Energy Policy Act (continued)

Faucets: The National Energy Policy Act limits the sale of faucets to 2.2 gpm at a pressure of 60 psi. The Alliance for Water Efficiency website states that "the water savings (from faucets) are small when compared to replacing toilets". Several of the challenges associated with replacing showerheads are prevalent for faucets. For most faucets, it is as easy to alter the flow rate as it is to open a plastic bottle; simply turn the aerator until it is removed.

Similar to the multiple spray showerheads, the automated shut-off faucets have become very popular but result in higher water use. Multiple studies have shown that the infrared automatic shut-off faucets use more water than the traditional fixtures. These fixtures are commonly preferred by consumers because they are convenient and reduce the exchange of germs (the consumer does not have to touch the fixture after washing). These automatic faucets are allowed under the plumbing code and the common installation of these fixtures also impacts the potential water savings associated with low flow faucet installation.

Since the water savings from faucets are smaller than other fixtures there is insufficient data to appropriately quantify the future savings, the savings from faucets were not directly calculated. If additional data was collected on the existing faucets in Albemarle County and the City of Charlottesville, then these savings may be able to be directly calculated for future water demand forecasting exercises.

Toilets: The National Energy Policy Act limits the sale of toilets to 1.6 gallons per flush or more efficient. The estimate for the potential for toilet rebates is conservative (i.e., may over-estimate the potential future water savings). All of the homes built prior to 1994 (based on housing age data from the City of Charlottesville and Albemarle County) were assumed to have older fixtures. A natural plumbing fixture conversion rate of 2-percent per year was applied from 1994 to 2060. In reality, the popularity of home improvement television shows and the recent availability of designer toilet fixtures have likely increased the fixture conversion rate to a rate greater than 2-percent per year. The rate of replacement is not available through building permits or home improvement stores, which serve a greater region than this Regional Water Demand Analysis. Given the complexity with estimating the age of toilet fixtures, the fixtures were assumed to be the same age as the home with the exception of the 2-percent replacement rate applied from 1994 to 2060. In part this assumption was made with an understanding that some showerheads and faucets will be replaced, although the data is not available to calculate these anticipated savings.

The potential savings associated with the conversion of older, less efficient toilet fixtures includes two separate elements; natural replacement by homeowners over time (related to the National Energy Policy Act) and toilets replaced through participation in the existing, voluntary toilet rebate program.

As described on the previous page, the natural replacement calculation assumes that toilets installed prior to 1994 are replaced at a rate of 2-percent per year through "passive" conservation, as part of compliance with the National Energy Policy Act.

Information on the age of housing structures and estimates of the number of toilet fixtures per house were provided by both the City of Charlottesville and Albemarle County. Table 15 shows the number of toilets associated with pre-1994 homes.

Table 15. Estimated Number of Toilets in Homes Constructed prior to1994

Housing Stock Age	City of Charlottesville	Albemarle County
Pre-1994 (to be Replaced)	20,207	61,658
Post-1994 (Efficient)	3,369	30,992

Water efficient technologies are continuing to improve and currently, there are many communities (California and Atlanta, GA) which require 1.28 gallon per flush toilets by law, exceeding the current National Energy Policy Act. This analysis assumed that there will be a change in the National Energy Policy Act that will require 1.28 gallon per flush toilets at sometime during the 50-year planning horizon. For this analysis, toilets that are replaced after 2018 were assumed to be replaced with a 1.28 gallon per flush fixture.

In addition to this "natural conservation" or natural replacement, this scenario includes conservation savings associated with the voluntary toilet rebate program. The current replacement rate of 6-percent per year for the City of Charlottesville and 1.5-percent per year for ACSA were forecasted to continue.

Additional reductions associated with the continued implementation of the voluntary water conservation measures, water conservation education program, and outdoor watering schedules were not explicitly calculated. The savings associated with these programs are already factored into the per capita water use calculated based on the 2006 to 2010 water use.

The continuation of existing water conservation programs could result in a 3.9-percent reduction in total demand for the year 2060 compared to the baseline demand. This scenario assumes that toilets have previously been replaced at a nominal rate of 2-percent per year in addition to the rebated fixtures. The potential future water savings from the replacement of older fixtures will decrease if a greater proportion of inefficient toilets have already been replaced.

Additional Water Conservation Initiatives – New Mandatory Programs

This scenario is intended to represent a "best-in-class" water conservation program, and includes new measures to be adopted, enforced and embraced. These new water conservation measures would build on the existing water conservation program (i.e., the potential savings identified include the savings from the continued implementation of the exiting program).

The new measures outlined in this section will require the support of the elected officials and the public as they include new mandatory water conservation programs as well as some new incentives that would require budget support. The cost of implementing these water conservation measures has been estimated based on available data. The new measures included in this example "best-in-class" water conservation program are outlined in Table 16. These savings will not be realized without adoption of enforceable policies. The Virginia Department of Environmental Quality would likely require copies of adopted ordinances or policies before relying on the decrease in demands reflected in this scenario.

The new water conservation program measures shown in Table 16 were selected based on reviewing commonly implemented water conservation programs successful in other communities and based on the water use profile outlined in Tables 2 through 5. There are a number of water conservation programs that could be implemented, but these new water conservation programs were considered to be representative of possible water conservation measures and were picked based on the water use by customer type and water use by end use analysis. Some of these programs, such as the "new residential water efficiency requirements" may be difficult to adopt in the Commonwealth[13]. A more comprehensive water conservation analysis could compare the individual cost and benefit of a wider range of water conservation measures, if there is strong support for additional measures.

Table 16. New Water Conservation Program Assumptions

Measure	Description	Area	Anticipated 2060 Savings	Anticipated Cost through 2060
Adopt Aggressive Conservation Rate Structure [1]	Currently ACSA has strong tiered rate structures that encourage water conservation. Adopting similar rates in the City of Charlottesville could encourage additional water conservation and may achieve up to a 5-percent water savings in 2060[14]. These tiered structures are typical	Urban	0.16 MGD	$75,000
		Crozet	N/A	N/A

[13] Because of the "Dillon Rule" in the Commonwealth, a new State enabling legislation would be required before the "new residential water efficiency requirements" could be mandated in the City of Charlottesville and Albemarle County.

[14] http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/rates/White-Paper-Rate-Structures-and-Conservation-March-13-2009.pdf

Measure	Description	Area	Anticipated 2060 Savings	Anticipated Cost through 2060
	for residential properties but occasionally apply to all customers.	Scottsville	N/A	N/A
New Multi-Family Sub-Metering Requirements [2]	Adopt new ordinances or policies that require new multi-family (MF) properties to sub-meter each unit. The *National Multiple Family Submetering and Allocation Billing Program Study* showed that sub-metering could reduce new multi-family water consumption by up to 15-percent[15].	Urban	0.12 MGD	$1,800,000
		Crozet	0.010 MGD	$140,000
		Scottsville	0.0003 MGD	$5,500
New Residential Water Efficiency Requirements [3]	Adopt new ordinances or policies that require that all new residential properties meet "best in class" water efficiency requirements. This requirement is modeled after the new EPA WaterSense New Homes program that projects a savings of up to 20-percent for new single-family residential properties[16].	Urban	0.71 MGD	$87,000,000
		Crozet	0.073 MGD	$8,000,000
		Scottsville	0.0021 MGD	$350,000
New Residential Rebates for High Efficiency Clothes Washers [4]	Adopt a new rebate program ($100) to encourage purchase of higher water efficiency washers. The savings assume that 1-percent of owner-occupied households with washing machines will participate each year in the voluntary rebate program. The high efficiency washing machines are up to 45-percent more efficient[17].	Urban	0.14 MGD	$6,000,000
		Crozet	0.011 MGD	$450,000
		Scottsville	0.0007 MGD	$30,000
New Commercial Rebate for Cooling System Improvements [5]	Adopt a new rebate or tax incentive program ($600) to encourage improvements. On average, cooling tower retrofits may reduce the water needs by up to 20-percent for the inefficient systems that participate.	Urban	0.05 MGD	$10,000,000 - $40,000,000
		Crozet	0.002 MGD	$500,000 - $2,000,000
		Scottsville	0.0004 MGD	$150,000 - $600,000

[15] *National Multiple Family Submetering and Allocation Billing Program Study.* Aquacraft for East Bay Municipal Utility District, CA. 2004.
[16] U.S. EPA. WaterSense New Home Program. http://www.epa.gov/WaterSense/spaces/new_homes.html
[17] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

Notes:

1. Costs for conservation rates include the estimated cost for a rate study for the City of Charlottesville.
2. Costs for the Multi-Family Sub-metering program reflect include cost to the local government (approximately 10%) and cost to the builder (approximately 90%) based on national averages. Assumes an additional cost to the government of $25/household for program administration and inspections and $250/household for the installation of a meter.
3. Costs for new residential water efficiency requirements reflect include cost to the local government (approximately 1%) and cost to the builder (approximately 99%) based on national averages. Assumes an additional cost to the government of $25/household for program administration and inspections and $3,000/household for the difference in development costs based on national estimates.
4. Costs for clothes washer rebates reflect include cost to the local government for the rebates (approximately 20%) and cost to the builder and/or homeowner (approximately 80%) based on national averages. Includes the cost to the local government of the $100 rebate and the additional cost of $350 paid by the homeowner for the new washing machine (assume a water efficient machine costs $600 and a non-efficient machine costs $200).
5. Costs for cooling tower rebates reflect the cost to the local government for the rebates (approximately 5-10%) and cost to the owner (approximately 90-95%) based on national averages. Includes the cost to the local government of $600 per rebate and the cost to the industry of $5,000 to $20,000.

The adoption of additional water conservation programs in addition to the continuation of existing water conservation programs could result in an11-percent reduction in total demand for the year 2060 compared to the baseline demand (includes the savings from the continued implementation of existing water conservation measures). This scenario assumes that enforceable programs and policies have been adopted by the City Council and Albemarle County Service Authority Board of Directors and appropriate funding sources secured for implementation.

Population/Employment Increase

Albemarle County and the City of Charlottesville have recently begun a comprehensive land use planning process that will look more closely at future population and employment forecasts. This process, however, is expected to take multiple years and therefore the results will not be available until after the November 2011 Regional Water Supply Planning deadline. Given the potential for changes in the population and employment, this analysis considered both a potential increase and decrease in population and employment. If the results of the population and employment forecasts associated with the comprehensive land use planning process vary significantly from these estimates, the Regional Water Supply Plan should be reviewed and updated.

There are several potential sources for an increase in the 2060 population and employment forecasts such as the National Ground Intelligence Center, increased enrollment at UVA, increases in density, or increases in the urban growth boundary. Population and employment may also rise in the future as population and employment migrate inward from the coast. Studies indicate that the sea level is rising and the City of Charlottesville and Albemarle County could be a destination for inward migration[18].

This scenario considered a 0.1-percent per year increase in the forecasted population, or 5-percent by 2060. These population increases also translate into increases in employment. The population and

[18] http://papers.risingsea.net/federal_reports/shore-protection-retreat-sea-level-rise-Virginia.pdf#page=52

employment increases in the year 2060 are shown in Table 17, along with some of the actions that could result in these increases. These actions primarily involve future increases to the urban growth boundary.

Table 17. Potential Increases to 2060 Population and Employment

Character Area	Population	Employment	Potential Sources
Charlottesville	+3,632	+2,834	Increased UVA enrollment Increases in density
Albemarle County[1]	+8,728	+4,531	National Ground Intelligence Center Changes in the Urban Growth Boundary
Urban - ACSA	+5,611	+4,317	Changes in the Urban Growth Boundary
Crozet	+680	+214	Increases in density
Scottsville	+47	0	Increases in density

Notes:

1. The Albemarle County population increase includes the increases listed for the ACSA Urban area, Crozet, and Scottsville.

The increase in population and employment scenario could result in a 4.1-percent increase in water demand for the year 2060 compared to the baseline demand. This scenario assumes that the adopted zoning and land use plans are consistent with the additional increase in population.

Population/Employment Decrease

Similar to the increase in population and employment, it is possible that the population and employment forecasts have overstated future growth. The lower population and employment could be associated with changes to the urban growth areas or slower growth than forecasted. Some residents have urged the City of Charlottesville and Albemarle County to adopt policies to reduce the anticipated future population and employment, and feel that the growth forecast should be made on that basis. This scenario considered the corresponding decrease in population and employment of 0.1-percent per year, or 5-percent by 2060. Table 18 shows the potential decrease in 2060 population and employment and changes that could result in lower future water demand forecasts.

Table 18. Potential Decrease to 2060 Population and Employment

Character Area	Population	Employment	Potential Sources
Charlottesville	-3,632	-2.834	Density allowances not achieved UVA enrollment follows a true distance learning model
Albemarle County[1]	-8,728	-4,531	Biscuit Run density is not "re-allocated" Slower than anticipated population growth
Urban - ACSA	-5,611	-4,317	Slower than anticipated population growth
Rural (Crozet)	-680	-214	Slower than anticipated population growth
Scottsville	-47	0	Slower than anticipated population growth

Notes:

1. The Albemarle County population increase includes the increases listed for the ACSA Urban area, Crozet, and Scottsville.

The decrease in population and employment scenario could result in a 4.1-percent decrease in water demand for the year 2060 compared to the baseline demand. This scenario assumes that growth is slower than previously anticipated and therefore the forecasted demands will occur beyond the 2060 planning horizon.

Other Changes in Water Use Patterns

There are other changes that were considered but not evaluated as there was little or no change anticipated. These potential factors should be periodically reviewed and re-evaluated as conditions in the regional water supply planning area change to the extent that future water demands are impacted.

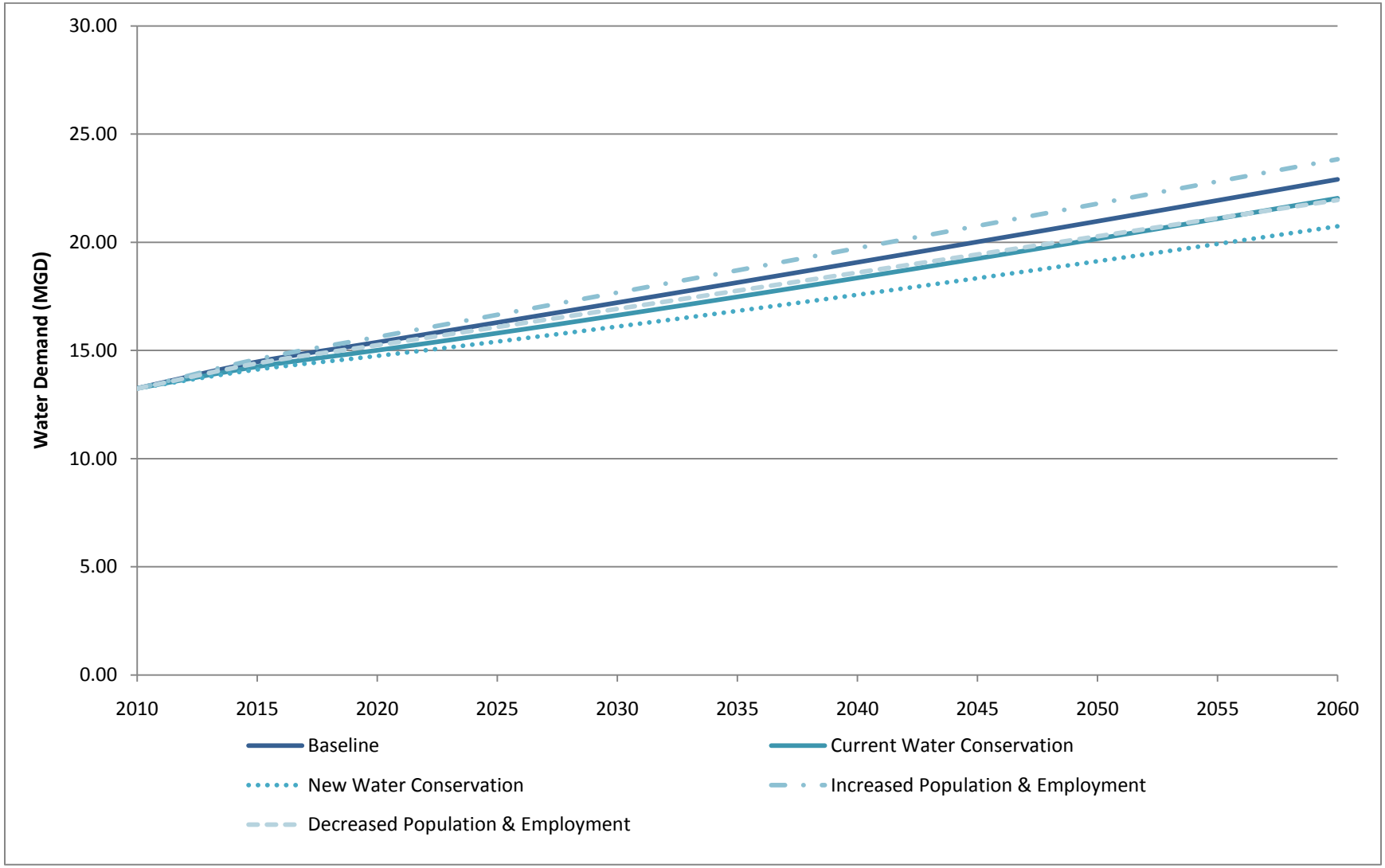
- **Non-Revenue Water** – Currently, most of the RWSA service area has a very low percentage of NRW at 13-percent. This very low level of NRW will likely increase in the next 2 years associated with an increase in the preventative water line flushing program. RWSA will be changing operations to use chloramines for disinfection instead of free chlorine to comply with national safety standards. This change will require a more routine line flushing program to meet drinking water quality standards. While increases are anticipated, the hope is that the ongoing leak detection and line replacement programs will maintain the current level of NRW into the future.
- **Per Capita Water Use** – The overall current per capita water use of 99.8 gpcd is very low compared to the national survey shown in Figure 5. Additional reductions in the per capita water use were considered; however the existing and future water conservation efforts effectively reduced the per capita water use and therefore additional manual reductions were not considered appropriate.
- **Per Employee Water Use** – The per employee water use could change substantially depending on the type of new industries or businesses in Albemarle County and the City of Charlottesville. If new employment is more water intensive, such as manufacturing or some research operations, the overall water needs will increase. As future employment information was not

available in the level of detail needed, no adjustments were made to the per employee water use.

- **Outdoor Water Use** – Currently, the average outdoor water use is approximately 12-percent of total use. As discussed in the weather normalization section, the weather patterns are expected to continue to grow more dramatic with higher rainfall intensities and greater spacing between rainfall. The outdoor water use may increase as a result of these changes in weather patterns. As discussed previously, insufficient information is available to forecast the expected weather changes.

Figure 14 presents the range of regional water demand forecasts as presented in this section for the entire Regional Water Supply Planning area.

Figure 14. Range of Regional Water Demand Forecasts for the Regional Water Supply Planning Area (2010 to 2060)



Most Probable Water Demand Forecasts

The Virginia Local and Regional Water Supply Planning Regulation states that the regional water supply plan shall be designed to (i) ensure that adequate and safe drinking water is available" and to "(iv) promote conservation." With these goals in mind, the water demand forecasts associated with continued implementation of the existing water conservation program are considered the "most probable". These forecasts, shown in Table 19, are based on the current zoning and land use plans and on currently adopted and enforceable water conservation measures.

Continued implementation of the existing water conservation program would likely yield the following human water demands by service area in 2060:

- Urban Service Area should plan for 16.96 MGD
- Crozet Service Area should plan for 0.99 MGD
- Scottsville Service Area should plan for 0.09 MGD
- The Community Water Systems should plan for 0.22 MGD
- The self-supplied area should plan for 3.78 MGD

As stated in AWWA M50, "all forecasts are inherently flawed." To this end, monitoring the demands over a period of many years and making adjustments as the trends in a community change is recommended. The Virginia Local and Regional Water Supply Planning Regulation requires that the demands be reviewed every 5 years and revised as necessary and resubmitted every 10 years. If zoning changes are implemented and/or the more aggressive water conservation programs are implemented, monitored and documented to be successful, then the water demands can be adjusted in future updates to the Regional Water Supply Plan. Similarly, if the higher per capita rates seen prior to 2003 return, the demands should be adjusted in future updates to the Regional Water Supply to reflect that change in conditions.

If the region would like to reduce these planned water demands, then ACSA and the City of Charlottesville would need to promptly adopt the ordinances and budgets needed to support the enhanced water conservation measures outlined in this report. The ACSA and City of Charlottesville would need to establish programs to monitor the water savings over a 10 year period to develop a basis for future forecasting efforts.

The basis and calculations for the water demand forecasts for each of the character areas are presented in individual profiles in Appendix A.

Table 19. Most Probable Water Supply Planning Forecasts by Supply Area for 2010 through 2060 (in MGD)

Scenario	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Urban	9.76	10.61	11.21	11.85	12.51	13.21	13.92	14.66	15.41	16.17	16.96
Crozet	0.43	0.48	0.54	0.59	0.64	0.70	0.76	0.81	0.87	0.93	0.99
Town of Scottsville	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09
CWS and self-supplied	2.97	3.07	3.18	3.28	3.38	3.48	3.59	3.69	3.79	3.89	4.00
TOTAL	13.24	14.24	15.01	15.8	16.61	17.47	18.36	19.25	20.16	21.08	22.04

Note: These forecasts reflect the Continued Implementation of Existing Water Conservation Program Scenario

APPENDIX A: CHARACTER AREA PROFILES

City of Charlottesville (Urban)[19]

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	49,625	51,522	53,574	55,694	57,883	60,144	62,481	64,896	67,393	69,973	72,642
# Employees	34,644	40,199	41,800	43,453	45,161	46,926	48,749	50,633	52,581	54,594	56,676
Residential Demand (MGD)	2.25	2.33	2.43	2.52	2.62	2.72	2.83	2.94	3.05	3.17	3.29
Employment Demand (MGD)	2.30	2.67	2.78	2.89	3.00	3.12	3.24	3.37	3.50	3.63	3.77
Irrigation Demand (MGD)	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003
Total Baseline Demand (MGD)	4.55	5.01	5.21	5.41	5.63	5.85	6.07	6.31	6.55	6.80	7.06
Total Baseline Demand + NRW (MGD)	5.13	5.65	5.87	6.10	6.34	6.59	6.85	7.11	7.39	7.67	7.96
Recommended Water Demand Forecasts[1]	5.13	5.56	5.74	5.94	6.16	6.39	6.64	6.90	7.17	7.45	7.74
New Mandatory Conservation	5.13	5.52	5.65	5.81	5.98	6.17	6.37	6.59	6.81	7.04	7.29
Increased Population & Employment	5.13	5.73	6.02	6.32	6.61	6.90	7.19	7.48	7.78	8.07	8.36
Decreased Population & Employment	5.13	5.65	5.86	6.08	6.29	6.50	6.71	6.93	7.14	7.35	7.56

Notes:

1. This scenario reflects the Continued Implementation of Water Conservation Program scenario.

[19] The City of Charlottesville water demands include the University of Virginia water demands and these should not be summed.

University of Virginia (Urban)[20]

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
On Grounds Demand											
# of Students On Grounds	6,600	6,820	7,130	7,440	7,750	8,060	8,370	8,680	8,990	9,300	9,610
# of Faculty/Staff	7,000	7,333	7,667	8,000	8,333	8,667	9,000	9,333	9,667	10,000	10,333
# of Hospital Staff	6,000	6,408	6,815	7,223	7,630	7,630	7,630	7,630	7,630	7,630	7,630
Student On Grounds Demand (MGD)	0.43	0.44	0.47	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63
Faculty/Staff Demand (MGD)	0.49	0.51	0.53	0.56	0.58	0.60	0.63	0.65	0.67	0.70	0.72
Hospital Demand (MGD)	0.30	0.33	0.35	0.37	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Total On Grounds Baseline Demand (MGD)	1.22	1.28	1.35	1.41	1.47	1.52	1.56	1.60	1.65	1.69	1.73
Total On Grounds Baseline Demand+ NRW (MGD)	1.38	1.44	1.52	1.59	1.66	1.71	1.76	1.81	1.86	1.91	1.95
Off Grounds Demand											
# of Students Charlottesville	9,300	9,680	10,120	10,560	11,000	11,440	11,880	12,320	12,760	13,200	13,640
# of Students ACSA	5,100	5,500	5,750	6,000	6,250	6,500	6,750	7,000	7,250	7,500	7,750
Student Charlottesville Demand (MGD)	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.58	0.60	0.62
Student ACSA Demand (MGD)	0.28	0.30	0.31	0.33	0.34	0.36	0.37	0.38	0.40	0.41	0.42
Total Off Grounds Demand (MGD)	**0.70**	**0.74**	**0.77**	**0.81**	**0.84**	**0.87**	**0.91**	**0.94**	**0.98**	**1.01**	**1.04**
Baseline											
Total UVA Demand (MGD)	1.92	2.02	2.12	2.22	2.31	2.39	2.47	2.55	2.62	2.70	2.78
Total Demand + NRW (MGD)	2.17	2.28	2.39	2.50	2.61	2.70	2.78	2.87	2.96	3.04	3.13
Scenarios (On Ground Demands) (MGD)											
New Mandatory Conservation	1.38	1.43	1.49	1.55	1.61	1.65	1.70	1.74	1.78	1.83	1.87

[20] The UVA demands are included in the City of Charlottesville and ACSA Urban demand calculations and should not be added. All on grounds water is provided by the City of Charlottesville.

ACSA (Urban)[21]

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	51,095	57,288	63,390	69,493	75,595	81,698	87,800	93,903	100,005	106,108	112,210
# Employees	45,540	50,293	54,279	58,264	62,250	66,235	70,221	74,206	78,192	82,178	86,163
Residential Demand (MGD)	2.80	3.14	3.47	3.81	4.14	4.47	4.81	5.14	5.48	5.81	6.14
Employment Demand (MGD)	1.11	1.23	1.33	1.42	1.52	1.62	1.72	1.81	1.91	2.01	2.11
Irrigation Demand (MGD)	0.20	0.22	0.24	0.27	0.29	0.31	0.34	0.36	0.38	0.41	0.43
Total Baseline Demand (MGD)	4.11	4.59	5.04	5.50	5.95	6.41	6.86	7.32	7.77	8.22	8.68
Total Baseline Demand + NRW (MGD)	4.63	5.17	5.68	6.20	6.71	7.22	7.73	8.25	8.76	9.27	9.79
Recommended Water Demand Forecasts[1]	4.63	5.05	5.47	5.91	6.36	6.82	7.28	7.76	8.24	8.73	9.22
New Mandatory Conservation	4.63	4.97	5.32	5.68	6.05	6.44	6.83	7.23	7.64	8.06	8.48
Increased Population & Employment	4.63	5.21	5.78	6.34	6.90	7.46	8.03	8.59	9.15	9.71	10.28
Decreased Population & Employment	4.63	5.11	5.58	6.04	6.51	6.97	7.44	7.90	8.37	8.83	9.30

Notes:
This scenario reflects the Continued Implementation of Water Conservation Program scenario.

[21] The ACSA Urban water demands include the portion of the University of Virginia water demands from the off grounds students living in Albemarle County and these should not be summed.

Crozet (ACSA)

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	5,562	6,366	7,170	7,973	8,777	9,581	10,385	11,189	11,992	12,796	13,600
# Employees	1,638	2,005	2,258	2,511	2,764	3,017	3,270	3,523	3,776	4,029	4,283
Residential Demand (MGD)	0.30	0.34	0.38	0.42	0.47	0.51	0.55	0.60	0.64	0.68	0.72
Employment Demand (MGD)	0.07	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.18	0.19
Irrigation Demand (MGD)	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Total Baseline Demand (MGD)	0.38	0.44	0.49	0.55	0.60	0.66	0.72	0.77	0.83	0.88	0.94
Total Baseline Demand + NRW (MGD)	0.43	0.50	0.56	0.62	0.68	0.75	0.81	0.87	0.93	1.00	1.06
Recommended Water Demand Forecasts[1]	0.43	0.48	0.54	0.59	0.64	0.70	0.76	0.81	0.87	0.93	0.99
New Mandatory Conservation	0.43	0.48	0.52	0.57	0.61	0.66	0.70	0.75	0.80	0.85	0.90
Increased Population & Employment	0.43	0.50	0.57	0.64	0.70	0.77	0.84	0.91	0.98	1.04	1.11
Decreased Population & Employment	0.43	0.49	0.55	0.60	0.66	0.72	0.78	0.83	0.89	0.95	1.01

Notes:
This scenario reflects the Continued Implementation of Water Conservation Program scenario.

Scottsville (ACSA)

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
# of People	618	649	680	712	743	774	806	837	868	900	931
# Employees	175	175	175	175	175	175	175	175	175	175	175
Residential Demand (MGD)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Employment Demand (MGD)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Total Baseline Demand (MGD)	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Total Baseline Demand + NRW (MGD)	0.080	0.081	0.083	0.085	0.086	0.088	0.090	0.091	0.093	0.094	0.096
Recommended Water Demand Forecasts[1]	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09
New Mandatory Conservation	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09
Increased Population & Employment	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10
Decreased Population & Employment	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.10

Notes:
This scenario reflects the Continued Implementation of Water Conservation Program scenario.

Community Water Systems and Self-Supplied

Description	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Community Water Systems											
# of People	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611	2,611
Residential Demand (MGD)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Total Baseline Demand (MGD	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Self-Supplied (Private Wells)											
# of People	32,934	34,161	35,388	36,615	37,842	39,069	40,296	41,523	42,750	43,977	45,204
Residential Demand (MGD)	2.75	2.85	2.96	3.06	3.16	3.26	3.37	3.47	3.57	3.68	3.78
Total Baseline Demand (MGD)	2.75	2.85	2.96	3.06	3.16	3.26	3.37	3.47	3.57	3.68	3.78
Baseline											
Total Baseline CWS & Self-Supplied (MGD)	2.97	3.07	3.18	3.28	3.38	3.48	3.59	3.69	3.79	3.89	4.00

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