Demand Analysis for the Urban Service Area

Prepared For

Prepared By

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Rivanna Water and Sewer Authority
Charlottesville, Virginia

DEMAND ANALYSIS FOR THE URBAN SERVICE AREA

Executive Summary

Background

Since 1973, the Rivanna Water and Sewer Authority (RWSA) has been responsible for providing a safe and dependable water supply to its customers in the City of Charlottesville and the surrounding areas of Albemarle County. Over the years, the population served by RWSA has increased which has resulted in higher water demands. In order to meet future water demands, it is first necessary to predict what those demands will be over the selected planning horizon.

RWSA has contracted with Gannett Fleming, Inc. to review, update and evaluate the demand analysis performed in 1997 for the Urban Service Area system based on currently available information. Vanasse Hangen Brustlin, Inc. (VHB) performed the 1997 demand analysis and the data used in the analysis was through approximately September 1996. This evaluation is intended to review all available data through 2003 and to use it as appropriate to update long-term water demand projections. This study utilizes the same methodology used by VHB in the referenced demand analysis.

Scope of Analysis

The scope of this analysis included: (1) reviewing the previous demand analysis; (2) collecting water usage data from the City of Charlottesville, Albemarle County Service Authority (ACSA), and the University of Virginia (UVA), as well as unmetered water usage up through the year 2003; (3) reviewing the comprehensive plans of the three consumer entities to better predict population and water demand growth over the planning horizon, and (4) determining the projected water demand in the year 2055, taking into account various factors such as water conservation and drought management.

Methodology

Various methods of projecting water demands using historical water demand data and population data are discussed. None of the methods include an allowance for water conservation or drought management. Future water demands can potentially be reduced through water conservation measures and drought management planning. Conventional water supply planning approaches, and current Commonwealth of Virginia requirements, indicate water supplies should be developed to satisfy projected demands. Therefore, drought management is not considered in these demands projections. An adjustment in the selected water demand projection is made to account for active water conservation.

In addition to the data presented in the VHB report, annual water demands and population data from 1996 through 2003 were obtained and reviewed. All population

data is included in current evaluations. However, water demand data was further evaluated for applicability. During the very severe drought of 2002, water demands for UVA, Charlottesville, and ACSA decreased over 20% when compared to 2001 water demands. It is very difficult to determine the individual impact of the temporary drought management measures implemented and the permanent effect of the active water conservation program concurrently implemented (and maintained today). However, the significant reduction in water demands in such a short period suggests the impact is primarily due to the drought management measures. Predicting recovery is also complicated by the unusually wet year in 2003. Since drought management is not considered in these water demand projections, the 2002 and 2003 data is not relevant to these projections methods. Therefore, the historical water demands through 2001 provide the best available data for making projections. Gannett Fleming utilized all available data through 2001 and made an adjustment for water conservation as described below.

The AWWA Manual M50 - ***Water Resources Planning*** is widely recognized as an industry standard in future water supply planning. This manual discusses the typical water use reductions associated with natural water conservation as well as with active conservation programs. Adjustments for active water conservation measures are made. While some of the industrial measures are listed as having the potential to significantly reduce water consumption, the majority of the conservation measures fall within the 5-10% reduction range.

Current water conservation measures were reviewed and compared against associated text values. Given the current and projected water conservation measures in place by Charlottesville, ACSA, and UVA, water conservation is expected to reduce future demands by 5%. Projected water demands were adjusted by this factor as indicated in Table 1.

Analysis Findings

The demand analysis performed by Gannett Fleming, Inc. determined a projected water demand for the years 2025 and 2055 based on the methods used by VHB in the 1997 demand analysis. The methodology utilized by VHB included four distinct approaches. "The first approach looks at historic trends in raw water volumes and projects these trends into the future. The other three approaches break down total demand into a series of distinct components, and project demand for each component into the future" (VHB, 1997).

Historic Metered Raw Water as a Predictor of Future Demand. This method analyzed the historic raw water production in million gallons per day (MGD) and produced two trend lines, a linear trend line and an exponential trend line. Considering all data through 2001, the linear and exponential trend lines predicted a water demand in 2055 of 20.44 MGD and 30.44 MGD, respectively. Gannett Fleming, Inc., in agreement with VHB, determined the linear trend line provided the most accurate prediction; therefore the 2025

and 2055 demands based on this approach were determined to be 15.61 MGD. and 20.44 MGD, respectively.

Population Trend/Per Capita Consumption as a Predictor of Future Demand. This approach broke down the analysis into demand components. The demand components were the City of Charlottesville, Albemarle County, University of Virginia, Water Uses Outside the Urban Service Area, and Unmetered Water Usage. Population projections were performed for each of the four population components based on trending data and the per capita water usage was determined for the various population groups and applied to the four population components. Upon adding together the various demand projections, the 2025 and 2055 water demands were found to be 15.02 MGD and 18.30 MGD, respectively.

Comprehensive Plans Utilized as a Predictor of Future Demand. The method utilized for this approach involved a review of the comprehensive plans for the City of Charlottesville, Albemarle County, and UVA in order to determine future water usage based on proposed zoning and development plans. At the time of this report, there was no documented change of population projections in the comprehensive plans for the three groups. Therefore the projected water demand utilized by VHB in the 1997 demand analysis was also used in this report. The 2055 water demand is 20.51 MGD.

Historic Demand as a Predictor of Future Demand. A similar method was used for this approach as was seen in the historic metered raw water method. Historic water demands were analyzed for the City of Charlottesville, ACSA, and UVA, and estimates were made for the amount of water demand associated with Water Uses Outside of the Urban Service Area and Unmetered Water Usage. Upon completion of these calculations, the water demand projected for the years 2025 and 2055 were 15.16 MGD and 19.11 MGD, respectively.

Determination of 2025 and 2055 Water Demand. Upon completion of the four approaches, the calculated water demands were averaged to find an acceptable projected water demand for the years 2025 and 2055. The gross projected water demands for 2025 and 2055 were found to be 15.26 MGD and 19.29 MGD, respectively. Active water conservation measures are estimated at 5% resulting net projected water demands for the years 2025 and 2055 of 14.5 MGD and 18.7 MGD respectively. Therefore the firm projected water demands for the years 2025 and 2055 are 14.5 MGD and 18.7 MGD respectively. The 2055 demand value is in general agreement with the range of 18-21 MGD determined by VHB in the 1997 report considering the events since that work was completed.

Rivanna Water and Sewer Authority
Charlottesville, Virginia

Demand Analysis for the Urban Service Area

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Demand Analysis for the Urban Service Area

1. Background and Scope of Study

1.1. Background

Since 1973, the Rivanna Water and Sewer Authority (RWSA) has been responsible for providing a safe and dependable water supply to its customers in the City of Charlottesville and the surrounding areas of Albemarle County. Over the years, the population served by RWSA has increased which has resulted in higher water demands. In order to meet future water demands, it is first necessary to predict what those demands will be over a selected planning horizon.

RWSA has contracted with Gannett Fleming, Inc. to review, update and evaluate the demand analysis performed in 1997 for the Urban Service Area system based on currently available information. Vanasse Hangen Brustlin, Inc. (VHB) performed the 1997 demand analysis and the data used in the analysis was through approximately September 1996. This evaluation is intended to review all available data through 2003 and to use it as appropriate to update long-term water demand projections. This study utilizes the same methodology used by VHB in the referenced demand analysis. The demand analysis generated by VHB is attached to this report as Appendix A.

The study performed by VHB concluded that the urban system water demand in the year 2050 will range between 18 MGD and 21 MGD. VHB selected 19.5 MGD as the projected 2050 water demand. The conclusion is based on an analysis performed using four different approaches. In accordance with the VHB report, “the first approach looks at historic trends in raw water volumes and projects these trends into the future. The other three approaches break down total demand into a series of distinct components, and project demand for each component into the future” (VHB, 1997).

In addition to changes due to the passage of time, a severe drought occurred in 2002, which had a significant impact on water demand. During the drought, the City of

Charlottesville (Charlottesville), the University of Virginia (UVA), and Albemarle County Service Authority (ACSA) implemented voluntary conservation measures including installation of low flow fixtures, water conservation education/awareness programs, and performed leak detection and repairs. In addition to the voluntary programs, drought restrictions were implemented including elimination of vehicle washing and lawn watering. These programs resulted in both permanent reductions in demand (low-flow fixtures) and temporary reductions in demand (drought restrictions). The implementation of these programs resulted in a significant reduction in demands during this period.

1.2. Scope of Study

The scope of this analysis includes: (1) reviewing the previous demand analysis; (2) collecting water usage data from the City of Charlottesville, Albemarle County Service Authority (ACSA), and the University of Virginia (UVA), as well as unmetered water usage through the year 2003; (3) reviewing the comprehensive plans of the three consumer entities to better predict population and water demand growth over the planning horizon, and (4) determining the projected water demand for selected planning horizons, considering various factors such as water conservation and drought management.

As indicated in the Commonwealth of Virginia *Guidance for Conducting a Comprehensive Public Drinking Water Supply Needs Assessment*, the Department of Environmental Quality (DEQ) utilizes a 50-year water supply planning horizon policy. The Commonwealth of Virginia *Waterworks Regulations* (12 VAC 5-590-640) require that waterworks be designed to provide for the estimated population 10 to 30 years hence. Based upon these two documents, planning horizons of 2055 and 2025 are established. The 2055 projected demands will be compared to the demands identified by VHB in the 1997 demand study. It should be noted that the VHB planning horizon was established at 2050, so the results of these two studies are not directly comparable.

2. Methodologies of Demand Analysis

The following sections will outline the methods and approaches utilized to determine the 2025 and 2055 projected water demands. Various methods of projecting water demands using historical water demand data and population data are discussed. None of the methods include an allowance for water conservation or drought management. Future water demands can potentially be reduced through water conservation measures and drought management planning. Drought management refers to a specific plan or plans to temporarily reduce water demands during rare periods of severely limited water supply. Conventional water supply planning approaches, and current Commonwealth of Virginia requirements, indicate water supplies should be developed to satisfy projected demands. Therefore, drought management is not considered in these demands projections. However, water conservation measures can influence the outcome of demand projections and are discussed below. An adjustment in the selected water demand projection is made to account for active water conservation.

In addition to the data presented in the VHB report, annual water demands and population data from 1996 through 2003 were obtained and reviewed. All population data is included in current evaluations. However, water demand data was further evaluated for applicability. During the very severe drought of 2002, water demands for UVA, Charlottesville, and ACSA decreased over 20% when compared to 2001 water demands. During this period, water conservation programs were intensified and low-flow fixture installation accelerated through "give-away" programs instituted by the City of Charlottesville and ACSA. The City of Charlottesville and ACSA also implemented drought management measures that precluded certain water uses (such as car washing and lawn watering) and included penalties for violations. An immediate and significant decrease is seen in the water consumption rates presented in Figures 1, 5, 6 and 8. It is very difficult to determine the individual impact of the temporary drought management measures implemented and the permanent effect of the active water conservation program concurrently implemented (and maintained today). However, the significant reduction in water demands in such a short period suggests the impact is primarily due to the drought management measures. It is also very difficult to predict the magnitude and

timing of the recovery from these drought management measures. Predicting recovery is also complicated by the unusually wet year in 2003. According to the Virginia State Climatology Office, 2003 broke the all time annual record (since 1937) for annual rainfall. Since drought management is not considered in these water demand projections, the 2002 and 2003 data is not relevant to these projections methods. Therefore, the historical water demands through 2001 provide the best available data for making projections. Gannett Fleming utilized all available data through 2001 and made an adjustment for water conservation as described below.

The AWWA Manual M50 - ***Water Resources Planning*** is widely recognized as an industry standard in future water supply planning. This manual discusses the typical water use reductions associated with natural water conservation as well as with active conservation programs. According to the manual, "natural water conservation occurs as commercial and industrial facilities and residential homes age and less water-efficient processes and fixtures are replaced with more water-saving practices and devices" and can result in a cumulative water reduction of 4-8% over a 20 to 40 year period (AWWA, 2001). Active conservation measures are identified as various industrial, commercial, and residential measures that can be implemented. While some of the industrial measures are listed as having the potential to significantly reduce water consumption, the majority of the conservation measures fall within the 5-10% reduction range.

Current water conservation measures were reviewed and compared against associated text values. Given the current and projected water conservation measures in place by Charlottesville, ACSA, and UVA, water conservation is expected to reduce future demands by 5%. Projected water demands were adjusted by this factor as indicated in Table 1.

2.1. Historic Metered Raw Water as a Predictor of Future Demand

The VHB approach was to analyze the historic raw water production in MGD and produce two trend lines, a linear trend line and an exponential trend line. Figure 1

presents the updated historic raw water production chart with new trend lines based on all data through 2003.

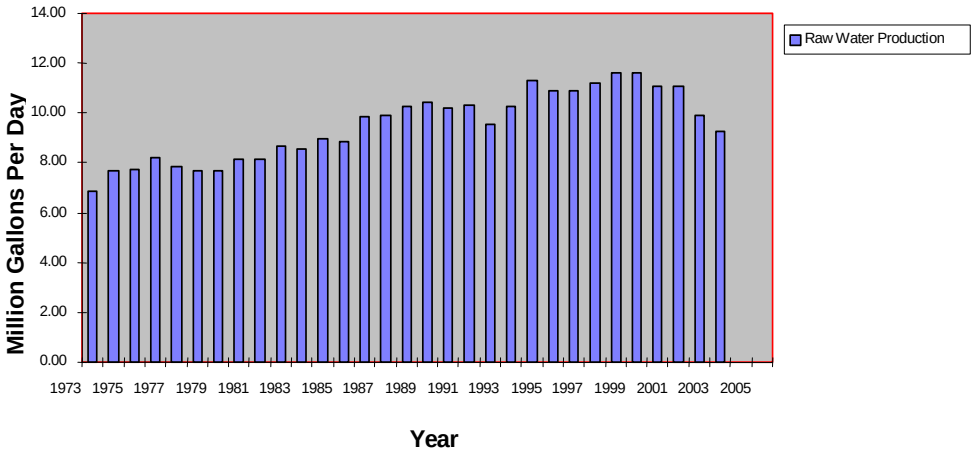

Figure 1: Historic Raw Water Production through Year 2003 (Including Drought)

As discussed in the methodology section above, the 2002 and 2003 water demand data is not used in this evaluation. Based on data through 2001 and as seen in Figure 2, the predicted demands are 20.44 MGD for the linear trend and 30.44 for the exponential trend.

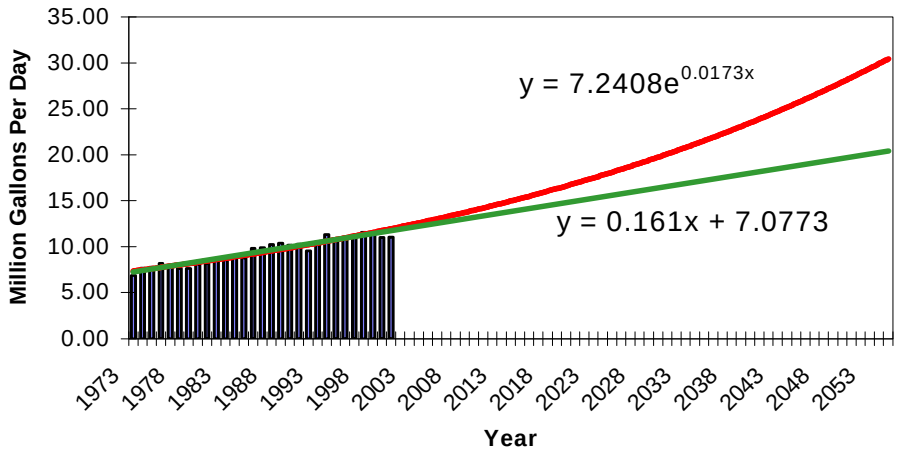

Figure 2: Historic Raw Water Production through Year 2001 (Excluding Drought)

The analysis performed by VHB indicated that the linear regression analysis trend line

provided a more accurate predictor of future demand. Based on a further review of the approach as well as the inclusion of the more recent data, Gannett Fleming concurs with this assessment. Therefore, the new data will result in a projected water demand of 20.44 MGD for the historical raw water production method utilizing data through 2001.

2.2 Population Trend/Per Capita Consumption As A Predictor of Future Demand

This and the three remaining approaches used by VHB broke down the analysis into demand components. The demand components were the City of Charlottesville, Albemarle County, University of Virginia, Water Uses Outside the Urban Service Area, and Unmetered Water Usage. Population projections were performed for each of the five population components identified.

Population projections for the City of Charlottesville, as seen in Figure 3, are based on historic data trends. The regression analysis was performed on population data from 1980 to the present and the power function trend line provided the "best fit" for the data. Available data between 1970 and 1980 contains anomalous changes that appear to be caused by various accounting of University of Virginia students. Therefore this data was eliminated for this evaluation. The linear trend line predicts a significant decrease in the population in the City of Charlottesville which is contrary to communications with City officials. The power function trend line provided a 2055 population projection of 39,861 people for the City of Charlottesville. This projection compares favorably with the information indicated by the Virginia Economic Commission population projections through 2030, as well as information received from the City of Charlottesville's Neighborhood Development Services, which indicated that the estimated population in 2010 (furthest projected value) is 39,500 people. The City of Charlottesville is assumed to have 100% connectivity to RWSA water for the purposes of this study.

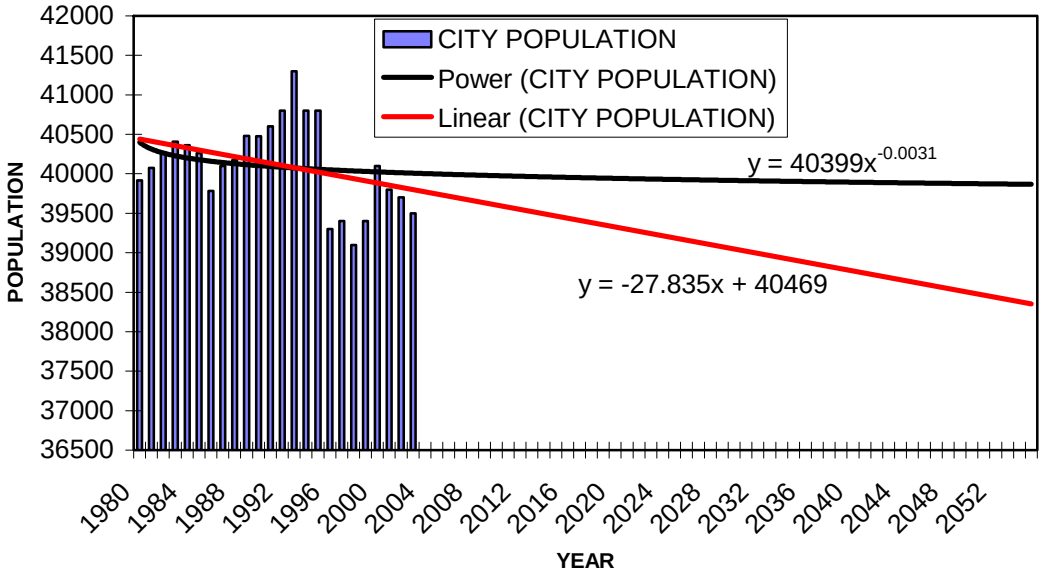

Figure 3: City of Charlottesville Population Projection Using 1980 to 2003 Data

Population projections for the University of Virginia were obtained by contacting the University's Landscape Architect's office, who directed Gannett Fleming, Inc. to the UVA website (www.virginia.ed/stats&facts) for official population figures. The student population projections indicate a current population of approximately 20,000 students and an estimated growth of approximately 100 students per year through the 50 year planning horizon of this study, for an ultimate student population of 25,000. The University of Virginia student population is assumed to have 100% connectivity to RWSA water for the purposes of this study.

Population projections for ACSA are based upon projections for the entire county. This analysis includes only that population within Albemarle County that is served in the urban service area as defined by Albemarle County, ACSA, RWSA, and the City of Charlottesville. The urban service area connections currently comprise approximately 47% of the total County population and VHB projected approximately 61% connectivity in 2050. Gannett Fleming has reviewed the methodology and recommends utilizing the

same connectivity ratio in this analysis. The overall county population data indicates growth in a linear trend. The regression analysis trend line based on a linear trend provides a population projection of 167,116 for the year 2055. Utilizing the 61% connectivity to the urban system, the population served by RWSA is projected at 101,941. Figure 4 illustrates the population projections for Albemarle County.

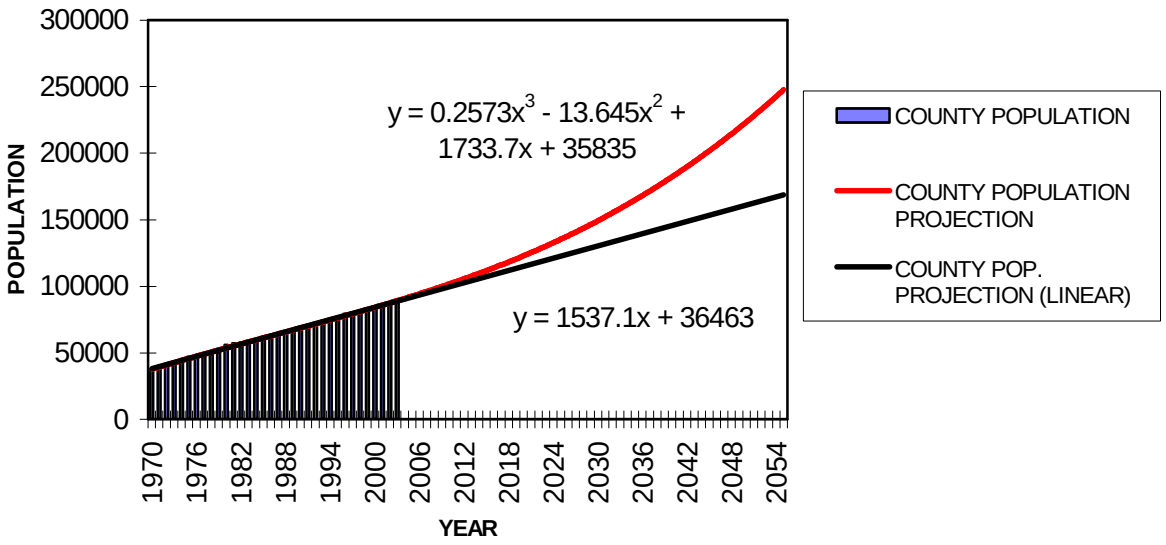

Figure 4: Albemarle County Population Projection Using 1970 to Present Data

Population projections for Water Uses Outside the Urban Service Area have changed slightly from the report prepared by VHB and provided in Appendix A. In the time since the 1997 report, the neighborhood of Key West has been added to the Urban Service Area, thus removing it from the category of "Water Use Outside the Urban Service Area". Therefore, the approximate number of consumers outside the Urban Service Area was changed from 1,918 people (VHB) to 1,431 people. However, the Key West development is believed to have only 194 lots which corresponds to approximately 487 consumers (using VHB's assumption that 1 lot = 2.51 consumers). Therefore, based on a per capita demand of 93 gallons per capita day (gpcd), the water demand associated with Key West is only .04 MGD which has a minimal effect on the projected water demands in this report.

To relate population projections to future water demand, the current average per capita usage was determined for all of the data through 2001. The same methodology was utilized as presented by VHB. This resulted in a new, and slightly lower, per capita demand for the City of 108.5 gallons per capita day (gpcd) and for the University at 77 gpcd. Average per capita usage for Albemarle County Service Authority customers and Water Uses Outside the Urban Service Area are changed from 99 gpcd to 93 gpcd and include updated equivalent residential units (ERU) data.

Unmetered Water Use has generally increased since the original water demand study was completed. The 1997 report lists unmetered water use at 13.1% of the total system water demand. More recently, unmetered water use has declined. Since this value has varied over time, it is best to use an average over a large period of time for water demand projection purposes. The average since 1982 (including the most recent data) is 13.3%. Therefore, 13.3% of total system water demand was used in this report.

Therefore, the resulting 2055 water demand utilizing the population trend method is the sum of the above demand component analyses and equals 18.30 MGD, while the projected water demand in 2025 equals 15.02 MGD.

2.3 Comprehensive Plans Utilized As A Predictor of Future Demand

The comprehensive plans for the City of Charlottesville, Albemarle County, and the University of Virginia have not published changes that would impact the projected 2055 demand. Gannett Fleming has used the demand projection performed by VHB report and resulted in a 2050 demand of 20.51 MGD based on this method. Details of this method can be found in the VHB report located in Appendix A.

2.4 Historic Demand As A Predictor of Future Demand

Similar to the population trend analysis, VHB broke the historic demand into several components.

The City of Charlottesville historic water demand was analyzed utilizing all available data and both linear and exponential trend lines were provided, as seen in Figure 5. The projected future demand based on either trend line indicated a decrease in demand by more than 30%. These trend lines appear to be significantly impacted by the 2002 drought period and inconsistent with population projections. If this demand projection was accepted a 2055 demand of approximately one-half of current demands would result while population projections are nearly flat. In lieu of the regression analysis method, Gannett Fleming generated an average daily demand for the City of Charlottesville based on data since 1982. The average daily demand from 1982 through 2003 was 4.3 MGD and the average daily demand through 2001 was 4.4 MGD.

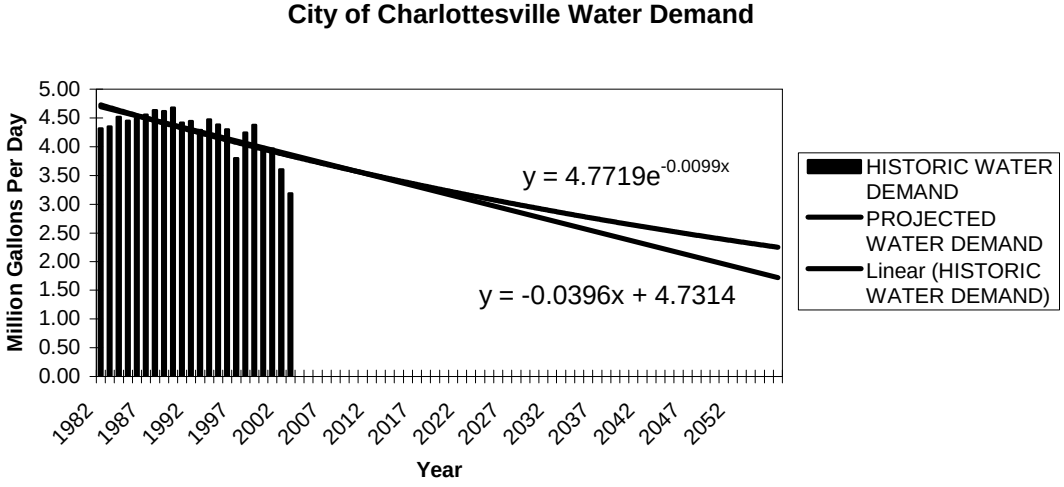

Figure 5: City of Charlottesville Historic Demand Analysis and Projection

Figures 6 and 7 illustrate the historic water demand for University of Virginia. Figure 6 includes all of the data including the drought of 2002. Figure 7 represents the same data but without the 2002 or 2003 data. As discussed in the methodology section above, the 2002 and 2003 water demand data is not used in this evaluation. The data in Figure 7 was analyzed using the regression analysis with both linear and power trend lines. The power trend line appeared to provide a more accurate analysis based upon expected growth

trends. The power trend line projects a 2055 demand of 2.13 MGD using all of the data through 2001.

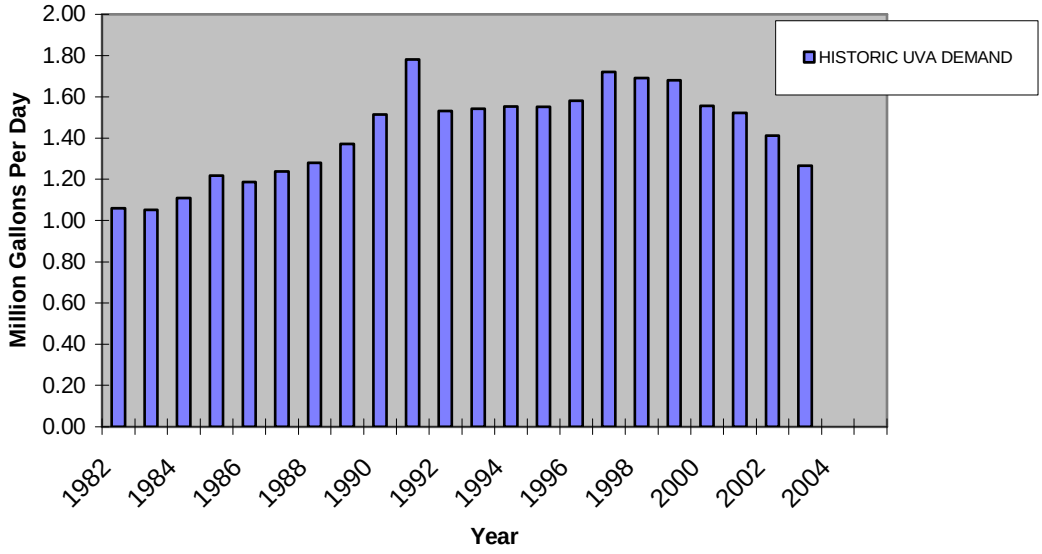

Figure 6: University of Virginia Historic Water Demand Analysis/Projection Using 1982 to 2003 Data

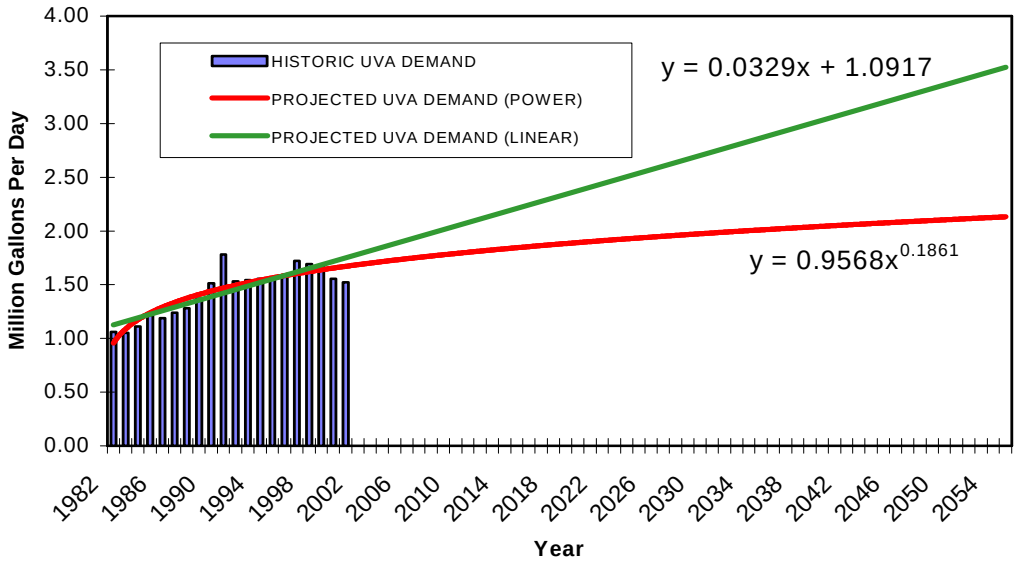

Figure 7: University of Virginia Historic Water Demand Analysis/Projection Using 1982 to 2001 Data

Figures 8 and 9 illustrate the historic water demand for Albemarle County Service Authority. Figure 8 includes all of the data including the drought of 2002. Figure 9

represents the same data but without the 2002 or 2003 data. As discussed in the methodology section above, the 2002 and 2003 water demand data is not used in this evaluation. The data in Figure 7 was analyzed using the regression analysis with both linear and power trend lines The linear trend line appears to provide the most accurate projection of future demand. The 2055 demand projected using this method is 9.91 when using all of the data through 2001.

Under this methodology, it was determined that the "Water Use Outside the Urban Service Area" and "Unmetered Water Usage" were calculated in a similar fashion in this approach to that in the previous approaches. Therefore, the projected water demands in 2025 and 2055 based on the historic demand approach are 14.38 MGD and 17.85 MGD, respectively.

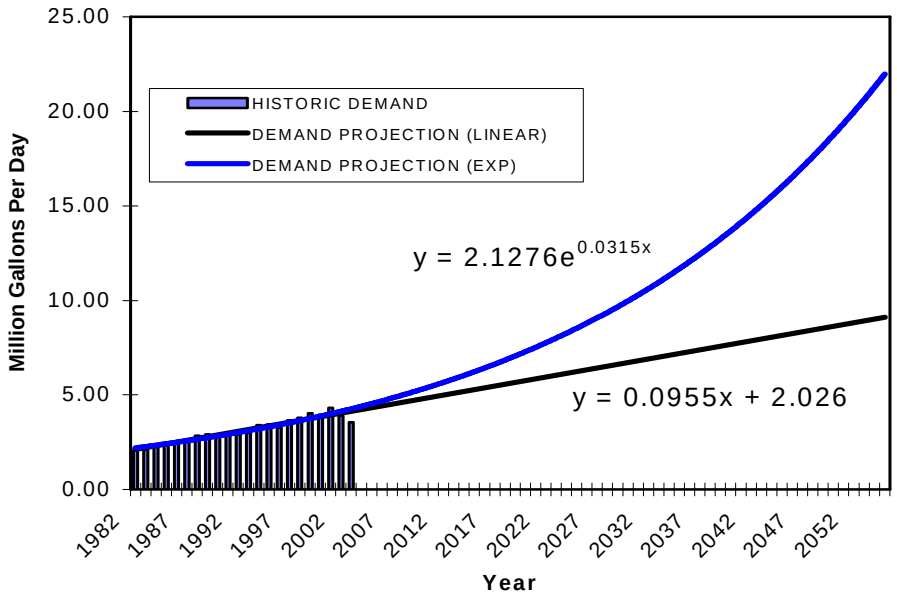

Figure 8: Albemarle County Service Area Historic Water Demand Analysis/Projection Using 1982 to 2003 Data

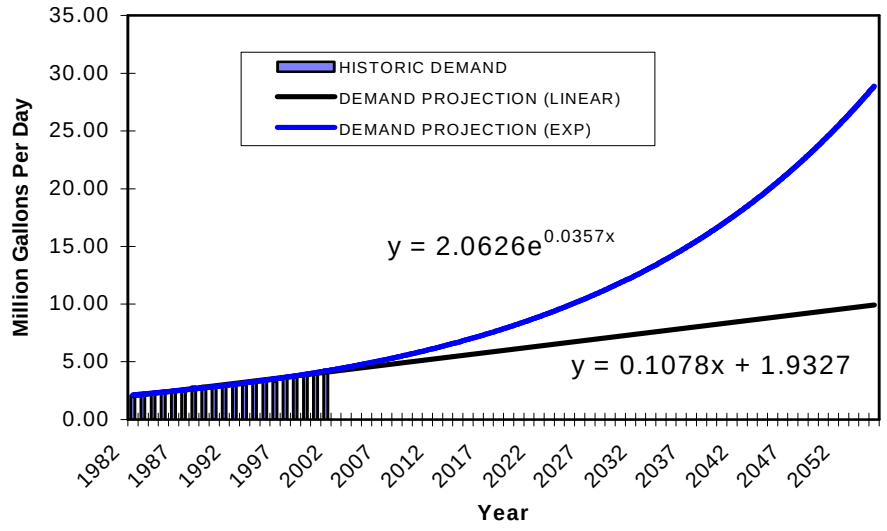

Figure 9: Albemarle County Service Area Historic Water Demand Analysis/Projection Using 1982 to 2001 Data

2.5 Summary

Following determination of the demand projections using each of these methods, Gannett Fleming averaged the demand projection for each of these methods to arrive at a projected demand for both 2055 and 2025. The gross projected demand for 2055 is 19.59 MGD and for 2025 is 15.26 MGD. These values were reduced by 5% to account for active water conservation measures. The resulting net projected demands for 2055 is 18.7 MGD and for 2025 is 14.5 MGD. Table 1 presents a summary of the data used to determine the demand projections. Therefore the firm projected water demand for 2055 is 18.7 MGD and for 2025 is 14.5 MGD.

3.0 References

1. AWWA. *Water Resources Planning – AWWA Manual M50*. American Water Works Association, Denver, CO. 2001.
2. Vanasse Hangen Brustlin, Inc. *Raw Water Supply Facility Permitting – Demand Analysis*. October 1997.

Table 1: RWSA Projected Water Demands

Projected Water Demands (MGD)

	VHB/O'Brien & Gere (2050)	Gannett Fleming (2055)	Gannett Fleming (2025)
Historic Raw Water Production Method (2050/2055)	20.40	20.44	15.61

	VHB/O'Brien & Gere (Year 2050)			Gannett Fleming (Year 2055)		
Population Trend/Per Capita Consumption Method	**Population Projection**	**Per Capita Demand (gpcd)**	**Water Demand (MGD)**	**Population Projection**	**Per Capita Demand (gpcd)**	**Water Demand (MGD)**
City of Charlottesville	45000	111	5.00	39861	108.5	4.32
University of Virginia	26300	77	2.03	25000	77	1.93
Albemarle County Service Authority	110000	99	10.89	101941	93	9.48
Water Uses Outside Urban Service Area	1918	99	0.19	1431	93	0.13
Unmetered Water Usage (13.1% VHB, 13.3% GF)			2.37			2.43
TOTAL	**183218**		**20.48**	**166802**		**18.30**

Notes: ACSA population projection based on 61% connectivity.

	Gannett Fleming (Year 2025)		
Population Trend/Per Capita Consumption Method	**Population Projection**	**Per Capita Demand (gpcd)**	**Water Demand (MGD)**
City of Charlottesville	39925	108.5	4.33
University of Virginia	22000	77	1.69
Albemarle County Service Authority	73812	93	6.86
Water Uses Outside Urban Service Area	1431	93	0.13
Unmetered Water Usage (13.1% VHB, 13.3% GF)			2.00
TOTAL	**135737**		**15.02**

Notes: ACSA population projection based on 61% connectivity.

	VHB/O'Brien & Gere (2050)
Comprehensive Plan Method	
City of Charlottesville	5.02
University of Virginia	2.03
Albemarle County Service Authority	10.89
Water Uses Outside Urban Service Area	0.19
Unmetered Water Usage	2.38
TOTAL	**20.51**

Note: No changes in the Comprehensive Plans were identified.

Historic Demand Method	**VHB/O'Brien & Gere (2050)**	**Gannett Fleming (2055)**	**Gannett Fleming (2025)**
City of Charlottesville	4.50	4.40	4.40
University of Virginia	2.10	2.13	1.93
Albemarle County Service Authority	8.90	9.91	6.68
Water Uses Outside Urban Service Area	0.19	0.13	0.13
Unmetered Water Usage	2.06	2.54	2.02
TOTAL	**17.75**	**19.11**	**15.16**

Summary of Gannett Fleming Demand Projections

	Year 2025	**Year 2055**
Historic Production	15.61	20.44
Population	15.02	18.30
Comp. Plan	N/A	20.51
Historic Demand	15.16	19.11
Gross Projected Demand (MGD)	**15.3**	**19.590**
Active Water Consumption (5%)	0.8	1.0
Net Projected Demand (MGD)	14.5	18.61
Say	14.5	18.7

APPENDIX A