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July 25, 2020

Jennifer Whitaker, PE  
Director of Engineering & Maintenance  
Rivanna Water and Sewer Authority  
695 Moores Creek Lane  
Charlottesville, VA 22902

**Re: Updated Demand Forecast Supplement for Crozet Area DWIP (Supplement No. 1)**

Dear Ms. Whitaker:

As part of the Drinking Water Infrastructure Plan (DWIP) for the Crozet Area, forecasts for drinking water demand were developed through the year 2075. Due to recent trends in water usage observed by the Rivanna Water and Sewer Authority (RWSA) and the Albemarle County Sanitation Authority (ACSA), water demands appeared to be increasing more rapidly than were predicted by the 2017 demand forecasts. The enclosed document utilizes recent billing data, water treatment plant production data and meter connection data to evaluate water usage and appropriately update the original demand forecast prepared in 2017 for the Crozet Area DWIP.

As can be seen in the enclosed document, review of the data suggests a modest increase in average day and maximum day demand at buildout (2075), from 1.5 mgd to 1.52 mgd and 2.5 mgd to 2.55 mgd, respectively. When in-plant water use is considered, the required water withdrawal at buildout from the Beaver Creek Reservoir increased to 1.67 mgd and 2.81 mgd on an annual average and maximum day basis, respectively, compared to 1.65 mgd and 2.75 mgd from the 2017 forecast.

Additionally, the data used as part of this demand forecast update supports the impact of COVID-19 on the most recent demand increases within the Crozet Area, which is strongly influenced by the fact that 80% of the account classes within the community are residential. Demands continue to be elevated at this time within the community, and it is unclear how long the increase will last, if it will truly be temporary once the pandemic crisis has ended, or if the increased levels will be sustained into the future. The data supports a conservative approach to water supply planning to allow events such as the COVID-19 pandemic to be addressed within infrastructure and permit limits.

The details supporting the above updated demand values can be found in the attached document, which serves to supplement and supersede the 2017 demand forecasts.

Very truly yours,

Aaron W. Duke, PE, BCEE  
Associate Vice President

Enclosure

Job no. 32438-001

# Hazen *Technical Memorandum*

**May 2020**

To: Rivanna Water & Sewer Authority

From: Jeremy Hise, P.E.  
Aaron Duke, P.E. BCEE  
Reed Palmer, P.E.  
Hazen and Sawyer



## **Crozet Area – Demand Forecast**

2020 Updated Water Demand Forecast

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## 1. Demand Forecast Update (2020)

### 1.1 Sources of Data for Update

Prior to updating the Crozet water demand forecasts, which were last updated in 2017, Hazen reviewed the following recent data:

- Billed Water – 2017 through April 2020
- WTP Flows – 2017 through current
- Water Connections – 2017 through current

The intent in reviewing this most recent data is to:

- Compare where the 2017 Demand Forecast anticipated Crozet demands would be in 2019 and 2020 against where they are at the end of 2019 and through April 2020.
- Assess whether the previously anticipated growth curves still seem reasonable or require adjustment.
- Review recent non-revenue percentages and determine whether the assumed non-revenue percentage, from the 2017 Demand Forecast, is still reasonable, or requires adjustment.
- Assess whether per capita and per employee usage rates are still accurate or require adjustment.
- Assess whether the assumed Maximum Daily Demand (MDD) to Average Daily Demand (ADD) ratio, MDD/ADD, is still reasonable or requires adjustment.
- Provide a preliminary assessment of the impact that COVID-19 has had on water demands through a comparison of March/April 2019 demands to March/April 2020 demands.

It is noted that the following data was not updated as a part of this effort, with the assumption being that this data has not substantially changed since the 2017 Demand Forecast and could be held constant for the 2020 Demand Forecast update:

- Status of any conservation or other programs that may impact demands for finished drinking water.
- Growth projections for the Crozet Service Area, including changes in zoning, land use patterns and/or buildout projections for each type of land use in the service area.
- Status of any known major developments, new industries or commercial facilities that are planned for the service area.

The updated 50-year projections presented herein have been made in 5-year increments for both average day and maximum day demands, with maximum day demands calculated using the aforementioned MDD/ADD ratio, based on the most current water production data.

## 1.1.1 Projection Methodology

Below is the step by step process by which the updated Demand Forecast was prepared.

Step 1 - Review January 2017 through April 2020 Monthly/Yearly Historical Billing Data and Production Data

- Determine current average daily demand (ADD) and compare it to the demand previously projected for the years 2019 and 2020. Assess whether growth has occurred more rapidly than anticipated.
- Determine the current non-revenue water contribution and compare against prior historical data to determine whether an update to the estimated non-revenue water contribution is warranted.
- Recommend whether an update to the MDD/ADD ratio is warranted.

Step 2 – Analyze January 2017 through April 2020 Billing Data and Assess Necessary Updates

- Identify current per capita usage, including distribution system non-revenue water. Compare current per capita usage against prior estimates to determine whether an increase or decrease to per capita usage is warranted.
- Identify current per employee usage, including distribution system non-revenue water. Compare current per employee usage against prior estimates to determine whether an increase or decrease to per employee usage is warranted.

Step 3 - Update Future Water Use Estimates

- Update future ADD estimates
- Estimate future MDD estimates

***Note:** Step 3 would typically involve a review of Zoning Data, as well as a review of possible population growth (residential and employment growth). However, for this Demand Forecast Update, growth projections for the Crozet Service Area, including changes in zoning, land use patterns and/or buildout projections for each type of land use in the service area, were not updated as it was assumed this data has not substantially changed since the 2017 Demand Forecast and could be held constant for this update.*

Step 4 – Develop an Updated Growth Curve Envelope

- Provide an updated historical growth evaluation
- Assess potential impact of more rapid growth
- Assess potential impact of development outside of the current service area boundary
- Assess potential impact that conservation measures may have on demands

## 1.2 Updated Projections

Each step of the demand forecast update process, including the associated results, is detailed below.

## 1.2.1 Review of Updated Yearly Historical Billing Data and Production Data

- Determine current ADD and compare against prior forecast

Current billing data and production data, from January 2017 through April 2020, were analyzed and the current ADD (for the year 2019) was determined to be 0.594 mgd. For comparison purposes, the 2017 Demand Forecast, estimated that ADD in 2019 would be 0.556 mgd. Demands were not anticipated to reach current 2019 levels until 2022, based on the 2017 Demand Forecast. ***This seems to indicate that development is occurring at a more rapid rate than originally anticipated.*** It is important to note this demand includes non-revenue water within the water distribution system but does not include in-plant water usage (i.e. backwash water and carrier water). This updated demand served as the starting point for the updated future growth curves presented within this Technical Memorandum.

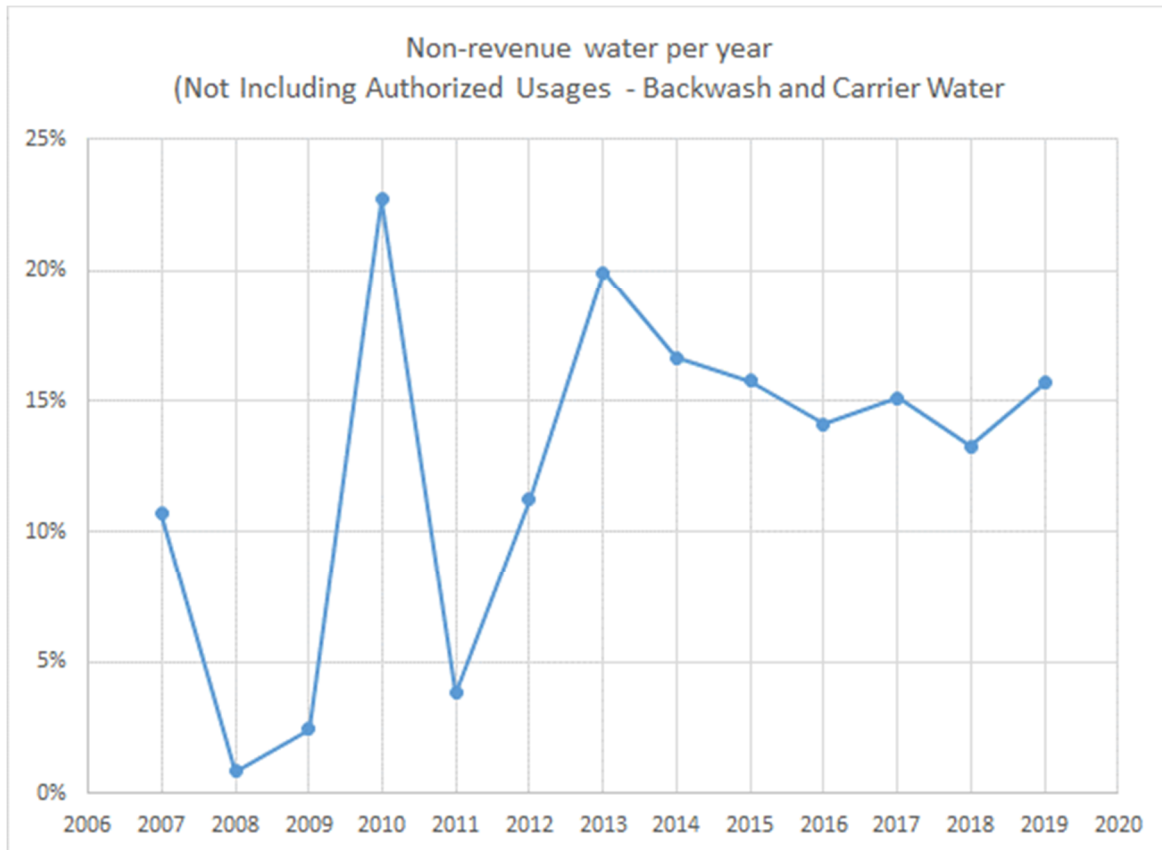
Previously, in-plant water usage was estimated at approximately 10% of water demand. Based on a review of current data (2017 through 2019), it is recommended that in-plant water usage continue to be assumed at 10% of water demand. A review of 2019 data indicated an in-plant water usage of 9%, which may fluctuate slightly based on WTP needs. Therefore, 10% should be added to the updated finished water demand projections to estimate raw water demand.

- Recommend whether an update to non-revenue water is necessary (as a percentage, %)

Similar to the analysis necessary to update the current ADD, updated billing data were compared to updated production data to determine whether an update to the non-revenue water percentage (%) was warranted. As part of the 2017 Demand Forecast, 15% non-revenue water was recommended for future demands as non-revenue water has fluctuated over time (Figure 1, which was updated to include 2017 through 2019 data). Based on a review of current data, it is recommended that non-revenue water continue to be assumed at 15% of water demand. Current data, 2017 to 2019, shows that non-revenue water has stabilized and has fluctuated between 13% and 16%. The 15% value provides a degree of conservatism in the projections without being overly conservative.

It is important to note that for demand projection purposes, non-revenue water % is not directly used in a calculation, rather it is used to assist in determining unit demands (described below). The unit demands used for future demand projections include a component for non-revenue water.

**Figure 1: Non-Revenue Water Since 2007**

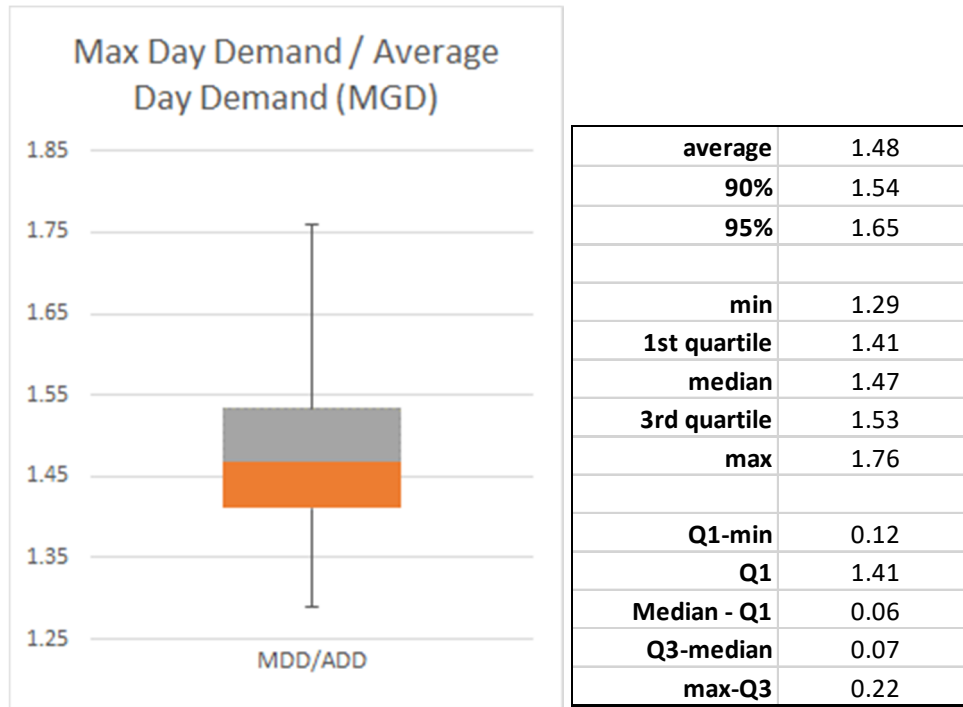


- Recommend whether an update to the MDD/ADD ratio is necessary

Updated historical production data, as well as updated billing data, were used to perform an updated statistical analysis with the intent to determine whether a change to the MDD/ADD ratio was warranted. The analysis assessed water that was consumed by customers within the distribution system as well as non-revenue water that is supplied to the distribution system but not consumed by customers. This analysis excluded in-plant water usage (i.e. backwash water and carrier water) but did take into consideration SCADA data to assess the impact that storage has on water production.

As part of the 2017 Demand Forecast, a 1.68 ratio was recommended. This prior recommendation considered drought preparedness balanced with operational changes to be implemented in the future to reduce the variation in daily demands and help to mitigate higher MDD/ADD ratios from occurring. Based on a review of current data, it is recommended that the MDD/ADD ratio of 1.68 continue to be assumed for future maximum daily demands. Similar to the 2017 Demand Forecast, this ratio represents an approximate 95% confidence level over the past ten years (Figure 2). For reference purposes, the average MDD/ADD ratio is 1.48 (was 1.47 as of the 2017 Demand Forecast) since 2006. MDD/ADD ratios from 2017 through 2019 ranged from 1.41 to 1.54; 2020 data was not used, as the data is only through April 2020.

**Figure 2: MDD/ADD Statistical Analysis (2006 to Current)**

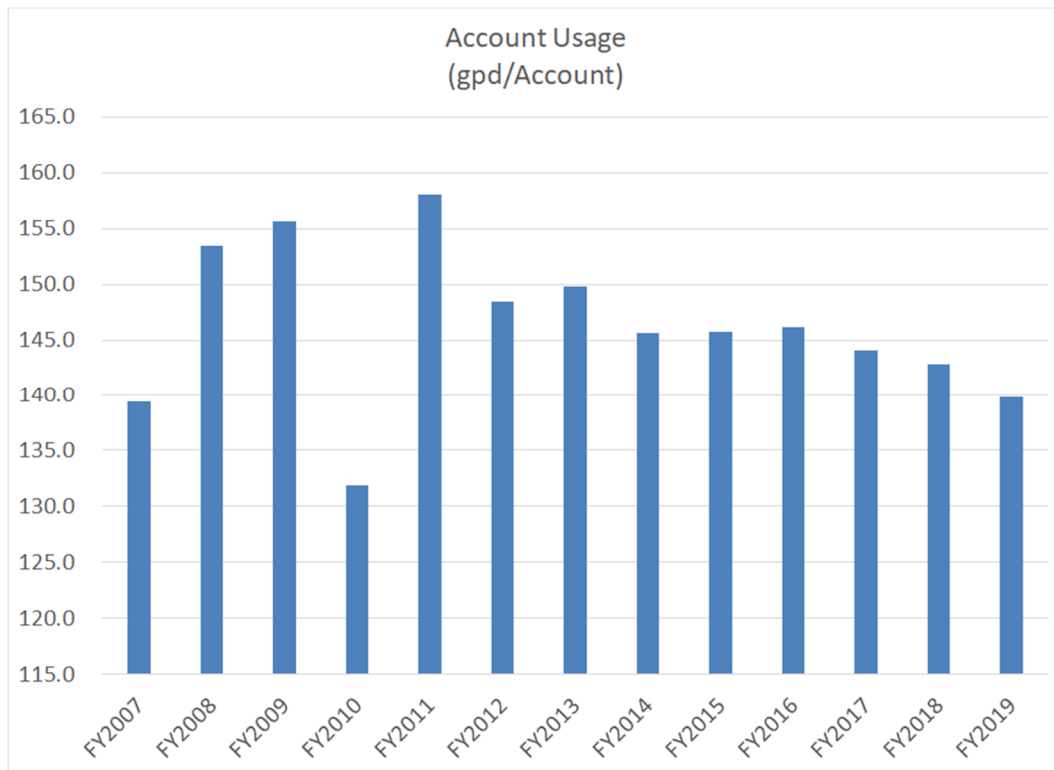


**1.2.2 Analysis of Updated Billing Data to Determine Whether a Change to Per Capita or Per Employee Usage is Necessary**

Updated billing data, spanning January 2017 through April 2020 from the Albemarle County Service Authority (ACSA) were analyzed in relation to billing account type to assess whether unit water demands have changed since the 2017 Demand Forecast. The unit water demand considered herein is a blended unit water demand for both residential and employment uses. As can be seen in Figure 3, unit water demands have slightly decreased since 2016, after experiencing a slight increase from 2014 to 2016. As was the case in 2017, variability in this blended unit water demand still exists.



**Figure 3: Crozet System Wide Unit Water Demand (Includes Non-Revenue Water)**

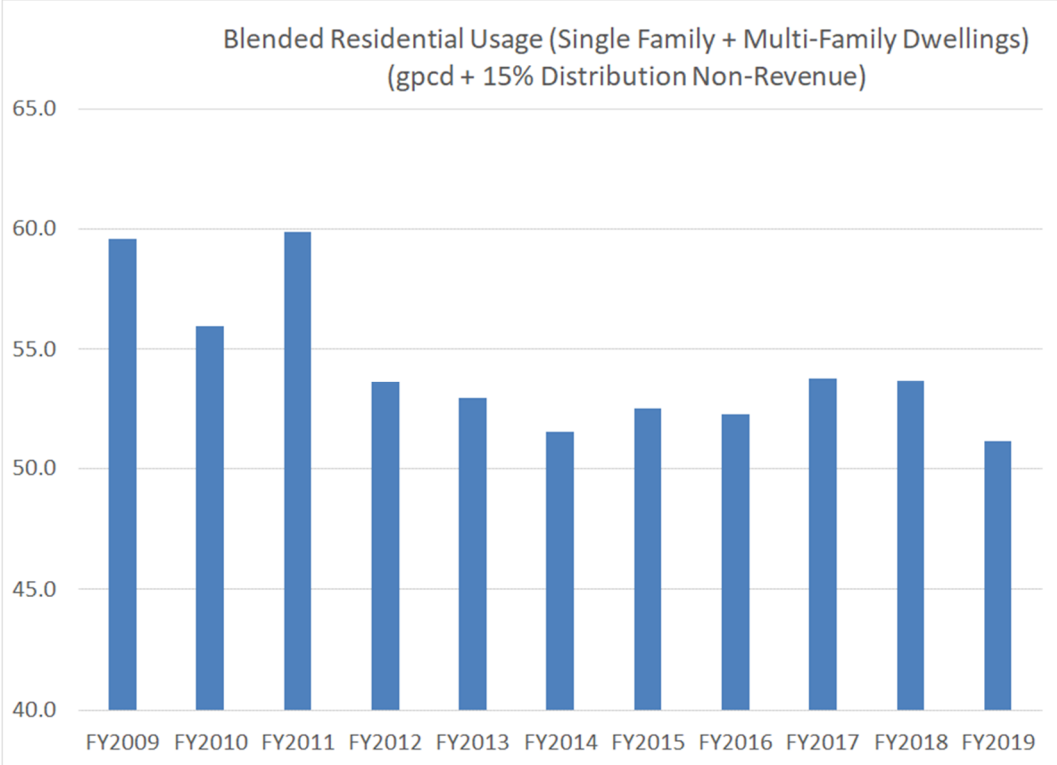


The updated billing data were analyzed using Microsoft Excel and Microsoft PowerBI to identify whether unit water demands for various demand sectors have changed since 2017. For reference purposes, in 2017, recommended unit water demands were 65 gpcd for new single family residential customers, 55 gpcd for new multi-family residential customers, and 65 gallons per employee per day (gped) for new employees (note: these unit water demands included distribution non-revenue water). A review of January 2017 through April 2020 billing data confirms that unit water demands of 65 gpcd for new single family residential customers, 55 gpcd for new multi-family residential customers, and 65 gallons per employee per day (gped) for new employees are still appropriate for future demands.

Based on the updated analysis completed, as presented in Figures 4 and 5, there has not been much change in the account class type distribution since the 2017 Demand Forecast (~80% residential and ~20% non-residential). Residential usage has stayed relatively consistent from 2017 through 2019. Employment (non-residential) unit usage has dropped a bit from 2017 through 2019, but it is anticipated that this usage type will fluctuate more than residential as it is highly dependent upon the type of employment (i.e. institutional (schools), industrial, commercial businesses, etc.). It is good practice to provide a bit more conservatism in employment usage estimates to ensure enough capacity is provided. As more billing data is gathered, future consideration can be given to adjusting unit water demands, if warranted.

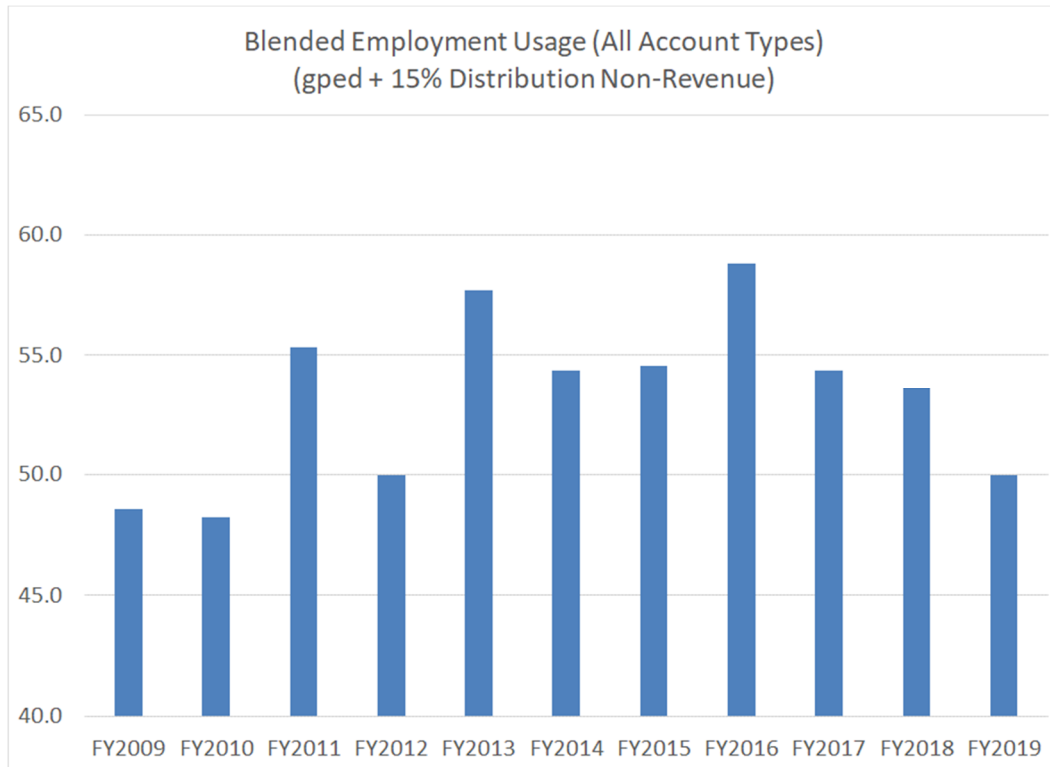
**Figure 4: Blended Residential Per Capita Water Demand by Fiscal Year**

Values based on residential population and residential usage (from billing records) and include 15% distribution system non-revenue water



**Figure 5: Blended Employment Per Employee Water Demand by Fiscal Year**

Values based on employment population and employment usage (from billing records) and include 15% distribution system non-revenue water



### 1.2.3 Updated Future Water Use Estimates

To update future water use estimates, the analysis would typically involve a review of Zoning Data, as well as a review of possible population growth (residential and employment growth). However, for this Demand Forecast Update, growth projections for the Crozet Service Area, including changes in zoning, land use patterns and/or buildout projections for each type of land use in the service area, were not updated as it was assumed this data has not substantially changed since the 2017 Demand Forecast and could be held constant for this update. **The population served (both employees and residential customers) in 2019 is estimated at 9,228 (7,306 residential and 1,922 employment), which when compared to the 2019 projected service population of 8,986 from the 2017 Demand Forecast indicates that population growth is occurring faster than that predicted a few years ago. This is also supported by the growth in ADD seen within the Crozet Service Area.** For reference purposes, it is also important to note that, based on a March 2020 Customer Class Report prepared by ACSA, the Crozet Service Area included 4,170 water connections, estimated to equal a residential population of 10,015 (population is the total Single-Family and Multi-Family units using an occupancy of 2.5). By comparison, the residential population estimated to be served in 2020 in this evaluation is 7,562 and the employment population estimated to be served in 2020 in this evaluation is 1,951, for a total population served in 2020 of 9,513. The total population served (9,513) is close to the residential population noted in the ACSA Customer Class Report. A higher residential population would result in lower unit water demands as the unit demands presented in Figures 4 and 5 are

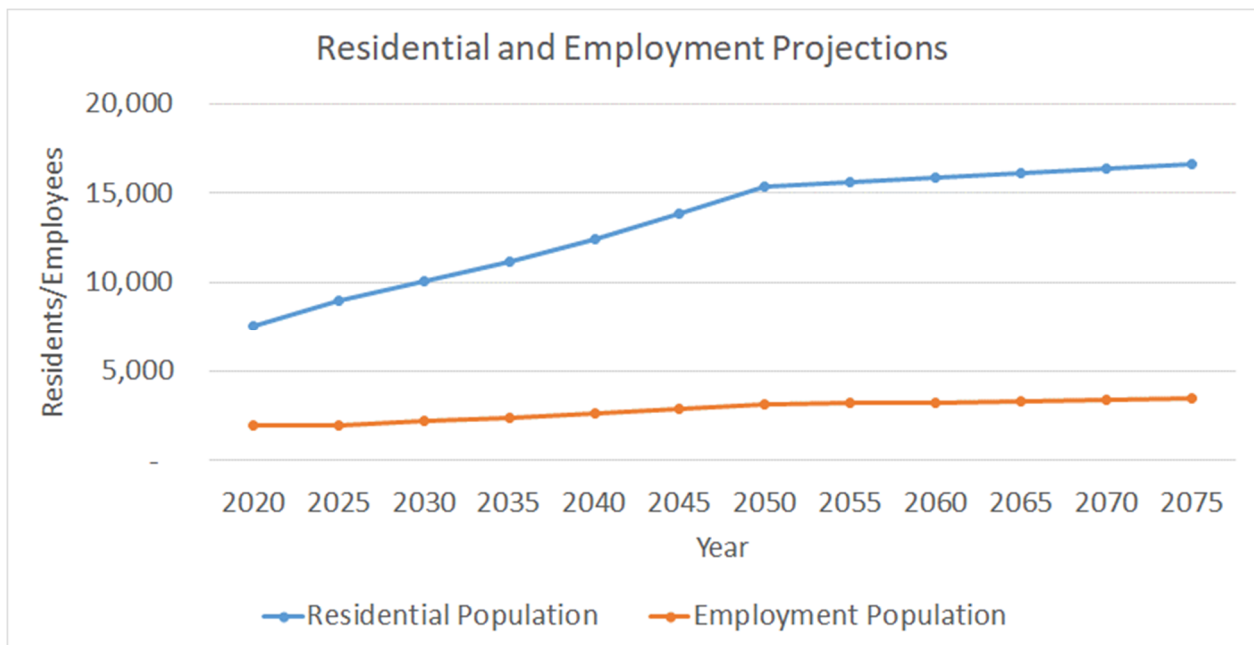
based on billing data divided by estimated population served. For purposes of this evaluation and to provide a slightly more conservative approach to predicting possible water demands, it is suggested to proceed with assuming a total population served of 9,513 in 2020 (7,562 residential and 1,951 employment). This will help to ensure that infrastructure is not undersized for future needs.

For reference purposes, as part of the 2017 Demand Forecast, Hazen utilized available land and current land use GIS data from the Albemarle County Office of Geographic Data Services (GDS) to assess the location of future developments and estimate a build out forecast for the service area (including growth outside the Development Area). Based on that analysis it was estimated that residential growth will far outweigh non-residential growth over the 50-year planning horizon, with limited non-residential growth projected to occur until after 2025. Population and employee projections were previously made using the following unit factors, which as noted above, were held constant for the Demand Forecast Update:

- 2.8 people per dwelling unit (Single Family)
- 2.0 people per dwelling unit (Multi-Family or Townhome)
- Non-residential to employees:
  - Institutional: 800 ft<sup>2</sup>/Employee
  - Light Industrial: 300 ft<sup>2</sup>/Employee
  - Mixed-Use (Retail and Commercial): 800 ft<sup>2</sup>/Employee

**Figure 6: GIS-Based Residential and Employment Projections**

**Note: Curves were Adjusted Slightly to Account for Near Term Accelerated Growth**



### 1.2.3.1 *Estimated Population and Employment Growth*

As was the case in the 2017 Demand Forecast, growth in population and employees was assumed to be linear between the following planning horizons, which were updated to reflect actual growth between January 2017 and the end of 2019 (partial 2020 data is available). Next to each planning horizon is the portion of the Crozet Service Area that is assumed to develop within that timeframe.

- 2020 to 2025 – Approved residential dwelling units (RDU), under review RDUs, and near term planned RDUs.
  - Note: The growth for this section was adjusted slightly to account for accelerated growth that has occurred, including growth in non-residential accounts (as well as residential accounts).
- 2025 to 2050 – 80% of future developable land minus areas that are not developable as listed below:
  - 2025 planned growth
  - Parcels with existing buildings/water consumption
  - Land usages including greenspace, parks and green systems, river corridor, public open space, privately owned open space, and environmental features
- 2050 to 2075 – Same as 2025 to 2050 – remaining 20% of developable land. The service area is assumed to reach buildout capacity in 2075.

- Update Demand Forecasts

Updated unit water demands identified in Section 1.2.2 were multiplied by the changes in population described above and then added to current 2019 demands (0.594 mgd) to project annual average water demands in future planning years. The results of this analysis are shown below in Table 1 and represent the updated ADD.

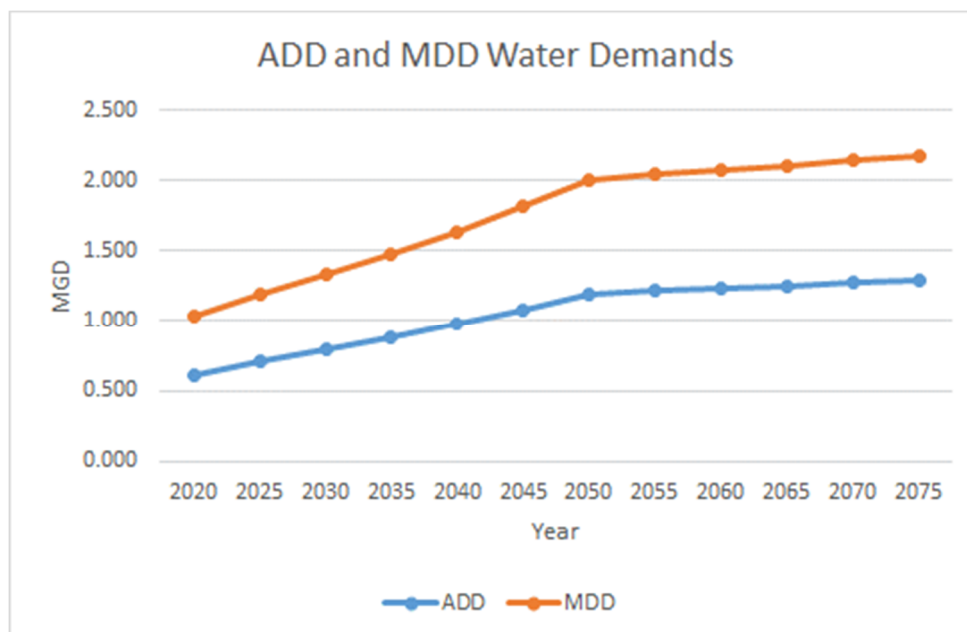
The updated ADD at each future planning year was then multiplied by the MDD/ADD ratio identified in Section 1.2.1 to project maximum daily water demands in future planning years. The results of this analysis are also shown below in Table 1 and represent the updated MDD. Figure 7 shows both the ADD and MDD growth in 5-year increments through the year 2075.

**Table 1\* : ADD and MDD (in MGD) Water Demand Projections Through 2075**

Year	Residential Projection	Growth Percentage	Water Demand (Residential + Employment)		Employment Projection	Growth Percentage	Additional Employment Flow	Total ADD Demand (MGD)*	Total MDD Demand (MGD)
			*Does Not Include In-Plant Water Use	Additional Residential Flow (65 gpcd)					
2019	7,306	4.25%	0.594		1,922	1.64%		0.594	0.998
2020	7,562	3.50%		0.017	1,951	1.50%	0.002	0.612	1.029
2025	8,981	3.50%		0.109	1,980	1.50%	0.004	0.707	1.187
2030	10,088	2.13%		0.181	2,199	1.78%	0.018	0.793	1.332
2035	11,209	2.13%		0.254	2,402	1.78%	0.031	0.879	1.477
2040	12,455	2.13%		0.335	2,624	1.78%	0.046	0.974	1.637
2045	13,839	2.13%		0.425	2,866	1.78%	0.061	1.080	1.814
2050	15,377	2.13%		0.525	3,130	1.78%	0.079	1.197	2.011
2055	15,613	0.31%		0.540	3,194	0.40%	0.083	1.217	2.044
2060	15,853	0.31%		0.556	3,258	0.40%	0.087	1.236	2.077
2065	16,096	0.31%		0.571	3,324	0.40%	0.091	1.257	2.111
2070	16,343	0.31%		0.587	3,392	0.40%	0.096	1.277	2.145
2075	16,594	0.31%		0.604	3,461	0.40%	0.100	1.298	2.180

\* As noted in Section 1.2.3, based on a March 2020 Customer Class Report, as prepared by ACSA, the Crozet Service Area included 4,170 water connections, estimated to equal a residential population of 10,015 (population is the total Single-Family and Multi-Family units using an occupancy of 2.5). The residential population estimated to be served in 2020 in this evaluation, as shown in this table, is 7,562 and the employment population estimated to be served in 2020 in this evaluation is 1,951, for a total population served in 2020 of 9,513. A higher residential population would result in lower unit water demands as the unit demands are based on billing data divided by estimated population served. Therefore, by proceeding with the assumption of a total population served of 9,513 in 2020 (7,562 residential and 1,951 employment), projected water demands will be slightly more conservative and help to ensure that infrastructure is not undersized for future needs.

**Figure 7: Projected Water Demands (ADD and MDD) – through 2075**



## 1.2.4 Updated Growth Curve Envelope

In addition to the updated growth curve developed in Section 1.2.3, various alternative growth projection scenarios were reconsidered to develop an updated growth curve envelope. As was the case during the 2017 Demand Forecast, and which is held consistent for this Demand Forecast Update, the approach for each alternative growth projection scenario evaluated is an attempt to answer the following questions:

*Can a new standard residential and non-residential unit water demand be applied effectively across a water service area?*

*Can this new standard serve as an adequate representation of water demands in the near and distant future?*

*How does the new standard compare to the most recent demands represented by field data (billing data)?*

The following assumptions were carried forward as a part of this Demand Forecast Update:

- Unit water demands (gpcd and gped) would not decrease over time – if unit demands were anticipated to decline over time, projected demands would be lower than those presented herein. The residential unit water demands within the Crozet Service Area continue to be in line with other systems in Virginia that have similar infrastructure age and home size and represent the water efficiency of new construction.
- Non-revenue water % will remain constant over time. The Crozet Service Area has a relatively low non-revenue water % when compared to similarly sized systems. Some of this may be attributed to the relative age of Crozet’s infrastructure (newer system).
- Non-revenue water is distributed throughout the Crozet service area based on demand.

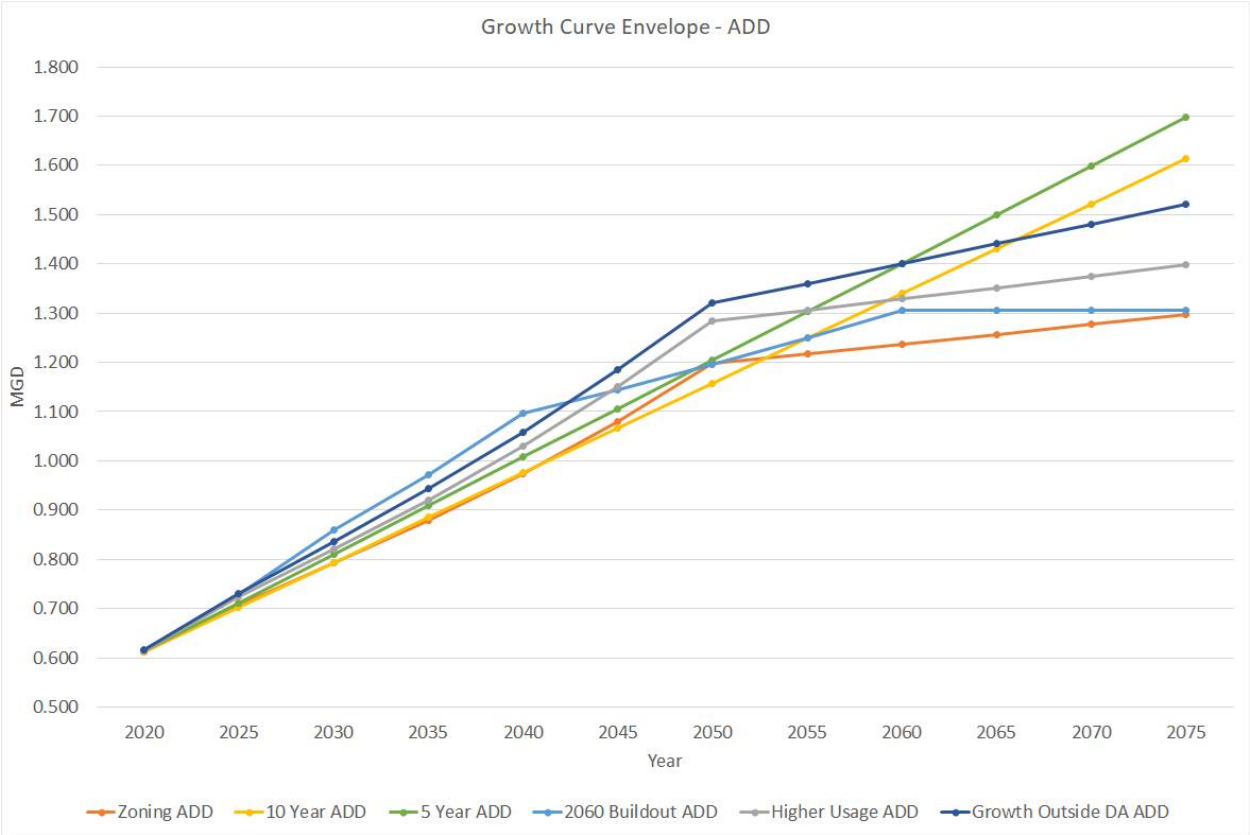
### 1.2.4.1 Updated Growth Projection Curves

The following growth projection scenarios were considered, which are the same as those used for the 2017 Demand Forecast. As shown in Figures 8 and 9, some of these alternative growth curves fall above and some fall below the baseline growth curve from Section 1.2.3 (Zoning ADD and Zoning MDD on the figures). Collectively they represent a range of plausible future water demands that could occur over the next 55 years (through 2075). As was the case in 2017 and remains the case in 2020, the recommended growth curve should balance water industry trends, current Crozet billing data, and a level of conservatism that addresses the importance to a water system in meeting its obligation to provide drinking water to its customers. The additional growth projections used in preparing the growth curve envelope for ADD and MDD are as follows:

- Historical Usage – 5-year and 10-year linear regression (Updated with data from January 2017 through April 2020)
- Zoning Based Projection – From Section 1.2.3 – ADD of 1.30 MGD, MDD of 2.18 MGD (Note: in the 2017 Demand Forecast ADD was 1.27 and MDD was 2.14 MGD)

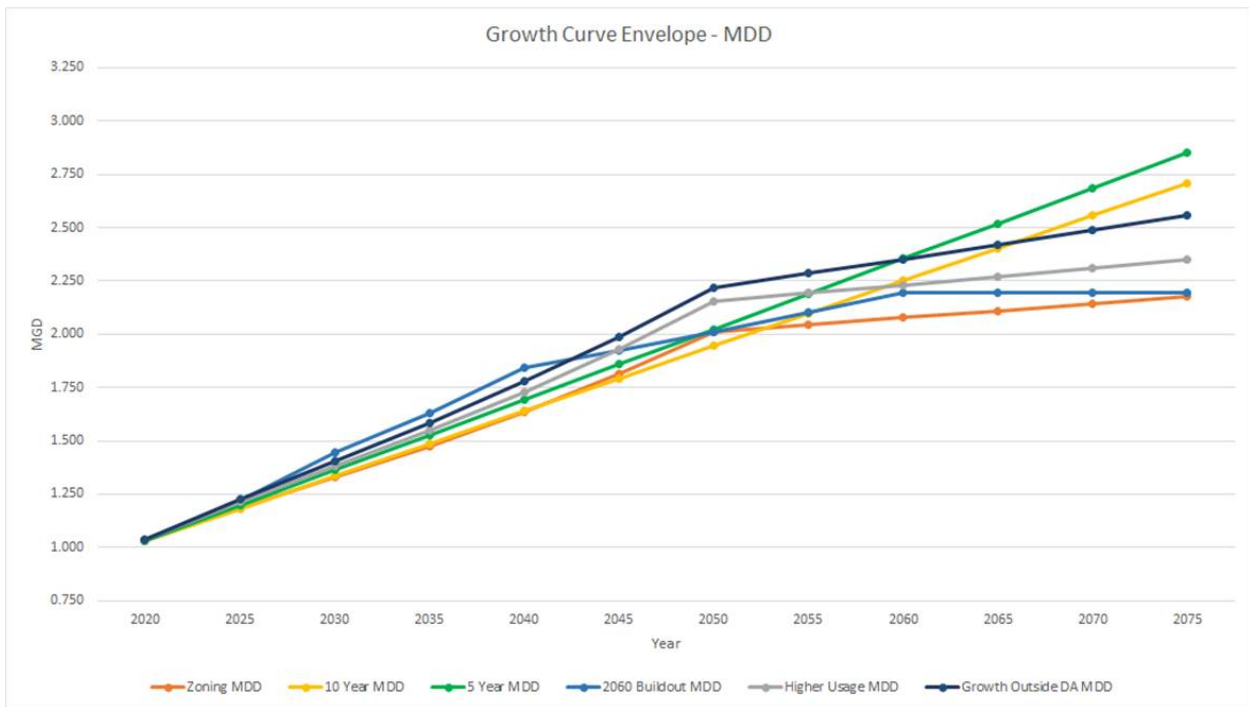
- More rapid growth – buildout reached by 2060
- More development outside of the current Crozet Service Area, within water only parcels (~0.2 MGD under MDD conditions)
- Modified sectoral usage – billing data analysis supports possible higher usage (75 gpcd single family, 60 gpcd multi-family, and 70 gpcd non-residential)

**Figure 8: Project ADD Growth Envelope**





**Figure 9: Project MDD Growth Envelope**



Given the range of projections, for planning purposes it was recommended that the buildout ADD (in 2075) would be 1.52 mgd and the MDD would be 2.55 mgd (compared to 1.5 mgd and 2.5 mgd from the 2017 Demand Forecast, which represents a slight increase in demand projections). This represents growth outside of the current Crozet Service Area within water only parcels. When in-plant water use is considered (i.e., adding in an additional 10% of production), the required water withdrawal from Beaver Creek Reservoir and the required water treatment capacity at the Crozet WTP under average and maximum conditions would be 1.67 and 2.81 mgd, respectively (compared to 1.65 mgd and 2.75 mgd from the 2017 Demand Forecast, which represents a slight increase in demand projections).

### 1.2.5 COVID-19 Impacts

As a part of this Demand Forecast Update, we completed a preliminary assessment of the impact that COVID-19 response measures have had on water demands through a comparison of March 2019 demands to March 2020 demands. Based on this assessment from March 2019 to March 2020, water demands have increased 8.2%. It is important to note that demands fluctuate over the course of a calendar year, so the calendar year impact due to COVID-19 is not yet fully known. Nevertheless, given the high proportion of residential demand in the Crozet Service Area, the fact that stay-at-home orders would increase water demand in Crozet is not surprising. Early monitoring of water demands from other communities since COVID-19 response measures took hold indicate increased residential demands and reduced commercial sector demands. However, water demand increases within the Crozet Service Area may not be completely related to COVID-19. For reference, ADD from 2017 to 2018 grew 0.07% and from 2018 to 2019 grew 11.6% - both data points well before the COVID-19 outbreak. To get an estimate of the portion of water demand increase that is due to continued development and the portion due to COVID-19 response, we compared an average of water demands from January and February 2019 to average demands from January

and February 2020, which actually showed a 3.5% reduction in water demands. Taken collectively, the data support the supposition that nearly all of the recent (2019 to 2020) water demand increase can be attributed to COVID-19 and the associated social behavioral changes (e.g. remote work, increased water use for sanitation, etc.).

The results, which show a marked increase in water demands, indicate the importance of water supply resiliency for the Crozet Service Area. It would appear that an increase in water demands is a direct result of the account class type distribution (~80% residential and ~20% non-residential), which is more heavily influenced by residential demands than typical urban communities. Although it is anticipated this water demand increase will be temporary, the duration of this temporary increase is not currently known. **However, this data supports a more conservative approach with respect to water supply need projections, such as those presented herein.**