

MADISON, VIRGINIA

Regional Water Supply Plan

Town and County of Madison, Virginia

Data Prepared by Andrea Putscher, Staff Member DEQ (through December 2010)

11/1/2011

This document is prepared in accordance with the Local and Regional Water Supply Plan regulations set forth within 9 VAC25-780 et seq. Many thanks to Andrea (“Andy”) Putscher for the many hours of work that she devoted to gathering and analyzing data from Virginia Department of Health and Virginia Department of Environmental Quality records and databases.

1. Introduction

1.1. Background

In the summer of 2002 the Commonwealth of Virginia and other mid mid-Atlantic states experienced severe drought conditions. As a result Virginia's Water Policy Technical Advisory Committee (TAC) was formed to develop a state water supply plan and to draft state regulatory criteria for the development of local and regional water supply plans. Effective November 2, 2005 the Virginia State Water Control Board enacted 9VAC25-780-10 through 9VAC25-780-190 to the Commonwealth's Local and Regional Water Supply Planning regulations, requiring each county, city and town within the Commonwealth to prepare and submit to the state a local or regional water supply plan.

Madison County has joined with the Town of Madison to develop a regional supply plan as required by the state's water supply planning regulations. Rapidan Service Authority (hereinafter, RSA), as the water service authority for the two jurisdictions, is also stakeholder in this regional plan. The deadline for the submission of this plan to the Commonwealth is November 2, 2011.

1.2. Purpose

The purpose of the state's Local and Regional Water Supply Planning regulations is to aid in the development of statewide water supply plans. The purpose of this document is to serve as a Regional Water Supply Plan, for Madison County and the Town of Madison, in accordance with 9VAC25-780. This regional plan will help to ensure that residents are adequately provided with safe drinking water; to encourage, promote, and protect all other beneficial uses of the commonwealth's water sources; and to encourage promote and develop incentives for alternative water sources. This regional plan will also aid in the development of water supply projects needed to meet the County's future water demands.

1.3. Scope

This regional water supply plan will address the following:

- **Describe existing water sources** in accordance with the requirements of 9VAC25-780-70. Existing water sources include community well systems, community water systems using stream intakes, self-supplied users of more than 300,000 gallons per month for non-agricultural uses, agricultural users of more than 300,000 gallons per month and self-supplied users on individual wells withdrawing less than 300,000 gallons per month.
- **Describe existing water use** in accordance with the requirements of 9VAC25-780-80.
- **Describe existing water resource conditions** in accordance with the requirements of 9VAC25-780-90. Conditions may include geologic, hydrologic, meteorological, and environmental conditions that pertain to or that may affect instream flow, instream uses and sources that currently supply water.



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- **Assess projected water demand** in accordance with the requirements of 9VAC25-780-100, including an estimate of water demand for 30-50 years into the future for each water system.
- **Describe water management actions** in accordance with the requirements of 9VAC25-780-110 and 9VAC25-780-120. Water management actions include practices for more efficient use of water, water conservation measures, measures to reduce unaccounted water losses, and drought response and contingency plans.
- **Provide a statement of need** in accordance with the requirements of 9VAC25-780-130. Assess whether existing water sources are adequate to meet projected demand.
- **Provide an alternatives analysis**, in accordance with 9VAC25-780-130, to identify potential alternative water sources to address any projected deficits in water supplies.

2. Existing Water Sources

2.1. Overview

The purpose of this section is to identify and to characterize the existing water sources in Madison County. These sources include a stream intake system; community groundwater systems, and self-supplied groundwater systems. Rapidan Service Authority (RSA) provides public drinking water services within the Town of Madison and in limited areas of Madison County, proximate to the Town limits. RSA uses an existing water treatment plant located off Rt. 657 (Thrift Road) in the County, near White Oak Run. Outside of the RSA service area, the County's population utilizes groundwater as their primary source of drinking water. A majority of the County's groundwater users are private residences with low-yield wells (producing less than 10 gallons per minute (gpm)). Although a substantial portion of Madison County consists of agricultural land and uses, there are no known major agricultural operations which utilize more than 300,000 gallons per month of groundwater or surface water.

2.2. Community Water Systems (CWS) Using Ground Water, 9VAC25-780-70

For ease of presentation these systems have been grouped in several subsets, based on similar hydrologic or hydrogeologic settings. Most of the County sits atop the Piedmont and Blue Ridge regional aquifer system.¹ Several geologic basins cover Madison: the Mesozoic/Triassic Basin; Eastern Piedmont/Paleozoic; and Blue Ridge/Proterozoic.

2.2.1. Triassic/Early Mesozoic Basin

Two of the community water systems using groundwater are located on the eastern margin of Madison County. They are likely geologically located on the 'Triassic Basin' (a.k.a. 'Early Mesozoic') basin along the Rapidan River and lower reaches of the Robinson River, just upstream of the confluence of those two rivers. Each supports its institutional and related residential public functions.

2.2.1.1. Woodberry Forest School

Woodberry Forest is a boarding school founded in 1889. Presently the school and its various facilities occupy twelve hundred (1200) acres of land in the eastern portion of Madison County, adjacent to the Rapidan River. A population of up to 700 persons has been served daily by this community water system; however, some of those users are there only in the daytime. As of 2011 the school enrolled approximately 400 boarding students and employed a faculty of 87. The school facilities served by this community water system include dormitories, faculty residences, office and classroom buildings, and various athletic facilities, including a golf course and swimming pool.

The CWS which serves Woodberry Forest School is supplied by two drilled wells. See Table 1, following below. The water is processed by a treatment system consisting of storage facilities assisted by booster pumps. The two wells range in depth from 145 to 199 feet, with multiple, varied water bearing zones between 59 to 117 ft. depths (i.e., in the fractured zones of the meta-sedimentary

¹ U.S.G.S. data



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bedrock). One well (Well 6”) serves as the primary water source. Use of the second well (Well 7”) has been minimized, because high iron concentrations in Well 7 require greater treatment than when the primary well is used alone. However, the availability of the second well satisfies a requirement imposed by the Virginia Department of Health (VDH) in order to ensure reliability (continuity during repairs and sufficient pressure during high demand periods) of supply for any CWS with 50 or more connections.

VDH EDS (1996) calculations suggest that withdrawal capacity of Woodberry Forest’s two wells is sufficient to meet maximum demands (360 ERC x 4 =1440 persons), to accommodate special events, short term seasonal increased demands, or to allow for some limited future growth and change in water demands, if other requisite infrastructure upgrades were to be installed. The 1996, and prior, EDS also note the existence of a pipeline connection to a CWS in the Town of Orange, located approximately 5 miles south along Rt. 15. This pipeline connection ensures a supplemental water supply to Woodberry Forest School, if needed.

2.2.1.2. Hartland Institute of Health and Education

The Hartland Institute of Health and Education (hereafter, “Hartland Institute”) was founded by lay Seventh-day Adventist in 1983 and is the home of Hartland College, Hartland Lifestyle Education Center and Hartland Publications. Hartland Institute is situated along the Robinson River in the eastern portion of the County. The CWS utilized by the Hartland Institute serves a variety of institutional, residential and agricultural uses.

The CWS which serves the Hartland Institute is supplied by two drilled wells. See Table 1, following below. The wells range in depth from 205 feet to greater than 298 feet.

Table 1. Water Sources Summary – Madison County Triassic Basin

Water System Name (PWSID)	Map Key	Number of Wells	Permitted Number of Connections	VDH Permitted System Capacity	Withdrawal Design Capacity: AVERAGE DAILY (gpd)	Withdrawal Design Capacity: MAXIMUM DAILY (gpd)	Well Yield (gpm)
Woodberry Forest School (6113300)	H ^A	2	N/A	76,000	-	-	-
Well 6	-	-	-	-	64,800	115,200	80
Well 7	-	-	-	-	75,330	144,000	100
Hartland Institute (6113165)	H ^B	2	N/A	33,600	-	-	-
Well 2A	-	-	-	-	N/A	8,640	6
Well 1B	-	-	-	-	N/A	53,280	37

2.2.2. Blue Ridge/ mid-Proterozoic Basin

Four of the County’s groundwater-supplied CWS are located in the South-central margin of the County of Madison. They are likely geologically situated on the middle-late Proterozoic Basin.

2.2.2.1. Oak Park Residential Subdivision

The Oak Park Subdivision is a cluster of residences served by a groundwater-supplied CWS. This system is operated by Aqua Virginia, and was upgraded in 2008. This system has limited storage capacity, and the withdrawal capacities detailed in Table 2, following below, exceed both the actual water demands (3,700 gpd average daily in 2009) and the capacity that would be permissible by VDH based on the available storage. This system has been granted ~~grandfathered~~ status by VDH at 28 existing connections for 50 to 64 people, on the strength of its proven history of effectively supporting the existing connections.

2.2.2.2. Achsah Acres Residential Subdivision

The Achsah Acres Subdivision is located in eastern Madison County, consisting of residences served by a groundwater-supplied CWS. The Achsah Acres CWS is supplied by three drilled wells, See Table 2, following below. ~~Well 4~~ is the only well that, as of 2009, was being used regularly for drinking water for the subdivision. Well 4 has a depth of 205 feet, and has a yield of 15 gpm and a pump capacity of 12 gpm. ~~Wells 1~~ and ~~Well 2~~ are not typically in operation. 2009 data indicates that these two wells were used only once—in the month of February. Wells 1 and 2 range in depth from 225 to 500 feet. The yields and pump capacities for Wells 1 and 2 are summarized in Table2, below. VDH permitted capacity for the water system at Achsah Acres is 3,336 gpd, based on limited storage capacity (October 2008).

2.2.2.3. Mountain View Nursing Home

Mountain View Nursing Home is an 80-bed inpatient nursing home (institutional use) operated by the Oak Grove Mennonite Church of Aroda. The Mountain View CWS is supplied by two drilled wells, both are replacement wells. See Table 2, below. (This CWS was grandfathered by VDH for 80 beds, but was substantially upgraded in 2002). ~~Well 2~~ is 325 feet deep with a well yield of 11 gpm. ~~Well 3,~~ when operational, is 225 feet deep with a well yield of 21gpm. Well 3 is not often utilized, due to the limited capacity of the onsite treatment plant for the system (there is a water quality issue related to VOC content, due to possible contamination from a fuel tank previously located on the site). The Virginia Department of Health permitted capacity for the system is 8,800 gpd; however, if and when Well 3 can be online and regularly in-service, the permitted capacity will become 23,920 gpd.

2.2.2.4. Happy Hills Residential Subdivision

Happy Hills Residential Subdivision is a residential subdivision. The Happy Hills CWS is supplied by two drilled wells that range in depth from 265 to 305 feet, with 2 to 3 varied water bearing zones of 60- to 105-foot depths.² This subdivision, originally developed by DeJarnette Realty prior to 1979, was sold to Broad Run Service Corp. in 1996. VDH has granted this CWS ~~grandfathered~~ status to serve 15 existing connections.

² Well construction information was taken from OGWCP database.



Table 2. Water Sources Summary – Madison County Proterozoic Basin

Water System Name (PWSID)	Map Key	Number of Wells	Permitted Number of Connections	VDH Permitted System Capacity	Withdrawal Design Capacity: AVERAGE DAILY (gpd)	Withdrawal Design Capacity: MAXIMUM DAILY (gpd)	Well Yield (gpm)
Oak Park (6113170)	H ^F	1	28	N.I.	3,700	-	-
Well 1	-	-	-	-	-	12,960	9
Well 2	-	-	-	-	-	14,400	10
Achsah (6113100)	H ^C	3	NA	3,336	-	-	-
Well 1	-	-	-	-	21,870	38,880	27*
Well 2	-	-	-	-	2,430	4,320	3
Well 4	-	-	-	-	9,720	17,280	12*
Mountain View Nursing Home (6113265)	H ^D	2	NA	8,800	-	-	-
Well 2	-	-	-	-	8,910	15,840	11
Well 3	-	-	-	-	8,505	15,120	10.5*
Happy Hills (6113160)	H ^G	2	15	N.I.	1,000	-	-
Well 1	-	-	-	-	-	N.I.	N.I.
Well 2	-	-	-	-	-	N.I.	N.I.

* Denotes a Well Yield that is limited by the pump capacity for the well.

2.2.3. Blue Ridge, middle/late Proterozoic Basin

Valley View is a residential subdivision located in the central part of Madison County. The CWS that serves this subdivision is grandfathered at 14 existing connections for 32 people (as of 2001). Valley View has one drilled well at a depth of 270 feet. There is no Virginia Department of Health permitted capacity listed in VDH records, the average daily usage is 2148 gpd per the SSR 2009 report (153 gpd per connection).

Rolling Brook Mobile Home Park is a residential mobile home park located in the central part of Madison County. The CWS that serves this subdivision has been grandfathered at 28 trailer connections since 1980. Rolling Brook Mobile Home Park has one drilled well at a depth between 385 and 700 feet. There is no Virginia Department of Health permitted capacity listed, however, the average daily usage is 3,450 gpd per the SSR 2009 report.

Table 3. Water Sources Summary – Blue Ridge

Water System Name (PWSID)	Map Key	Number of Wells	Permitted Number of Connections	VDH Permitted System Capacity	Withdrawal Design Capacity: AVERAGE DAILY (gpd)	Withdrawal Design Capacity: MAXIMUM DAILY (gpd)	Well Yield (gpm)
Valley View (6113500)	H ^E	1	14	32	N.I.	N.I.	N.I.
Rollingbrook Mobile Home Park (6113195)	H ^H	1	28	N.I.	3,450	N.I.	N.I.

2.2.4. Proterozoic Basin - Lynchburg Group - Conglomerate and metagraywacke

Copely Fields is a housing subdivision in the eastern part of Madison County originally developed by Jefferson Homebuilders. The CWS that serves this subdivision is grandfathered at 12 connections; however, Health Department records indicate that it is currently operating at 13 connections. Copely Fields has one drilled well, however, there is no further Virginia Department of Health information on the system. The average daily use was 1,260 gpd for 2008 – 2009 and 1,569 gpd for 2006.

Water System Name (PWSID)	Map Key	Number of Wells	Permitted Number of Connections	VDH Permitted System Capacity	Withdrawal Design Capacity: AVERAGE DAILY (gpd)	Withdrawal Design Capacity: MAXIMUM DAILY (gpd)	Well Yield (gpm)
Copely Fields (6113115)	H ^J	1	12	N.I.	N.I.	N.I.	N.I.

2.2.5. North Eastern Madison County – Proterozoic Basin - Robertson River Igneous Suite - Hitt Mountain alkali feldspar syenite

Meadowbrooke is an assisted living (institutional) residential facility that has been grandfathered for 40 persons since 2003. Meadowbrooke has one drilled well at a depth of 110 feet with two permitted connections for the system. The well has a well yield that ranges from 3 to 16 gpm, however, there is no Virginia Department of Health permitted capacity listed for this system.

Water System Name (PWSID)	Map Key	Number of Wells	Permitted Number of Connections	VDH Permitted System Capacity	Withdrawal Design Capacity: AVERAGE DAILY (gpd)	Withdrawal Design Capacity: MAXIMUM DAILY (gpd)	Well Yield (gpm)
Meadowbrooke (6113188)	H ^K	1	2	N.I.	N.I.	N.I.	3-16 gpm



2.3. Groundwater Used by Non-Agricultural Self-Supplied Users of more than 300,000 gallons per month

NONE. At the current time, there are no known non-agricultural self-supplied users of more than 300,000 gallons per month in the Town or County of Madison, who report to DEQ annually. This is a category of users that need further research in future iterations of the Water Supply Plan.

2.4. Agricultural Self-Supplied Users, more than 300,000 gallons per month

NONE. Based on conversations with Brad Jarvis, the Agricultural Extension Agent for Madison County, there are no self-supplied agricultural users of more than 300,000 gallons per month in the County or Town of Madison. According to the Irrigation Survey Table from the 2007 Census of Agriculture, there are 18 farms that irrigate a total of 69 acres of land. This information confirms that there are not likely to be agricultural self-supplied users of more than 300,000 gallons per month (e.g., to use 300,000 gallons per month, an agricultural user would need to apply about 1 inch of water over 11 acres over the course of a month to equate to the 300,000 gallons per month rate). Further, there are no records of DEQ reports for agricultural uses of more than 300,000 gallons per month. Thresholds for reporting to DEQ (9 VAC 25-250-10) are: 1 million gallons per month for irrigation of crops or 300,000 gallons per month or 10,000 gallons per day for livestock watering.

2.5. Self-Supplied Users, Less than 300,000 gallons per month

2.5.1. Self-Supplied Residential Users of Groundwater (Individual Wells)

The estimated number of residences self-supplied from “individual wells” which include individual wells, private shared wells, cisterns, or springs is 4,896 households countywide. Some of these residences also serve as business addresses.

To estimate this, we began with Census data estimating 5,279 households within Madison County, then subtracted 175 residential accounts of RSA (2009) and 208 CWS residential connections identified in VDH SSRs. This leaves 4,896 households assumed for purposes of this Plan to be self-supplied residential users. Using 2009 VEC population estimates of 13,950 persons in 5,279 occupied housing units, a persons-per-household figure of 2.64 persons was calculated. Therefore, it is estimated that the residential population served by individual wells (2009) is approximately 12,925 persons, or approximately 92% of the County’s population.

2.5.2. Self-Supplied Non-Agricultural Business and Institutional Users of Groundwater (Individual Wells)

According to County records there are more than 300 commercial and industrial-zoned parcels (County GIS/zoning data). As of 2009, census data indicated 315 “business firms” in Madison County and VEC data (2010) indicates the presence of 343 employers. Using a mid-point figure of 322 employers, and subtracting 109 non-residential RSA accounts (2009) 213 is the number of self-supplied businesses estimated to be using individual wells.

2.5.3. Self-Supplied Agricultural Use

According to the 2007 Agricultural Census, there exist 564 farms comprising 102,757 acres total countywide. The specific farming operations that are reported in the census of agriculture account for 70,798 acres, and in addition to those there are berries and grapes, orchards and the livestock operations. Water requirements for crops are tabulated in Section 3. The water use associated for consumption by livestock is also tabulated in Section 3. It is not known how much of this water is taken from developed capacity on the 18 farms (e.g., from pumped from wells or surface water intakes) and how much is taken from direct rainfall or livestock drinking from ponds and streams. However, only 69 acres of irrigated farm lands were reported county-wide in the 2007 census of agriculture.

2.6. Community Water Systems Using Surface Water Reservoirs.

Madison County has only one CWS that uses a surface water reservoir. That CWS is owned and operated by the Rapidan Service Authority.

Water System Name (PWSID)	Map Key	Reservoir Name Reservoir watershed Basin / Sub-basin	Reservoir watershed Drainage Area (square miles)	On-Stream Storage Available for Water Supply (gallons)	Design Capacity Average Daily Withdrawal (gpd)	Design Capacity Maximum Daily Withdrawal (gpd)	Design Capacity Associated Water Treatment Plant (gpd)	Reservoir Safe Yield (MGD)	VDH Permitted System Capacity (gpd)	Permitted Number of Connections
Rapidan Service Authority Town of Madison (6113200)	H ¹	White Oak Lake Rappahannock Upper Rappahannock	5.06	162,000,000	192,000	489,600	250,000	1.41	250,000	625

1. **Name of Reservoir:** White Oak Lake
2. **Sub-Basin:** Rapahannock/Upper Rappahannock (Robinson River)
3. **Drainage Area:** 5.02 square miles (*DEQ calculations, 2005*)
4. **On-stream storage available for water supply:** 163 MG/163,000,000 gallons (*DEQ calculations, 2005*)
5. **Design capacity for average daily withdrawals:** (refers to intake on White Oak Run, see next section) 192,000 gallons per day (0.019 MGD)
6. **Design capacity for maximum daily withdrawals:** 489,600 gallons per day (0.49 MGD)
7. **Safe yield of the reservoir:** 1.41 MGD (*DEQ calculations, 2005*)
8. **Design capacity of associated water treatment plant:** 250,000 gallons per day (0.25 MGD)
9. **Department of health permitted capacity:** 250,000 gallons per day (0.25 MGD)
10. **Limitations on withdrawal established by permit:** none. This is a grandfathered system.



2.7. Community Water Systems Using Stream Intakes

Madison County has only one CWS that uses a stream intake. That CWS is owned and operated by the Rapidan Service Authority (RSA).

1. **Name of stream or river:** White Oak Run
2. **Sub-Basin:** Rappahannock/Upper Rappahannock (Robinson River)
3. **Drainage area of the intake:** 10 square miles
4. **Design capacity for average daily withdrawals:** 192,000 gallons per day (0.019 MGD)
5. **Designed maximum daily withdrawal:** 489,600 gallons per day (0.49 MGD)
6. **Safe yield:** 1.50 MGD
7. **Lowest daily flow of record:** 0.25 MGD
8. **Design capacity of pump station:** 0.288 mgd
9. **Design capacity of water treatment plant:** 250,000 gallons per day (0.25 MGD)
10. **Department of health permitted capacity:** 250,000 gallons per day (0.25 MGD), based on the capacity of the one (1) water treatment plant
11. **Limitations on withdrawal established by permit:** none. This is a grandfathered system.

2.8. Other sources

At this time Madison County and the Town of Madison do not have any agreements in place to purchase water from any other locality.

2.9. Source Water Protection

There are no known source water assessment plans or wellhead protection programs in the County. The assessment maintained by the state Office of Drinking Water lists several well systems (non-residential) as having a high susceptibility to contamination, as of 2/15/2006: The Bavarian Chef; Camp Shenandoah Springs; Copeley Fields subdivision; Criglersville Elementary School; Giovanna's Italian Eatery; Graves Mountain Lodge; Happy Hills subdivision; Hartland Institute; The Inn at Meander Plantation; Madison County School Board and Primary School; Madison Tastee Freeze; Meadowbrooke Assisted Living; Mountain View Nursing Home; Oak Park subdivision; Rapidan Baptist Camp; Rolling Brook Mobile Home Park; Seven Oaks Pathwork Center; Shenandoah Hills Campground; Valley View subdivision; and Woodberry Forest School.

3. Evaluation of Existing Uses, 9VAC25-780-80

3.1.Overview

Throughout this Water Supply Plan, water demand and withdrawal data from 2009 will be used as the baseline year in this Section 3 and for the Projections set forth in Section 5. (As of the time that data was gathered for inclusion in this report 2009 data was the most recent available from Health Department and DEQ sources)

3.2.Community Water Systems using Ground Water

3.2.1. Triassic Basin – Early Mesozoic

Table 4. Water Use Data for year 2009 – Madison County - 2 CWS in Triassic Basin a.k.a Early Mesozoic Aquifer

Water System Name (PWSID)	Map Key	Number of Wells	Population Served	Number of Connections	Average Daily Withdrawal (MGD)	Maximum Daily Withdrawal (MGD)
Woodberry Forest School (6113300)	H ^A	2	565	67	0.043	0.083
Well 6	-	-	-	-	0.042	-
Well 7	-	-	-	-	0.001	-
Hartland Institute (6113165)	H ^B	2	120	22	0.014	0.034
Well 2A	-	-	-	-	0.012	-
Well 1B	-	-	-	-	0.002	-

Woodberry Forest School

1. Category of Use: Institutional
2. Description:
 - a. Population Served by CWS (2009): 400
 - b. Number of Connections: 67 (2009)³
3. Daily Use, average: 0.043MGD (43,000 gpd)
4. Maximum daily withdrawal: 0.138 MGD
5. During the maximum water use month (April 2009) average daily water use is 1.3 times the average daily water use for that year, at 0.056 MGD (56,000 gpd).
6. On the maximum day or peak day of water use (August 2009) the daily water use is 1.9 times the average daily water use at 0.0826 MGD (82,600 gpd).
7. A typical and average month's total water use is approximately 0.14 MG/ mo.

³ Historically the Woodberry Forest CWS water use has been estimated to be divided approximately 80- 85% residential and institutional sanitary and drinking water, and about 15-20% landscape and turf irrigation. Of the 67 connections listed for VDH, the approximate number of residential connects is 31 single family homes, 4 duplex units, 4 dorms with multiple apartments, 3 other buildings with multiple apartments, and 3 residences attached to the dorms. The 46th residential connection includes a 6-room efficiency apartment building that was unoccupied in 2009. The remaining 21 connections include the institutional connections.



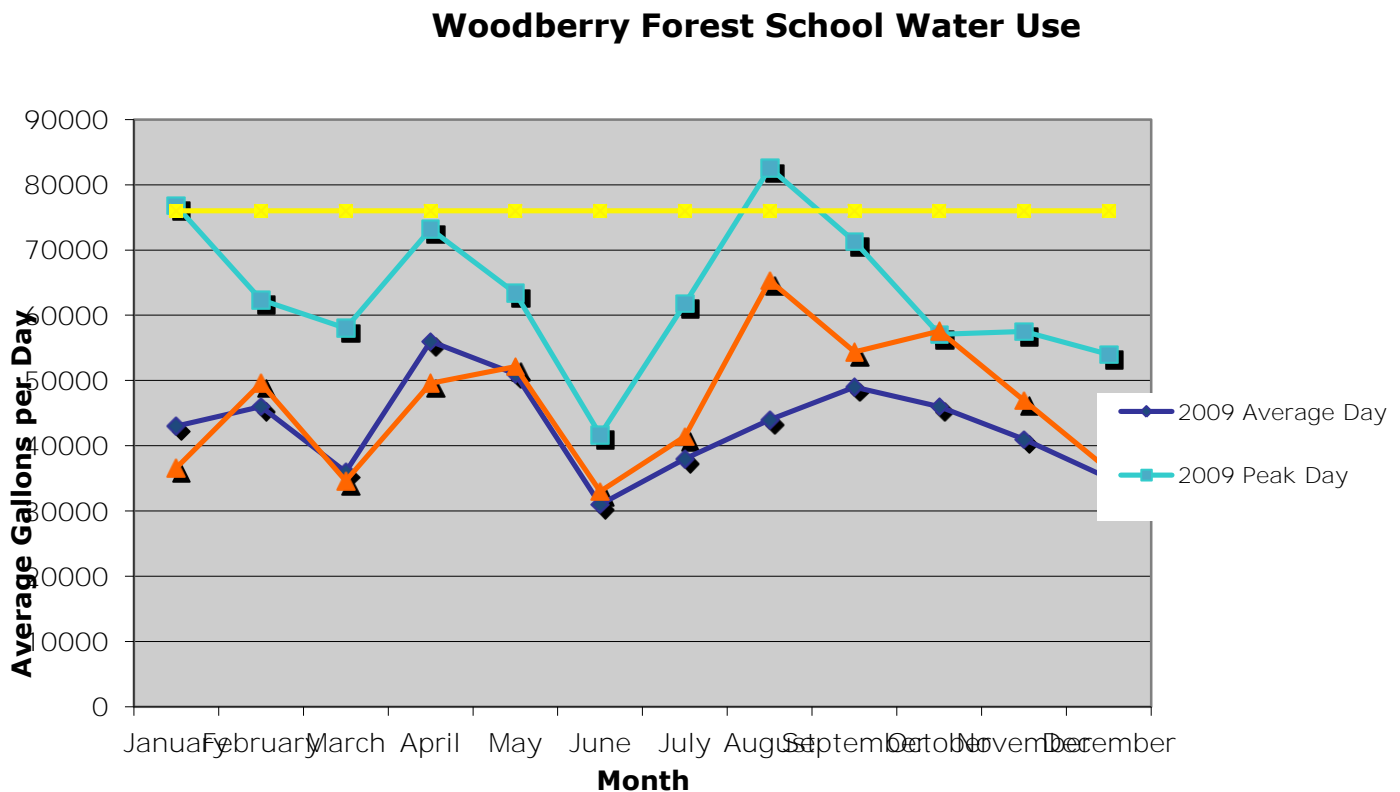
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8. The annual total water use is 1.72 million gallons (MG)
9. Above- average water use (0.051 to 0.056 MGD, up to 56,000 gpd) is reported for the late Spring months (April/ May) when school activities are in full swing and in late summer/ early Fall, when students are returning to campus and weather conditions are in the warm to hot range.
10. Below- average water use (0.031 to 0.036 MGD, as low as 31,000 gpd) occurs in the months of December–January (reflecting winter break), in March (Spring holidays) and the months of June –July (summer vacation).

In addition to drinking water, the water used from this system is for the irrigation of a limited set of playing fields, landscaping and lawns within the academic campus and residences, and for watering cattle. According to Mark Beal, the community system operator for Woodberry Forest, additional ponds and two wells are used for additional water needs by the Woodberry Forest farm and for irrigation of athletic fields. This water use is not part of the CWS but has the status of self-supplied water use of non-agricultural and agricultural water uses. The quantity of this water use for 2009 had not yet been reported when data was collected for this Water Supply Plan.

Water use data supplied in this Plan is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009.

Figure 5. Water Use Chart for Years 2007 and 2009 Woodberry Forest School

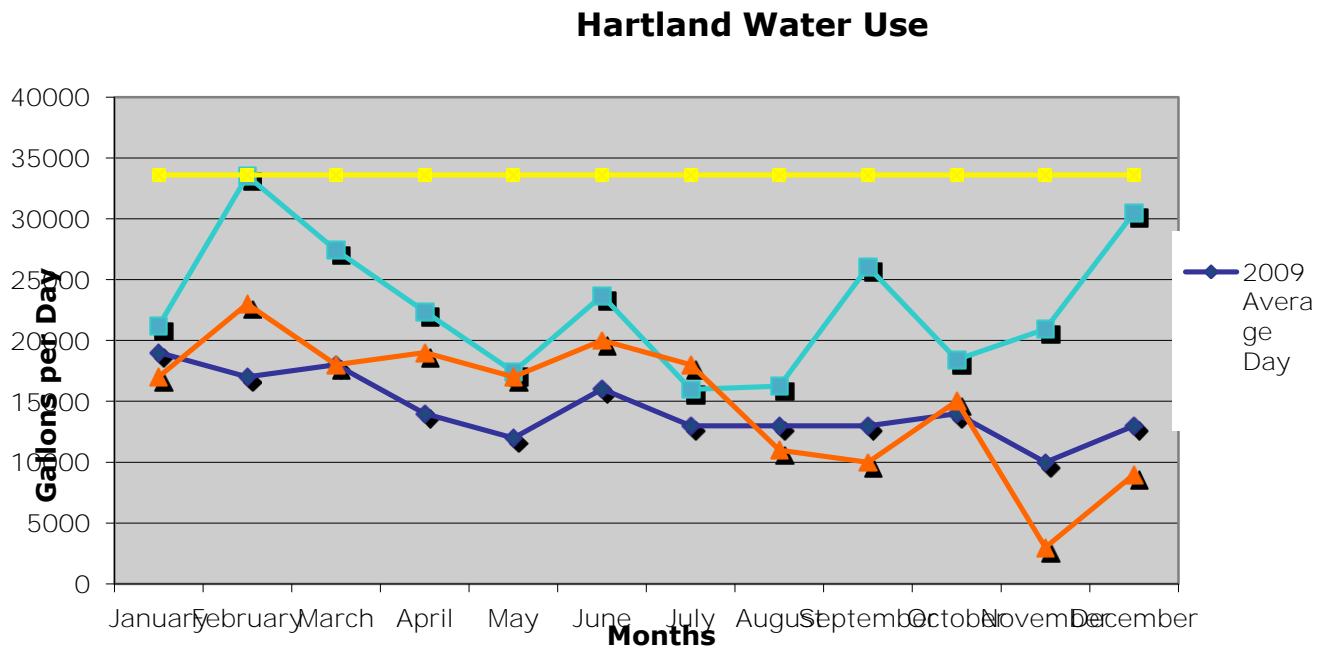


Hartland Institute

1. Category of Use: Institutional
2. Description:
 - a. Population served by CWS (2009): 120
 - b. Number of connections: 22
3. Daily use: average 0.014 MGD (14,000 gpd) for 2009
4. Maximum daily withdrawal: 0.034 MGD (33,510 gpd)
5. During the maximum water use month (January 2009) average daily water use is 1.357 times the average daily water use for that year, at 0.014 MGD (14,000 gpd).
6. On the maximum day or peak day of water use (0.034 MGD, or 33,510 gpd, in February 2009) the daily water use is 2.428 times the average daily water use for that year.
7. Monthly use: A typical and average month's total water use is approximately 0.43 MG/ mo.
8. Annual use: The annual total water use is 5.21 million gallons (MG).
9. Above-average use occurs: No pattern
10. Below-average use occurs: No pattern

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.

Figure 6. Water Use Chart for Hartland Institute Years 2007 and 2009





3.2.2. Proterozoic Basin

Table 7. Water Use Data for year 2009 – Madison County - 4 CWS in Proterozoic Basin

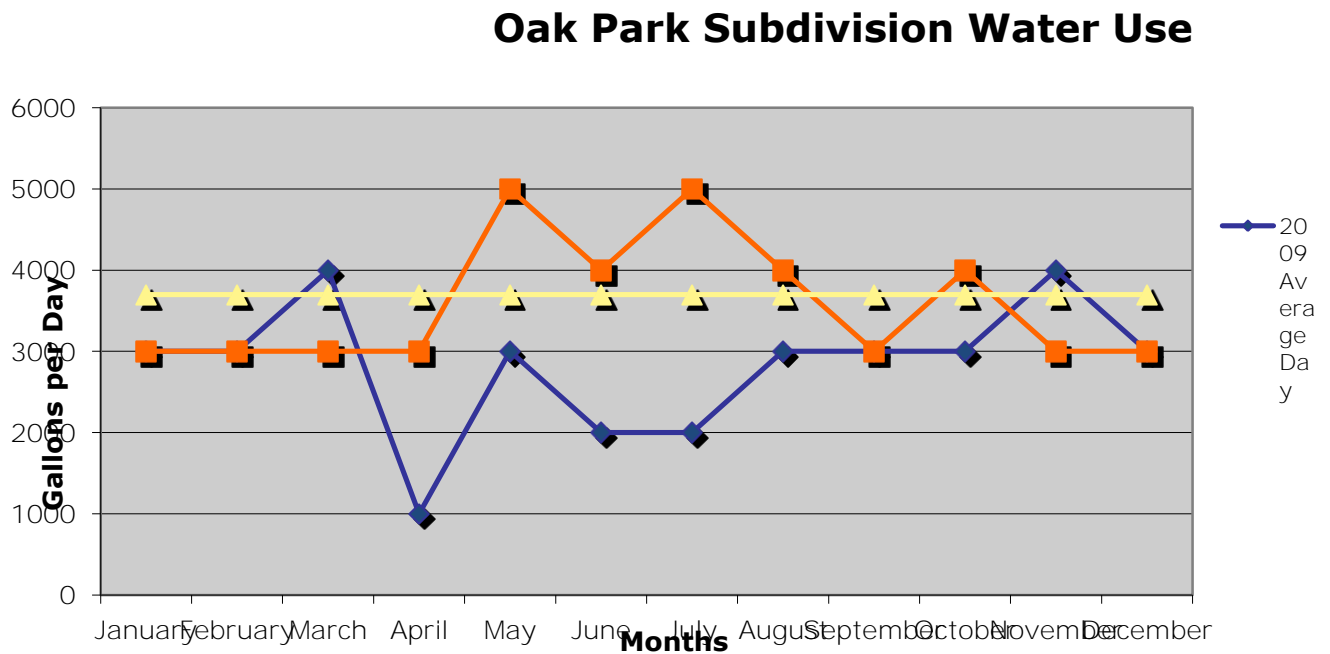
Water System Name (PWSID)	Map Key	Number of Wells	Population Served	Number of Connections	Average Daily Withdrawal (MGD)	Maximum Daily Withdrawal (MGD)
Oak Park (6113170)	H ^F	1	50	22	.003	N/A
Well 1	-	-	-	-	.002	-
Well 2	-	-	-	-	.001	-
Achsah (6113100)	H ^C	3	63	28	.005	N/A
Well 1	-	-	-	-	0	-
Well 2	-	-	-	-	0	-
Well 4	-	-	-	-	.005	-
Mountain View Nursing Home (6113265)	H ^D	2	80	1	.01	N/A
Well 2	-	-	-	-	-	-
Well 3	-	-	-	-	-	-
Happy Hills (6113160)	H ^G	2	N/A	15	.002	N/A
Well 1	-	-	-	-	.001	-
Well 2	-	-	-	-	.001	-

Oak Park Subdivision

1. Category of Use: Residential
2. Description:
 - a. Population served by Oak Park CWS (2009): 50
 - b. Number of connections (2009): 22
3. Average daily withdrawal: 0.003 MGD (3,000 gpd) for 2009
4. Maximum daily withdrawal (2009): data not available
5. During the maximum water use month (November 2009) average daily water use is 1.33 times the average daily water use for that year, at 0.004 MGD.
6. On the maximum day or peak day of water use (data not available, so it cannot be compared with average daily use).
7. Monthly average use: A typical and average month's total water use is approximately 0.09 MG/ mo.
8. Annual use: The annual total water use is 1.05 million gallons, mostly from Well #1, although two (2) wells are available.
9. Above-average use occurs: No patterns evident from 2009 data. 2009 data did not reflect increased water usage during summer months, although 2007 data did show increased summer use.
10. Below-average use occurs: No patterns evident from 2009 data.

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.

Figure 8. Water Use Chart for Oak Park Subdivision Years 2007 and 2009



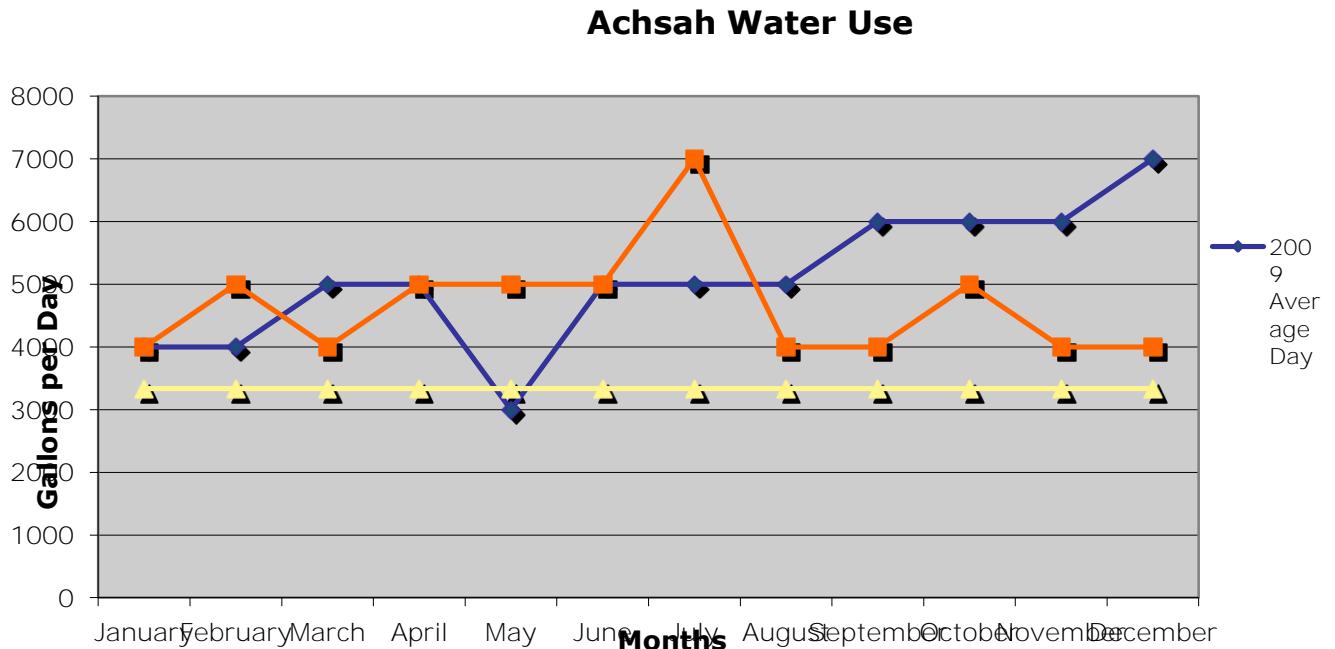
Achsah Acres Subdivision

1. Category of Use: Residential
2. Description:
 - a. Population served by CWS (2009): 63
 - b. Number of connections (2009): 28
3. Average daily withdrawal: 0.005 MGD (5,000 gpd) for 2009
4. During the maximum water use month (December 2009, with 0.007 MGD), the average daily water use is 1.4 times average daily water use
5. Maximum daily withdrawal (2009): data is not available for daily usage, readings taken weekly
6. Monthly average use: A typical and average month's total water use is approximately 0.15 MG/ mo.
7. Annual use: The annual total water use is 1.84 million gallons (MG), mostly from Well # 4, although three (3) wells are available.
8. Above-average use occurs: No pattern is evident from the 2009 data
9. Below-average use occurs: No pattern is evident from the 2009 data

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.



Figure 9. Water Use Chart for Achsah Subdivision Years 2007 and 2009

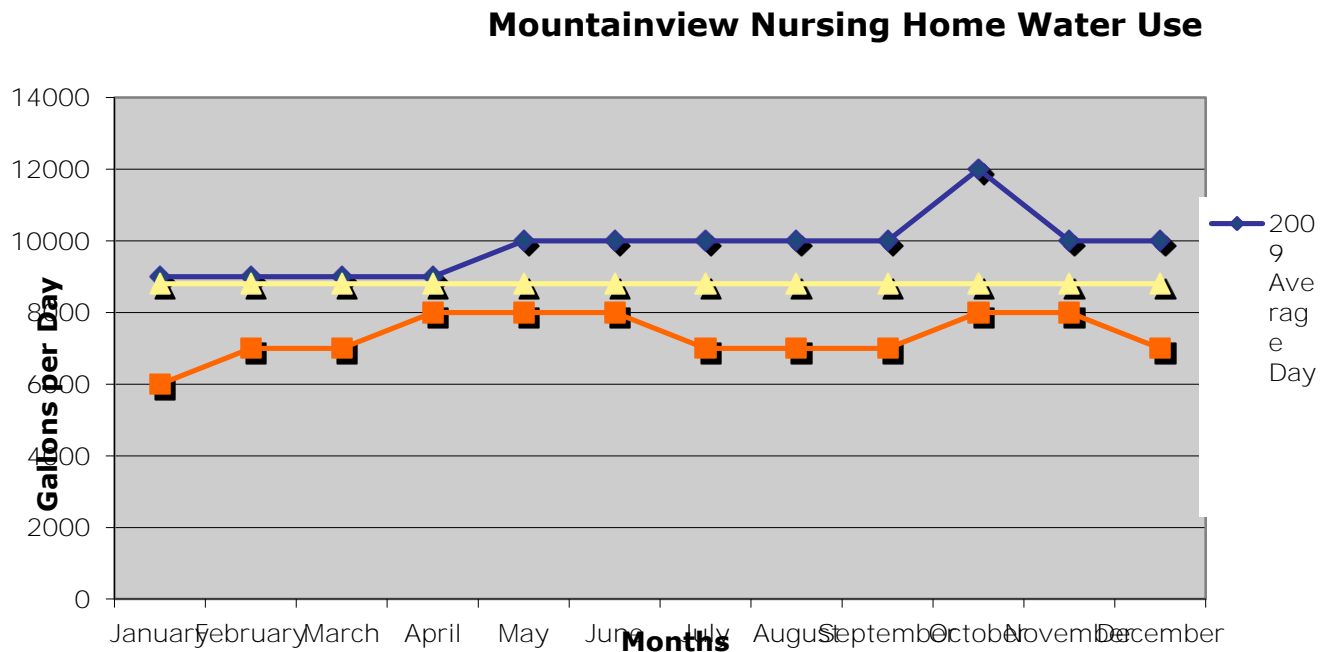


Mountain View Nursing Home

1. Category of Use: Institutional
2. Description:
 - a. Population served by CWS (2009): 80
 - b. Number of connections (2009): 1
3. Daily Use: average 0.01 MGD (10,000 gpd) for 2009
4. During the maximum water use month (October 2009) average daily water use is 0.012 MGD (11,560 gpd), which is 1.2 times the average daily water use for that year.
5. Maximum daily withdrawal (2009): daily data not available, readings taken weekly
6. The maximum day or peak day of water use is unknown, because data is not collected on a daily basis.
7. Monthly use: A typical and average month’s total water use is approximately 0.30 MG/ mo.
8. Annual use: The annual total water use is 3.55 million gallons (MG). Two (2) wells are being used as of 2009.
9. Above-average use occurs: No pattern
10. Below-average use occurs: No pattern

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.

Figure 10. Water Use Chart for Mountainview Nursing Home Years 2007 and 2009



Happy Hills Subdivision

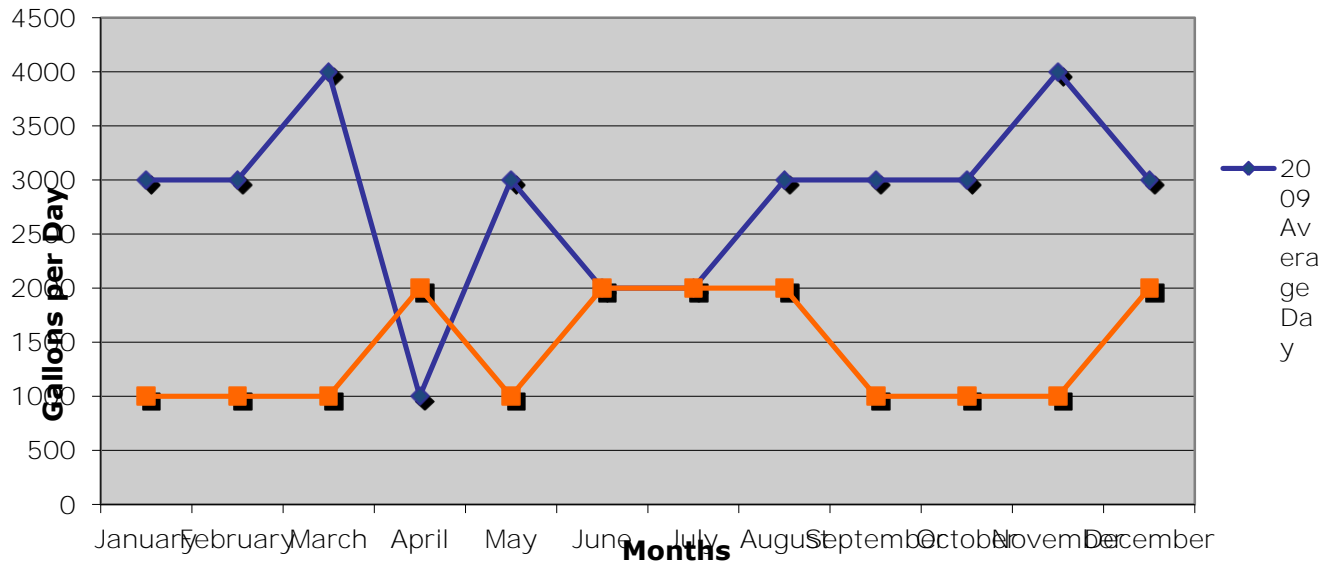
1. Category of Use: Residential Use
2. Description:
 - a. Population served by CWS (2009)
 - b. Number of connections (2009): 15
3. Daily Use (2009), average 0.002 MGD (2,000 gpd)
4. During the maximum water use month (2009) average daily water use is 0.002028 MGD which is approximately the same as the average daily water use for that year;
5. Maximum daily withdrawal (January 2009): unknown. Data collected only on a monthly basis.
6. The maximum day or peak day of water use is unknown. Data is collected on a monthly basis.
7. Monthly use: A typical and average month's total water use is approximately 0.05 MG/50,000 gallons month.
8. Annual use: The annual total water use is 0.62 million gallons (MG), distributed between two (2) wells in use.
9. Above-average use occurs: No evident pattern
10. Below-average use occurs: No evident pattern

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.



Figure 11. Water Use Chart for Happy Hills Subdivision Years 2007 and 2009

Happy Hills Subdivision Water Use



3.2.3. Blue Ridge

Table 12. Water Use Data for year 2009 – Madison County - 2 CWS in the Blue Ridge Aquifer

Water System Name (PWSID)	Map Key	Number of Wells	Population Served	Number of Connections	Average Daily Withdrawal (MGD)	Maximum Daily Withdrawal (MGD)
Valley View (6113500)	H ^E	1	N/A	N/A	.003	N.I.
Rollingbrook Mobile Home Park (6113195)	H ^H	1	59	26	.003	N.I.

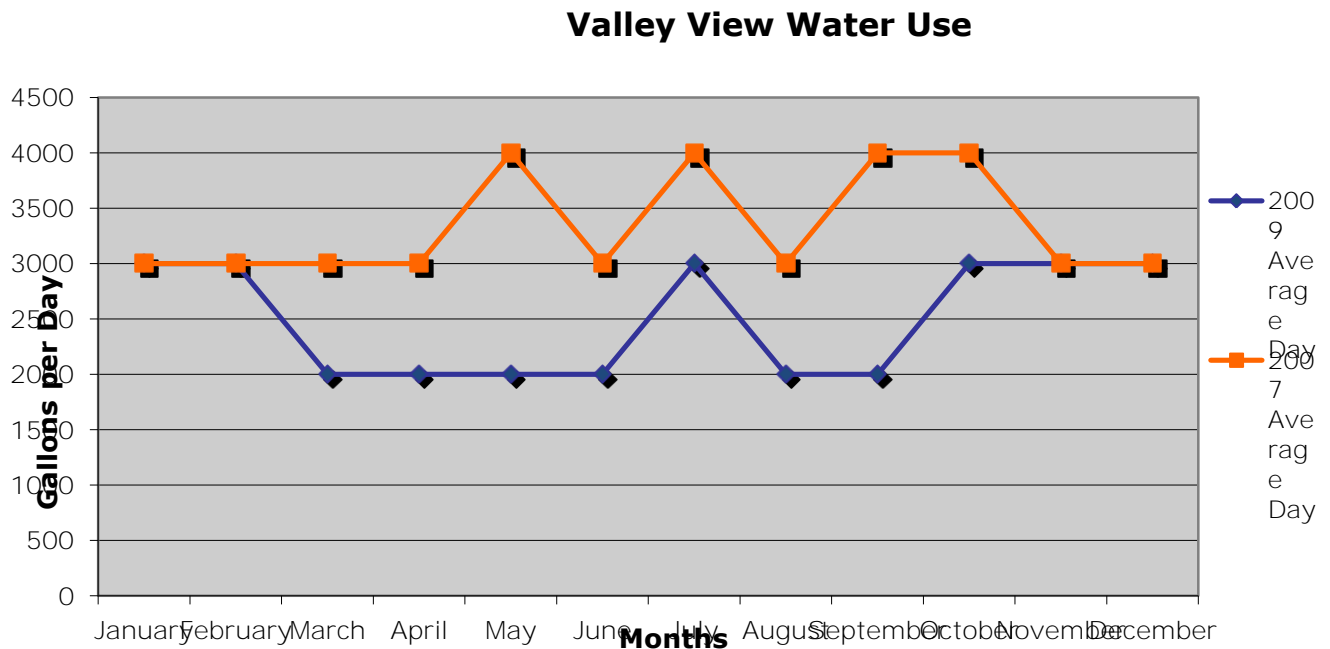
Valley View Subdivision

1. Category of Use: Residential Use
2. Description:
 - a. Population served by CWS (2009): unknown
 - b. Number of connections (2009): unknown
3. Daily Use (2009): average 0.003 MGD (3,000 gpd)
4. During the maximum water use month (December 2009) average daily water use is 0.0033 MGD, which is approximately 110 percent of the average daily water use for that year.
5. Maximum daily withdrawal (2009): unknown. Data collected only on a monthly basis.
6. The maximum day or peak day of water use is unknown. Data is collected on a monthly basis.

7. Monthly use: A typical and average month's total water use is approximately 0.08 MG/80,000 gallons/ month.
8. Annual use: The annual total water use is 0.93 million gallons (MG) from one well in use.
9. Above-average use occurs: In both 2007 and 2009 water use was highest during the months of July and October.
10. Below-average use occurs: No evident pattern

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.

Figure 13. Water Use Chart for Valley View Years 2007 and 2009



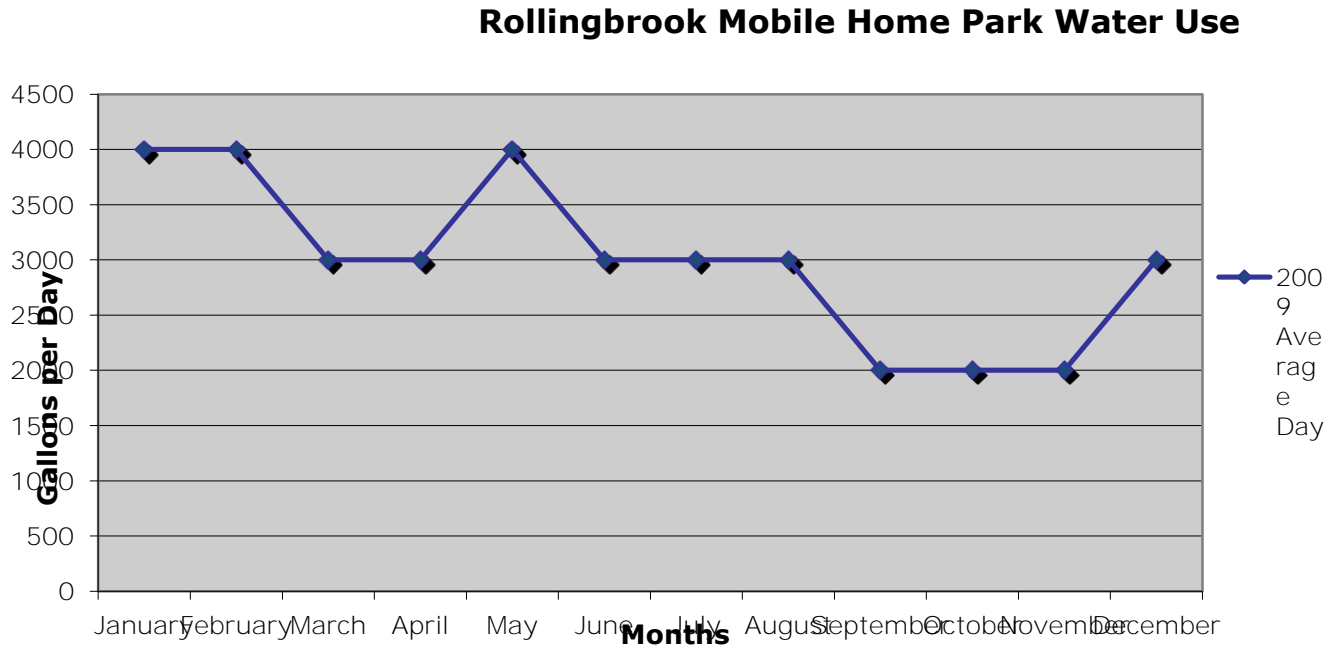
Rollingbrook Mobile Home Park

1. Category of Use: Residential Use
2. Description:
 - a. Population served by CWS (2009): 59
 - b. Number of connections (2009): 26
3. Daily Use (2009): average 0.003 MGD (3,000 gpd)
4. During the maximum water use month (May 2009) average daily water use is 0.004 MGD (4,000 gpd), which is approximately 133 % of the average daily water use for that year;
5. Maximum daily withdrawal (2009): unknown. Data collected only on a monthly basis.
6. The maximum day or peak day of water use is unknown. Data is collected on a monthly basis.
7. Monthly use: A typical and average month's total water use is approximately 0.09 MG/90,000 gallons month
8. Annual use: The annual total water use is 1.07 million gallons (MG), from one well in use.
9. Above-average use occurs: in the spring (April and May 2009).
10. Below-average use occurs: in the fall (September – November).

The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.



Figure 14. Water Use Chart for Rollingbrook Mobile Home Park Years 2007 and 2009



3.2.4. Proterozoic Basin - Lynchburg Group - Conglomerate and metagraywacke

Table 15. Water Use Data for year 2009 – Madison County - 1 CWS in the Proterozoic Basin - Lynchburg Group - Conglomerate and metagraywacke

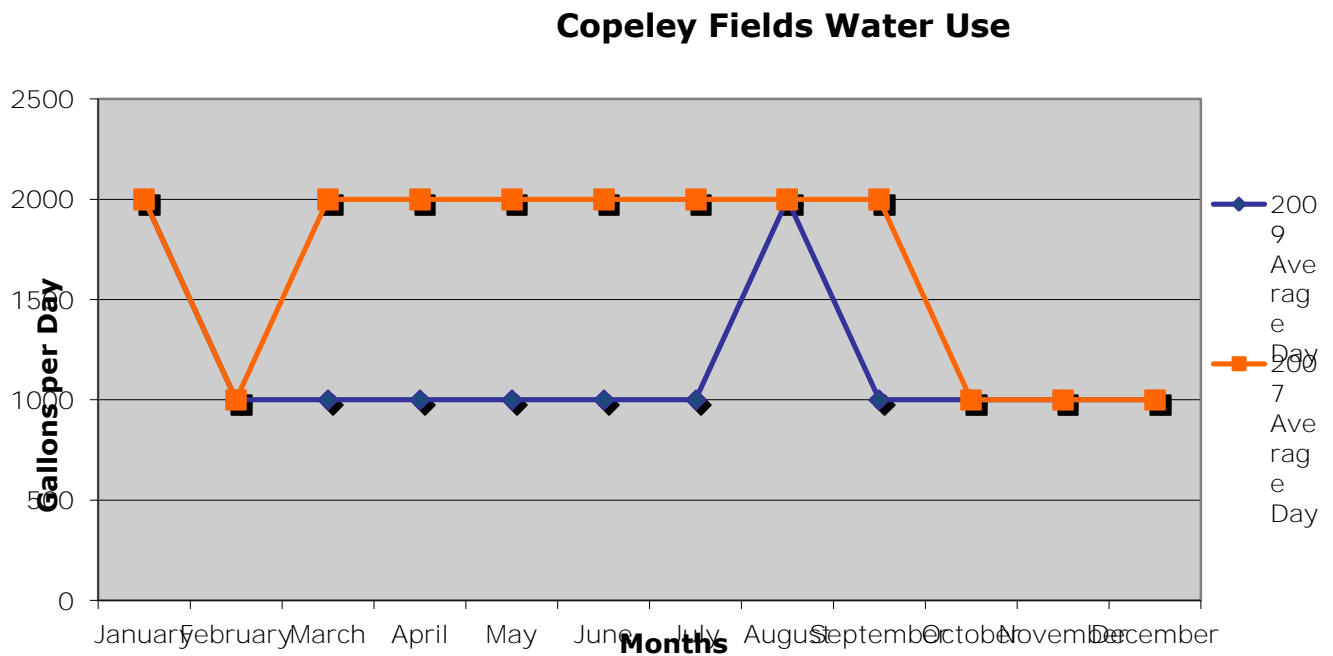
Water System Name (PWSID)	Map Key	Number of Wells	Population Served	Number of Connections	Average Daily Withdrawal (MGD)	Maximum Daily Withdrawal (MGD)
Copeley Fields (6113115)	H ^J	1	N.I.	13	.003	N.I.

Copeley Fields

1. Category of Use: Residential Use
2. Description:
 - a. Population served by CWS (2009): N/A
 - b. Number of connections (2009): 13
3. Daily Use (2009): average 0.001 MGD (1,000 gpd)
4. During the maximum water use month (August 2009) average daily water use is 0.001526 MGD (1,526 gpd), which is approximately 150% of the average daily water use for that year.
5. Maximum daily withdrawal (2009): unknown. Data collected only on a monthly basis.

6. The maximum day or peak day of water use is unknown. Data is collected on a monthly basis.
7. Monthly use: A typical and average month's total water use is approximately 0.04 MG/40,000 gallons month.
8. Annual use: The annual total water use is 0.46 million gallons (MG), from one well in use.
9. Above-average use occurs: In 2007 above average use occurred March – September. In 2009, above average use occurred in August.
10. Below-average use occurs: In 2009 water use was below average a substantial portion of the year.

Figure 16. Water Use Chart for Copely Fields Years 2007 and 2009



The water use data is derived from Virginia Department of Health waterworks permit compliance monthly reports for 2007 and 2009. Comparison to DEQ year 2007 water withdrawal reports indicates that this production data is equivalent to withdrawal data to within rounding error.



3.2.5. Proterozoic Basin - Robertson River Igneous Suite - Hitt Mountain alkali feldspar syenite

Table 17. Water Use Data for year 2009 – Madison County - 1 CWS in the Proterozoic Basin - Robertson River Igneous Suite - Hitt Mountain alkali feldspar syenite

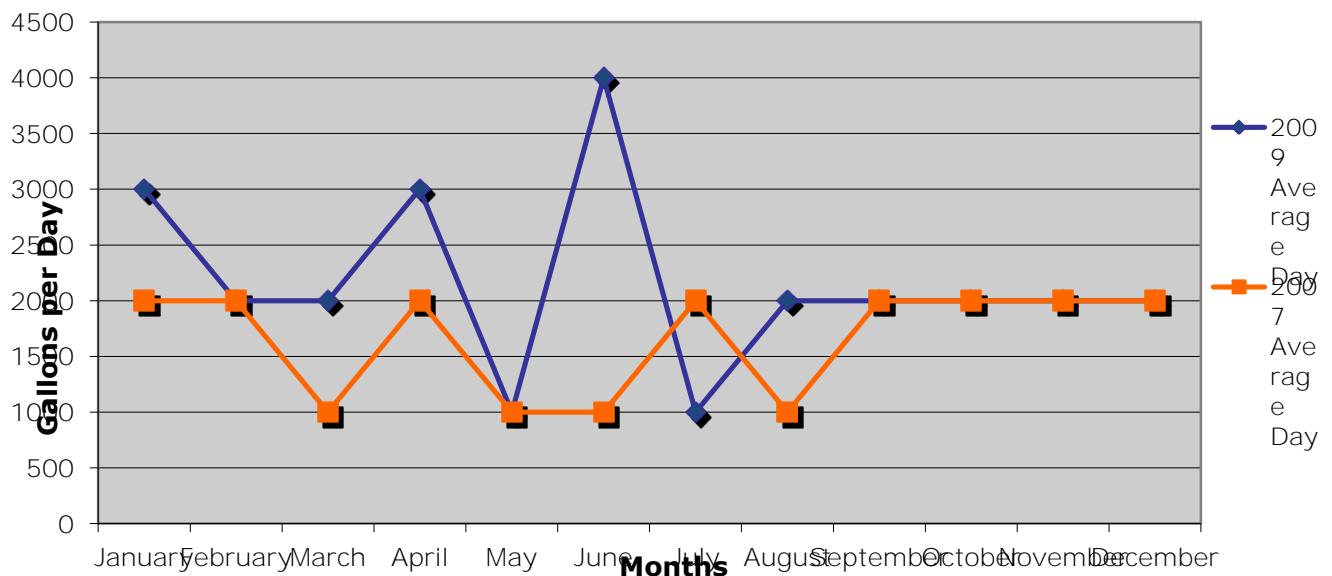
Water System Name (PWSID)	Map Key	Number of Wells	Population Served	Number of Connections	Average Daily Withdrawal (MGD)	Maximum Daily Withdrawal (MGD)
Meadowbrooke (6113188)	H ^K	1	35	2	.002	N.I.

Meadowbrooke

1. Category of Use: Institutional Use (Assisted Living)
2. Description:
 - a. Population served by CWS (2009): 35
 - b. Number of connections (2009): 2
3. Daily Use (2009): average 0.002 MGD (2,000 gpd)
4. During the maximum water use month (June 2009) average daily water use is 0.003953 MGD (3,953 gpd), which is approximately 198% of the average daily water use for that year.
5. Maximum daily withdrawal (2009): unknown. Data collected only on a monthly basis.
6. The maximum day or peak day of water use is unknown. Data is collected on a monthly basis.
7. Monthly use: A typical and average month's total water use is approximately 0.07 MG/70,000 gallons month.
8. Annual use: The annual total water use is 0.82 million gallons (MG), from one well in use.
9. Above-average use occurs: In 2007 above average use occurred in April and June. In 2009, above average use occurred in April and June.
10. Below-average use occurs: In 2007, March, May-June, and August. In 2009, May and July.

Figure 18. Water Use Chart for Meadowbrooke Assisted Living Years 2007 and 2009

Meadowbrooke Assisted Living Water Use



3.3.Existing Water Use Uses: Community Water Systems Using Stream Intakes and Surface Water Reservoirs

Rapidan Service Authority (RSA)

Table 19. Water Use Data for year 2009 – Madison County – RSA

Water System Name (PWSID)	Map Key	Population Served	Number of Connections	Average Daily Withdrawal (MGD)	Maximum Daily Withdrawal (MGD)
Rapidan Service Authority (6113200)	H ¹	784	285	.075	.159

1. Category of Use: municipal water supply
2. Description: On March 1, 1993 RSA became the owner of the water treatment plant of the Town of Madison. There is currently a single water treatment plant serving the Town of Madison and portions of the County. Existing water use from the water treatment plant is supplied from a single stream intake located on White Oak Run; however, the system is designed so that releases may be made from a single reservoir (White Oak Lake) when necessary. The dam and reservoir were created in 1964. Per the annual report of RSA, the Madison Water Treatment Plant has a rated capacity of 250,000 gpd and serves 285 connections. The water distribution system contains 8 miles of mains, with a 500,000 gallon concrete ground tank.
 - a. Population: the population within the planning area served by this CWS is 784.
 - b. Connections: 285
3. Average Daily Withdrawal: (2010): 0.077 MGD (77,000 gallons per day)
4. During the maximum water use month (December 2010) average daily water use is 0.088 MGD (88,000gpd), which is approximately 114% of the average daily water use for the year
5. Maximum Daily Withdrawal (2010): 0.22 MGD (220,000 gallons)
6. Peak Day Water Use, ⁴ 0.219 MGD (219,000 gallons per day)
7. A typical and average month's total water use is approximately 2.34 MG/ 2,340,000 gallons per month
8. The annual total water use is 28.06 MG per year.
9. Above-average use occurs: in 2009, slightly above-average use occurred August – October. This trend is likely related to use of water by the County's school facilities, which are in session from late August through late June.
10. Below-average use occurs: in 2009, slightly below-average use occurred June-August. This trend is likely related to reduced use of water by the County's school facilities during summer break.

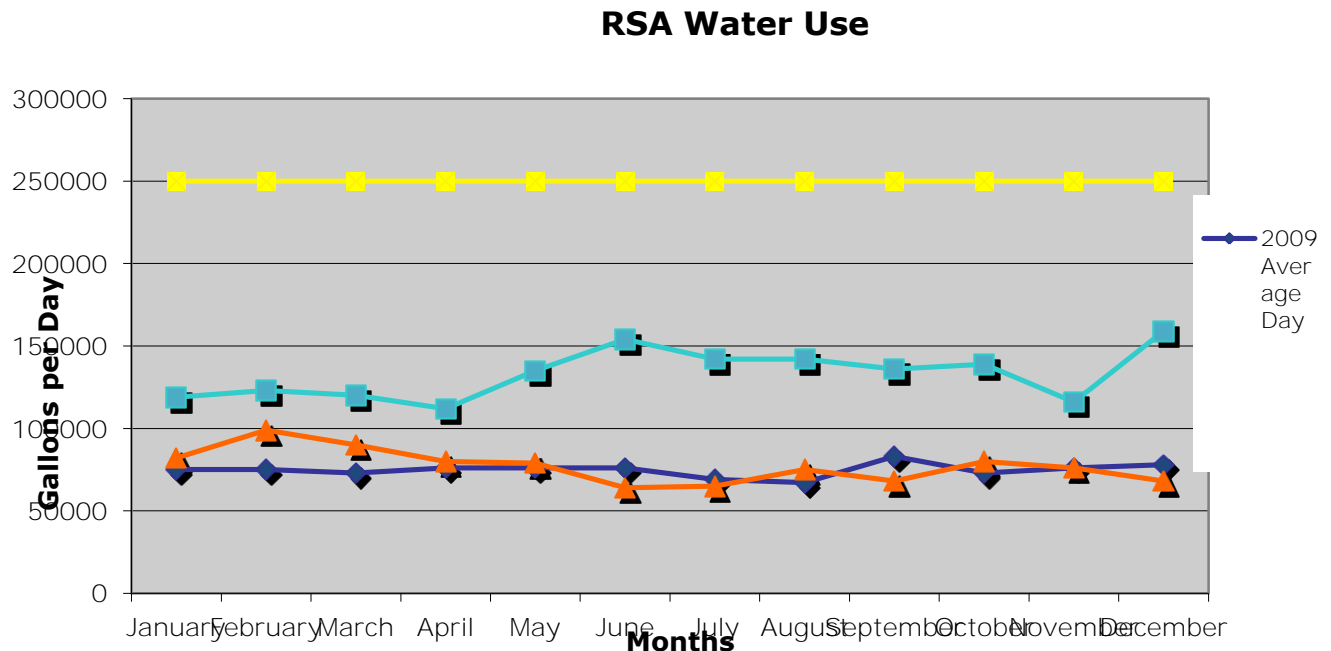
⁴ The peak day water use for Madison's Water Treatment plant is not the peak-day withdrawal because peak withdrawals happen on Fridays or Mondays, as the plant prepares or recuperates from weekend use, when the plant is not in operation. We look at peak-day use by the system for all seven days, not based on withdrawals that occur just on five days.



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11. Existing in-stream beneficial uses potentially affected by the point of stream withdrawal: some recreational uses are available to individuals who own the private property adjacent to the stream, such as fishing.

Figure 20. Water Use Chart for Rapidan Service Authority Years 2007 and 2009



3.4. Disaggregated Community Water System Use

The use of Water within community water supply systems is divided into a number of categories. Water use by category in municipal and private community water systems is included in the following chart, based on average daily use in 2009:

	Residential	CIL	Heavy Industrial	Military	Water Production	Unaccounted for Losses	Sales	Total
RSA	0.035	0.030			0.077	0.011		0.153
Woodberry Forest	.0390					0.004		0.043
Hartland Institute	0.013					0.001		0.014
Oak Park	0.003							0.003
Achsah	0.005							0.005
Mountain View Nursing Home	0.009					0.001		0.010
Happy Hills	0.002							0.002
Valley View	0.003							0.003
Rollingbrook	0.003							0.003
Copeley Fields	0.001							0.001
Meadowbrooke	0.002							0.002
TOTAL	0.115	0.030			0.077	0.017		0.239
PERCENT OF TOTAL	48%	13%			32%	7%		

3.5. Self-Supplied Users—Greater than 300,000 Gal/Month

As previously mentioned in Section 2 of this Plan there are currently no known agricultural or non-agricultural users withdrawing more than 300,000 gallons per month in surface or groundwater.

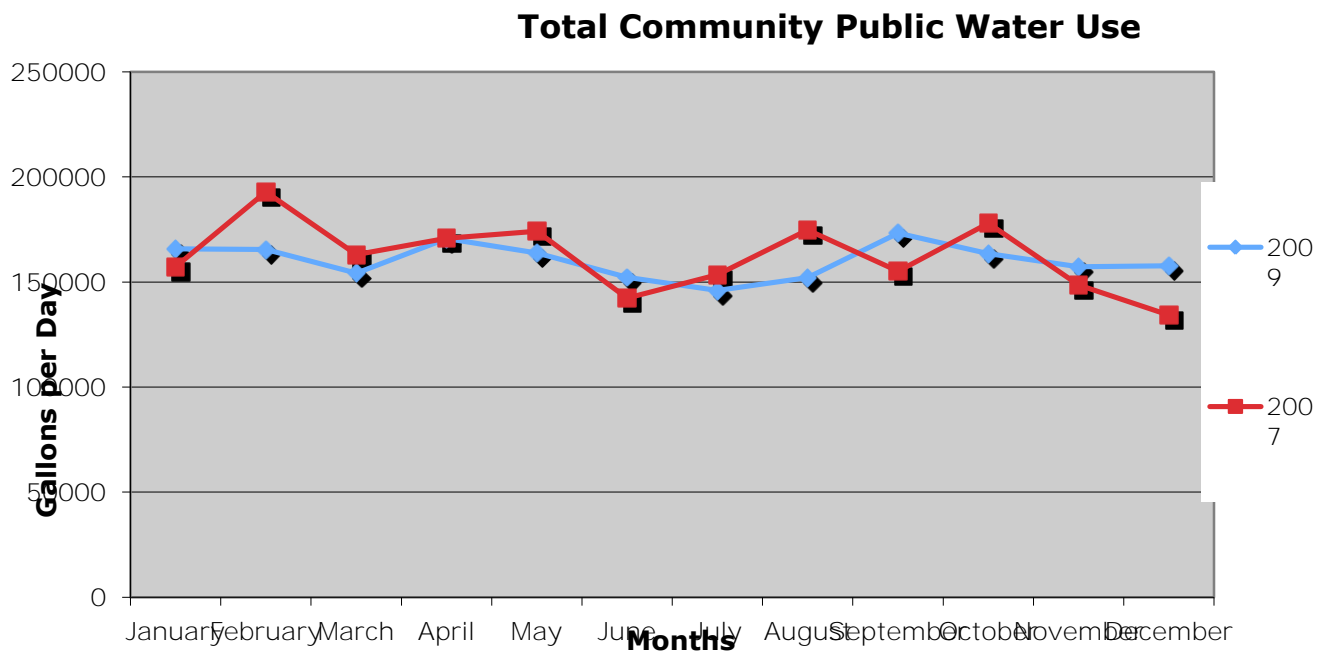
3.6. Self-Supplied Users—Less than 300,000 Gal/Month

3.6.1. Estimated Water Use, CWS

Total water use by 11 Community Water System averages 161,000 gallons per day. Within these 11 CWS systems, the average day water use during the maximum water use month is greater than the annual average daily water use by factors ranging from 1 to 1.98 for an average max month factor of 1.33. Only two of the community water systems have identified self-supplied users in their CWS area for agricultural and non-agricultural use: Woodberry Forrest and RSA. This self-supplied water use is believed to be a limited amount; however, no specific data is available.

There are 175 residential accounts in RSA and 208 CWS residential connections identified in VDH SSRs. Using a persons-per-household estimate of 2.64, it is estimated that there are approximately 1,011 persons supplied by community water systems. (*It is acknowledged that the 1,011 persons supplied by community water systems is not the same as the reported number of people served by community water systems found within health department data; however, we are using the estimated number of persons for the purpose of this water supply plan*).

Figure 21. Total Community Public Water Use for Years 2007 and 2009





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Figure 22, below, shows the range of per capita water use (use per person) for the County of Madison. When purely residential water use is calculated, the mean daily per capita water use is 63 gpd per person. When community water systems that include institutional, agricultural, and commercial uses, in addition to residential, are included, then the average daily per capita water use rises to 80 gpd per person.

Figure 22. Summary of Year 2009 CWS Water Use Characteristics

Summary of CWS Service Area Water Use Characteristics					
Water System Name	Ground Water Used GPD	Surface Water Used GPD	Per Capita Water Use (GPD / Person)	Peak Day Factor (Annual Peak Day/Annual Average)	Max Month Factor (Daily Average in Max Month/Annual Daily Average)
Woodberry Forest School - CWS	43,000	-	76	1.9	1.3
Woodberry Forest School – Self-Supplied	NA	NA	NA	NA	NA
Hartland Institute	14,000	-	116.6*	2.43	1.36
Oak Park	3,000	-	60	N/A	1.33
Achsah Acres	5,000	-	79	N/A	1.4
Mountain View Nursing Home	10,000	-	125	N/A	1.2
Happy Hills	2,000	-	51	N/A	1
Valley View	3,000	-	N/A	N/A	1.1
Rolling Brook Mobile Home Park	3,000	-	51	N/A	1.33
Copeley Fields	1,000	-	89	N/A	1.5
Meadowbrooke	2000	-	57	N/A	1.98
RSA	-	75,000	95**	2.12	1.11
RSA – Self-Supplied					

*Includes Agricultural water use

** Includes 109 non-residential connections

Note: Rows in grey are Community Water Systems with Mixed Use development that might include Institutional, agricultural, or commercial uses.

3.6.2. Estimated Water Use: Self-Supplied Users — Less than 300,000 gallons per month of Ground and Surface Water, Outside Areas of CWS

Self-Supplied Residential Users

The estimated number of residences self-supplied from “individual wells” which include individual wells, private shared wells, cisterns, or springs is 4,896 households countywide. (Some of these residences also serve as business addresses.) To estimate this, we began with the 2009 estimated census data of 5,279 occupied housing units, and then subtracted 175 residential accounts in RSA and the 208 CWS residential connections identified in VDH SSRs. 4,896 households is the remainder, assumed for purposes of this Plan to be self-supplied residences. Using 2009 estimated population figure of 13,950 persons in 5,279 occupied housing units, there exist 2.64 persons per household. The 2.64 persons per household figure was used to estimate that the residential population served by individual wells would be roughly 12,925 persons in residences served by individual wells. If each of these persons is assumed to use 63 gallons per day per person (*the lower mean calculated among purely residential CWS users, see the preceding section*) it is estimated that the average gallons per day used are roughly 814,275 gpd (0.814 mgd). If the 12,925 self-supplied users were in a mixed-use development, the average daily water use per person would be estimated based on 80 gallons per day per person equating to 1,034,000 gpd (1.034 mgd).

Self-supplied non-agricultural business and institutional users

As detailed in Section 2, the number of self-supplied non-agricultural businesses or institutions is estimated at 206 at locations outside CWS areas. (There are additional businesses that are operated from residential addresses.). According to VEC’s Community Profile for Madison County, there are 343 employers within the County, with a total of 2,057 employees (*3,136 minus 579 government employees and approximately 500 employees of private educational and institutional employers using CWS*).

Review of the VDH records did not provide an accurate assessment of water used by these water users. Therefore, we estimate that the non-agricultural business and institutional use is 25 gallons per person per day, for their own use or for the product, services, and customers served by those employees in the Town and County. The resulting business water use would be 51,425 gallons per day for business and institutional use in the Town and County.

Some of this water use may actually be accounted for by the community water systems with mixed use (e.g., RSA, which includes the businesses located in the Town of Madison) and Woodberry Forest School. However, none of the water use estimates presented here take into direct account tourist, short-term campers, and other non-resident water users, therefore it makes sense to use the estimated 51,425 gallons per day as a means of capturing such use. This estimates also assume that higher self-supplied water use at camps, restaurants, and lodgings is offset by the water use attributable to employees within community water systems that are not self-supplied. (*In some neighboring counties, a simple estimate of 100 gallons per day of water use for each self-supplied resident is used to estimate the combined residential, business, and institutional use. However, in Madison, using a self-supplied population of 12,925 people and multiplying it by the average of 25 gpd for businesses and institutional use yields a result of 323,125 gallons per day water use. Due to the rural nature of the county and the fact that about 50% of the workforce in the county commutes*



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outside of the county limits, it was determined that this estimate was too large to show the realistic non-residential water use of the county as of 2009).

Self-supplied agricultural users

Both surface water and groundwater sources are used to supply the County's agricultural water uses. The quantity of water used from surface water sources for agricultural uses is not known, and the quantity of well water withdrawn for various agricultural uses is not known.

According to data of the USGS data for the Commonwealth of Virginia (2005) livestock water withdrawals, total, were 29.8 million gallons per day. Of that total, 22.8 million gallons per day were from surface water and 7.04 million gallons per day were from groundwater.

In Figure 23, below the total number of livestock for the County of Madison according to the 2007 Agricultural Census is shown in addition to the amount of water each animal is expected to consume per day. Estimations show that expected amount of water consumption by all livestock in the County of Madison would be 375,058.5 gallons per day.

Figure 23. Water Use by Livestock per Day⁵

Livestock	Number of Livestock	Avg. Gallons per Day	Total Gallons per Day
Cattle			
Beef	12,789	12.0	153,468
Milk	1,459	25.0	36,475
Other	13,884	10.0	138,840
Hogs & Pigs	676	10.0	6,760
Sheep & Lambs	363	3.0	1,089
Horses & Ponies	1109	12.0	13,308
TOTAL	30280		349,940

⁵ Gallons per Day statistics from Pumping Water from Remote Locations for Livestock Watering, 442-755, Virginia Cooperative Extension (2009) and Provision of Water for Swine, Allen Harper, Livestock Update, Virginia Cooperative Extension (2008)

In Figure 24, below, the total number of crops planted for the County of Madison according to the 2007 Agricultural Census data is shown in addition to the water requirements for each crop. The total daily water consumption for each crop was then calculated to estimate a total water requirement of crops for the County of Madison.

Figure 24. Water used by Crops

Crops - Madison County				
	Total Acreage	Dry tons Harvested	Water Requirements	2007 Annual Water Use Gallons per Day
Field Corn & Corn Silage	6,028		25.9 inches/acre	11,614,859
Soybeans	3,929		24 inches/acre	7,015,105
Barley	465		17 inches/acre	588,088
Grass Hay, Silage, all forage	21,919		28 inches/acre	45,658,297
Wheat	762		18 inches/acre*	1,020,395
Winter wheat	762		18 inches/acre*	1,020,395
Pasture	38,167		28 inches/acre	79,503,638
Alfalfa Hay	1,031	3589	5 inches/ton	1,295
Oats	22		18 inches/acre**	29,460
Berries (grapes?)	233		23.4 inches/acre***	405,613
Orchard	23		18 inches/acre****	30,799
TOTAL				147,887,944

*These numbers were assumptions from looking at various sources and comparing it to the water requirements for Barley.

** Data from www.extension.oregonstate.edu/gilliam/sites/default/files/Oat_production.pdf

*** Data from www.avf.org

**** Data from the NEW YORK STATE HORTICULTURAL SOCIETY

The crop water uses in 2009 were not met by irrigating. According to the most recent agricultural census, installed capacity for irrigation is limited to 69 acres of land on 18 farms. Hence, these water requirements had to be met by precipitation or other means.



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Summary of Water Use 2009 – Madison County & Town of Madison	
	Amount of Water Used per Day
Community Water Systems	161,000
Self Supplied Non-Agricultural (300,000+ gpd)	0
Self Supplied Agricultural (300,000+ gpd)	0
Self Supplied Residential	814,275 - 1,034,000
Self Supplied Business and Institutional	98,700
TOTAL WITHDRAWN	929,075 – 1,293,700
Self Supplied Agricultural	
Crops	146,887,944
Livestock	349,940
TOTAL AGRICULTURAL USED	147,237,884

4. Existing Water Resources Conditions, 9 VAC 25-780-90

In accordance with 9VAC25-780-90 of the Local and Regional Water Supply Planning regulations, this Water Supply Plan must include a description of existing environmental conditions that pertain to, or may affect, in-stream flow; in-stream uses; and sources that provide the County’s current water supply.

4.1. State or Federal Listed Threatened or Endangered Species or Habitats of Concern

Figure 25. Table of State and Federal Threatened, Endangered or concerned species

Species	Common Name	Federal Status	State Status
<i>Aegolius acadicus</i>	Northern Saw-whet Owl		SS
<i>Aredea alba egretta</i>	Great Egret		SS
<i>Bartramia longicauda</i>	Upland Sandpiper		ST
<i>Carpodacus purpureus</i>	Purple Finch		SS
<i>Catharus guttatus</i>	Hermit Thrush		SS
<i>Certhia americana</i>	Brown Creeper		SS
<i>Circus cyaneus</i>	Northern Harrier		SS
<i>Cistothorus platensis</i>	Sedge Wren		SS
<i>Clemmys guttata</i>	Spotted Turtle		CC
<i>Condylura cristata parva</i>	Star Nosed Mole		SS
<i>Corynorhinus townsendii virginianus</i>	Virginia big-eared Bat	FE	SE
<i>Crotalus horridus</i>	Timber Rattlesnake		CC
<i>Dendrocica magnolia</i>	Magnolia Warbler		SS
<i>Elliptio lanceolata</i>	Yellow Lance	FS	SS
<i>Falco peregrinus</i>	Peregrine Falcon		ST
<i>Gallinula chloropus cachinnans</i>	Common Moorhen		SS
<i>Haliaeetus leucicephalus</i>	Bald Eagle	FS	ST
<i>Lanius ludivicianus</i>	Loggerhead Shrike		ST
<i>Lanius ludivicianus migrans</i>	Migrant Loggerhead Shrike		ST
<i>Lasmigona subviridis</i>	Green Floater	FS	ST
<i>Limnothlypis swainsonii</i>	Swainson’s Warbler		SS
<i>Lontra Canadensis lataxina</i>	Northern River Otter		SS
<i>Notropis bifrenatus</i>	Bridle Shiner		SS
<i>Plethodon shenandoah</i>	Shenandoah Salamander	FE	SE
<i>Pyrgus wynandot</i>	Appalachian grizzled Skipper	FS	ST



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Regulus satrapa	Golden-crowned Kinglet		SS
Sitta candensis	Red-breasted Nuthatch		SS
Somatogyrus virginicus	Panhandle Pebblesnail	FS	
Speyeria idalia idalia	Regal Fritillary	FS	
Spiza americana	Dickcissel		SS
Sterna caspia	Caspian Tern		SS
Troglodytes troglodytes	Winter Wren		SS
Tyto alba pratincola	Barn Owl		SS
Vermivora chrysoptera	Golden-winged Warbler		SS

* FE=Federal Endangered; FT=Federal Threatened; FP=Federal Proposed; FC=Federal Candidate; FS=Federal Species of Concern; SE=State Endangered; ST=State Threatened; SC=State Candidate; SS=State Special Concern; CC=Collection Concern

** Information from Virginia Department of Game and Inland Fisheries, <http://vafwis.org>, web search, 1/5/11

4.2. Anadromous, trout and other significant fisheries

Madison County’s rivers boast some of the finest trout fishing in Virginia, and the Virginia Department of Game and Inland Fisheries cites the Rapidan River as Virginia's best known trout stream. The Rapidan was the first state stream to receive special regulation to protect the river within the Shenandoah National Park and the Rapidan Wildlife Management Area. The stream contains a viable native brook trout population with adults ranging from 10 to 11 inches. Access to the Rapidan is available over Route 662 from Graves Mill and over Route 649 from Criglersville. Fishing within the Rose River is available outside of the park at Graves Mountain Lodge or by special arrangement at the Rose River Farm. The Conway and Robinson Rivers are also popular with anglers.

4.3. River segments that have recreational significance, including state scenic river status

Madison County’s rivers, particularly the Rapidan, Rose and Conway Rivers, are popular for recreational fishing. These and other rivers, such as the Robinson, are also popular locations for canoeing, kayaking and waterfowl hunting activities.

The National Park Service Rivers, trails & Conservation Assistance Program lists two river segments as having recreational significance of scenic status. (1) The Rapidan River from Graves Mill to the headwaters (approximately 9 miles) is significant for two reasons. In terms of recreation, it is a unique and significant wild brook trout fishery. Hydraulically, it is one of the last remaining undeveloped, low order rivers in this section. (2) The Robinson River, approximately 26 miles of the from the confluence with the Rapidan River to the Route 670 Bridge. This portion of the river is significant recreationally due to the variety of flow gradients including Class 3 rapids with numerous 2 to 3 foot ledges. Historically, this segment of the river was in proximity of, and of strategic importance to, the Civil War battles of Cedar Mountain and the ensuing second battle of Manassas Junction.⁶

⁶ Information from www.nps.gov/rtca/nri/states/va.html

4.4. Sites of historic or archeological significance

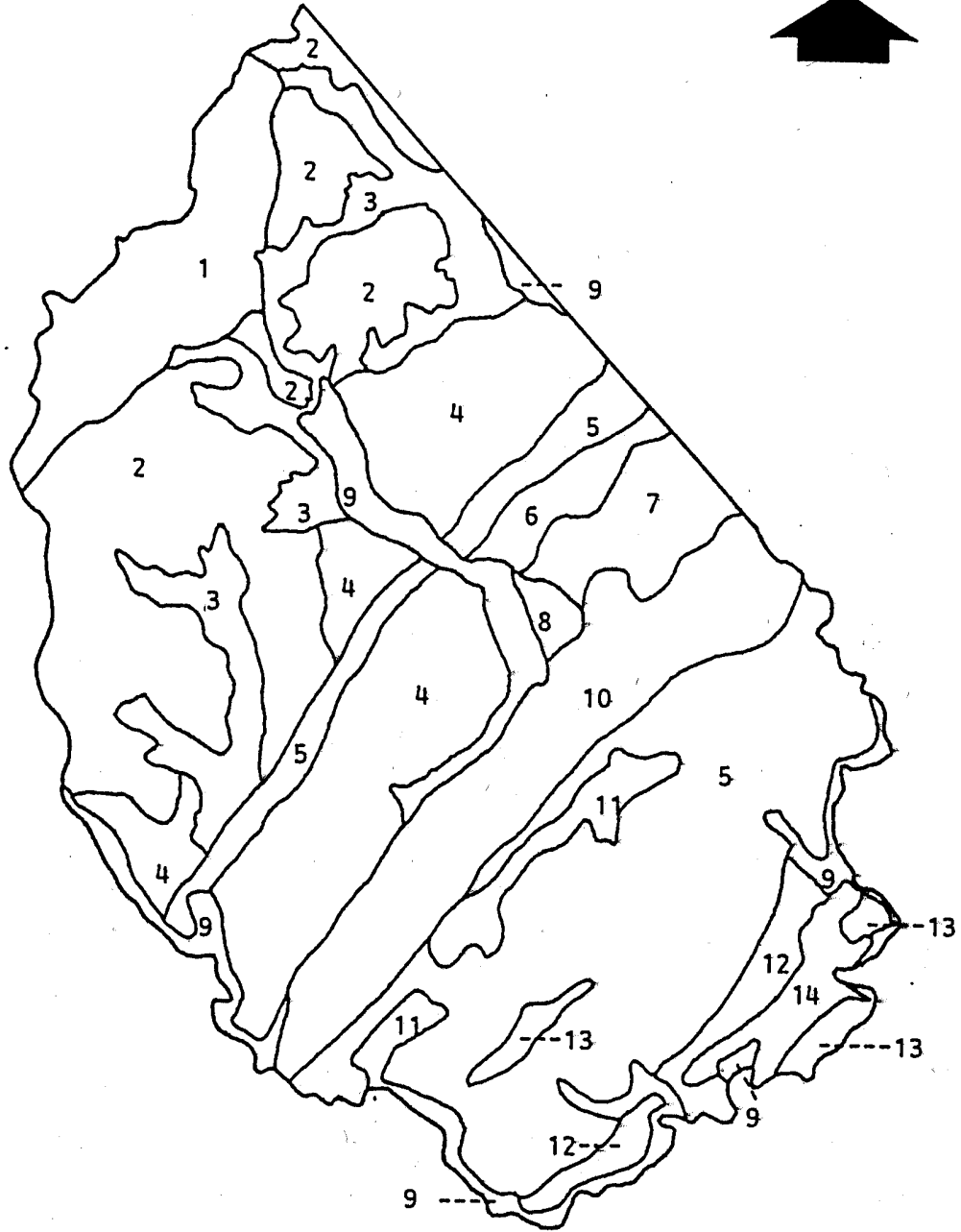
Madison County has several districts and properties designated on the Virginia and National Registers of Historic Places. Two historic districts are on the National Register (Madison Courthouse District and James City Historic District). In addition, the following sites are listed on the National Register:

- Hebron Lutheran Church
- Madison County Courthouse
- The Residence, Woodberry Forest
- Brampton
- Greenway (Prospect Hill)
- Clore Homeplace
- Locust Hill
- Graves Mill
- Hoffman Round Barn

Also listed on the National Register are several sites within the Shenandoah National Park: (1) George T. Corbin Cabin; (2) Skyline Drive; (3) Cliff Kill Site; (4) Big Meadows Site; (5) Gentle Site; (6) Robertson Mountain Site.



4.5. Unusual geologic formations or special soil types



Key to Soils Map:

<u>Soil Association Name</u>	<u>Number</u>	<u>Building</u>	<u>Farming</u>	<u>Forest</u>
Rock land/Myersville/Catoctin	1	Fair	Poor	Fair
Porters/Rock land	2	Fair	Poor	Fair
Tusquitee/Colluvial/Unison	3	Fair	Fair	Good
Brandywine/Eubanks/Lloyd	4	Good	Fair	Good
Elioak/Hazel/Meadowville	5	Good	Fair	Good
Brandywine/Eubanks	6	Fair	Fair	Good
Brandywine/Chester/Meadowville	7	Good	Good	Good
Hiwasee/Wickham/Roanoke	8	Fair	Good	Good
Chewacla/Congaree/Codorus	9	Poor	Good	Good
Cecil/Lloyd/Louisburg	10	Fair	Fair	Poor
Lloyd/Hazel/Elioak	11	Good	Good	Good
Fauquier/Catoctin	12	Good	Good	Good
Davidson/Bremo/Zion	13	Fair	Good	Good
Rapidan/Penn/Bucks	14	Good	Good	Good

4.6. Wetlands

There are wetlands in the County of Madison. They are mostly associated with ponds, impounded streams, and within the riverbanks of the Rapidan and Robinson Rivers. The locations of the wetlands in Madison County are best viewed in INSTAR by Virginia Commonwealth University at a map scale of 2500 feet. An entire map of the county was not suitable to show the wetlands for this document. For water supply planning purposes, be aware that the wetlands are present and would need to be considered at the scale of any water supply development projects.

4.7. Riparian buffers and conservation easements

In the County of Madison, there are a number of conservation easements from federal, state, and private. There are 65 Virginia Outdoor Foundation Conservation Easements in the Madison equating to 11,461.43 acres of land.⁷ No information on Riparian Buffers can be found at the current time.

4.8. Land use and land coverage, including items such as percentage of impervious cover within a watershed and areas where new development may impact water quality of the source

Historically, the location of development in the County has been closely related to the physical characteristics of the land. Two general patterns have emerged, one in the mature Piedmont plateau and another in the Blue Ridge area. In both the Piedmont and Blue Ridge Provinces, most development is scattered along the County's road system. The roads of the Piedmont generally follow the ridgelines. Development has been confined to those ridges and adjacent plateaus, with their well-drained soils, nearly level building sites and superior views.

⁷ http://www.virginiaoutdoorsfoundation.org/VOF_pub-statsbycounty.php



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The pattern of development in the Blue Ridge area is quite different. Here the wooded mountain slopes have confined roads and development to the stream valleys, often to the floodplains. Residential development and agriculture share the narrow streams.

The many villages in the County provide focal points for the scattered pattern of development. Villages are usually 3-5 miles apart along the county's major roads and 5-8 miles apart along the secondary roads. The villages serve local commercial and service functions and are generally characterized by a rural post office and general store, often with older houses nearby and one or more churches. Brightwood, Rochelle, and Aroda are typical Piedmont villages. Wolfstown, Syria and Etlan are typical Blue Ridge villages.

Until 1967 only one large subdivision had been recorded, a 50-lot division near Pratts. Between 1967 and 1976, over 3,250 acres were converted into residential subdivisions, creating more than 1,400 lots. The total amount of land subdivided and number of lots created is much greater if smaller subdivisions (fewer than five lots) are considered. Several of the subdivisions, those above Wolfstown and Syria especially, are recreation oriented. Lots have often been created on the steep slopes of the Blue Ridge, with average lot sizes well below the minimum lot sizes required by the more recently adopted Zoning Ordinance. The fact that most of these recreational lots have not yet been built upon offers the county an opportunity to control the significant erosion hazard posed by small lot development through strict administration of the Erosion and Sedimentation Control Ordinance. The subdivisions of the Piedmont are generally scattered along the County's roads. Several of the older subdivisions are located just southeast of the Town of Madison, creating a focal point for medium density development.

Commercial development is of three basic types: highway commercial uses, located primarily along Route 29, serving large percentages of through and truck traffic; village and neighborhood commercial uses, serving local needs; and community commercial facilities, serving major shopping needs and located near the Town of Madison. Residents living at the edges of the county have other major shopping opportunities in Culpeper, Orange, and Gordonsville. Industrial development has taken place largely within a mile of the Route 29 corridor. Several wood products industries have developed outside of this corridor in order to locate closer to the timber sources. Virtually all development outside the Town of Madison is served by individual wells and septic disposal systems.

4.9. The presence of impaired streams and the type of impairment⁸

Impaired Name	Location	Categories Not Supported	Cause
Beautiful Run	Upstream from Route 620 to Rapidan River	Recreation	Escherichia coli
Deep Run	Muddy Run to Robinson River	Recreation	Escherichia coli
Finks Run	Headwaters to Robins River	Recreation	Escherichia coli
Great Run	Headwaters to	Recreation	Escherichia coli

⁸ <http://www.deq.virginia.gov/wqa/305b2010.html>

	Robinson River		
Hughes River	Route 707 to Route 231	Aquatic Life	Water Temperature
Leathers Run	.65 miles downstream Route 641 crossing to Robinson River	Recreation	Escherichia coli
Little Dark Run	Headwaters to Dark Run	Recreation	Escherichia coli
Rapidan River	Conway River to White Run	Recreation	Escherichia coli
Rapidan River	Poplar Run to Robinson River	Recreation	Escherichia coli
Rapidan River	Marsh Run to Blue Run	Recreation	Escherichia coli
Robinson River	Rose River to White Oak Run	Recreation	Escherichia coli
Robinson River	Rose River to Route 231	Aquatic Life	Water Temperature
Robinson River	White Oak Run to Rapidan River	Recreation	Escherichia coli
Rose River	River mile 2.6 to Robinson River	Aquatic Life	Water Temperature
Unnamed tributary to Rapidan River	-	Recreation	Fecal coliform bacteria
White Oak Run	Town of Madison's raw water intake to Robinson River	Recreation	Escherichia coli

4.10. The location of point source discharges

According to DEQ's CEDS permit database, there are a number of different types of point source discharges in the County of Madison. There are two VPDES general H2O permits, seven VPDES single-family homes general permits, one VPDES petrol general permit, and seven VPDES individual permits all at various locations within the county. At the time of the preparation of this Plan, no map showing the location of such point source discharges could be found, and Madison County and the Town of Madison do not have GIS data on the location of the discharges.

4.11. Other potential threats to the existing water quality and quantity

Other than the various categories of environmental sensitivity discussed in this section, there are no other quantifiable threats to the existing water quality and quantity in Madison County.



4.12. Geologic, hydrologic and meteorological conditions within Madison County

Madison County lies within the Piedmont and the Blue Ridge physiographic provinces. Elevations range from 298 feet at the junction of the Robinson and Rapidan Rivers to 4,049 feet at the summit of Hawksbill Mountain.

The Piedmont province makes up about 70 percent of the county. It is well dissected by many small streams and rivers that flow in narrow, meandering valleys. The landscape is mostly gently sloping to strongly sloping, but in places is steep. Outlying mountains, such as Thoroughfare, Lost Banks, Gaar, Mitchell, Dulaney and Carpenter, as well as Blakey and German Ridges, break the usual pattern of slopes in the Piedmont. Most of the soils are well drained, but a few poorly drained soils occur along streams, on toe slopes, and in a few saddles. Elevations range from about 300 feet to approximately 1,000 feet. In the Piedmont province there is a greater diversity of geology than in the Blue Ridge province, causing a wide variation in the quantity and quality of available groundwater.

The Blue Ridge province makes up most of the western part of the county and about 30 percent of the total land area. It is strongly dissected by many intermittent and permanent streams that have cut deep, narrow valleys bordered by steep rocky slopes and narrow ridges. Slopes are moderately steep to very steep. Elevations range from about 1,000 feet to approximately 4,000 feet. The soils are rocky, shallow to deep, and mostly well drained. In the Blue Ridge province, impervious bedrock limits well production to fracture locations, and steep slopes limit the rate of groundwater recharge.

The rocks of Madison County are igneous, sedimentary and metamorphic. Seven major geologic formations occur in the county. These formations, from west to east, are: the Catoctin (greenstone basalt and schist); the Pedlar (granodiorite, granite and granite gneiss); the Old Rag, a coarse-grained granite; the Lovington (dark-colored biotite granite and gneiss); the Robinson River (a light-colored, acidic granite); the Lynchburg (mica schist and greywacke sandstone); and the Newark Group (Triassic conglomerate, sandstone and shale). There are also intrusions of diabase, greenstone and other basic rocks. Rocks in the Piedmont province are dominantly metamorphosed rocks of igneous and sedimentary origin. They are largely granite gneiss, mica, schist and phyllite and partly greenstone schist, sandstone, conglomerate and shale. Rocks in the Blue Ridge province are dominantly metamorphosed rocks of igneous origin, dominantly greenstone schist, granodiorite, granite, and granite gneiss. There are small inclusions of sandstone.

In the Piedmont, slopes are generally less than 15%, with some 15-24% slopes adjacent to streams and rivers. There is a concentration of 25% and greater slopes along the fault ridge on which the Town of Madison stands and around the smaller mountains in the Piedmont. Most of these steep slopes are presently in forest cover, their most appropriate use. There is a delicate balance between soil, forest cover, and weather on the 25% slopes such that the removal of any large amount of tree cover could cause serious erosion and landslides.

Maps showing the major floodplains according to the Federal Emergency Management Agency (FEMA) are available for viewing in the Office of the Zoning Administrator. These are 100-year floodplains, which means that in any one given year there is a 1% chance that a flood covering those areas will occur. Floods are natural events and they deposit fine soils that enrich the soil fertility of floodplain land. Since the 100-year floodplain refers to probability, it is also statistically possible,

though not likely, that there could be more than one 100-year flood in any given year. The flood that stands out in the minds of most County residents is the 2000-year Flood of June 1995. On June 27, 1995 a severe storm affected an area of about fifty square miles in Madison County. Extreme landslides occurred in Graves Mill and Criglersville. Over a period of sixteen hours, thirty inches of rain fell. Some areas experienced twenty-five inches of rain over just five hours. This resulted in soil slides and slumps and rock slides over massive areas of hillsides, with debris flows that took out entire forests. As these materials came to rest in stream valleys, flash floods resulted, destroying houses, roads, utilities, livestock, and crops.⁹ Following this great storm the U.S. Department of Interior and the U.S. Geological Survey mapped debris flow hazard areas, and this map is available at the Madison County Zoning Office.

Madison County has warm summers, moderate winters and generally adequate rainfall. At the higher elevations in and near the Shenandoah National Park, winters are considerably colder, summers are cooler and precipitation is somewhat more plentiful. The County is well inland from the ocean, but is in the path of warm, moist air currents moving northward, and cold, dry air currents moving southeastward. These alternating air currents frequently bring sharp changes in the weather and add to the variations in climate from one season to another.

Temperature. The altitude causes a significant difference in temperatures. Temperatures drop approximately three degrees per thousand feet increase in altitude and vary by as much as ten degrees across the County. The mean annual temperature varies slightly from year to year, but is commonly 54 to 59 degrees at the lower elevations and 45 to 50 degrees along Skyline Drive. Temperatures above 95 degrees or below 0 degrees are infrequent and prolonged periods of very warm or very cold weather are unusual. Some mild spells occur in winter and occasional periods of dry, mild weather relieve stretches of warm, humid weather in summer.

Growing Season. The growing season, defined as the period between the average dates of the last freezing temperature in the spring and the first of the fall, is 184 days. It is long enough to allow proper maturation of a large variety of crops. The pasture season is slightly longer, but the winter months are cold enough that feed and shelter are needed for livestock. Freezing temperatures ordinarily occur later in spring and earlier in the fall at the higher elevations than at the lower elevations.

Precipitation. Annual precipitation ranges from about 42 inches in the southeastern part of the County to more than 51 inches atop the Blue Ridge Mountains; however, actual amounts vary greatly from one year to the next. Monthly precipitation ranges from more than 4 inches in summer to about 3 inches in fall. Rainfall tends to be higher in the mountains. The amount varies greatly from year to year for any given month. Rainfall is occasionally very light in all months of the year and occasionally it is excessive. Although rainfall is heaviest in summer, it is often insufficient because the need for moisture is greatest and evaporation is highest. In summer, rainfall occurs mainly as thundershowers, some of which are heavy and result in considerable runoff. The heaviest rains, usually lasting two to three days, are associated with hurricanes that pass inland across the Atlantic or Gulf coasts. Prolonged dry spells occur in many years with the result that soil moisture is insufficient at one or more times during the growing season. Occasionally, several dry years occur in succession, and drought is serious. This happened in the early 1930's, the 1960's, the mid-1980's and more recently in 2002. Thunderstorms occur about 40 days per year and sometimes cause minor lightning damage. Damaging hailstorms occur infrequently. Hurricanes that reach the County have diminished

⁹ Source: Morgan, B.A., Wiczorek, G.F., Campbell, R.H., and Gori, P., USGS Open File Report 97-438, L. 1997).



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wind velocities and cause little damage but can cause torrential rainfall. Heavy snowstorms occur every few years causing some damage.

Humidity and Wind. The average annual relative humidity in Madison County, estimated from surrounding weather stations, is approximately 65 to 70 percent. Average monthly relative humidity ranges from about 60 percent in spring to about 75 percent late in summer. In general, southerly and northwesterly winds are about equally frequent over the County. Northwesterly winds prevail in the winter and southerly winds in summer. The average monthly wind speed ranges from about 7 miles per hour in August to about 11 miles per hour in March. Winds are usually lightest early in the morning and strongest early in the afternoon.

5. Projected Water Demand

5.1. Overview

Madison County, including the Town of Madison, remains a rural community. Despite modest residential growth from 2000 to 2010, no significant residential or commercial development has occurred and none is projected to occur. Population estimates used in this section are from the U.S. Census Bureau and Virginia Employment Commission. Population figures and projections for Madison County are as follows: 2010 Actual: 13,308 (U.S. Census); 2010 Projected: 14,105 (Virginia Employment Commission); 2020 Projected: 15,624 (Virginia Employment Commission); 2030 Projected: 17,222 (Virginia Employment Commission)

5.2. Community Water System Demand Projections

While VEC population projections indicate that the County's population, inclusive of the Town, is projected to increase modestly, the population and water use in all but one existing community water system is projected to remain constant. Most of the CWS are already operating with the maximum number of permitted connections.

Projected Water Use for Community Water Systems										
	2009		2010		2020		2030		2040	
	Annual Average Daily (MGD)	Average Daily in Maximum Month (MGD)	Annual Average Daily (MGD)	Average Daily in Maximum Month (MGD)	Annual Average Daily (MGD)	Average Daily in Maximum Month (MGD)	Annual Average Daily (MGD)	Average Daily in Maximum Month (MGD)	Annual Average Daily (MGD)	Average Daily in Maximum Month (MGD)
Woodberry Forest School (CIL)	0.043	0.056	0.043	0.056	0.043	0.056	0.043	0.056	0.043	0.056
Hartland Institute (CIL)	0.014	0.019	0.014	0.019	0.014	0.019	0.014	0.019	0.014	0.019
Oak Park (Residential)	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004
Achsah (Residential)	0.005	0.007	0.005	0.007	0.005	0.007	0.005	0.007	0.005	0.007
Mountainview Nursing Home (CIL)	0.01	0.012	0.01	0.012	0.01	0.012	0.01	0.012	0.01	0.012
Happy Hills (Residential)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Valley View (Residential)	0.003	0.0033	0.003	0.0033	0.003	0.0033	0.003	0.0033	0.003	0.0033
Rollingbrook Mobile Home Park (Residential)	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004
Copley Fields (Residential)	0.001	0.0015	0.001	0.0015	0.001	0.0015	0.001	0.0015	0.001	0.0015
Meadowbrook Assisted Living (CIL)	0.002	0.0039	0.002	0.0039	0.002	0.0039	0.002	0.0039	0.002	0.0039



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Rapidan Service Authority (RSA)	0.075	0.083	0.077	0.088	0.090	0.103	0.099	0.113	0.109	0.124
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The following community water systems are categorized as institutional uses: Woodberry Forest School, Hartland Institute, Mountainview Nursing Home and Meadowbrooke.

- The total institutional annual average daily water use for 2009 is 0.069 MGD and is expected to stay the same until 2040.
- The total residential annual average daily water use for 2009 is 0.017 MGD and is expected to stay the same until 2040.
- RSA is distinct from the other CWS in that water used by the system is drawn from surface water instead of ground water and it includes several categories of water use. Due to infrastructural water and sewer limitations, the RSA system is projected to stay the same at 0.075 MGD of annual average daily water use through 2040 unless upgrades are put into place.

5.3. Disaggregated Use Projections, CWS

Community Water Supplies Using Surface Water or Stream Intake (1)

	Residential	CIL	Heavy Industrial	Military	Water Production	Unaccounted for Losses	Sales	Total
RSA 2010	0.035	0.030			0.077	0.011		0.153
RSA 2020	0.041	0.035			0.090	0.013		0.179
RSA 2030	0.045	0.038			0.099	0.014		0.196
RSA 2040	0.050	0.042			0.109	0.015		0.216

Community Water Supplies Using Groundwater (10)

	Residential	CIL	Heavy Industrial	Military	Water Production	Unaccounted for Losses	Sales	Total
2010	0.115	0.030			0.077	0.017		0.239
2020	0.135	0.035			0.090	0.020		0.280
2030	0.149	0.038			0.099	0.022		0.308
2040	0.164	0.042			0.109	0.024		0.339

5.4. Self-Supplied Non-Agricultural Users of Surface and Ground Water, More than 300,000 gallons per month, outside CWS

There are no known self-supplied non-agricultural users of surface and ground water withdrawing more than 300,000 gallons per month. No such users are currently projected.

5.5. Self-Supplied Agricultural Users of Surface and Ground Water, More than 300,000 gallons per month, outside CWS

There are no known self-supplied agricultural users of surface and ground water withdrawing more than 300,000 gallons per month. No such users are currently projected.

5.6. Self-Supplied Users, Less than 300,000 gallons per month, outside CWS

Self-Supplied Residential Users

2020 Population Projection (VEC): 15,624 (17.40% increase over 2010 projection)

2020 Estimated households, self-supplied: 4896 (2009) + 17.40% = 5747.47

2020 Persons served by self-supplied sources = 5,747.47 x 2.64 = 15,174.47

2020 Gallons Per Day Projected: 15,174.47 x 63 gpd = 955,991.39 (0.956 mgd)

2030 Population Projection (VEC): 17,222 (10.23% increase over 2020 projection)

2030 Estimated households, self-supplied: 5,747 (2020 projected) + 10.23% = 6334.92

2030 Persons served by self-supplied sources = 6,334.92 x 2.64 = 16,724.19

2030 Gallons Per Day Projected: 16,724.19 x 63 gpd = 1,053,623.89 (1.054 mgd)

2040 Population Projection (calculated, per VEC %): 18,944 (10% increase over 2020 projection)

2040 Estimated households, self-supplied: 6,334.92 (2030 projected) + 10.23% = 6,982.98

2040 Persons served by self-supplied sources = 6,982.98 x 2.64 = 18,435.07

2040 Gallons Per Day Projected: 18,435.07 x 63 gpd = 1,161,409.62 gpd (1.161 mgd)

Self-Supplied non-agricultural business and institutional users

2009 Use Estimated: 51,425 gpd (0.0514 mgd)

2020 Projection¹⁰: 60,262.92 gpd (0.6026 mgd)

2030 Projection: 70,628.14 gpd (0.0706 mgd)

2040 Projection: 82,776.18 gpd (0.0828 mgd)

Self-supplied agricultural users

2009 Use Estimated, total: 147,237,884 (gallons per day)

2020 Projection: 172,861,693 (172.862 MGD)

2030 Projection: 190,545,444 (190.545 MGD)

2040 Projection: 210,038,243 (210.038 MGD)

5.7. Total Projected Water Demand

The chart following below shows the projected water use for all sectors, community water systems and self supplied residences and businesses, excluding agriculture for each of the decades of the planning period on an annual average daily basis for the County of Madison.

- Agricultural water use and existing community water systems are projected to remain constant.
- Residential use is projected to increase by the same percentages as estimated by VEC for population
- Water use for businesses is projected based on VEC estimates for employment increases

¹⁰ VEC estimates a 14.14% increase in employment for Madison County by 2018, and an annual projected rate of increase of 1.33%.



Projected Water Demand Water Use by Decade for Non-Agricultural Uses				
	Low Estimate (GPD)	Low Estimate (MGD)	High Estimate (GPD)	High Estimate (MGD)
2009 Existing Water Use	929,075	.929	1,293,700	1.2937
2010 New Water Use	10,075		14,260	
2010 Expected Water Use	939,150	.9391	1,307,960	1.3079
2020 New Water Use	98,735		139,748	
2020 Expected Water Use	1,037,885	1.0378	1,447,708	1.4477
2030 New Water Use	103,870		147,017	
2030 Expected Water Use	1,141,755	1.1417	1,594,725	1.5947
2040 New Water Use	103,870		147,017	
2040 Expected Water Use	1,245,625	1.2456	1,741,742	1.7417

Disaggregated Use, as percentage of totals for 2020, 2030 and 2040:

Residential Use: 48% of total shown above

CIL: 13% of totals shown above

Heavy Industrial: 0%

Military: 0%

Water Used in Water Production Processes: 32%

Unaccounted for Losses: 7%

5.8. Cumulative demand, use conflict, or in-stream flow information developed

None.

6.0. Drought Management and Water Demand Actions

State Water Supply Planning Regulations at 9VAC25-780-120 require this Plan to establish a drought response and contingency program that includes community water systems and self-supplied users who withdraw more than an average of 300,000 gallons per month of surface water and ground water. As noted previously herein, Madison County has no known self-supplied users who withdraw more than an average of 300,000 gallons per month of surface water and ground water. Therefore this section of the Plan will focus on community water systems.

A water demand management plan consists of long-term water conservation strategies that focus on maintaining a balance between supply and demand.

6.1. Drought Management

The County will monitor drought conditions by following the drought declarations of the Virginia Drought Monitoring Task Force (DMTF), as outlined in the 2003 Virginia Drought Assessment and Response Plan (VDARP). According to the VDARP, the Town and County of Madison are located within the Northern Piedmont Drought Evaluation Region. The following climatic conditions are likely to precede the occurrence of a significant drought event within the Northern Piedmont Drought Evaluation Region:

6.1.1. Monitor Ground Water Levels

According to VDARP, the Gordonsville Observation Well, USGS local number 45P 1 SOW 030, will be used to monitor shallow ground water responses to drought conditions in the Northern Piedmont region. Ground water levels will be compared with historic level statistics for the period of record. The following table outlines drought stages on ground water levels.

Drought Stage	Criteria
Watch	Measured ground water levels between the 10 th and 25 th percentile for all historic levels
Warning	Measured ground water levels between the 5 th and 10 th percentile for all historic levels
Emergency	Measured ground water levels below the 5 th percentile for all historic levels

6.1.2. Monitor Precipitation deficits

The DMTF evaluates precipitation based on the water year, which begins October 1st. Comparing current precipitation amounts with historical values as a percent of normal long-term average values will monitor precipitation deficits. Normal long-term average precipitation is defined as the mean precipitation for a thirty-year period of record for the area and time period being evaluated. Throughout the water year, the significance of a precipitation deficit changes and a drought stage will



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trigger at different percentages of normal based on the date of the evaluation. The following table outlines drought stages based on precipitation deficits, according to month or evaluation.

Months Analyzed	Normal (% of Normal Precipitation)	Watch (% of Normal Precipitation)	Warning (% of Normal Precipitation)	Emergency (% of Normal Precipitation)
October – December	>75.0	<75.0	<65.0	<55.0
October – January	>80.0	<80.0	<70.0	<60.0
October – February	>80.0	<80.0	<70.0	<60.0
October – March	>80.0	<80.0	<70.0	<60.0
October – April	>81.5	<81.5	<71.5	<61.5
October – May	>82.5	<82.5	<72.5	<62.5
October – June	>83.5	<83.5	<73.5	<63.5
October – July	>85.0	<85.0	<75.0	<65.0
October – August	>85.0	<85.0	<75.0	<65.0
October – September (and previous 12 months)	>85.0	<85.0	<75.0	<65.0

6.1.3. Monitor Streamflow

According to the VDARP, the Rapidan River gage near Culpeper (USGS Station 01667500) will be used to monitor Northern Piedmont streamflow values. Representative daily flow values will be compared with historic flow statistics for the period of record. The following table outlines drought stages based on streamflow measures. Please note, a streamflow that represents the 5th percentile of return flow frequencies indicates that, for the period of record, 95% of streamflows have exceeded the current flow. Additionally, RSA will monitor stream flow at its stream intake in Madison County.

Drought Stages	Criteria
Watch	Representative daily streamflows between the 10 th and 25 th percentile for return flow frequencies
Warning	Representative daily streamflows between the 5 th and 10 th percentile for return flow frequencies
Emergency	Representative daily streamflows below the 5 th percentile for return flow frequencies

6.1.4. Monitor Reservoir Storage

According to the VDARP, the Lake Anna reservoir for the Spotsylvania Water Supply Reservoir System will be the monitor used for the Northern Piedmont reservoir storage gauge. Water supply will be evaluated based on the estimated days of available usable storage. Usable storage will be

calculated as that storage above the level where advanced water treatment will be required. Additionally, RSA will monitor reservoir levels at the White Oak Reservoir in Madison County.

	Normal	Drought Watch	Drought Warning	Drought Emergency
Smith Mountain Lake	>793 feet msl	793 to 791.5 feet msl	791.5 to 790 feet msl	<790 feet msl
Lake Moomaw	>1565 feet msl	1565 to 1562.5 feet msl	1562.5 to 1560 feet msl	<1560 feet msl
Lake Anna	>248 feet msl	248 to 246 feet msl	246 to 244 feet msl	<244 feet msl
Kerr Reservoir	<3 feet below the guide curve	3 to 6 feet below the guide curve	> 6 feet below the guide curve	<288 feet msl

RSA’s facilities in Madison County are particularly affected by precipitation levels, stream flow and reservoir storage. These are the primary factors that will be used by RSA to determine drought stages.

6.1.5. Drought Response

As noted previously in this Plan all water sources within Madison County and the Town of Madison are well-based, except for RSA’s facilities (surface water impoundment and intake).

The supply of water for the RSA’s water treatment plant is dependent upon the flows of the White Oak Run. The General Manager of the RSA will notify Madison County and the Town of Madison when the RSA determines that a change in the drought stage is necessary to maintain an adequate water supply. Working in collaboration with Madison County and the Town of Madison, declarations of drought stages shall be established by the RSA General Manager, based upon the drought indicators discussed in this plan and the current demand for water. When the Madison County Administrator is notified by the RSA that a declaration is required, the County Administrator will promptly take steps necessary to notify the public of the change in drought stages and any restrictions in effect during this stage. RSA operates as a service authority with its own policies, procedures, and responsibilities. The permits for the operation of RSA facilities may override conservation measures associated with the drought management actions presented in this section

Drought Watch Responses

Upon declaration of a drought watch the following measures will be taken:

- The RSA will implement a notification program of high water users through monthly billings and/or fliers. Construction contractors that are using large amounts of water for flushing lines or irrigating newly sodded or seeded lawns will also be contacted.
- Notice to the public water supply users of the drought watch stage through the RSA’s use of fliers in the RSA office
- Announcements and educational information posted on the homepage of the Madison County website and in the Madison County Eagle
- Signage and public message boards displaying information about the current drought stage



Madison County & Town Water Supply Plan

- RSA, Madison County and the Town of Madison will advertise the following voluntary conservation measures:
 - Check toilets, faucets, hoses and couplings for leaks and repair.
 - Take shorter showers, and turn off the water when shampooing, shaving, or brushing your teeth.
 - Reduce outdoor use, and water your lawn and shrubs only between the hours of 6 p.m. and 6 a.m., to minimize evaporation.
 - Use a broom instead of a hose to clean stairs, driveways, and sidewalks
 - Wash only full loads in the washing machine or use the appropriate water level selection.
 - Reduce vehicle washing.
 - Scrape - don't rinse – dishes before putting them in the dishwasher
 - Wash vegetables and fruits in a basin of water, not allowing the water to run while washing.
 - Install moisture sensors on sprinkler systems.
 - Education of public employees in the County and the School system, to help maximize the impact of voluntary measures

Drought Warning Responses

The goal of responses at the drought warning stage is to reduce water use by five to ten percent. The following measures will be undertaken at a drought warning stage:

- RSA will implement mandatory water conservation measures with its customers
- RSA will consider putting into place meter checks and testing
- RSA will consider enacting higher water rates

Drought Emergency Responses

The goal of responses at the drought emergency stage is to reduce water use by ten to fifteen percent. The following measures will be undertaken:

- The Board of Supervisors and Town of Madison will consider enacting an ordinance for mandatory water conservation measures and restrictions
- RSA will notify high water users by phone. Per RSA policy, users that do not comply with the mandatory conservation measures and restrictions can have their water service terminated
- RSA will consider enacting higher water rates
- Madison County and RSA may consider a moratorium on new water connections

If at any point in this sequence of drought stages the Governor issues an executive order declaring a statewide drought emergency, or a regional drought emergency including the Northern Piedmont Drought Evaluation Region, Madison County, the Town of Madison and RSA will evaluate the status of the drought indicators to determine if a change in the drought emergency stage in Madison is warranted.

Should drought conditions become increasingly severe or extended, RSA may implement water rationing as a measure to protect the supplies of the public water system. If this is necessary RSA will work closely with the state Water Control Board and the Virginia Department of Emergency Management with support from Madison County and the Town of Madison, to secure the necessary resources to maintain the health and welfare of the public water supplied users.

6.2. Water Demand Management

This section details long-term water conservation strategies to be considered by the County and Town of Madison.

6.2.1. Efficient Use

Madison County, including the Town of Madison, has enacted the Uniform Statewide Building Code (USBC). The USBC incorporates all of the maximum flow and water consumption guidelines of the 2006 International Plumbing Code. Other measures that could be considered by the Town and County are establishment of landscaping standards in their zoning ordinances to allow only low-water use landscaping and irrigation devices. Water reclamation is a tool that can be used, and the USBC addresses the construction of gray-water collection and distribution systems for irrigation. Reclamation and reuse of industrial or municipal wastewater requires addenda to VPDES or VPA permits.

6.2.2. Use Reduction

Currently Madison County and the Town of Madison do not have any formal technical, financial, or educational programs aimed at reducing the amount of water used by their residents. Madison County and the Town of Madison could also consider the following:

- Encouraging RSA, as a public waterworks, to partner with the EPA in its WaterSense Program, to promote information about water conservation
- Encourage the replacement of old fixtures with low-flow water closet and showerhead retrofits
- Supporting RSA in rate increases during peak months or high use periods
- Educational workshops in public schools, advertised to the general population

6.2.3. Loss and leak reduction

RSA uses a fairly simple and straight-forward method to account for losses in the system: water produced less water sales, including sales through hydrants, equals the total water loss. A significant increase in total water loss is a trigger to start surveying for an undetected leak in the distribution system and/or perform meter checks to determine if the water is being metered inaccurately. Another program that RSA may consider is requiring or offering individual water audits for its high-use customers. Supported by a nominal fee paid by the user, these water audits could identify leaks on the other side of the meter and also provide a face-to-face opportunity for an introduction of conservation measures. Other beneficial programs may include an active (vs. passive) leak detection program and an infrastructure replacement program.



7.0. Statement of Needs and Alternatives

7.1. Municipal Water System Adequacy

The future capacity of the RSA water system was evaluated by comparing current capacity of the system with the projected future demand (see Section 5). For this purpose, total system capacity is equivalent to 0.25 MGD, which is the current permitted capacity for the water treatment plant in Madison County. Projected demand:

2009: 0.075 MGD average daily use
2020: 0.088 MGD average daily use
2030: 0.097 MGD average daily use
2040: 0.107 MGD average daily use

It is estimated that the RSA municipal water system in Madison County and the Town of Madison will need a water supply source or sources to supply an average daily demand of approximately 0.107 MGD in the year 2040. The current system is adequate to meet these demands.

7.2. Private Community Water Supply Systems

Woodberry Forest School and Hartland Institute appear to be fine (ratio between source capacity and use is good) unless they expand enrollment significantly or further diversify activities at their sites. Infrastructure can be improved to take advantage of capacity that is available in existing wells or their replacements. For planning purposes it is estimated that water uses at these facilities will gradually grow to 79% of capacity during the next 40 years.

Other Community Water Systems: All of the community water systems other than Woodberry Forest School and Hartland Institute are currently operating at their maximum number of permitted connections; therefore, no additional capacity is anticipated to be needed for the households served by these systems.

Self-Supplied Users: all other users in Madison County and the Town of Madison are self-supplied users of ground and surface water. It is projected that the demand for these water sources will increase in proportion to population growth in the Town and County; however, there is no indication at the present time that existing ground and surface water resources could not meet projected increases.