Northern Shenandoah Regional Water Supply Plan

7/26/2011

The Draft Regional Water Supply Plan was prepared by the Northern Shenandoah Valley Regional Commission and Technical Advisory Committee members from the twenty jurisdictions participating in this Plan. The contents of this Plan are draft and should be considered preliminary in nature until each jurisdiction has had the opportunity to review and approve of this Regional Water Supply Plan. The Regional Water Supply Plan was prepared to meet the mandate set forth in 9 VAC 25 780.

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Executive Summary:

Northern Shenandoah Regional Water Supply Plan:

This summary provides an overview of the following sections of the Plan:

- History and Purpose of the Plan
- Current Water Sources and Use
- Estimated Future Water Demand
- Drought Ordinance and Response Plan
- Statement of Water Need by 2040

History and Purpose:

The purpose of the regional water supply plan is to comply with the State Water Control Board regulation 9 VAC 25-780, Local and Regional Water Supply Planning. This regional water supply plan is designed to facilitate comprehensive assessment of existing water sources and uses, estimation of projected water demand in the Northern Shenandoah Valley to 2040, and a determination of water surpluses and or deficits to meet the projected water demands. The data contained in the attendant spreadsheets (found on NSVRC website) and in this Plan serve the flowing functions: meet the mandated requirements of a locality or region; provide documentation and estimates of all reportable water sources and uses within a jurisdiction for a statewide database; raise the awareness of the ability of a locality's existing water uses to meet the projected demand by 2040; aid information for future discussions across jurisdictions for potential future interconnected water sharing; and form one part of the Virginia Water Resources Plan to ensure an adequate supply for all users balanced with ecosystem needs.

To prepare the data for this Plan, a technical advisory committee (TAC) was assembled comprised of the twenty jurisdictions located within the Northern Shenandoah Valley planning region. Participating jurisdictions assigned members to the TAC representing the City of Winchester; five counties of Clarke, Frederick, Page, Shenandoah, and Warren; and the fourteen towns of Berryville, Boyce, Edinburg, Front Royal, Luray, Middletown, Mount Jackson, New Market, Shenandoah (town), Stanley, Stephens City, Strasburg, Toms Brook, and Woodstock. The twenty jurisdictions participating in the regional Plan signed a resolution before November 2008 for the Northern Shenandoah Valley Regional Commission to prepare the water supply plan on their behalf and submit it to the Virginia Department of Environmental Quality (DEQ) on or before November 2, 2011, per the regulation. The Northern Shenandoah Valley Regional Commission prepared this regional water supply plan with the involvement of all TAC members.

Current Water Source / Use:

Existing public and private community water supply systems were detailed for each locality. In addition homes and businesses served by groundwater wells were noted. These wells vary in quantity throughout the year.

In addition, agricultural water use was documented from users that report over 300,000 gallons per month. Agricultural water use by livestock was estimated based on the 2007 Census of Agriculture data for each county in the planning region. Estimates for livestock were calculated based on number and type of animal with a water demand based on animal type. The data from the 2007 Census of Agriculture also provided County lands in crops by acreage. This data was presented; however, is not included in water demand because the quantity of water to irrigate crops is climate dependent. In general, most agriculture in the counties of the region use surface water stream intakes for irrigation with gas-run pumps to withdraw the water. No water usage estimate was calculated for the croplands and vineyards because the use of water on crops varies with annual precipitation. Nonagricultural self-supplied users were also documented in this Plan.

Estimated Water Demand:

Residential water demand was based on future population projections for 2010, 2020, 2030, and 2040. The public community water systems were compared to the future estimated population and attendant water need. The private water supply systems were estimated to remain the same throughout the timeline to 2040 (the number serviced by a trailer park or subdivision would remain static). Future estimates of users on community water systems for commercial, industrial, water sales, and unaccounted for losses were calculated based on 2008 data, locality comprehensive plans, and patterns in an area. Self-Supplied nonagricultural and agricultural users were also included in the future water use. Most of these were considered to remain the same in 2008 as they will be in 2040 (some may close, others open with the net number of self-supplied users remaining the same). These often included golf clubs, campgrounds, and other facilities. The number of people not serviced by public or private community water systems were those estimated to be on groundwater individual wells. Estimates of the future water users not serviced with residential community water supply were determined by the projected population not within a water distribution system in the future years.

Drought Response and Contingency Plan

State regulations stipulate a minimum of three drought stages be included in the Water Supply Drought Response Sections. The Northern Shenandoah Valley Regional Water Supply Plan's Drought Response Section includes these three graduated stages of a drought:

Drought Stage	Description	Action
Watch	Drought potential if conditions persist	Increase water conservation awareness; voluntary actions by citizens
Warning	Onset of drought is imminent	Water conservation awareness; precautionary measures voluntary but encouraged by localities

Emergency	Significant drought or low water event	Mandatory responses for water conservation by localities and public

Jurisdictions will have varied declarations of a drought in part due to water sources, water demands, upstream water withdrawals, groundwater's delayed response to reflect low precipitation, equipment failure, and local variations in meteorology and soil moisture.

Local ordinances adopted by the localities within this planning region will be appended to the Water Supply Plan. The ordinances document jurisdictional commitment to water conservation implementation and enforcement of the Drought Response Section.

Local Triggers:

Each locality has selected local triggers to monitor and use to declare a drought or low water condition. Typically triggers include a stream level measured at a gage or a groundwater level measured at a specified level in a well, if available. A locality may assume a trigger is activated when either their local trigger has reached a predetermined level and / or a trigger from a neighboring jurisdiction within the same sub watershed has been reached. For localities with trigger levels set at percentile flows not posted on the NSVRC.virginia.gov website, the water purveyor will calculate flows to assess if conditions warrant a drought stage declaration.

While some drought response actions are applicable to all jurisdictions in the planning region (see list below), other drought response actions are individually determined by each locality based upon the environmental setting and their position within the watershed, water source, and political circumstances. Local water managers and staff will be apprised of Drought Stage declarations through the use of automated crew messaging / emergency notification.

Note: In the event of a prolonged, multi-seasonal drought emergency, the locality reserves the right to institute a program of water rationing.

The NSVRC will act as a clearinghouse and provide public notification of any drought stage declaration within the region. The public notices will serve to build and raise awareness of the drought status and educate the public of early water conservation steps individuals and localities can implement. Drought stage downgrading will be conducted by the local water purveyor, jurisdictional CAO, or designee as determined by each locality. Decisions to downgrade a stage will be based on the local trigger, DEQ, and other designated triggers as precipitation increases and soil moisture content and water levels rise in streams and wells.

Statement of Water Need:

The projected future water demands through 2040 were assessed.

Winchester:

The City of Winchester has two water sources (river intake and a spring) with a combined maximum capacity of 15 MGD. The future growth scenarios increase the demand to 9.11 MGD. This demand can be met by the existing sources, with an estimated 5.9 MGD surplus in water supply.

Clarke County, Towns of Berryville and Boyce:

Town of Berryville:

Berryville will meet future projected water needs through 2040 based on uses presented below. However, peak water usage in 2040 exceeds the current VDH permitted capacity of water. Therefore, a new permit would be necessary for increased water withdrawal. In addition, implementation of water conservation techniques will decrease water use by 20% thereby, resulting in future peak days demands to be met by existing sources.

Town of Boyce:

The existing supplies and permits for water for the Town of Boyce will meet future water demands to 2040 based on water uses projected below. It should be noted that a decrease in per capita usage of 132 gpd/user would also decrease water demand. A peak factor of 1.2 was used to predict water use on peak days. If a peaking rate of 1.5 were used, the peak day water use by 2040 would not be met, although the annual water demand for 2040 would be satisfied.

Frederick County, Towns of Middletown and Stephens City:

In Frederick County there are two towns, both of which purchase water from another locality or entity. The Town of Middletown purchases water from the City of Winchester. The Frederick County Sanitation Authority provides water wholesale to the Town of Stephens City. In addition, Frederick County Sanitation Authority provides water to County residents located in the vicinity near the City of Winchester.

Estimates of future water demand for those serviced by the Frederick County Sanitation Authority include residential water demand, commercial demand, sales to Stephens City, and unaccounted for losses. Several assumptions were made including the demand by commercial light industrial users and will remain the same from 2008 through 2040. The quantity of water to be sold to Stephens City will remain the same from 2008 through 2040, and the unaccounted for system losses will remain the same from 2010 through 2040, assuming appliance efficiency and distribution upgrades occur. The projected number of residents to be serviced by the Frederick County Sanitation Authority was assumed to remain proportionate to the overall County population from 2008 and 2010. If the Sanitation Authority service area increases based on the projections below and the assumptions of water loss, sales, and commercial demand remain static, the demands projected through 2040 are as follows.

The permitted design capacity for the quarries supplying Frederick County Sanitation Authority is 4.928 million gallons per day (MGD). The Bartonsville well site has a capacity of 0.5 MGD totaling 5.42 MGD capacity. The Frederick County Sanitation Authority also purchases up to 2 MGD from the City of

Winchester. Therefore, the sum total of existing water available to Frederick County Sanitation Authority is 7.92 MGD. Based on an available current supply of 7.92 MGD, a deficit of water in Frederick County is anticipated to occur between 2020 and 2030. If the Frederick County Sanitation Authority service area continues to serve the same percent of the County population as it increases over time, there will be a proportional increase in residents served by the Sanitation Authority. However, it should be noted that the Virginia Department of Health recommends that once a locality's water demand exceeds 80% of the source capacity, additional water should be secured. The water demand projected for 2020 is 7.83 MGD which exceeds 80% of the 7.92 source capacity. Therefore, it is recommended that between present time and 2020, Frederick County plan for additional water supplies to meet future demands. Either the Sanitation Authority will have to expand their water supply capacity and / or the service area will have to remain at or near the number of 2010 residential connections. Or, as population increases in the County, more residences will need to be required to use groundwater wells.

Town of Middletown:
The Town of Middletown is anticipated to use water at the rates projected below. Given those rates, the Town will need to look for sources of water by 2030 to meet the demand that will exceed the existing water purchase contract with the City of Winchester. The existing water contract is capped for Middletown at 0.238 MGD. It should be noted, these preliminary projections of water are based on a per capita water daily demand that exceeds state averages (152 gallons per day). Calculations using state averages of 125 gpd per person would lower the demand. Measures of conservation and other reduction implementation strategies could also significantly reduce the water demand and thereby not necessitate additional water supplies for the future planning period.

Town of Stephens City:
The Town of Stephens City has water supplied by the Frederick County Sanitation Authority. Based on projections, the Town of Stephen City water use is expected to be met by the existing water system and supplies through 2040.

Page County, and Towns of Luray, Shenandoah, and Stanley
Based on the ubiquitous nature of groundwater underlying Page County, future demands are anticipated to be met with groundwater wells.

Town of Luray:
All future users for water in the Town of Luray are anticipated to be met by the existing water supplies and permitted capacity to the year 2040. The peak demand for 2040 potentially exceeds the permitted capacity by 2030; however, daily consumptive uses could implement conservation to extend the supply of the sources to satisfy future uses.

Town of Shenandoah:
Even with a higher than average per capita usage, the Town of Shenandoah is anticipated to have all future water demands met by their exiting supplies. See the summary below of future use projections and have a surplus of 0.3 MGD.

Town of Stanley:
Future water demands are anticipated to be met by existing water supplies for the Town of Stanley through 2040 with a surplus of 0.05 MGD for peak days by 2040.

Shenandoah County, Towns of Edinburg, Mt. Jackson, New Market, Strasburg, Toms Brook, and Woodstock:
Based on future water use in Shenandoah County the existing water supplies from Stoney Creek Sanitary District and groundwater wells are anticipated to meet future water use. It is assumed that future development outside water supply service areas will require well development to support housing in rural areas.

Town of Edinburg:
Future Water uses are anticipated to be met by the existing water supplies in the Town of Edinburg through the planning period to 2040. As is (with no conservation practices implemented), the 2040 average demand would be met by existing wells supplies with a surplus of 0.172 MGD.

Town of Mount Jackson:
The Town of Mount Jackson will have all water demands met by existing supplies. The per capita water usage rate was fairly low for Mount Jackson. The peaking rate was also low for the Town, at 1.2. The Town will have a surplus of 0.26 MGD in 2040 for average daily use, and a surplus of 0.172 MGD for peak days by 2040.

Town of New Market:
The Town of New Market will have all future water demands up through 2040 satisfied by existing Town water sources. By 2040, there will be a surplus of 1.238 MGD on peak days and a surplus of 1.779 MGD on average daily usage days.

Town of Strasburg:
The Town of Strasburg will have water demands met through Town supplies throughout the planning period of 2040. Based on increased permitted source to 3 MGD it is estimated that given the usage predicted in this Plan, by 2040 the Town will have a surplus of 1.713 MGD for average daily use and a surplus of 1.546 MGD for peak days.

Town of Toms Brook:
The Sanitary District has a permitted capacity of 0.241 MGD. Calculated future water use for the Town of Toms Brook will be met throughout the planning horizon of 2040 with a surplus of water from the existing source, Toms Brook-Maurertown District.

Town of Woodstock:
The Town of Woodstock will be able to satisfy all water demands through 2040 from the Town intake on the Shenandoah River. Based on demand calculations, there will be a water surplus of 0.137 MGD by 2040 on peak days and a surplus of 0.191 MGD on average daily use days.

Warren County and the Town of Front Royal:

The projected future water demands in Warren County are anticipated to be met through 2040. In general, additional rural development will require groundwater well construction to meet future needs in areas outside community water service systems.

Town of Front Royal:

Projected water use in the Town of Front Royal was calculated from 2008 water average daily water use of 2.048 MGD and peak day usage in 2008 was 3.35 MGD. Based on projected uses, the Town of Front Royal will meet residential water use and peak uses through 2040 with a permitted capacity of 4 MGD. It should be noted that disaggregated water use for other sectors such as business and system losses is not included in this estimated demand.

NORTHERN SHENANDOAH VALLEY REGIONAL WATER SUPPLY PLAN

1.0 INTRODUCTION

The Northern Shenandoah Valley regional water supply planning group is comprised of twenty local governments that formed a technical advisory committee (TAC). Participating jurisdictions assigned members to the TAC representing the City of Winchester, five counties of Clarke, Frederick, Page, Shenandoah, and Warren; and the fourteen towns of Berryville, Boyce, Edinburg, Front Royal, Luray, Middletown, Mount Jackson, New Market, Shenandoah (town), Stanley, Stephens City, Strasburg, Toms Brook, and Woodstock. In addition, members of the Clarke County Sanitation Authority, Frederick County Sanitation Authority, Stoney Creek District and Toms Brook- Maurertown District were on the TAC. The twenty jurisdictions participating in the regional Plan signed a resolution before November 2008 for the Northern Shenandoah Valley Regional Commission to prepare the water supply plan on their behalf and submit it to the Virginia Department of Environmental Quality (DEQ) on or before November 2, 2011, per the regulation. The Northern Shenandoah Valley Regional Commission prepared this regional water supply plan with the involvement of all TAC members.

The purpose of the regional water supply plan is to comply with the State Water Control Board regulation 9 VAC 25-780, Local and Regional Water Supply Planning. This plan is designed to facilitate comprehensive assessment of existing water sources and uses, estimation of projected water demand in the Northern Shenandoah Valley to 2040, and a determination of water surpluses and or deficits to meet the projected water demands. In addition, this Plan surveys the water conservation steps taken in each jurisdiction, documents drought response actions, and helped develop consideration of alternative water supplies. The goal is to achieve the following:

- Provide adequate, reliable, and safe water to citizens balancing the need for environmental protection and future growth.
- Establish a comprehensive and continuous planning process for the wise use of our water resources.
- Plan for water needs for 30-50 years
- Involve public in decision process
- Identify alternative water sources
- Encourage regional water planning

Three years were used to characterize water use and sources: 2002, 2003, and 2008. The TAC determined that the wettest and driest years within the recent decade as well as the most recent year should all be included in this Plan.

The planning region relies on both groundwater from wells and springs and surface water from intakes on rivers.

2.0 EXISTING WATER SUPPLY

2.1 Existing Water Sources

Under the 1974 Safe Drinking Water Act, the Environmental Protection Agency (EPA) is the Federal agency with responsibility for protecting public water systems. EPA's definition of public water systems is one that provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year. EPA has defined three types of public water systems:

- Community Water System (CWS): A public water system that supplies water to the same population year-round.
- Non-Transient Non-Community Water System (NTNCWS): A public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals which have their own water systems.
- Transient Non-Community Water System (TNCWS): A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time.

In Virginia, the Virginia Department of Health has primary responsibility for compliance with the Safe Drinking Water Act requirements. Below is a description of community water systems for the twenty localities within the Northern Shenandoah Valley planning region.

2.1.1 Clarke County

Existing water sources in Clarke County include a public community water system owned and operated by the Clarke County Sanitation Authority and several private community water systems. Three-fourths of the people in Clarke County depend on groundwater as their source of drinking water. In the early 1990's groundwater wells within the White Post area were polluted by benzene. These wells have since been remediated and groundwater no longer poses a threat to water quality. In addition, Clarke County has implemented groundwater well protection ordinances that endorse sound land use practices to protect groundwater quality.

Public Community Water Systems. The Clarke County Sanitation Authority has a public community water system with water with an intake on Prospect Hill Spring with a permitted capacity of 180,000 gallons per day (gpd). Prospect Hill Spring is under the influence of surface water. The Clarke County Sanitation Authority provides and sells water to citizens located within the Town of Boyce. The Authority maintains three finished water storage tanks with a combined capacity of 275,000 gallons. In addition, there are several private community water systems in the County that use groundwater as a source. The two towns within Clarke County are Berryville and Boyce. The water supply for them is discussed in sections 2.1.2 and 2.1.3. There are homes and businesses within Clarke County that are served by individual groundwater wells. A map of the community water systems in Clarke County is included in Map 2.1

Private Community Water Systems. Private community water systems include Grafton school, serving 123 persons with a groundwater well; the Retreat with six groundwater wells and a maximum permitted capacity of 59,200 gpd; and River Park with a groundwater well and a maximum capacity permitted at 13,600 gpd.

2.1.2 Town of Berryville

The Town of Berryville has a public community water system with an intake on the main stem of the Shenandoah River with a permitted capacity of 864,000 gpd. There are no private community water systems within the town.

2.1.3 Town of Boyce

The Town of Boyce has water provided for by the Clarke County Sanitation Authority. Boyce does not own nor bill the distribution system.

2.1.4 Frederick County

Existing water sources in Frederick County include public community water systems owned and operated by the Frederick County Sanitation Authority, as well as privately owned community water systems. Frederick County has two towns: Middletown and Stephens City. In addition to public and private community water systems, there are homes and businesses within Frederick County that are served by groundwater wells. These wells vary in quantity throughout the year. A map showing the public community water systems in Frederick County is presented on Map 2.1.

Public Community Water Systems. Frederick County Sanitation Authority has three groundwater wells (Anderson, Whetzel, and Bartonsville) with water storage in a series of interconnected quarries. Water quantity for the wells is as follows: Anderson well permitted maximum capacity is 547,000 gpd; the Whetzel well permitted max capacity is 936,000 gpd; and the Bartonsville well has a maximum permitted capacity of 509,760 gpd. The permitted design capacity for the Frederick County Sanitation Authority is 4.928 MGD. The Authority also purchases up to 2 million gallons a day (MGD) from the City of Winchester. The Authority provides water to Stephens City as well as to the Town of Stephens City.

Private Community Water Systems. Private community water systems in Frederick County on groundwater wells include the four systems of Hilltop Trailer Park (permitted 14 connections at 5,600 gpd); Shawnee Land with four wells serving 155 connections (with a combined permitted capacity of 172,800 gpd); Lake Holiday Estates with seven groundwater wells and a combined permitted capacity of 326,000 gpd; and Tavenner Trailer Court with four groundwater wells with a combined average capacity of 244,800 gpd serving 81 connections.

2.1.5 Town of Middletown

Middletown purchases water from the City of Winchester, but the town owns and operates the water distribution system. There are no private community water systems in Middletown.

2.1.6 Town of Stephens City

The Town of Stephens City purchases water from the Frederick County Sanitation Authority. There are no private community water systems in Stephens City limits.

2.1.7 Page County

Existing water sources in Page County include public community water systems owned using groundwater wells and springs, as well as privately owned community water systems. Page County has three towns: Luray, Shenandoah Town, and Stanley. In addition to public and private community water systems, there are homes and businesses within Page County that are served by groundwater wells. These wells vary in quantity throughout the year. A map showing the public community water systems in Page County is presented on Map 2.1.

Public Community Water Systems. Some of the Page County residents are served by the Town of Stanley groundwater wells.

Private Community Water Systems. Private community water systems in Page County on groundwater wells include the Egypt Bend Estates with two wells and a combined maximum permitted capacity of 38,100 gpd; Luray Homes with two wells and a combined permitted capacity of 12,000 gpd; Old Farms Subdivision with two wells and a combined permitted capacity of 3,200 gpd; Page Valley Estates on two groundwater wells with a combined permitted capacity of 20,106 gpd; and Shenandoah Utility Services on one groundwater well with a permitted capacity of 28,000 gpd.

2.1.8 Town of Luray

The Town of Luray provides water from Hite Spring and groundwater Well # 6. In addition, they have one spring (Hudson) that is currently closed and Yager (not developed). The Town of Luray has a combined permitted capacity of 1.224 MGD. There are no private community water systems in Luray.

Luray served a daily water use of 837,559 gallons per day in 2008, with an average peak daily use of 944,435 gallons per day.

In 2010 the Town of Luray serves a population of 4,895. In addition, in 2010 the Town provided County residents with out-of-town water to 130 connections. The Town estimated this to be 130 connections times 2.5 residents per household connection, plus the 2010 population for a total water service provided to 5,220 persons.

2.1.9 Town of Shenandoah

The Town of Shenandoah has three groundwater wells that serve the town with a combined permitted design capacity limited by yield for Wells 2 and 3 and pump capacity for Well No. 5; therefore, the source capacity permitted is 0.601 MGD. There are no private community water systems within the Town of Shenandoah.

2.1.10 Town of Stanley

The Town of Stanley has six groundwater wells with a combined permitted capacity for the first four of 805,650 gpd. There are no private community water systems in Stanley. Part of the Stanley water distribution serves residents outside town limits in the County through 774 connections. This provides an estimated 0.0017 MGD within the Page County area. Stanley is in the process of a wellhead protection program including fencing and an ordinance.

2.1.11 Shenandoah County

Existing water sources in Shenandoah County include public community water systems owned and operated by the Sanitary District, as well as privately owned community water systems. Shenandoah County has five towns: Edinburg, Mount Jackson, New Market, Strasburg, Toms Brook, and Woodstock. In addition to public and private CWS, there are homes and businesses within Shenandoah County that are served by groundwater wells. These wells vary in quantity throughout the year. A map showing the public community water systems in Shenandoah County is presented on Map 2.1.

Public Community Water Systems. Shenandoah County has two Sanitary Districts; one serving the Bayse-Bryce Mountain Resort area and the other serving the Town of Toms Brook. The Stoney Creek Sanitary District is comprised of seven groundwater wells with a combined permitted design capacity of 392,800 gpd.

Private Community Water Systems. Nine private community water systems on groundwater wells exist in Shenandoah County and include Battleground Trailer Park, with a daily capacity limited by storage to 11,200 gpd; Edinburg Extended with two groundwater wells with a combined permitted capacity of 34,000 gpd (max capacity 42,000 gpd); George's Chicken has six wells with a combined permitted capacity of 14.98 MGD (plus purchases water from Woodstock Town); Hollar Subdivision has three wells with a combined permitted capacity of 26,000 gpd (maximum combined design capacity of 259,200 gpd); Lambert's Mobile Villa with two groundwater wells and a permitted capacity of 14,800 (maximum combined capacity design is 119,068); Massanutten View has three wells with an average daily use of 24,000 gpd (maximum combined design capacity is 158,400 gpd); Mountain Waterworks has one well permitted to serve 17 connections (max 6,800 gpd); Ryan's Subdivision has one well serving 17 connections (6,800 gpd max); and Valley View Subdivision has two wells serving 19 connections with an average daily capacity of 5,225 gpd (93.6 gpd maximum design combined capacity).

2.1.12 Town of Edinburg

The Town of Edinburg has two groundwater wells with a maximum design capacity of 432,000 gpd, though the current VDH permit is 240,000 gpd. Edinburg's water supply is limited by its filtration capacity. There are no private community water systems in Edinburg. Edinburg Town has a wellhead protection ordinance.

2.1.13 Town of Mount Jackson

The Town of Mount Jackson has five groundwater wells serving the Town with a combined permitted capacity of 699,200. In addition, the Town has recently had two additional wells permitted by VDH that are capped and waiting to be brought into the system. There are no private community water systems serving the Town. Mount Jackson has conducted an inventory of potential sources of point source pollution within their wellhead areas.

2.1.14 Town of New Market

New Market Town has six groundwater wells with a maximum designed capacity of 2,923,200 gpd (2.92 MGD). There are no private community water systems within New Market. New Market has a wellhead protection overlay area.

2.1.15 Town of Strasburg

The Town of Strasburg has a public community water system based on an intake of surface water on the North Fork of the Shenandoah River. The town was permitted to withdraw 1MGD but their permit was increased to 3 MGD in 2010. Strasburg holds a Virginia Water Protection (VWP) Permit for the intake. There are no private community water systems in Strasburg.

2.1.16 Town of Toms Brook

The Toms Brook Sanitary District serves the Town of Toms Brook with two wells with a combined maximum design capacity of 241,600 gpd. There are no private community water systems within Toms Brook.

2.1.17 Town of Woodstock

The Town of Woodstock has a public community water systems based on an intake of surface water on the North Fork of the Shenandoah River. The town was permitted to withdraw 2.02 MGD. There are no private community water systems in Woodstock.

2.1.18 Warren County

Existing water sources in Warren County include privately owned community water systems. Warren County has one town: Front Royal. The town has a public CWS. In addition to public and private CWS, there are homes and businesses within Warren County that are served by groundwater wells. These wells vary in quantity throughout the year. A map showing the public community water systems in the Town of Front Royal is presented on Map 2.1.

Public CWS. Warren County has no public community water systems.

Private CWS. Warren County has five private community water systems on groundwater wells. These include: Dungadin Subdivision with three wells and a combined permitted capacity of 22,000 gpd (maximum design capacity is limited to 11,520 gpd); Freezeland Manor Subdivision with two wells with a combined permitted 33,600 gpd capacity (storage limited to 20,867 gallons); High Knob with six wells and a combined capacity permitted at 155,520 gpd; Jackson Meadow with two wells and a combined permitted

17,680 gpd capacity; three groundwater wells at Shenandoah River Estates permitted capacity combined of 22,000 gpd; and Shenandoah Shores with five wells and a permitted capacity of 159,600 gpd.

2.1.19 Town of Front Royal

The public community water system serving the Town of Front Royal and some of the surrounding Warren County is based on surface water river intakes. Three river intakes (on Sloan Creek, Happy Creek, and the South Fork of the Shenandoah River) have a combined permitted capacity of 4 MGD. No private community water systems are located within Front Royal. The Town of Front Royal holds a Virginia Water Protection (VWP) Permit for the intake.

2.1.20 Winchester City

Existing water sources in the City of Winchester include public community water systems owned and operated by the City of Winchester, with no privately owned community water systems. In addition to public CWS, there are businesses within City of Winchester that are served by groundwater wells. These wells vary in quantity throughout the year. A map showing the public community water systems in City of Winchester is presented on Map 2.1 (page 137)

Public Community Water Systems. Winchester City has an intake on the North Fork of the Shenandoah River with a design capacity limited by the sedimentation basin of 10 MGD (the pumping capacity is 14 MGD). In addition, Winchester has a permit to withdraw up to 1 MGD from Fay Spring. Fay Spring requires treatment and is not currently in use.

2.2 Amount of Water Available to be Purchased from Outside each Jurisdiction from any Source with the Capacity to Withdraw more than 300,000 Gallons per Month of Surface and Groundwater

The Clarke County Sanitation Authority (CCSA) currently provides water to the Town of Boyce. There is no known contract between the Town of Boyce and CCSA, and Boyce owns no water distribution infrastructure. The Frederick County Sanitation Authority (FCSA) currently purchases water from the City of Winchester. It has a contract allowing them to continue purchasing water with no end date with a cap of 2 MGD. The FCSA currently provides water to the Town of Stephens City. There is no known end date for the contract between the Town of Stephens City and the FCSA. The City of Winchester sells water to the Town of Middletown with a cap of 238,000 gpd. The City of Winchester and the Town of Middletown are entering discussions in June 2011 regarding the limit of water to be purchased. There is no end date for the water purchase agreement between FCSA and Winchester. The Stoney Creek Sanitation District in Shenandoah County provides water to the Orkney Springs / Bayse village. The Toms Brook-Maurertown Sanitation District in Shenandoah County serves Toms Brook with water. Toms Brook does not own nor operate any water infrastructure. No sanitation district's contracts have expiration dates.

2.3 Estimate of Agricultural Users of More Than 300,000 Gallons per Month

The water usage records from Virginia DEQ were reviewed but detailed livestock or crop data was not available for agricultural users of groundwater or surface water. The U.S. Department of Agriculture 2002 and 2007 Census of Agriculture data for each county in the planning region was assessed to provide estimates of crop land in acres and cattle head size. Estimates of agriculture in the counties were based on the 2007 Census of Agriculture data. In general, most agriculture in the counties of the region uses surface water stream intakes for irrigation with gas-run pumps to withdraw the water. No water usage estimate was calculated for the croplands and vineyards because the use of water on crops varies with annual precipitation. The agricultural livestock and crop (type and quantity) for each county are presented in the table below. Estimates for livestock were calculated based on number and type of animal. There are no known Self-Supplied users of more than 300,000 gallons per month of water within the Towns or City, only those identified were within the outlying County rural areas. Below is a listing of agricultural users of water reporting to DEQ and those identified from the Census of Agriculture database. While Census of Agriculture data presented includes both head of livestock and cropland; only water usage for livestock is estimated from the data. Total crop irrigation unreported has not been estimated for any counties since the irrigation of crops varies based on climatological conditions. Crop acreage is noted but not used in the water usage estimate.

2.3.1 Clarke County

Self-Supplied agricultural reported users of water in Clarke County included Dorsey and Moore (0.0794 MGD in 2008), White Post Farm (unreported quantity), and Ivy Hill Farm (0.0353 MGD). The total agricultural large users of water in Clarke reported use about 0.1147 MGD in 2008. According to the Census of Agriculture data, the farms in Clarke County cover 67,919 acres with an estimated monthly use of water of 5,365,800 or 0.179 MGD. Total cropland in Clarke County was 32,530 acres in the 2007 Census of Agriculture data.

2.3.2 Frederick County

Self-Supplied agricultural users of water in Frederick County included Timber Ridge Fruit Farm (no information on water use reported in 2008), MacDonald Farm (0.003 MGD), and Springwood Farms (0.04 MGD). The total agricultural large users of water in Frederick reported use about 0.043 MGD. According to the 2007 Census of Agriculture, Frederick County has 98,278 acres in farmland for livestock and approximately 37,900 acres in crops with an estimated monthly water use for livestock of 5,459,040 gallons or 0.182 MGD.

2.3.3 Page County

Self-Supplied agricultural users of water in Page County using over 300,000 gallons per month in 2008 included Noah Turner Landscaping (0.031 MGD) and Happy Valley Greenhouse (using a reported 0.001 MGD), with a totaling reported farm use of 0.032 MGD. In addition, according to the 2007 Census of Agriculture, Page County farmland covers 64,387 acres. There were approximately 27,702 acres in crops grown in Page County. Based on the number of farms and types of livestock, it was estimated that 8,264,880 gallons per month are used or 0.2755 MGD.

2.3.4 Shenandoah County

No Self-Supplied agricultural users of water in Shenandoah County using over 300,000 gallons per month in 2008 were reported. According to the 2007 Census of Agriculture, farms in Shenandoah County cover 141,286 acres and 60,247 acres are crops land. Based on the number and type of livestock, an estimated 14,630,760 gallons per month are used on the farm lands collectively, or 0.488 MGD.

2.3.5 Warren County

The Front Royal Fish Cultural Station was the only large Self-Supplied agricultural water user reported in 2008 to use over 300,000 gallons per month. According to the 2007 Census of Agriculture, Warren County has 47,635 acres in farmland and 13,354 acres in crops. Based on livestock type and head, an estimated 3,127,680 gallons of water are used monthly to support farms, or 0.104 MGD.

A summary of the 2007 Agricultural Census data is presented below.

AGRICULTURAL SUMMARY in NORTHERN SHENANDOAH VALLEY					
Agricultural Census Data	**Clarke County**	**Frederick County**	**Page County**	**Shenandoah County**	**Warren County**
Farms (acres) 2007	67,919	98,278	64,387	141,286	47,635
Farms (acres) 2002	74,279	112,675	64,045	133,032	48,940
Land in irrigated farms (ac) 2007	6,630	8,107	1,698	8,918	502
Farm harvested cropland (ac) 2007	4,241	2,791	916	3,046	96
Other nonpasture cropland (ac) 2007	42	2	(D)	65	-
Pastureland farms irrigated (ac) 2007	1,783	(D)	647	2,270	197
Irrigated Land (ac) 2007	515	299	295	756	58
Total Cropland (acres) 2007	32,530	37,900	27,702	60,247	13,354
Total Cropland (acres) 2002	47,926	59,312	33,178	70,324	23,536
Irrigated harvested cropland (ac) 2007	515	282	(D)	725	43
Irrigated pastureland / other (ac) 2007	-	17	(D)	31	15
Land enrolled in conservation / Reserve (acres) 2007	(D)	707	119	398	27
2002	858	1,187	466	804	167
Top Livestock Inventory (numbers)					
Cattle and Calves 2007 (number)	14,905	15,164	22,958	59,600	13,500
Horses and Ponies (number)	2,891	1,089			
Hog and Pigs (number)		(D)			
Goats (all)		717			
Poultry - Layers (number)	1,533	1,265	248,956		
Broilers Chicken			7,015,010		
Turkeys			902,211		
Pullets			139,000		

Sheep and Lambs (number)	791		600	3,800	
Top Crop (acres)					
Forage-Land used for all Hay, Haylage, Grass Silage, and Greenchop (Ac) 07	16,909	21,776	16,360		
Corn for Grain (ac) 2007	3,115	2,199	2,752		
Corn for Silage (ac) 2007	1,750	1,126	2,728		
Soybeans for beans (ac) 2007	2,030	831	776		
Apples (ac) 2007	590	5,600			
Barley for Grain (ac)			1,050		

Based on the 2007 Census of Agriculture data, the number of farms and types of livestock were reviewed and an estimated monthly use of water was calculated. The table below presents agricultural monthly water use estimated in the region. As stated previously, estimated water use for crops was not calculated because crop irrigation is dependent upon the seasonal water conditions.

AG Water Use				
County	**# of Farms**	**Avg. Size of Farms (Acres)**	**Livestock**	**Estimated Monthly Usage (Gallons)**
Clarke	496	136	14905	5365800
Frederick	676	145	15164	5459040
Page	530	121	22958	8264880
Shenandoah	1043	135	40641	14630760
Warren	387	123	8688	3127680
Regional Total Monthly water Use				36848160

2.4 Residences and Businesses that are Self-Supplied and Individual Wells Withdrawing Less than 300,000 Gallons per Month

Estimation of the residences and businesses that are Self-Supplied and served by individual groundwater wells withdrawing less than 300,000 gpm (gallons per month), is calculated by subtracting the public and private community water systems from the locality population. Populations served by the public community water systems were provided by each jurisdiction based on 2008 data. Populations served by the private community water systems were estimated from the number of connections multiplied by estimated community household for that locality. The County population served by individual wells has Town populations and private water systems subtracted.

Locality	**2008 Total Population**	**Minus Town Population**	**Population Served by Public CWS**	**Estimated Population served by Private community water systems (est 125 gpd)**	**Estimated Remaining Population Served by Individual Wells**	**Estimated Water Use on Wells (75 gpd)**
Clarke County	13,758	9,261		705	8,556	641,700

Town of Berryville	3,941	0	3,941			
Town of Boyce	556	0	556			
Frederick County	74,786	71,851		5993	65,858	4,939,350
Town of Middletown	1,199	0	1,199			
Town of Stephens City	1,736	0	1,736			
Page County	23,869	15,321		811	13,810	1,035,750
Town of Luray	4,895	0	5,220			
Town of Shenandoah	2,104	0	2,104			
Town of Stanley	1,491	0	2,500			
Est Page County Served by Stanley CWS			700			
Shenandoah County	40,609	21,656		1,357	20,299	1,522,425
Town of Edinburg	1,001	0	1,001			
Town of Mount Jackson	2,290	0	2,290			
Town of New Market	2,477	0	2,477			
Town of Strasburg+	6,242	0	7,096			
Town of Toms Brook	251	0	251			
Town of Woodstock	5,838	0	5,838			
Warren County	36,377	22,107		3,097	19,010	1,425,750
Town of Front Royal	14,270	0	14,270	0		
City of Winchester	25,679	0		0		

George's Chicken uses 14,980,000 gpd
+ Strasburg population is for 2009

2.5 Wellhead Protection Ordinance / Sourcewater Protection Programs

The County of Clarke has a wellhead protection program in place. Frederick County has an ordinance to protect the quarries storing the groundwater from being accessed by the general public. In addition FCSA has a fence surrounding the quarries to limit accessibility. In Page County, the Town of Stanley is developing an ordinance to protect wellhead areas. In Shenandoah County, the Towns of New Market, Edinburg, and Mount Jackson have wellhead protection programs in place.

3.0 EXISTING WATER USE INFORMATION

The populations for each jurisdiction in the Northern Shenandoah Valley region were available by U.S. Census for 2000 and 2010 and are presented on the table below. In addition, the estimated populations for the years reported in this water supply plan include 2002, 2003 and 2008. Estimates for the Town populations during 2002, 2003, and 2008 were calculated by a straight line derivation from 2000 and 2010 Census data.

Population			Estimated Population*		
Locality	**Census 2000**	**Census 2010**	Est 02	Est 03	Est 08
Clarke County	**12,652**	**14,034**	12,928	13,067	13,758
Berryville Town	2,963	4,185	3,207	3,329	3,941
Boyce Town	426	589	442	459	556
Frederick County	**59,209**	**78,305**	63,028	64,938	74,486
Middletown Town	1,015	1,265	1,015	1,045	1,199
Stephens City Town	1,146	1,829	1,469	1,514	1,736
Page County	**23,177**	**24,042**	23,350	23,437	23,869
Luray Town	4,871	4,895	4,891	4,902	4,953
Shenandoah Town	1,878	2,373	1,935	1,963	2,104
Stanley Town	1,326	1,689	1,367	1,388	1,491
Shenandoah County	**35,075**	**41,993**	36,459	37,150	40,609
Edinburg Town	813	1,041	856	880	1,001
Mount Jackson Town	1,664	1,994	2,056	2,095	2,290
New Market Town	1,637	2,146	2,198	2,245	2,477
Strasburg Town	4,017	6,398	5,404	5,686	6,242
Toms Brook Town	255	258	247	247	251
Woodstock Town	3,952	5,097	5,058	5,188	5,838
Warren County	**31,584**	**37,575**	32,782	33,381	36,377
Front Royal Town	13,589	14,440	13,759	13,844	14,270
Winchester City	**23,585**	**26,203**	24,109	24,370	25,679

Note* Estimated Population calculated from (Census 2010 - Census 2000)/10 = annual increase

The residential population of each jurisdiction is provided by community water systems or Self-Supplied wells.

The average per capita use of water can vary from 80 gallons/day to 200 gallons/day in the United State (Virginia Polytechnic State University, Water Resource Center, 2009). The Commonwealth of Virginia Waterworks Regulations is based on a use of 100-gallons/day/capita. For planning purposes, consideration should be given to water losses from the treatment plant to delivery point, which is estimated at about 30%. Also, a margin of safety will compensate for uncertainty in population projection. Therefore, for this Water Supply Plan for the Northern Shenandoah Valley, an estimate of water demand per capita of 125 gallons a day was used to compensate for uncertainty in per capita water use and population increase for residents served on municipal water systems (not including industrial, agricultural and other uses).

3.1 Community Water Systems Use

See the combined spreadsheet for Sections 70 and 80 posted on the NSVRC website, for a detail of public and private water use. In addition, the spreadsheet contains an estimated monthly water demand disaggregated into categories for use including residential, commercial, heavy industrial, military, production process water, unaccounted-for water losses, sales and other. These water sources and demands are summarized for each jurisdiction below.

3.2 Clarke County

Public Community Water Systems. The Clarke County Sanitation Authority has a public community water system with an intake on Prospect Hill Spring with a permitted capacity of 180,000 gallons per day (gpd). The Clarke County Sanitation Authority maintains three finished water storage tanks with a combined capacity of 275,000 gallons. The source for Clarke County, also serving the Town of Boyce, is 0.18 MGD. In 2008, the Average Daily Use was 0.066 MGD, with a Maximum Daily Use of 0.157 MGD that predominantly served residents within the Town of Boyce. The Clarke County Sanitation Authority in 2011 has 276 water accounts in the Town of Boyce. Of these 276, 20 are commercial customers and 256 are residential customers. The Sanitation Authority has 59 water accounts in White Post, of which six are commercial customers and 53 are residential. There are also 107 water accounts in Millwood. Of these 107, 10 are commercial customers and 97 are residential customers. In total for the Sanitation Authority, there are 442 total water accounts, of which 36 are commercial and 406 residential. Of the 442 water accounts, 276 serve the Town of Boyce. Based on 2.25 persons/house times 125 gallons of water used per capita per day, approximately 77,625 gpd are supplied to meet the population demand of Boyce.

Private Community Water Systems. Grafton School, serves 123 persons with a groundwater well (123 persons times 125 gpd a person is 15,375 gpd). The Retreat is served by groundwater wells and a maximum permitted capacity of 59,200 gpd. River Park groundwater well has a maximum capacity permitted at 13,600 gpd. The combined private community water system for Clarke County has a source capacity of 0.0882 MGD.

In 2002 the surface water Average Daily Use was 0.02476 MGD and the Maximum Daily Use was 0.0618 MGD (no reported withdrawal for Grafton School or River Park). In 2002, the Average Daily Withdrawal for private Community water users was 0.025 MGD and the Maximum Daily Withdrawal was 0.06 MGD. In 2008, the Average Daily Withdrawal for private community water users was 0.02 MGD and the Maximum Daily Withdrawal was 0.06 MGD.

3.3 Town of Berryville

The public community water system for Berryville has an intake on the main stem of the Shenandoah River with a permitted capacity of 864,000 gpd. In 2002 the Average Daily Use was 0.365 MGD and the Maximum daily use in 2002 was 0.749 MGD. In 2003, the Average Daily Use was 0.365 MGD and in 2008, the Average Daily Use was 0.381 MGD.

3.4 Town of Boyce

The Town of Boyce has water provided by the Clarke County Sanitation Authority. In 2002 the Average Daily Use was 0.067 MGD and in 2003 the Average Daily Use was 0.085 MGD. In 2008, the Average Daily Use was 0.089 MGD, with a maximum daily use of 0.157 MGD that was predominantly for residents within the Town of Boyce.

3.5 Frederick County

Public Community Water Systems. The Frederick County Sanitation Authority has three groundwater wells (Anderson, Whetzel, and Bartonsville) with water storage in a series of interconnected quarries. Water quantity for the wells is as follows: Anderson well permitted maximum capacity is 547,000 gpd; the Whetzel well permitted max capacity is 936,000 gpd; and the Bartonsville well has a maximum permitted capacity of 509,760 gpd. The Authority also purchases up to 2 million gallons a day (MGD) from the City of Winchester. The Authority provides water to the Town of Stephens City. The Frederick County Sanitation Authority has a source capacity of 4.928 MGD. Currently the Frederick County Sanitation Authority has 13,502 connections, not including bulk water sold to the Town of Stephens City.

In 2002 the average daily use was 2.4764 MGD. In 2008 the average daily use was 6.73 (however 4.8 MGD went to Frederick County and the Town of Stephens City users). The maximum daily use was 5.29 MGD reported in 2008.

Private Community Water Systems. Private community water systems in Frederick County on groundwater wells include the four systems of Hilltop Trailer Park (permitted 14 connections at 5,600 gpd); Shawnee Land with four wells serving 155 connections (with a combined permitted capacity of 172,800 gpd); Lake Holiday Estates with seven groundwater wells and a combined permitted capacity of

326,000 gpd; and Tavenner Trailer Court with four groundwater wells with a combined average capacity of 244,800 gpd serving 81 connections. The combined source capacity for the private community water supply systems is 0.749 MGD.

3.6 Town of Middletown

In 2008 the average daily use was 0.182 MGD which was purchased from the City of Winchester.

3.7 Town of Stephens City

The Town of Stephens City purchases water from the Frederick County Sanitation Authority. There are no private community water systems in Stephens City limits. The Average Daily use in 2002 was 0.0927 MGD.

3.8 Page County

Public Community Water Systems. Some of the Page County residents are served by the Town of Stanley groundwater wells.

Private Community Water Systems. Private community water systems in Page County on groundwater wells include the Egypt Bend Estates with two wells and a combined maximum permitted capacity of 38,100 gpd; Luray Homes with two wells and a combined permitted capacity of 12,000 gpd; Old Farms Subdivision with two wells and a combined permitted capacity of 3,200 gpd; Page Valley Estates on two groundwater wells with a combined permitted capacity of 20,106 gpd; and Shenandoah Utility Services on one groundwater well with a permitted capacity of 28,000 gpd. In 2002, the Average Daily Withdrawal for private Community water users was 0.02 MGD and the maximum daily withdrawal was 0.06 MGD.

3.9 Town of Luray

The Town of Luray provides water from one spring (Hite) and one groundwater well (Well #6). In addition, they have two wells currently closed (Hudson and Yager Spring). The Town of Luray has a combined permitted capacity of 1.224 MGD. There are no private community water systems in Luray. There is a well #6 which is currently offline but has a daily capacity of 0.496 MGD and a maximum daily capacity of 0.662 MGD. Luray served a daily water use of 837,559 gallons per day in 2008, with an average peak daily use of 944,435 gallons per day. In 2010 the Town of Luray serves a population of 4,895. In addition, in 2010 the Town provided County residents with out-of-town water to 130 connections. The Town estimated this to be 130 connections times 2.5 residents per household connection, plus the 2010 population for a total water service provided to 5,220 persons.

3.10 Town of Shenandoah

The Town of Shenandoah has three groundwater wells that serve the town with a combined permitted design capacity limited by yield for Wells 2 and 3 and pump capacity for Well No. 5; therefore, the source capacity permitted is 0.601 MGD. There are no private community water systems within the Town of Shenandoah. In 2002 the average Daily Use was 0.2626 MGD with a Maximum Withdrawal of 0.539 MGD. In 2008 the average Daily Use was 0.32 MGD with a Maximum Withdrawal of 0.51 MGD.

3.11 Town of Stanley

The Town of Stanley has six groundwater wells with a combined permitted capacity for the first four of 805,650 gpd. There are no private community water systems in Stanley. Part of the Stanley water distribution serves residents outside town limits in the County through 774 connections. Stanley is in the process of a wellhead protection program including fencing and an ordinance. In 2002 the Average Daily Use was 0.3977 MGD, with no maximum daily withdrawal numbers reported. In 2008 the Average Daily Use was 0.42 MGD, with no maximum daily withdrawal numbers reported.

3.12 Shenandoah County

Public Community Water Systems. Shenandoah County has two Sanitary Districts serving the Bayse-Bryce Mountain Resort area and the Town of Toms Brook. The Stoney Creek Sanitary District is comprised of seven groundwater wells with a combined permitted design capacity of 392,800 gpd. In 2002 the Stoney Creek water use was 0.159 MGD, maximum daily use was 0.263 MGD. In 2008 the Average Daily Use was 0.228 MGD, with a maximum daily withdrawal of 0.332 MGD reported.

Private Community Water Systems. Nine private community water systems on groundwater wells exist in Shenandoah County and include Battleground Trailer Park, with a daily capacity limited by storage to 11,200 gpd; Edinburg Extended with two groundwater wells with a combined permitted capacity of 34,000 gpd (max capacity 42,000 gpd); George's Chicken has six wells with a combined permitted capacity of 14.98 MGD (plus purchases water from Woodstock Town); Hollar Subdivision has three wells with a combined permitted capacity of 26,000 gpd (maximum combined design capacity of 259,200 gpd); Lambert's Mobile Villa with two groundwater wells and a permitted capacity of 14,800 (maximum combined capacity design is 119,068); Massanutten View has three wells with an average daily use of 24,000 gpd (maximum combined design capacity is 158,400 gpd); Mountain Waterworks has one well permitted to serve 17 connections (max 6,800 gpd); Ryan's Subdivision has one well serving 17 connections (6,800 gpd max); and Valley View Subdivision has two wells serving 19 connections with an average daily capacity of 5,225 gpd (93.6 gpd maximum design combined capacity). The Battleground Trailer Park water use was 0.0084 MGD or 0.01 MGD. The combined private water supply source is 14.9288 MGD

3.13 Town of Edinburg

The Town of Edinburg has two groundwater wells with a maximum design capacity of 432,000 gpd, though the current VDH permit is 240,000 gpd. Edinburg's water supply is limited by its filtration capacity. There are no private community water systems in Edinburg. Edinburg Town has a wellhead protection ordinance. In 2002 the average daily use was 0.15 MGD and the Maximum Daily Use was 0.249 MGD. In 2008 the Average Daily Use was 0.16 MGD, with a maximum daily withdrawal of 0.42 MGD reported.

3.14 Town of Mount Jackson

The Town of Mount Jackson has five groundwater wells serving the Town with a combined permitted capacity of 699,200. In addition, the Town has recently had two additional wells permitted by VDH that are capped and waiting to be brought into the system. For 2002 the Average Daily Use was 0.293 and the Maximum Daily Use was 1.01 MGD. In 2008 the Average Daily Use was 0.26 MGD, with a maximum daily withdrawal of 0.92 MGD reported.

3.15 Town of New Market

New Market Town has six groundwater wells with a maximum designed capacity of 2,923,200 gpd (2.92 MGD). There are no private community water systems within New Market. 0.38 MGD was the Average Daily Use in 2002 with a Maximum Daily Use of 1.12 MGD. In 2008 the Average Daily Use was 0.68 MGD, with a maximum daily withdrawal of 1.65 MGD reported.

3.16 Town of Strasburg

The Town of Strasburg has a public community water system based on an intake of surface water on the North Fork of the Shenandoah River. The town was permitted to withdraw 1MGD but their permit was increased to 3 MGD in 2010. In 2002 the Average Daily Use was 0.744 and the Maximum Daily Use was 0.958 MGD. In 2008 the Average Daily Use was 1.68 MGD, with a maximum daily withdrawal of 1.94 MGD reported.

3.17 Town of Toms Brook

Toms Brook Town has two wells with a Sanitary District with a combined maximum design capacity of 241,600 gpd. In 2002 the Average Daily Use was 0.095 MGD and the Maximum Daily Use was 0.176 MGD. In 2008 the Average Daily Use was 0.13 MGD, with a maximum daily withdrawal of 0.2 MGD reported.

3.18 Town of Woodstock

The Town of Woodstock has a public community water systems based on an intake of surface water on the North Fork of the Shenandoah River. The town was permitted to withdraw 2.02 MGD.
In 2002, the Average Daily Use was 1.01 MGD with maximum daily use of 2.41 MGD. There was no reported information for the Town of Woodstock in 2002. In 2008 the Average Daily Use was 0.0042 MGD .

3.19 Warren County

Public CWS. Warren County has no public community water systems.

Private CWS. Warren County has five private community water systems on groundwater wells. The Combined private community water system design permitted capacity is 0.4104 MGD. High knob private CWS had an average daily use unreported but the pump capacity was noted to be 0.047 MGD. Total private use in 2008 was 1.62 MGD.

3.20 Town of Front Royal

The public community water system serving the Town of Front Royal and some of the surrounding Warren County is based on surface water river intakes. Three river intakes (on Sloan Creek, Happy Creek, and the South Fork of the Shenandoah River) have a combined permitted capacity of 4 MGD. In 2008 the Average Daily Use was 2.048 MGD, with a maximum daily withdrawal of 3.35 MGD reported.

3.21 Winchester City

Public Community Water Systems. Winchester City has an intake on the North Fork of the Shenandoah River with a design capacity limited by the sedimentation basin of 10 MGD (the pumping capacity is 14MGD and). In addition, Winchester has a permit to withdraw up to 1 MGD from Fay Spring. Fay Spring requires treatment and is not currently in use. In addition to residential use averaging 1.55 MGD, the City of Winchester sells water to the Town of Middletown and Frederick County averaging a total of 2.11 MGD; other uses include Commercial and industrial light use 2.201 MGD, and unaccounted for losses in the City is 1.853 MGD. Permitted source capacity for the public community water system is 11 MGD based on 10 MGD intake on the Shenandoah River and 1 MGD for Faye Springs. In 2008 the Average Daily Withdrawal was 7.71 MGD (with 0.1821 MGD to Middletown and 1.93 MGD to Frederick County Sanitation Authority). The daily maximum withdrawal in 2008 was 10.44 MGD.

3.22 Estimate of Water Used by Self-Supplied Nonagricultural Users of More than 300,000 Gallons per Month of Surface and Groundwater Inside the Service Areas of the Community Water System

Surface Water Intake Water Users

In Clarke County there is Federal Emergency Management Agency (FEMA) with an average daily use in 2008 of 0.715 MGD. FEMA uses water from an intake on the Shenandoah River. In Frederick County

there were three Self-Supplied nonagricultural users of water including the Winchester Golf Club (Golf pond water of 0.0896 MGD); the other two, Carpers Valley Golf Course and Gore Plant, had no water usage in 2008. Page County has one Self-Supplied nonagricultural water user the Luray Caverns Country Club, using an average daily 0.0405 MGD of stream water from the South Fork of the Shenandoah River. In Shenandoah County there are three Self-Supplied nonagricultural water users: Bryce Resort (with surface water intake on Stoney Creek of 0.2222 MGD for creating snow and golf course); Shenvalee Lodge Inc. with a Smith Creek intake of 0.045 MGD; and the Strasburg Plant (O-N Minerals Company) with groundwater in Shenandoah Quarry with an average daily use of 0.0009 MGD. The Riverton Plant has an intake on the Shenandoah River in Warren County, but did not report any water use in 2008. In the City of Winchester the WINCHESTER PLANT (Federal Mogul Friction Product) is a Self-Supplied nonagricultural user but had no water use reported in 2008. The total MGD for these surface water Self-Supplied nonagricultural users is 1.114 MGD.

Groundwater Users

Berryville Graphics is the one nonagricultural Self-Supplied groundwater user in Clarke County using 0.0028 MGD. In Frederick County the groundwater Self-Supplied nonagricultural users include Valley Protein (0.1434 MGD) and Gore Plant (0.015 MGD). In Shenandoah County the nonagricultural Self-Supplied users of groundwater include George Chicken (0.332 MGD); Shrine Mont (0.26); Valley Milk Products; Strasburg Plant; Bowman's Apple; and Howell Metal. The total Self-Supplied users of groundwater in Shenandoah County in 2008 used 1.937 MGD. In Warren County the groundwater use includes the Bowling Green Club (0.05 MGD) and Shenandoah Valley Golf Club (0.0332 MGD). In the City of Winchester the Federal Mogul Plant used 0.39 MGD.

3.23 Estimate of Water Used by Self-Supplied Nonagricultural Users of More than 300,000 Gallons per Month of Surface and Groundwater Outside the Service Areas of the Community Water System

None reported.

3.24 Estimate of Water Used by Self-Supplied Agricultural Users of More than 300,000 Gallons per Month of Surface and Groundwater Inside the Service Areas of the Community Water System

The breakdowns are calculated by County only from the Census of Agriculture data. Estimates of water use for cattle (beef) & calves 12 gpd, milk cows 35 gpd, pigs 5 gpd, sheep 2 gpd, poultry layers and broilers 0.06, horses consume 12 gpd, goats 0. No water irrigation estimates were calculated for crops although the following water usages were considered likely for normal wet years: soybean 25 inches/acre, veggies 15 inches/acre, and unknown 20 inches/acre. Livestock water usage is presented in source descriptions, Chapter 2.

3.25 Estimate of Water Used by Self-Supplied Agricultural Users of More than 300,000 Gallons per Month of Surface and Groundwater Outside the Service Areas of the Community Water System

None reported.

3.26 Estimate of Water Used by Self-Supplied Users of Less than 300,000 Gallons per Month of Surface and Groundwater Inside the Service Areas of the Community Water System

Estimates of individual residents on wells per County were calculated using 2008 population minus those served by public and private community water systems. The average water use per capita for individual wells was 75 GPD.

Estimation of the residences and businesses that are Self-Supplied and served by individual groundwater wells withdrawing less than 300,000 gpm (gallons per month), is calculated by subtracting the public and private community water systems from the locality population. Populations served by the public community water systems were provided by each jurisdiction based on 2008 data. Populations served by the private community water systems were estimated from the number of connections multiplied by estimated community household for that locality. The County population served by individual wells has Town populations and private water systems subtracted.

Locality	2008 Total Population	Minus Town Population	Population Served by Public CWS	Estimated Population served by Private community water systems (est 125 gpd)	Estimated Remaining Population Served by Individual Wells	Estimated Water Use on Wells (75 gag)
Clarke County	13,758	9,261		705	8,556	641,700
Town of Berryville	3,941	0	3,941			
Town of Boyce	556	0	556			
Frederick County	74,786	71,851		5993	65,858	4,939,350
Town of Middletown	1,199	0	1,199			
Town of Stephens City	1,736	0	1,736			
Page County	23,869	15,321		811	13,810	1,035,750
Town of Luray	4,880	0	5,220			
Town of Shenandoah	2,104	0	2,104			
Town of Stanley	1,491	0	2,500			
Est Page County Served by Stanley CWS			700			
Shenandoah County **	40,609	21,656	3,889	1,357	15,064	1,129,800
Town of Edinburg	1,001	0	1,001			
Town of Mount Jackson	2,290	0	2,290			
Town of New Market	2,477	0	2,477			
Town of Strasburg	6,242*	0	7,096			
Town of Toms Brook	251	0	289			
Town of Woodstock	5,838	0	5,838			
Warren County	36,377	22,107		3,097	19,010	1,425,750
Town of Front Royal	14,270	0	14,270	0		
City of Winchester	25,679	0		0		

George's Chicken uses 14,980,000 gpd
* Strasburg Town population provided for 2009
** Shenandoah County Sanitary District – connections
1600x3600 population; Toms Brook-Maurertown Sanitary

District 289

A summary of water used in million gallons a day (MGD) in 2008 is provided on the table below for each locality in the Northern Shenandoah Valley Regional Commission planning region.

Locality	Public CWS Source Capacity	Purchased Water Available	Private CWS Permitted Capacity	2008 Public CWS	2008 Priv CWS	SSU NonAG >300K gpm	SSU Ag >300K	Ag Estim	SSU NonAg <300K gpm		Sum of Water Used by Locality in 2008
Clarke County	0.18		0.0882	.066	0.025	0.7178	.115	.179	0.6417		
Town of Berryville	0.864			0.381							0.381
Town of Boyce				0.089							0.089
Frederick County	5.2	2	0.749	2.484	0.599	0.248	.043	.182	4.939		
Town of Middletown		0.11		0.182							0.182
Town of Stephens City		.238		0.108							0.108
Page County			0.101			0.041	.032	0.2755	1.036		
Town of Luray	1.224			0.823							0.823
Town of Shenandoah	0.601			0.187							0.187
Town of Stanley	0.8056			0.428							0.428
Shenandoah County	0.3928			0.228	1.838	.86	0	0.488	1.522		
Town of Edinburg	0.24			0.162							0.162
Town of Mt Jackson	0.6992			0.267							0.267
Town of New Market	2.92			0.685							0.685
Town of Strasburg	1*			0.853							0.853
Town of Toms Brook	0.2416			0.135							0.135
Town of Woodstock	2.02			0.624							0.624
Warren County			0.4104		1.62	0.0832	0.7326	0.104	1.426		
Town of Front Royal	3			2.264							2.264
City of Winchester	11			1.54		0.39					7.71
Subtotals											

** Note Town of Strasburg to increase source capacity to 3 MGD by September 2011*

4.0 EXISTING RESOURCE INFORMATION

This section of the Northern Shenandoah Valley Regional Water Supply Plan is prepared in accordance with Title 9: Environment, of the State Water Control Board's final regulation for Water Supply Planning 9 VAC 25-780-10 through 9 VAC 25-780-190, under Statutory Authority: Sections 62.1-44.15 and 62.1-44.38:1 of the Code of Virginia. A combination of groundwater, springs, and surface water supply potable water to the planning area.

4.1 General Environmental Setting

Geology and Hydrology:

The Shenandoah Valley is a 160 mile-long valley located in the northwestern portion of Virginia. The Shenandoah Valley is part of the Great Valley within the Appalachian Mountain chain. The Appalachian Mountains stretch from Georgia to Maine; the Great Valley stretches from Pennsylvania to Alabama. The headwaters for the Shenandoah River are in Augusta and Rockingham Counties. The Shenandoah Valley lies in a north-south direction, and is bounded between the Blue Ridge Mountains on the east and the Allegheny Mountains on the west. Water runoff has carved the mountains' distinctive alternating pattern of ridges and valleys. The soils include karst and non-karst features.

The Shenandoah River, which runs through the valley, flows north and is a tributary to the Potomac River that drains into the Chesapeake Bay, and ultimately Atlantic Ocean. A soft limestone layer forms much of the base of the Shenandoah Valley. The Shenandoah River carved out the Shenandoah Valley, dissolving the limestone and carrying the sediments north to the Potomac.

Meteorology:

The climate of the Shenandoah Valley, particularly regarding precipitation, is strongly influenced by the surrounding mountains. When moist air flows toward Virginia from areas to the west and northwest, it encounters the high relief of the Allegheny Mountain system to the west of the Shenandoah Valley. As that air is forced to rise over the mountains (known as orographic lifting), it cools, moisture condenses out and the bulk of the precipitation falls on the western slopes of the Alleghenies. This leaves comparatively drier air to descend into the Valley and produce less precipitation. Likewise, when moist air from the nearby Atlantic Ocean flows across Virginia from the east, it encounters the Blue Ridge Mountains to the east of the Shenandoah Valley. The same orographic lifting usually results in lower precipitation amounts in the Valley. This double "rain shadow" effect puts the Shenandoah Valley in the driest portion of Virginia and makes it one of the driest locations in the eastern U.S.

Typical annual precipitation amounts for nearby stations on the east-facing slopes of the Blue Ridge Mountains run about ten inches higher than the Shenandoah Valley (around 48 inches as opposed to 38 inches). Statewide average annual precipitation is around 44 inches.

The general mechanisms for precipitation change throughout the course of the year. Larger-scale mid-latitude cyclones and associated frontal passages predominate the colder months and smaller-scale thunderstorm activity usually providing most of the rainfall in the warmer months. The Shenandoah Valley, along with the rest of Virginia, experiences no distinct "dry" or "wet" seasons with respect to precipitation. Nonetheless, the normally high rates of evapotranspiration in the summer months usually lead to an overall loss of moisture, while the colder months allow for the replenishment of deep soil and groundwater reserves.

In addition, the varied height and orientation of the flanking mountains can create large differences in precipitation amounts at smaller scales. This is especially true during the summer months, when the primary source of rainfall in Virginia is the thunderstorm.

The predominant flow of surface winds is northeasterly and southeasterly in direction throughout the Valley. Diurnal heating and cooling also gives rise to a mountain and valley breeze, which circulates air from higher surrounding elevations to the Valley floor and up again. Summer average temperatures in the Valley are in the mid-70's (°F) and rarely reach the 100° mark, while winter temperatures average in the mid-30's. The freeze-free growing season averages about six months, from mid-April to Mid-October, though local microclimates and elevational differences can bring considerable variation.

Rainfall is drained out of the Valley through a series of tributaries and streams that flow into the Shenandoah River, flowing northward to the Potomac River. According to P. Jerry Stenger, UVA Climatologist, the following data was collected during 1971 to 2000 in Berryville, Woodstock, Luray, and Frederick County weather stations. The average annual precipitation in our area is 38.27 inches, the maximum average annual temperature is 65.48 degrees Fahrenheit (F) and minimum temperature average is 41.66 F. The season temperature variation ranges from annual averages for winter max/min is summarized in Table 4.1. While most of the Commonwealth receives an annual precipitation of 40 inches a year, the Shenandoah Valley receives an average of about 33-36 inches a year. The Blue Ridge Mountains on the eastern side of the Valley averaged 46-58 inches (*Climatesource.com*). Precipitation averaged more than 52 inches with a maximum area above 64 inches on the western sides and peaks of the Appalachian and Allegheny Mountains in West Virginia.

TABLE 4.1: Seasonal Regional Average Climatic Norms Regional Average Climatic Normals (1971–2000) by Season

	Winter	Spring	Summer	Fall	Annual
Total Precipitation (Inches)	7.80	10.03	10.74	10.01	38.58
Average Daily Maximum Temperature (°F)	44.5	65.0	84.8	67.6	65.5
Average Daily Minimum Temperature (°F)	23.3	40.0	60.5	42.7	41.7
Average Daily Mean Temperature (°F)	33.9	52.5	72.7	55.2	53.6

4.2: Local Climate Facts for each weather station from 1971 to 2000

Station Climatic Normals (1971–2000) By Month			
Total Precipitation (Inches)			
Station Name	**County**	**Elev. (Ft.)**	**Annual**
BERRYVILLE	Clarke	600	38.27
LURAY 5 E	Page	1400	41.61
WINCHESTER 7 SE	Frederick	680	39.10
WINCHESTER WINC	Frederick	720	36.40
WOODSTOCK 2 NE	Shenandoah	680	37.52
			38.58
Average Daily Maximum Temperature (°F)			
Station Name	**County**	**Elev. (Ft.)**	**Annual**
BERRYVILLE	Clarke	600	64.5
LURAY 5 E	Page	1400	68.7
WINCHESTER 7 SE	Frederick	680	63.2
WINCHESTER WINC	Frederick	720	65.2
WOODSTOCK 2 NE	Shenandoah	680	65.8
			65.48
Average Daily Minimum Temperature (°F)			
Station Name	County	Elev. (Ft.)	Annual
BERRYVILLE	Clarke	600	42.2
LURAY 5 E	Page	1400	41.0
WINCHESTER 7 SE	Frederick	680	43.6
WINCHESTER WINC	Frederick	720	40.8
WOODSTOCK 2 NE	Shenandoah	680	40.7
			41.66

4.1.1 Detailed Resource Characteristics

A description of existing environmental conditions is included that may possibly affect in-stream and groundwater uses as well those conditions that may potentially impact the quality and or quantity of supply sources currently serving the planning area.

4.2 State or Federal Listed Threatened or Endangered Species or Habitats of Concern

Two state agencies are responsible for listing the threatened and endangered species: the Virginia Department of Conservation and Recreation (DCR) maintains the plants and insects in the region and Virginia Department of Game and Inland Fisheries (VDGIF) maintains the animals listed. The U.S. Department of Agriculture and U.S. Fish & Wildlife Service identify federally protected species which are also on the state lists. The entire list of aquatic species or those associated with riverine ecosystems found to inhabit identified from VDGIF to occur within the region is appendicized to this Plan.

The Tiers are defined as:

Tier	Degree of Conservation Need	Description
1	Critical Conservation Need	Faces an extremely high risk of extinction or extirpation. Populations of these species are at critically low levels, facing immediate threat(s), or occur within an extremely limited range. Intense and immediate management action is needed.
2	Very High Conservation Need	Has a high risk of extinction or extirpation. Populations of these species are at very low levels, facing real threat(s), or occur within a very limited distribution. Immediate management is needed for stabilization and recovery.
3	High Conservation Need	Extinction or extirpation is possible. Populations of these species are in decline or have declined to low levels or are in a restricted range. Management action is needed to stabilize or increase populations.
4	Moderate Conservation Need	The species may be rare in parts of its range, particularly on the periphery. Populations of these species have demonstrated a significant declining trend or one is suspected which, if continued, is likely to qualify this species for a higher tier in the foreseeable future. Long-term planning is necessary to stabilize or increase populations.

According to the code of Virginia "Special concern" means any species, on a list maintained by the VDGIF director, which is restricted in distribution, uncommon, ecologically specialized or threatened by other imminent factors.

4.3 Anadromous Fish, Trout, and Other Significant Fisheries

There are no anadromous fish present within the planning region; however, the migratory catadromous American eel is present. Game fish occur abundantly throughout the South Fork, North Fork, and mainstem of the Shenandoah River and many of their tributaries. The following game fish are actively sought through sport fishing during the seasons spring through fall: Rock bass, Smallmouth bass, Largemouth bass, Green sunfish, Bluegill sunfish, Redbreast sunfish, and Pumpkinseed. In addition, trout are native and others are stocked in the mainstem, North Fork, and South Fork of the Shenandoah River. Rainbow trout occurs in the mainstem, North Fork, and South Forks of the Shenandoah River. The South Fork and North also have Brook trout and Brown trout. The Fisheries Division of VDGIF has identified all of the reaches in this region as wild (Class I-IV) or stockable (Class V and VI) trout streams or as tributaries

to wild trout streams. Local canoe and camping shops advertise periodic trout fishing events. Annual fly fishing tournaments hosted in Page, Shenandoah and Warren Counties on tributaries to the Shenandoah draw local and visiting sportsman.

The predominant fishes within the South Fork, North Fork, and mainstem of the Shenandoah River identified by the Virginia Polytechnic and State University are listed below: (http://www.cnr.vt.edu/PLT/potomacshenandoah/aquaticinsects/fishoftheshenandoahriver.htm)

- **Mainstem of the Shenandoah River:**

American eel
Banded killifish
Margined madtom
Channel catfish
Yellow bullhead
Brown bullhead
Rainbow trout
Common carp
Central stoneroller
Cutlips minnow
Bluntnose minnow
Pearl dace
Longnose dace
Blacknose dace
Bluehead chub
Creek chub
River chub
Fallfish
Spotfin shiner
Common shiner
Rosyface shiner
Comely shiner
Spottail shiner
Swallowtail shiner
Northern hogsucker
Shorthead redhorse
Mottled sculpin
Fantail darter
Tessellated darter
Rock bass
Smallmouth bass
Largemouth bass
Green sunfish
Bluegill sunfish
Redbreast sunfish
Pumpkinseed

- **South Fork of the Shenandoah River:** All species present in the mainstem of the Shenandoah River (listed above) plus Brook trout, Brown trout, Satinfin shiner, and White sucker.
- **North Fork of the Shenandoah River:** All species present in the mainstem of the Shenandoah River (listed above) plus Brook trout, Brown trout, Satinfin shiner, White sucker, Fathead minnow, and Greenside darter.

4.4 State Scenic River segments and Significant Recreational Rivers

Throughout the Shenandoah watershed, opportunities are ubiquitous for canoeing, kayaking, and whitewater rafting through rentals, guided tours, and general recreation.

The Virginia DCR administers the Wild and Scenic River Program. In June 2009 the DCR issued a list of 24 scenic river designations in Virginia. One reach of the Shenandoah River in the planning area is legislatively designated as a Virginia Scenic River. The Shenandoah River 21.6 mile section from the Warren/Clarke County line to the state border between West Virginia and Virginia State is designated as scenic under legislation 21.6 §10.1-417. This section of the river was originally designated in 1979, and extended in 1992. The DCR has identified two

river segments in our planning region as “Desirable components: evaluated and found worthy of designation” as a Scenic River in Virginia (http://www.dcr.virginia.gov/recreational_planning/documents/srmap.pdf). These two segments include the North Fork in Shenandoah County from Burnshire Bridge (Route 758) to the town of Strasburg and in Page/Warren Counties the segment of the South Fork of the Shenandoah River from Goodes Mill to Overall. Five segments of the Shenandoah River located in the planning region were determined by DCR to contain “Potential Components: Identified as being worthy of future study” for consideration as a Scenic River. These potentially suitable scenic segments include: North Fork of the Shenandoah River from New Market to Burnshire Bridge; Cedar Creek headwaters to its confluence with the North Fork; North Fork Shenandoah River from its confluence with Cedar Creek to the town of Front Royal; South Fork of the Shenandoah River from Port Republic (upstream of the planning region) to Goodes Mill; and South Fork Shenandoah from Overall to the town of Front Royal.

In order for a river be declared a National Wild and Scenic River, it takes an act of Congress. There are no river segments in the planning area designated as National Wild and Scenic.

Historic and Archaeological Resources

Huntsberry Farm Project (Shenandoah Valley Battlefields Foundation) is the largest historical site within the planning region. Smaller archeologically and historically significant areas and districts are within the Towns and the City of Winchester. A complete listing of archeologically and historically significant areas is appended (pending).

Geologic Formations

The area of the Shenandoah Valley was once under the ocean over 450 million years ago. The bones of the fish and shells, rich in calcium, settled to the bottom of the ocean. Over time, these calcium-rich deposits formed rocks under the pressure of the water above creating dolomite and limestone sedimentary layers. Eventually the ocean receded and the mountains were thrust up, approximately 300 million years ago. The mountains eroded from water and weather and the streams drained into what is known as the Shenandoah River, carving the valley. The resultant soils and rock formations on the Valley floor and along mountain sides contain much of the limestone and dolomite. As water from runoff and precipitation contacts the limestone and dolomite, a chemical reaction occurs and the rock dissolves, creating a karst landscape. Karst is a landform feature created from the dissolved rocks that can take the form of caves, caverns, sinkholes, seeps, springs, and ponures. These karst features are ubiquitous throughout the planning area. Karst landscapes have a direct and rapid interconnection with the surface. Land use activities in karst areas have immediate impacts on water quality.

Another unique feature of the Valley is the fertile, well draining soils. The area is ranked high in the state for agriculture. The fertile Valley soils make Shenandoah Valley the “breadbasket” of Virginia.

It is important to note that a section of Clarke County has a sole source aquifer designation. The EPA defines a sole or principal source aquifer as one which supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. EPA guidelines also stipulate that these areas can have no alternative drinking water source(s) which could physically, legally, and economically supply all those who depend upon the aquifer for

drinking water. For convenience, all designated sole or principal source aquifers are usually referred to simply as "sole source aquifers."

4.5 Wetlands

Palustrine forested, scrub-shrub, and emergent wetlands constitute the wetland types within the planning area. The U.S. Fish & Wildlife Service's National Wetland Inventory (NWI) Map layer was reviewed as layer using a geographical information system. The overall wetland estimates from the NWI maps are presented below. In general, the National Wetland Inventory estimated wetlands are considered to be an underestimate of wetland acreages. In order to accurately assess wetland acreage, an ecological field investigation and aerial photographic interpretation should be conducted.

Deleted:

Locality	Locality Size (Sq Mi)	Locality Size (Ac)	Wetland Acreage (Estimated from NWI maps)
Clarke County	178	113,920	4,086
Frederick County	416	266,240	1,914
Page County	314	200,960	22,550
Shenandoah County	513	328,320	8,693
Warren County	216	138,240	9,736
Winchester City	9	5,952	12

Page County has the highest percentage of land in wetlands, with over 11% of the total land area in wetlands. Over 7 % of the total land in Warren County is wetlands and more than 3.5% of Clarke County's total land is in wetlands. In Shenandoah County just over 2.6% of the land area is wetland. Less than one percent of the land area in both Frederick County and the City of Winchester is wetlands

Wetlands are vital for sustaining populations of fish and wildlife in the United States. They provide habitat for approximately one-third of federally-listed plants and animals, and nesting, migratory and wintering areas for more than 50 percent of the Nation's migratory bird species. Wetlands play an important role in water quality improvement by nutrient removal. Wetland plants filter and trap sediments, thereby improving water quality. Wetlands also have an important role in improving water quantity, such as flood control. Groundwater fed streams in the area are replenished and a wall of floodwater can be soaked up by wetland ecosystems if present along riverbeds.

4.6 Riparian Buffers and Conservation Easements

The Virginia Department of Forestry has some riparian buffers located within the planning area *(see http://www.dof.virginia.gov/regCentral/she-wq-rfb.shtml)*. In addition, the Natural Resources Conservation Service (NRCS) Soil and Water Conservation District (SWCD), has worked with localities to plant vegetated buffers through the Conservation Reserve Program (CRP), the Environmental Quality Incentives Program, and the state's cost-share program to increase riparian corridors.

A conservation easement is a legal agreement between a landowner and a government agency or non-profit conservation organization that places permanent limits on the future development of the property in order to protect the land. While often donated by landowners, the County then has the opportunity through state grant funding, to purchase one or more conservation easements from local landowners. Landowners who establish a conservation easement permanently protect their land while retaining ownership and enjoyment of the property. Landowners do not have to grant public access to conserved properties, and most conserved properties are actively used for farming or as forestland. The establishment of conservation easements through the DCR, state conservation board / agency, or a local land trust such as the Virginia Department of Forestry, Virginia Outdoor Foundation, Virginia Land Conservation Foundation Valley Conservation Council, Potomac Conservancy, or Chesapeake Bay Foundation assist in acquiring easements for localities and private landowners. Land owners can elect to place an easement on riparian areas without any incentive except for a federal income tax deduction and local tax incentives. The land trust agency holds the easement.

Land protected either as a buffer or in an easement preserves habitats of ecosystems, provides connectively for migrations, affords open space, provides livestock management and improves water quality. Estimates of preserved land, by acres, for each county within the planning area are presented below.

- Clarke County - 3068 acres
- Frederick County - over 5,469 acres
- Page County - 1,230 acres
- Shenandoah County - 1,625 acres
- Warren County - over 5,034 acres

4.7 Land Use and Land Cover

The Shenandoah River drains 1,957,690 acres of land. The watershed can be broken down into several land-uses. Forest and agricultural lands make-up roughly 1,800,000 acres of watershed. The maximum elevation within the watershed is 3,350 feet mean sea level. The minimum elevation is 300 feet mean sea level and occurs at the confluence with the Potomac River. The Shenandoah River basin is composed of three sub basins (8-digit United States Geologic Survey (USGS) Hydrologic Unit Codes (HUC)). The three sub basins are the South Fork of the Shenandoah River (HUC 02070005), North Fork of the Shenandoah River (HUC 02070006), and the Shenandoah River (HUC 02070007).

The data for this section is presented in the table below, based on Comprehensive Plans. It should be noted that the land use classifications are specific to each jurisdiction, and not necessarily transferrable.

Locality	Sq. miles	Acres
Frederick County	414.6	265,360.70
Winchester City	9.3	5,974.00

Clarke County	176.6	113,034.50
Warren County	213.7	136,766.70
Shenandoah County	512.2	327,811.10
Page County	311.1	199,120.00
Total NSV Region:	1,637.60	1,048,067.20
Fed/State land	250	160,000
Clarke County Land Use:		
LAND_USE	**SqMiles**	**Sum_ACRES**
Developed	12.95	8288
Crop	36.6	23424
Edge	10.1	6464
Managed Natural	3.66	2342.4
Pasture	51	32640
Wooded	61.6	39424
Frederick County Land Use:		
LAND_USE	**SqMiles**	**Sum_ACRES**
Business	7.11	4553.37
Highway Commercial	0.17	105.63
Historic	2.88	1840.59
Industrial	10.60	6783.46
Institutional	0.47	301.67
Mixed-Use	1.16	745.29
Mobile Home Community	0.15	92.87
Mixed-Use Age Restricted	0.04	23.28
Mixed-Use Commercial Office	0.24	150.45
Mixed-Use Industrial Office	0.24	152.13
Neighborhood Village	0.18	114.78
Natural Resources & Recreation	2.00	1282.74
Open Space	0.03	16.12
Planned Unit Development	2.97	1899.99
Recreation	0.56	356.58
Residential	14.48	9267.65
Urban Center	0.76	485.78
Residential	14.5553	9315.41
Urban Center	0.75827	485.29
Agricultural	371.955	238051

Winchester Land Use:	**Sq Miles**	**Sum_ACRES**
High Residential	0.584	373.76
Medium Residential	1.4	896
Low Residential	1.5	960
Heavy Industrial	0.12	76.8
Light Industrial	1.1	704
Major Commercial	1.14	729.6
Major Institutional	0.49	313.6
Park/Open	0.62	396.8
Public	0.33	211.2
Residential/Office	0.15	96
Special Mix-Use	0.114	72.96
Page County Land Use:		
LAND_USE	**SqMiles**	**Sum_ACRES**
Primary Community	3.21669	2,058.68
Secondary Community	8.72842	5,586.19
Towns	8.47256	5,422.44
Agricultural	144.186	92,279
Environmental Protection	111.863	71,592
Shenandoah Land Use:		
LAND_USE	**SqMiles**	**Sum_ACRES**
Residential	97.56	62,440
Commercial (mixed uses)	8.96	5,740
Industrial	1.9	1,220
Agricultural (cropland, etc.)	150.97	96,623
Open Space (wooded, barren, state and national parks, etc.)	269.82	172,687
Major Institutional	1.91	1,223
Warren County Land Use:		
LAND_USE	**SqMiles**	**Sum_ACRES**
Residential	18.49	11,836
Commercial (mixed uses) & Industrial	3.6	2,306
Agricultural (cropland, etc.)	140.22	89,744
Open Space (wooded, barren,	34.41	22,024

state and national parks, etc.)		

4.8 Impaired Streams

Two legacy contaminants are in the Shenandoah River: mercury and Polychlorinated biphenols (PCBs). This background section summaries the history of how mercury and PCBs were introduced into the river. A listing of all TMDL stream segments follows.

History:

PCB Contamination:

PCBs are one of two legacy contaminants threatening the quality of the Shenandoah River. PCBs consist of 209 chemical compounds (congeners) that were sold under various trade names. PCBs accumulate in the fatty tissue and are considered highly toxic probable carcinogens. PCBs were outlawed in the 1970s in the U.S.

Avtex Fibers rayon plant (manufacturing site on 440-acres in Front Royal), was a source of leaking PCBs into the Shenandoah River. After manufacturing rayon, polyester, and polypropylene fibers for commercial, defense, and space industries for more than 45 years, Avtex Fibers (and previous owners) closed in 1989. In June 1986, Avtex was designated a Superfund site on U.S. EPA's National Priorities List. Per EPA's fact sheet:

> *The contamination discovered at the Avtex Fibers site was of such magnitude and complexity that the area has been the subject of a number of removal, enforcement, and long-term cleanup actions. Tons of rayon manufacturing wastes and by-products, zinc hydroxide sludge, and fly ash and boiler room solids were disposed of on site in 23 impoundments and fill areas encompassing 220 acres. Waste disposal practices at the plant contaminated the groundwater under the site and in residential wells across the river from the site. The principle contaminants found in the groundwater were carbon disulfide, ammonia, arsenic, antimony, phenol and high pH. Arsenic, lead, and PCBs have been found in soils. PCBs associated with the plant were detected in the Shenandoah River. When the plant closed in 1989, the community was left to contend with severely contaminated land and water.*

Currently, the former Avtex site has undergone extensive remediation; however, the legacy of PCBs remains as a contaminant in the river. Avtex site was one of ten sites selected by EPA as a pilot Superfund Redevelopment Initiative with the goal of returning the site to productive use.

In 1989, Virginia issued a "do not eat" advisory for all species of fish in the mainstem Shenandoah River and portions of the North and South Forks of the Shenandoah. Because of this fish consumption advisory, the Shenandoah River was listed on both Virginia's and West Virginia's 1998 Section 303(d) lists of TMDL streams. The river is listed for other impairments as well. Two segments of the Shenandoah River measuring approximately 42 stream miles in length were listed on Virginia's Section 303(d) list. The first segment, the North Fork of the Shenandoah River running from Passage Creek to its influence with the South Fork of the Shenandoah River, measures 5.33 miles in length. The second segment, composed of the South Fork of the Shenandoah River and the mainstem of the Shenandoah River, measures 36.45 miles in length. A third segment of the Shenandoah River was listed on West Virginia's 1998 Section 303 (d) list.

Mercury Contamination:

In addition to PCBs, the second legacy contaminant threatening water quality is mercury. From 1929 to 1950, a DuPont textile plant, located in the headwaters of the South Fork in Waynesboro, discharged mercury waste into the South River. Mercury subsequently contaminated the South Fork of the Shenandoah River, the mainstem of the Shenandoah River, and the floodplains along the three rivers. A 2009 USGS study of mercury contamination revealed that 96 percent of the mercury loads to the South River come from soil contaminated by this textile plant, are continuing to contaminate several Shenandoah Valley rivers at a rate of "about 416 pounds of mercury / year" into the South River (USGS, Eggleston, 2009).

TMDL Stream Segments:

The following list provides a summary of each TMDL stream segment within the planning region and the cause(s) of impairment, river miles, and location.

South Fork Shenandoah River
Location: South Fork Shenandoah River from its confluence with North and South Rivers downstream to its confluence with Hawksbill Creek. (Start Mile: 100.97 End Mile: 41.98 Total Impaired Size: 58.99 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli
Impairment = Benthics on South Fork Shenandoah River from its confluence with North and South Rivers downstream to its confluence with Hawksbill Creek. (Start Mile: 100.97 End Mile: 41.98 Total Impaired Size: 58.99 Miles)

Naked Creek (In process of getting delisted due to natural causes of impairment, mountainside sloughing)
Location: Naked Creek including the East Branch from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 12.44 End Mile: 0.00 Total Impaired Size: 12.44 Miles)
City / County in Planning Area: Page Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Cub Run
Location: Cub Run originating on the east side of the Massanutten Mountain from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 9.62 End Mile: 0.00 Total Impaired Size: 9.62 Miles)
City / County in Planning Area: Page Co
Impairment = Escherichia coli

Line Run
Location: Line Run from the headwaters downstream to its confluence with Honey Run. (Start Mile: 3.9 End Mile: 0.00 Total Impaired Size: 3.9 Miles)
City / County in Planning Area: Page Co.

Impairment = Escherichia coli

Honey Run

Location: Honey Run from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 4.53 End Mile: 0.00 Total Impaired Size: 4.53 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli

Mill Creek

Location: Mill Creek from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 6.74 End Mile: 0.00 Total Impaired Size: 6.74 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli

Big Run

Location: Big Run from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 5.4 End Mile: 0.00 Total Impaired Size: 5.4 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli

Lake Arrowhead (No TMDL – due to natural conditions of lake stratification)

Location: Lake Arrowhead (Total Impaired Size: 36.07 Acres)
City / County in Planning Area: Page Co.
Impairment = Oxygen, Dissolved

Pass Run

Location: Pass Run from the headwaters downstream to its confluence with Hawksbill Creek. (Start Mile: 9.07 End Mile: 0.00 Total Impaired Size: 9.07 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli

Hawksbill Creek

Location: Hawksbill Creek from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 19.23 End Mile: 0.00 Total Impaired Size: 19.23 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli
12 miles – temperature impairment

East Hawksbill Creek

Location: East Hawksbill Creek from the headwaters downstream to its confluence with Hawksbill Creek. (Start Mile: 9.13 End Mile: 0.00 Total Impaired Size: 9.13 Miles)

City / County in Planning Area: Page Co.
Impairment = Escherichia coli, Benthic-Macroinvertebrate Bioassessments

Rocky Branch
Location: Rocky Branch from the headwaters downstream to its confluence with Pass Run. (Start Mile: 4.18 End Mile: 0.00 Total Impaired Size: 4.18 Miles)
City / County in Planning Area: Page Co.
Impairment = pH

Jeremys Run
Location: Jeremys Run from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 10.94 End Mile: 0.00 Total Impaired Size: 10.94 Miles)
City / County in Planning Area: Page Co.
Impairment = pH

South River/South Fork Shenandoah River/North Fork Shenandoah River/Shenandoah River
Location: South River from the INVISTA discharge downstream (inclusive of the entire South Fork Shenandoah River and North Fork Shenandoah River from its confluence with Passage Creek downstream to its confluence with the South Fork Shenandoah River) to the Shenandoah River's confluence with Craig Run. (Start Mile: 163.27 End Mile: 8.16 Total Impaired Size: 155.11Miles)
City / County in Planning Area: Page Co., Warren County
Impairment = Mercury

South Fork Shenandoah River
Location: South Fork Shenandoah River from its confluence with North and South Rivers downstream to its confluence with Hawksbill Creek. (Start Mile: 100.97 End Mile: 41.98 Total Impaired Size: 58.99 Miles)
City / County in Planning Area: Page Co.
Impairment = Escherichia coli
Location: South Fork Shenandoah River from its confluence with North and South Rivers downstream to its confluence with Hawksbill Creek. (Start Mile: 100.97 End Mile: 41.98 Total Impaired Size: 58.99 Miles)
For Impairment = Benthic-Macroinvertebrate Bioassessments

Cedar Creek
Location: Cedar Creek from its confluence with Fall Run downstream to its confluence with Stickley Run. (Start Mile: 17.87 End Mile: 3.68 Total Impaired Size: 14.19 Miles)
City / County in Planning Area: Frederick Co., Shenandoah Co.
Impairment = Escherichia coli

Crooked Run

Location: Crooked Run excluding the tributary feeding the east arm of Lake Frederick from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 8.87 End Mile: 0.00 Total Impaired Size: 8.87 Miles)
City / County in Planning Area: Frederick Co., Warren Co.
Impairment = Escherichia coli, Dissolved Oxygen

Stephens Run
Location: Stephens Run from an unnamed tributary .95 miles upstream of Crooked Run downstream to its confluence with Crooked Run. (Start Mile: .95 End Mile: 0.00 Total Impaired Size: .95 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Oxygen, Dissolved

Little Isaacs Creek
Location: Little Isaacs Creek from the Timber Ridge School STP downstream (including an unnamed tributary originating near Reynolds Store) to its confluence with Isaacs Creek. (Start Mile: 9.53 End Mile: 0.00 Total Impaired Size: 9.93 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Escherichia coli

Hogue Creek
Location: Hogue Creek from the headwaters downstream to its confluence with Back Creek. (Start Mile: 16.76 End Mile: 0.00 Total Impaired Size: 16.76 Miles)
City / County in Planning Area: Frederick Co.
Impairments = Escherichia coli, Temperature

Babbs Run
Location: Babbs Run from the headwaters downstream to its confluence with Back Creek. (Start Mile: 11.46 End Mile: 0.00 Total Impaired Size: 11.46 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Fecal Coliform

Opequon Creek
Location: Opequon Creek and its tributaries from the headwaters downstream to its confluence with Abrams Creek. (Start Mile: 57.47 End Mile: 32.66 Total Impaired Size: 24.81 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Escherichia coli

Abrams Creek
Location: Abrams Creek from the headwaters downstream to its confluence with Opequon Creek. (Start Mile: 10.8 End Mile: 0.00 Total Impaired Size: 10.8 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Escherichia coli, Benthic-Macroinvertebrate Bioassessments

Opequon Creek
Location: Opequon Creek from its confluence with Abrams Creek downstream to the VA/WV state line. (Start Mile: 32.66 End Mile: 23.56 Total Impaired Size: 9.1Miles)
City / County in Planning Area: Frederick Co.
Impairment = Escherichia coli, Benthic-Macroinvertebrate Bioassessments

Lick Run
Location: Lick Run (also known as Hiatt Run) from its headwaters downstream to its confluence with Opequon Creek. (Start Mile: 8.85 End Mile: 0.00 Total Impaired Size: 8.85 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Escherichia coli

Redbud Run
Location: Redbud Run and tributary from the headwaters downstream to its confluence with Opequon Creek. (Start Mile: 8.05 End Mile: 0.00 Total Impaired Size: 8.05 Miles)
City / County in Planning Area: Frederick Co.
Impairments = Escherichia coli, Benthic-Macroinvertebrate Bioassessments

South River/South Fork Shenandoah River/North Fork Shenandoah River/Shenandoah River
Location: South River from the INVISTA discharge downstream (inclusive of the entire South Fork Shenandoah River and North Fork Shenandoah River from its confluence with Passage Creek downstream to its confluence with the South Fork Shenandoah River) to the Shenandoah River's confluence with Craig Run. (Start Mile: 163.27 End Mile: 8.16 Total Impaired Size: 155.11 Miles)
City / County in Planning Area: Page Co., Clarke Co., Warren Co.
Impairment = Mercury

South Fork Shenandoah River/North Fork Shenandoah River/Shenandoah River
Location: South Fork Shenandoah River from the Rivermont Drive Bridge downstream to the VA/WV state line on the Shenandoah River (inclusive of the North Fork Shenandoah River from its confluence with Passage Creek downstream to its confluence with the South Fork Shenandoah River). (Start Mile: 51.10 End Mile: 0.00 Total Impaired Size: 51.10 Miles)
City / County in Planning Area: Clarke Co. Warren Co.
Impairment = PCB

Happy Creek
Location: Happy Creek from the headwaters downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 8.42 End Mile: 0.00 Total Impaired Size: 8.42 Miles)
City / County in Planning Area: Warren Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Holmans Creek
Location: Holmans Creek from the headwaters downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 10.42 End Mile: 0.00 Total Impaired Size: 10.42 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Escherichia coli, Benthic-Macroinvertebrate

North Fork Shenandoah River
Location: North Fork Shenandoah River from its confluence with Turley Creek downstream to its confluence with Stony Creek. (Start Mile: 92.61 End Mile: 60.75 Total Impaired Size: 31.86 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Escherichia coli, Benthic-Macroinvertebrate

Mountain Run/Smith Creek/War Branch
Location: Mountain Run from the headwaters downstream to its confluence with Smith Creek; Smith Creek from the headwaters downstream to its confluence with the North Fork Shenandoah River; War Branch from the headwaters downstream to its confluence with Smith Creek. (Start Mile: 5.98, 33.83, 6.81 End Mile: 0.00, 0.00, 0.00 Total Impaired Size: 5.98 Miles, 33.83 Miles, 6.81 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Escherichia coli

Smith Creek
Location: Smith Creek from the Shenandoah Fisheries outfall downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 25.19 End Mile: 0.00 Total Impaired Size: 25.19 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Mill Creek
Location: Mill Creek from the headwaters downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 15 End Mile: 0.00 Total Impaired Size: 15 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Fecal Coliform, Benthic-Macroinvertebrate Bioassessments

Crooked Run
Location: Crooked Run from the headwaters downstream to its confluence with Mill Creek. (Start Mile: 3.89 End Mile: 0.00 Total Impaired Size: 3.89 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Stoney Creek

Location: Stony Creek from its confluence with Foltz Creek downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 17.04 End Mile: 0.00 Total Impaired Size: 17.04 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Escherichia coli

Impairment = Benthic-Macroinvertebrate Bioassessments - Stony Creek from the Georges Chicken discharge downstream to its confluence with the North Fork Shenandoah River.
(Start Mile: 5.76 End Mile: 0.00 Total Impaired Size: 5.76 Miles)

Laurel Run
Location: Laurel Run from its confluence with an unnamed tributary near USFS Road 252 downstream to its confluence with Stony Creek. (Start Mile: 3.72 End Mile: 0.00 Total Impaired Size: 3.72 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Little Stony Creek
Location: Little Stony Creek from the headwaters downstream to its confluence with an unnamed tributary near USFS Road 92. (Start Mile: 3.24 End Mile: 0.00 Total Impaired Size: 3.24 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Stony Creek
Location: Stony Creek from the headwaters downstream to its confluence with Foltz Creek. (Start Mile: 26.49 End Mile: 17.04 Total Impaired Size: 9.45 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Temperature

Toms Brook
Location: Toms Brook from the headwaters downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 7.18 End Mile: 0.00 Total Impaired Size: 7.18 Miles)
City / County in Planning Area: Shenandoah Co.
Impairments = Benthic-Macroinvertebrate Bioassessments

Narrow Passage Creek
Location: Narrow Passage Creek from the headwaters downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 10.75 End Mile: 0.00 Total Impaired Size: 10.75 Miles)
City / County in Planning Area: Shenandoah Co.
Impairments = Escherichia coli

Pughs Run

Location: Pughs Run from the headwaters downstream to its confluence with the North Fork Shenandoah River. (Start Mile: 5.86 End Mile: 0.00 Total Impaired Size: 5.86 Miles)
City / County in Planning Area: Shenandoah Co.
Impairments = Escherichia coli

Tumbling Run
Location: Tumbling Run from the headwaters downstream to the 5 mile upper limit of the PWS designation for the Strasburg Public Water Intake. (Start Mile: 5.05 End Mile: .9 Total Impaired Size: 4.15 Miles)
City / County in Planning Area: Shenandoah Co.
Impairments = Escherichia coli

North Fork Shenandoah River
Location: North Fork Shenandoah River from its confluence with Passage Creek downstream to its confluence with the South Fork Shenandoah River. (Start Mile: 5.29 End Mile: 0.00 Total Impaired Size: 5.29 Miles)
City / County in Planning Area: Warren Co.
Impairment = Escherichia coli

Orndorff Spring Branch
Location: Orndorff Spring Branch from the spring downstream to its confluence with Cedar Creek. (Start Mile: .23 End Mile: 0.00 Total Impaired Size: .23 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Cedar Creek
Location: Cedar Creek from the headwaters downstream to a spring branch near Van Buren Furnace (Start Mile 21.07 End Mile 18.54 Total Impaired Area: 2.53 Miles)
City / County in Planning Area: Shenandoah Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Cedar Creek
Location: Cedar Creek from its confluence with Fall Run downstream to its confluence with Stickley Run. (Start Mile: 17.87 End Mile:3.68 Total Impaired Size: 14.19 Miles)
City / County in Planning Area: Frederick Co. Shenandoah Co.
Impairment = Escherichia coli

Passage Creek
Location: Passage Creek from its confluence with Peters Mill Run downstream to its confluence with the North Fork Shenandoah River. (Start Mile:18.47 End Mile: 0.00 Total Impaired Size: 18.47 Miles)
City / County in Planning Area: Shenandoah Co.
Shenandoah Co. Warren Co.
Impairment = Escherichia coli

Manassas Run
Location: Manassas Run from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 9.15 End Mile: 0.00 Total Impaired Size: 9.15 Miles)
City / County in Planning Area: Warren Co.
Impairment = Fecal Coliform

Borden Marsh Run
Location: Borden Marsh Run and tributaries from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 9.46 End Mile: 0.00 Total Impaired Size: 9.46 Miles)
City / County in Planning Area: Clarke Co., Warren Co.
Impairment = Escherichia coli

Willow Brook
Location: Willow Brook from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 3.95 End Mile: 0.00 Total Impaired Size: 3.95 Miles)
City / County in Planning Area: Warren Co.
Impairment = Escherichia coli

Crooked Run
Location: Crooked Run excluding the tributary feeding the east arm of Lake Frederick from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 8.87 End Mile: 0.00 Total Impaired Size: 8.87 Miles)
City / County in Planning Area: Frederick Co., Warren Co.
Impairment = Escherichia coli

Crooked Run
Location: Crooked Run excluding the tributary feeding the east arm of Lake Frederick from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 8.87 End Mile: 0.00 Total Impaired Size: 8.87 Miles)
City / County in Planning Area: Frederick Co., Warren Co.
Impairment = Oxygen, Dissolved

Stephens Run
Location: Stephens Run from an unnamed tributary .95 miles upstream of Crooked Run downstream to its confluence with Crooked Run. (Start Mile: .95 End Mile: 0.00 Total Impaired Size: .95 Miles)
City / County in Planning Area: Frederick Co.
Impairment = Oxygen, Dissolved

Crooked Run X-trib

Location: Crooked Run X-trib from the headwaters downstream to its confluence with Crooked Run. (Start Mile: .09 End Mile: 0.00 Total Impaired Size: .09 Miles)
City / County in Planning Area: Warren Co.
Impairment = Oxygen, Dissolved

Page Brook Run/Spout Run
Location: Page Brook Run from the headwaters downstream to its confluence with Roseville Run; Spout Run from its confluence with Page Brook Run downstream to its confluence with the Shenandoah River. (Start Mile: 8.78, 3.70 End Mile: 0.00, 0.00 Total Impaired Size: 8.78 Miles, 3.70 Miles)
City / County in Planning Area: Clarke Co.
Impairment = Fecal Coliform

Spout Run
Location: Spout Run from its confluence with Page Brook Run downstream to its confluence with the Shenandoah River. (Start Mile: 3.70 End Mile: 0.00 Total Impaired Size: 3.70 Miles)
City / County in Planning Area: Clarke Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Long Branch
Location: Long Branch from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 3.63 End Mile: 0.00 Total Impaired Size: 3.63 Miles)
City / County in Planning Area: Clarke Co.
Impairment = Escherichia coli

Chapel Run
Location: Chapel Run and tributaries from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 9.44 End Mile: 0.00 Total Impaired Size: 9.44 Miles)
City / County in Planning Area: Clarke Co.
Impairment = Escherichia coli

Chapel Run
Location: Chapel Run and tributaries from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 9.44 End Mile: 0.00 Total Impaired Size: 9.44 Miles)
City / County in Planning Area: Clarke Co.
Impairment = Benthic-Macroinvertebrate Bioassessments

Dog Run
Location: Dog Run from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 4.80 End Mile: 0.00 Total Impaired Size: 4.80 Miles)
City / County in Planning Area: Clarke Co.
Impairment = Escherichia coli

Wheat Spring Branch

Location: Wheat Spring Branch from the headwaters downstream to its confluence with the Shenandoah River. (Start Mile: 4.31 End Mile: 0.00 Total Impaired Size: 4.31 Miles)

City / County in Planning Area: Clarke Co.

Impairment = Escherichia coli

Reference – State Water Control Board

http://townhall.virginia.gov/L/GetFile.cfm?File=E:\townhall\docroot\103\1593\2876\Text_DEQ_2876_v2.pdf

4.9 Point Source Discharges

Significant point sources of discharges into the Shenandoah River include permitted activities through the DEQ Virginia Pollutant Discharge Elimination System (VPDES) permit program and the three sanitary landfills located in planning area. The landfills are located in Page County (serving Page and Warren Counties), Frederick County (serving Frederick and Clarke Counties and the City of Winchester), and Shenandoah County. DEQ maintains a list of all "major" dischargers, a distinction based on discharge quantity and content.

DEQ administers the VPDES permit program, under the State Water Control Law 9 VAC 25-31 as mandated by Section 402 of the Clean Water Act. Other point source discharges are administered through the EPA's Phase 1 (11/16/90) and Phase 2 (12/8/99) storm water regulations, and pending Virginia stormwater regulations to be managed by both DCR and the DEQ.

4.10 Potential Threats to Water Quantity and Quality

As stated earlier, the two legacy contaminants in the soils of the Shenandoah River include mercury and PCB contamination. In early December 2009, the U.S. Geological Survey released a report summarizing contaminated riverbank and floodplain soils as the main source of mercury found in fish in several Shenandoah Valley rivers. The study found that 96 percent of the mercury loads to the South River, a tributary of the Shenandoah River's South Fork, are from soil that was contaminated between 1929 and 1950 by a textile manufacturing plant in Waynesboro, Va.

The discharged mercury waste contaminated the South River and eventually the South Fork of the Shenandoah River, the Shenandoah River and the floodplains along all three rivers. In the report, USGS estimates that about 416 pounds of mercury get into the South River annually.

Non-point sources of pollution pose a threat to water quality including urban sprawl and associated runoff. In addition, agriculture, a predominant land use throughout the planning area poses threats to water quality with runoff, livestock in rivers, and use of fertilizers, pesticides, and herbicides. Deforestation is another land use in the area that threatens to adversely impact adjacent streams and their quality of water.

Another potential threat to groundwater quality in the region is significant petro release sites. DEQ maintains a database from data gathered during monitoring of these significant petro release sites. Various remediation measures have been implemented including no action to pump-out abatement with extensive monitoring of plume and substitution of water supplies for potentially contaminated wells surrounding petro release sites. Per DEQ's database, the larger petro release sites in the planning region include:
Page County – Hope Mills Country Store
Clarke County – White Post, south of Boyce (remediated)
Frederick County – Flying J truck stop
Warren County – Northern Virginia 4H Center
Shenandoah County – Shenandoah Caverns Shell; Sheetz 701 Truck Stop; Hamburg Store; Conicville; Borden's Auto Parts; Walker's Cash Grocery; Emmart Oil Bulk Plant; Loves Truck Stop; Wilcohen's Travel Plaza; Holsinger Brother's Exxon; and Holsinger Chevron.

Above ground, and underground storage tanks (ACTs and USTs) listed in DEQ database indicate numerous storage tanks within the planning area. If the integrity of the storage tank is compromised, threats to water quality may result. Proposed development in all counties can adversely impact future water quantity through increased demand. For example, the proposed Cloverbud projects in Page County that include industrial as well as secondary residential infrastructure expansions, may impact water quality and quantity. Efforts will be taken to adhere to state and local regulations during construction and maintenance to minimize impacts posed to the quality of receiving water bodies.

Another threat to water quality is the potential for hydrofracking for natural gas in the planning region. Although the Marcellus shale within the planning area is not as productive in natural gas as areas to the west and south, the proximity to the Tennessee Valley Transmission Main pipeline makes tapping into local gas wells attractive. The Marcellus areas in the Northern Shenandoah Valley are primarily located within the western portion of Frederick and Shenandoah Counties. Permits for exploratory wells have been issued in these two counties but no exploratory drilling has occurred to date. In the event a permit is issued by the Virginia Department of Mines, Mineral and Energy for a natural gas well site, the planning commission will work closely with the locality to develop ordinances to help protect water quality and quantity.

5.0 Projected Water Demand

Future water demand projections were projected for community water sources and small self supplied wells in the Northern Shenandoah Valley planning region based on population forecasts. Future large self supplied users was also estimated and is presented in this section. Disaggregated water use by community system is presented as data was available. It is noted that at the time of preparation of this regional Water Supply Plan, some disaggregated water use data was not available for all jurisdictions and therefore was not presented in this Plan.

5.1 Population Data

The technical water supply advisory committee selected to look at a thirty year planning horizon for the water supply plan. The 2010 U.S. Census data became available for use during the preparation of this Northern Shenandoah Valley Regional Water Supply Plan and were included in the calculations. Therefore, the 30 year planning horizon was estimated from 2010 projections using the most current growth data available to 2040. The population is presented by decades for the region. The 2020 and 2030 County population projections were available from the Virginia Employment Commission data (Weldon Cooper Institute, University of Virginia). For the City of Winchester and five counties of Clarke, Frederick, Page, Shenandoah, and Warren, the future population was calculated using a scatter plot of Census data for each locality for 2000 and 2010, Virginia Employment Commission projection for 2020 and 2030 and a straight line projected out to 2040. The Northern Shenandoah Valley Regional Planning Commission staff met with each County and respective Town(s) and the City of Winchester to best determine projected growth corridors and future population projections to allocate County population growth into the Towns. The projected growth corridors and future service areas were also discussed. The projections in the table below reflect the population projections assessed from discussions with the localities.

NSRVC Water Supply Plan: Population & Projections

	Decennial Census Count					Projected Population*			% County Population		Avg. % of County Population 2000-2010
County/*Town*	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**	**2030**	**2040^**	**2000**	**2010**	
Clarke County	**8,102**	**9,965**	**12,101**	**12,652**	**14,034**	**18,320**	**21,230**	**26,027**			
Berryville				2,963	4,185	4,877	5,651	6,928	23.4%	29.8%	26.6%
Boyce				426	589	693	803	984	3.4%	4.2%	3.8%
Frederick County	**28,893**	**34,150**	**45,723**	**59,209**	**78,305**	**95,648**	**114,539**	**142,853**			
Middletown				1,015	1,265	1,626	1,947	2,428	1.7%	1.6%	1.7%
Stephens City (Town)				1,146	1,829	2,009	2,405	3,000	1.9%	2.3%	2.1%

Page County	**16,581**	**19,401**	**21,690**	**23,177**	**24,042**	**25,659**	**27,038**	**28,539**			
Luray				4,871	4,895	5,311	5,597	5,908	21.0%	20.4%	20.7%
Shenandoah (Town)				1,878	2,373	2,309	2,433	2,568	8.1%	9.9%	9.0%
Stanley				1,326	1,689	1,642	1,730	1,826	5.7%	7.0%	6.4%
Shenandoah County	**22,852**	**27,559**	**31,636**	**35,075**	**41,993**	**49,427**	**56,927**	**66,906**			
Edinburg				813	1,041	1,186	1,366	1,606	2.3%	2.5%	2.4%
Mount Jackson				1,664	1,994	2,323	2,676	3,145	4.7%	4.7%	4.7%
New Market				1,637	2,146	2,422	2,789	3,278	4.7%	5.1%	4.9%
Strasburg				4,017	6,398	7,573	8,963	10,609	11.5%	15.2%	13.4%
Toms Brook				255	258	345	398	468	0.7%	0.6%	0.7%
Woodstock				3,952	5,097	5,783	6,660	7,828	11.3%	12.1%	11.7%
Warren County	**15,301**	**21,200**	**26,142**	**31,584**	**37,575**	**45,722**	**53,092**	**65,143**			
Front Royal (1)				13,589	14,440	16,069	17,543	19,954		20.0%	
Front Royal (2)				13,589	14,440	19,660	22,830	28,011	43.0%	38.4%	40.7%
Winchester (City)	**14,643**	**20,210**	**21,947**	**23,585**	**26,203**	**29,339**	**32,485**	**36,571**			
Region (Total)	**106,372**	**132,485**	**159,239**	**185,282**	**222,152**	**264,115**	**305,311**	**366,039**			

Notes:

*Projected using US Census 1970-2010 and Virginia Employment Commission (2020, 2030) for extrapolated straightline projection from 2000 to 2030

^2040 population estimated using % change 2000 to 2030

Population estimates for Mount Jackson, New Market, Strasburg and Woodstock in Shenandoah County include an additional 20% projected future growth rate increase

Front Royal (1) Assumes 20% of the County population resides within the town

Front Royal (2) assumes trend of average % of county population 2000-2010

5.2 Projected Water Demand

The projected population presented in 5.1, above, forms the basis for the residential water consumption rates. Municipalities served by public and private community water systems were estimated to remain at the same capacity. Future population increases were compared to existing infrastracutre of the public and private community water systems. It should be noted that improvements to existing infrastructure could often increase the yield of water supply available to consumers. As localities upgrade their systems, the northern Shenandoah Valley Regional Water Supply Plan will be revised to include increases in water supplies.

The community water systems that supply each jurisdiction also supply total demand in other water uses in addition to residential consumption. When available, water use was provided in separate disaggregated categories reflecting use and demand in areas of residential, commercial (institutional and light industrial), heavy industrial, water used in production processes, unaccounted for water losses, sales to other community water

systems/localities, and other. In the future, a locality may choose to project the water demand for the nonresidential uses (commercial, light industrial, heavy industrial, production processes, unaccounted for losses, sales, etc.) by applying the annual average percent change in employment from 2000 to 2010 to the current demand for each category.

Peaking factors were evaluated when looking at the projected water demands. When a locality did not provide a peak monthly demand, a peaking factor of 1.5 was assumed.

Self-supplied agricultural users who utilize more than 300,000 gallons of water a month were not reported and not available. Therefore, for the purposes of this Plan, it was assumed that the agriculture in this region will stay the same and is not likely to increase. Estimates of agricultural use were held constant throughout the planning horizon up to 2040. Private, small self-supplied individual users of less than 300,000 gallons per month were those groundwater wells. The population of residents and small businesses estimated to be small self-supplied users of less than 300,000 gallons per month.

The goal of this section of the Plan is to forecast populations and water use to 2040 and identify water deficits or surpluses. Water deficits or surpluses identified herein are preliminary based on best available information to date. It should be noted that the mandated Virginia Code requires this Plan to be reviewed every five years; and updated and resubmitted to Virginia Department of Environmental Quality and the State Water Control Board every ten years. In this review and update process, deficits and surpluses will be revised based on most recent population projections, development patterns, and water conservation actions employed by localities.

Data collection included population projections and employment estimates from Weldon-Cooper, the Virginia Employment Commission, and Virginia Economic Development Partnership. In addition, data for growth and development was compiled from the annual Northern Shenandoah Valley Regional Housing Report, Comprehensive plans, and economic development projections. Where locality-specific information was detailed, it was substituted for the Weldon-Cooper statistical estimates of population. In this section of the Plan, water demand projections are forecasted for a 32 year time horizon to 2040. Population figures extending beyond 2020 is less confident than those forecasts from present to 2010; however, these will be revised during the periodic Plan updates.

Water demands presented per County include three broad categories: community water systems, small Self-Supplied users, and large Self-Supplied (agricultural and nonagricultural) water users. Community water systems include water provided to localities as well as non-municipalities. A public community water system serves at least 15 residential connections or at least 25 individuals. Average daily water use calculations for the community water systems for Clarke and other localities in this report were based on 2008 data presented in 80 B1-B3.

Small Self-Supplied water demand projections are users of less than 300,000 gallons a month. This group of water users is assumed to be primarily groundwater wells and is anticipated to remain static with 2008 data unless further changed by locality comments. All Self-Supplied users and nonmunicipal community water systems were anticipated to remain static. Future water demand was calculated by increasing the residential municipal community water use, increasing a given percent from previous decade, per the Virginia Employment Commission. For example, if the population increased 11.66% between 2020 and 2030; then the 2020 demand was multiplied by 11.66% and added to the 2020 demand to calculate the 2030 demand. This demand estimation process was applied for calculating all localities.

Demand projections for large nonagricultural Self-Supplied water (for both surface water and groundwater sources) are incomplete due to data gaps from some of the large nonagricultural Self-Supplied users reported in Sections 70 and 80 of this Plan, previously submitted to the Northern Shenandoah Valley Regional Commission. The agricultural large Self-Supplied water projections expected to stay static with the 2008 numbers, until additional data is provided to quantify this use.

Employment Data and Analysis

Additional characterization of water use for each locality included evaluation of current and likely future commercial, industrial, and manufacturing large water consumers. According to the Virginia Employment Commission, the top employers in the Northern Shenandoah Valley are listed below. These top employers are anticipated to continue to grow and be top water users throughout the planning period to 2040 (per Virginia Employment Commission).

- Valley Health System
- Wal Mart
- Frederick County School Board
- Food Lion
- VDOT
- Page County School Board
- Marshall's
- Cracker Barrel Old Country Store
- Berryville Graphics
- The Home Depot
- City of Winchester
- U.S. Department of Homeland Defense
- Shenandoah County School Board
- Target Corporation
- Lowes' Home Centers, Inc.
- Warren County School Board
- Winchester City Public Schools
- Postal Service
- Rubbermaid Commercial Products LLC
- George's Chicken
- Shenandoah University
- County of Frederick
- Martin's Food Market

These listed employers provide the largest percentage of employment within the Shenandoah Valley as categorized by industry with many serving in manufacturing, construction, retail trade, educational services, health care and social assistance, and accommodation and food services sectors.

Assumptions:

- Extrapolation of population to 2040 from 2000-2030
- Town water use as a percentage of overall County water use
- Locality projections include recent Comp Plans and developments

- Small Self-Supplied business water use remains static 2008-2040 (golf course)
- Per capita water use is 75 gallons a day for self supplied wells and 125 gpd for public and private community water systems

Population data available through Weldon-Cooper and the Virginia Employment Commission estimate to 2030; therefore, population projections beyond 2030 numbers provided by Weldon-Cooper and Virginia Employment Commission were calculated by extrapolating the slope of the linear population projections from 2000 to 2030 to the outyear of 2040. The second assumption, allocation of County water use to Towns, was based on individual meetings with each County and respective Town(s). Comprehensive Plans and infrastructure needs were reviewed. Jurisdictional populations were allocated to each Town within a County based on assumptions documented during locality meetings. For individual jurisdictions, the population projections vary accordingly based on geographic size and its development with many of the jurisdictions defined as rural with more open spaces and less population density. The third assumption addresses locality projections readjusted to reflect the most recent County Comprehensive Plans addressing planned development and amenities.

An additional assumption was the demand usage of water. It was assumed that the small Self-Supplied business users would remain fixed, such that a golf course in Warren County would not expand in size nor use additional water in the future than what it currently used in 2008. Water per capita quantity was the fifth assumption. Water use was calculated by multiplying water consumption per capita for the population served by the small Self-Supplied water system that includes 75 gpd per person for groundwater (rural demands) and 110 to 125 GPD per person for surface water intakes. Another demand assumption was that town water residences would consume an average of 125 gallons a day, whereas county private well water use would consume 75 gallons a day per person. This consumption estimate corroborates with the U.S. Geological Survey's water consumptive calculations.

City of Winchester

The average daily demand for residents is anticipated to increase 42.4% by 2040 from 1.55 MGD in 2008 to 2.21 MGD in 2040. The commercial / industrial use is expected to increase at a similar rate of 42.4% increasing the demand of 2.2 MGD in 2008 to 3.13 MGD in 2040. The sales of water to Middletown and Frederick County Sanitation Authority are anticipated to remain constant throughout the planning time period to 2040 with 0.2 MGD to Middletown and 1.9 MGD to Frederick County. The unaccounted for water loss of 1.85 MGD is expected to decrease in the future with improvements made to the antiquated distribution system dropping the loss by 10% to 1.67 MGD. The daily total water use in 2008 was 7.70 MGD. The daily water use in 2040 is expected to be 9.11 MGD. The water use by category for Public Community Water Systems is presented in the table below.

	System	Residential	Commercial	Unaccounted	Water Sold

Water System Name	Total (MGD)	(MGD)	Institutional Light Industrial (MGD)	for Losses (MGD)	Amount Sold (MGD)	System Name
2008Winchester City	7.7	1.55	2.20	1.85	2.11	FCSA and Middletown
2040 Winchester City	9.11	2.21	3.13	1.67	2.11	FCSA and Middletown

The City of Winchester has two water sources (river intake and a spring) with a combined maximum capacity of 15 MGD. The future growth scenarios increase the demand to 9.11 MGD. This demand can be met by the existing sources, with an estimated 5.9 MGD surplus in water supply, as presented below. Improvements to water structure will result in additional source increased Virginia Department of Health engineering report). The City anticipates experiencing a 42.4% demand increase between 2008 and 2040 and a 10% decrease in unaccounted for losses based on infrastructure repairs currently planned.

Winchester Supply Source	Maximum Source Capacity (MGD)
NF Shenandoah River	14.00
Faye Spring	1.00
Total Available Capacity	15.00
Estimated Daily Demand - 2040	9.11
Estimated Available Capacity - 2040	15.0

Clarke County, Towns of Berryville and Boyce:

In Clarke County the residential community water systems for municipalities include surface water stream intake on the Shenandoah River mainstem for the Town of Berryville and the Clarke County Sanitation Authority withdrawal from Prospect Hill Spring for the Town of Boyce and some Clarke County. The nonmunicipal residential community water use includes three groundwater well users: Grafton School, the Retreat, and River Park. It is assumed that the nonmunicpal community water systems water use will be static for a total of 151,840 gpd (125,920 gpd for the Retreat and River Park average daily) and maximum daily 25,920 gpd for Grafton - since an average daily withdrawal is not available.

Clarke County's Self-Supplied users for nonagricultural demand in 2008 included the federal commercial sources: Federal Emergency Management Agency and Berryville Graphics. The three large Self-Supplied users that demand water for agriculture include White Post, Ivy Hill, and Moore & Dorsey. Small Self-Supplied users using less than 300,000 gallons a month include residences and small businesses on individual wells. In 2008 this was estimated to be 24 residences in the Town of Berryville (multiplied by factor of 2.28 persons/ household times estimated 75 gpd per capita) and 46 residences in the County of Clarke multiplied by a factor of 2.5 using 75 gpd or 0.0086 MGD. The small businesses in Clarke County using private wells were estimated. All Self-Supplied users and nonmunicipal community water systems

were anticipated to remain static. Future water demand was calculated by increasing the residential municipal community water use, increasing a given percent from previous decade, per the Virginia Employment Commission.

Clarke County			
Community Water Users (CWS)		2008 MGD Avg	2008 MGD Max
Clarke County Sanitation Authority (SW)	Berryville Town	0.383	0.776
Prospect Hill Spring	Boyce Town	0.066	0.157
Nonmunicipal Community Water Users			
Grafton School	(123 people)		0.03
Retreat		0.023	0.069
River Park		0.013	
Total Nonmunicipal Community Water Users			
Small Self-Supplied Users (GW)			
Berryville 24 Residences**	GW	0.004	
Clarke County 46 Residences**	GW	0.009	
Large Self-Supplied Users - NonAg			
Federal Emergency Management Agency	SW	0.072	
Berryville Graphics	GW	0.003	
Large Self-Supplied Users - Ag			
White Post	SW	0.018*	
Ivy Hill	SW	0.035	
Moore & Dorsey	GW	0.0794	
Small businesses	GW	0.017	

Notes

* 2002 only reported water use

** Per Capita consumption = residences X DEQ No. persons/house X 75 gpd

A summary of Clarke County is provided below. It is anticipated that will groundwater wells, sufficient water is available to meet anticipated projected demand for water to 2040.

Clarke County Projected Water Demand

Clarke County Projected Annual Average & Peak Demand

Year	Projected Population	Projected Population on Wells (Minus Service Areas)	Resultant Demand (gpd)	Estimated Annual Average Well Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted System Capacity (MGD)
2008	**13,758**	8556	641700	0.642		0.18
2010	**14,034**	9620	721500	0.722		0.18

2020	**18,320**	12750	956250	0.956		0.18
2030	**21,230**	14776	1108200	1.108		0.18
2040	**26,027**	18115	1358625	1.359		0.18

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

Projected Disaggregated Demand

2008 Disaggregated Water Use Data

Year	Projected Disaggregated Water Demand (MGD)								
	Private CWS (gpd)	Commercial Institutional Light Industrial SSU (gpd)	Heavy Industrial (gpd)	Self Supplied Users (gpd)	Estimated Livestock Use (gpd)	Ag Users (estimated) (gpd)	Unaccounted for Losses (gpd)	Water Sold (gpd)	Total Private Estimated (gpd)
2008	20000	107,000	71500	641700	179,000	114,700			1,133,900
2010	20000	107,000	71500	721500	179,000	114,700			1,213,700
2020	20000	107,000	71500	956250	179,000	114,700			1,448,450
2030	20000	107,000	71500	1108200	179,000	114,700			1,600,400
2040	20000	107,000	71500	1358625	179,000	114,700			1,850,825

To determine the population of Clarke County on individual small self-supplied wells and not serviced with municipal community water systems, the Town populations were subtracted from the County population, or an estimated 12,335 people were determined to get their water from individual wells. Multiplying that estimated population on wells by an average of 75 gallons per day per capita yielded 0.92513 MGD. However, a portion of that population is serviced by nonmunicipal (private) residential community water systems that consumed 0.0136 MGD. Therefore, 0.92513 MGD minus 0.0136 MGD yields 0.91153 MGD of water that is estimated to service the remaining 2008 County population by well water. Clarke County is expected to increase in population by the following rates per decade: 12.19% by 2020, 11.66% by 2030, and 9.91% by 2040. The County estimates of water use for populations not serviced by community water systems are reflected in the demand figures.

In summary, the existing and projected water demand for Clarke County is as follows:

2010	0.9115 MGD
2020	0.9562 MGD
2030	1.1081 MGD
2040	1.3586 MGD

Town of Berryville:

Berryville will meet future projected water needs through 2040 based on uses presented below. However, peak water usage in 2040 exceed the current VDH permitted capacity of water. Therefore, a

new permit would be necessary for increased water withdrawal. In addition, implementation of water conservation techniques will decrease water use by 20% thereby, resulting in future peak days demands to be met by existing sources.

Town of Berryville Projected Water Demand

Town of Berryville Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted Capacity
2008	3,941	100		0.381	0.582	0.864
2010	4,185	100		0.419	0.641	0.864
2020	4,877	100		0.488	0.747	0.864
2030	5,651	100		0.565	0.864	0.864
2040	6,928	100		0.693	1.06	0.864

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.381		100

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.383	0.633	1.65
February	0.383	0.6	1.57
March	0.353	0.517	1.47
April	0.358	0.481	1.34
May	0.375	0.562	1.52
June	0.432	0.607	1.41
July	0.378	0.555	1.47
August	0.396	0.776	1.96
September	0.38	0.542	1.43
October	0.375	0.547	1.46
November	0.359	0.603	1.68
December	0.394	0.569	1.44
Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand	**4.566**	**6.992**	**1.53**

The Town of Berryville disaggregated community water system use is presented in the table below.

Water System Name	System Total (MGD)	Residential (MGD)	Commercial Institutional Light Industrial (MGD)	Heavy industrial (MGD)	Unaccounted for Losses	Production Processes (MGD)

Berryville Town	0.342	0.196	0.089	0.000	0.049	0.015

Town of Boyce:

The existing supplies and permits for water for the Town of Boyce will meet future water demands to 2040 based on water uses projected below. It should be noted that a decrease in per capita usage of 132 gpd/user would also decrease water demand. A peak factor of 1.2 was used to predict water use on peak days. If a peaking rate of 1.5 were used, the peak day water use by 2040 would not be met, although the annual water demand for 2040 would be satisfied.

Town of Boyce Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.2)	VDH Permitted Capacity (MGD)
2008	556	73,275	131.79	0.073	0.088	0.18
2010	589	77625	131.79	0.078	0.094	0.18
2020	693	91330	131.79	0.091	0.109	0.18
2030	803	105827	131.79	0.106	0.127	0.18
2040	984	129681	131.79	0.13	0.156	0.18

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor

Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.073		160

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.079	0.128	1.62
February	0.074	0.099	1.34
March	0.074	0.148	2
April	0.072	0.124	1.72
May	0.073	0.148	2.03
June	0.091	0.141	1.55
July	0.1	0.196	1.96
August	0.111	0.182	1.64
September	0.122	0.224	1.84
October	0.105	0.2	1.9
November	0.081	0.123	1.52
December	0.09	0.169	1.88
Avg 2008 Water Withdrawal Peaking Factor			21

Projected Disaggregated Demand	**1.072**	**1.882**	**21**
2008 Disaggregated Water Use Data	**0.089**	**0.157**	**1.75**

Year	Projected Disaggregated Water Demand (MGD)								
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Water Sold (gpd)	Total (gpd)
2008	0.073								0.073
2010	0.078								0.078
2020	0.091								0.091
2030	0.106								0.106
2040	0.13								0.13

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Frederick County, Towns of Middletown and Stephens City:

In Frederick County there are two towns, both of which purchase water from another locality or entity. The Town of Middletown purchases water from the City of Winchester. The Frederick County Sanitation Authority provides water wholesale to the Town of Stephens City. In addition, Frederick County Sanitation Authority provides water to County residents located in the vicinity near the City of Winchester.

The sources of water distributed by the Sanitation Authority include groundwater well, spring, surface water, quarry water, and purchase from the City of Winchester, all of which is treated by the Sanitation Authority, stored in quarries, and served to residents of the Town of Stephens City and those in Frederick County on public water service. The quarries utilized by the Authority function not only for storage but are also used as a supply source. A summary of 2008 and recent water use for those served by the Frederick County Sanitation Authority is summarized below.

Year	# Connections	Residential Connections	Residential Population (2.25 persons/house)	Residential Water Use (125 gpcd) MGD	Unaccounted losses MGD	Sales (Stephens City) MGD	Avg Annual Use MGD	Other Demands	Demand MGD
2008	13,018	12,518	28,166	**2.15**	0.390	0.140		2.840	5.520
2010	13,520	12,977	29,198	1.850	0.330	0.120	4.430	2.430	4.430

It is interesting to note that the demand for water between 2008 and 2010 decreased. This decrease is consistent with trends noted in the American Water Works Association and is likely reflective of the economy with residents conserving water to lower monthly bills. Estimates of future water demand for those serviced by the Frederick County Sanitation Authority include residential water demand, commercial demand, sales to Stephens City, and unaccounted for losses. Several assumptions were

made including the demand by commercial light industrial users and will remain the same from 2008 through 2040. The quantity of water to be sold to Stephens City will remain the same from 2008 through 2040, and the unaccounted for system losses will remain the same from 2010 through 2040, assuming appliance efficiency and distribution upgrades occur. The projected number of residents to be serviced by the Frederick County Sanitation Authority was assumed to remain proportionate to the overall County population from 2008 and 2010. If the Sanitation Authority service area increases based on the projections below and the assumptions of water loss, sales, and commercial demand remain static, the demands projected through 2040 are as follows.

	County Population	Residents on FCSA	Projected Demand to FSCA (125 gpd/capita) MGD (1)	Unaccounted losses MGD (2)	Sales (Stephens City) MGD	Commercial /Other Demands	Total Estimated Demand
2008	73769	28,166	**2.15**	0.39	0.14	2.84	5.52
2010	78,305	29,198	1.850	0.33	0.12	2.43	4.73
2020	95,648	36,230	4.529	0.33	0.14	2.84	7.83
2030	114,539	43,386	5.423	0.33	0.14	2.84	8.733
2040	142,853	54,111	6.764	0.33	0.14	2.84	10.074

The permitted design capacity for the Frederick County Sanitation Authority quarries is 4.928 MGD. The Bartonsville well site has a capacity of 0.5 MGD totaling 5.42 MGD capacity. The Frederick County Sanitation Authority also purchases up to 2 million gallons a day (MGD) from the City of Winchester. Therefore, a sum total of water available through existing water sources is 7.92 MGD. Given the existing water supply of 7.92 MGD, a deficit of water in Frederick County is anticipated to occur between 2020 and 2030. If the Frederick County Sanitation Authority service area continues to serve the same percent of the County population as it increases over time, there will be a proportional increase in residents served by the Sanitation Authority. However, it should be noted that the Virginia Department of Health recommends that once a locality's water demand exceeds 80% of the source capacity, additional water should be secured. The water demand projected for 2020 is 7.83 MGD which exceeds 80% of the 7.92 source capacity. Therefore, it is recommended that between present time and 2020, Frederick County plan for additional water supplies to meet future demands.

Either the Sanitation Authority will have to expand their water supply capacity and / or the service area will have to remain at or near the number of 2010 residential connections. Or, as population increases in the County, more residences will need to be required to use groundwater wells.

Other water users in Frederick County not serviced by the Sanitation Authority were projected. These demands include those on groundwater wells, private community water systems (i.e., Lake Holiday

Estates), and both agricultural and nonagricultural large self-supplied users of water. These are briefly summarized below:

Private Community Water Systems

The combined nonmunicipal private community water users in Frederick County served over 575 people and used an average of 0.333 MGD based on 80% of the system design capacity. This demand calculation was used since no data are available for actual water consumed. It is assumed that this demand will remain static throughout the planning horizon of 2040.

Groundwater Wells

An estimate of County residents that relies on individual groundwater wells assumed that the Sanitation Authority will remain providing water to an average 2.64% of the overall County population (based on 2008 and 2010 connections). The estimated number of those on groundwater wells was calculated based on the projected County populations minus those estimated to be served by Frederick County Sanitation Authority or those on private community water systems. An estimated 45,028 County residents were not serviced with municipal community water systems in 2008 and obtain their water from individual groundwater wells. It is assumed the average water demand for well users is 75 gallons per day per person. Residents on groundwater were estimated as follows:

	County Population	Residents on FCSA (1)	Residents served by Private CWS	Estimated Residents on Wells
2008	73769	28,166	575	45,028
2010	78,305	29,198	575	48,532
2020	95,648	36,230	575	58,843
2030	114,539	43,386	575	70,578
2040	142,853	54,111	575	88,167

1) Estimated FCSA users as 2.64 % of County residents for 2020-2040

Self-Supplied Users

The large Self-Supplied nonagricultural users' combined water use was 0.147 MGD. Large Self-Supplied agricultural users with a combined demand of 0.043 MGD, where data are available; however, four of the six agricultural Self Supplied Users did not provide water use data in 2002, 2003, or 2008. Five small Self-Supplied businesses that use private water supplies (less than 300,000 gallons / month) met a

business demand of 0.815 MGD. These small Self-Supplied users represent 0.067 MGD consumed in 2008. These demands are anticipated to remain the same throughout the planning period to 2040.

Town of Middletown:

The Town of Middletown is anticipated to use water at the rates projected below. Given those rates, the Town will need to look for sources of water by 2030 to meet the demand that will exceed the existing water purchase contract with the City of Winchester. The existing water contract is capped for Middletown at 0.238 MGD. It should be noted, these preliminary projections of water are based on a per capita water daily demand that exceeds state averages (152 gallons per day). Calculations using state averages of 125 gpd per person would lower the demand. Measures of conservation and other reduction implementation strategies could also significantly reduce the water demand and thereby not necessitate additional water supplies for the future planning period.

Town of Middletown Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted System Capacity (MGD)
2008	1199	152		0.182		Purchase
2010	1,261	152		0.191		Purchase
2020	1,540	152		0.234		
2030	1,844	152		0.280		
2040	2,300	152		0.349		

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.182		151.8

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.169		
February	0.235		
March	0.184		
April	0.177		
May	0.188		
June	0.2		
July	0.218		
August	0.186		

September	0.158
October	0.129
November	0.142
December	0.203

Avg 2008 Water Withdrawal Peaking Factor

Projected Disaggregated Demand

2008 Disaggregated Water Use Data

Year	Projected Disaggregated Water Demand (MGD)								
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Water Sold (gpd)	Total (gpd)
2008	0.182								0.182
2010	0.191								0.191
2020	0.234								0.234
2030	0.280								0.280
2040	0.349								0.349

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of Stephens City:

The Town of Stephens City has water supplied by the Frederick County Sanitation Authority. Based on projections presented below, the Town water use is expected to be met by the existing water system and supplies.

Town of Stephens City Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (Estimated 1.5)	VDH Permitted System Capacity (MGD)
2008	1,736	62.200		0.108	0.162	Purchase
2010	1,825	62.200		0.114	0.171	Purchase
2020	2,229	62.200		0.139	0.209	
2030	2,669	62.200		0.166	0.249	
2040	3,328	62.200		0.207	0.311	

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor **2008 Water Withdrawal Peaking Factor**

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)		2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
0.108		62.2	January	0.135	N/A	
			February	0.107		
			March	0.102		
			April	0.086		
			May	0.088		
			June	0.102		
			July	0.12		
			August	0.099		
			September	0.092		
			October	0.168		
			November	0.095		
			December	0.099		
			Avg 2008 Water Withdrawal Peaking Factor			

Projected Disaggregated Demand

2008 Disaggregated Water Use Data

Year	Projected Disaggregated Water Demand (MGD)								
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Water Sold (gpd)	Total (gpd)
2008	0.108								0.108
2010	0.114								0.114
2020	0.139								0.139
2030	0.166								0.166
2040	0.207								0.207

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Page County, and Towns of Luray, Shenandoah, and Stanley

In Page County, using data provided by the Towns of Luray, Shenandoah and Stanley, over 45 percent of the County's population is connected to some form of public utilities currently. In 2009, Page County's "natural increase" (total number of births per year, less total number of deaths as calculated by the Virginia Department of Health) was a negative number, indicating more residents died that year in the County (11.2 deaths per every 1,000 residents) than those born that year (10.1 births per every 1,000 residents). Page County's percentage of population increase has declined over the past several Census

cycles. From 1970 – 1980 the County experienced a 17 percent population increase, from 1980 – 1990 an 11.7 percent population increase, from 1990 – 2000 a 6.8 percent population increase, and 2000 – 2010 a 3.7 percent population increase. The recent 3.7 %increase is assumed to be a result of a modest net in-migration to the County, with the "natural" population increase/decrease being a nonfactor.

An historic decline in population can be observed for the past 40 years and the future population projections reflect this decline; however, the projections still show a *slight net increase* in population for each ten year cycle until 2040. These slight net increases assume in-migration of population into the County each year with a small percentage that stay rather than leave. Any unforeseen circumstance (e.g. a major industry moving into, or out of, the County, etc.) could change this assumption. Therefore, a 2 percent overall projected population increase was assessed for Page County between 2010 – 2020, and continued until 2040. In addition, portions of the County's growth were assigned to the County's Towns based upon historic trends.

In Page County the residential community water use is supplied by groundwater wells and springs servicing the three Towns. In 2008, the combined water use for nonmunicipal community sources were all groundwater wells withdrawing a total of 0.9512 MGD in 2008 (based on 80% total system design (actual water consumption use not available). These include Egypt Bend Estates, Luray Homes, Shenandoah Utilities, and undisclosed populations in nonmunicipal community water users subdivisions.

The large Self-Supplied nonagricultural user was the Luray Caverns Country Club. Eight large Self-Supplied agricultural users in Page County withdrew water from a combination of stream intakes, groundwater, and a spring totaling a 0.103 MGD withdrawal for five agricultural users. Three large self-supplied agricultural users did not report withdrawals. Small Self-Supplied users include schools, Shenandoah National Park, and Stanley Industrial Park with a combined withdrawal in 2008 of 0.547 MGD. This was assumed to be static throughout the planning time; however, it is noted that the Stanley has identified a potential growth corridor in their Industrial Park and is converting to community water systems expanded to accommodate anticipated increase in water demand user. An estimated 96 houses on private wells in the service areas of the towns were multiplied by the County average of 2.42 persons per household using 75 gpd total 0.017424 MGD in 2008.

The Town of Luray served a daily water use of 837,559 gallons per day in 2008, with an average peak daily use of 944,435 gallons per day. In 2010 the Town of Luray served a population of 4,895. In addition, in 2010 the Town provided County residents with out-of-town water to 130 connections. The Town estimated this to be 130 connections times 2.5 residents per household connection, plus the 2010 population for a total water service provided to 5,220 persons. The Town of Luray anticipates a growth rate of 0.13% or four new light commercial industrial users in the planning period and two new heavy industrial connections (0.07% increase) during the planning period between present to 2040. The Town

of Shenandoah served 21 household connections outside of the Town limits in 2010. The Town of Stanley provides water to much of Page County residents outside the Town limits. The service area for County residents outside of town limits served by Stanley Town in 2010 was 774 connections. The total number/Percent of Page County residents living in towns or connected to Town utilities was 45.7% of the overall County population.

Estimates for Page County and the Towns of Luray, Shenandoah, and Stanley population are as follows:

Population	**2020**	**2030**	**2040**
Page Co Population Served	24,523	25,014	25,515
Luray Population Served	4,944	4,994	5,044
Total Service-Area Population	5,281	5,356	5,428
(Out of Town Population plus Luray Population)			
Shenandoah Population Served	2,504	2,605	2,683
Total Service-Area Population	2,572	2,697	2,793
(Out of Town Population plus Town Population)			
Stanley Population Served	1,472	1,517	1,563
Total Service-Area Population	3,457	3,552	3,624
(Out of Town Population plus Stanley Population)			
Total Number/Percent of County	11,310	11,605	11,845
Residents Connected to Town Utilities	/46.1%	/46.3%	/46.4%

An estimated 13,213 people were not serviced with municipal community water systems in 2010. In 2008, the estimated population on individual wells was 15,781. Multiplying that population times an average 75 gallons per day per capita yielded 1.183575 MGD not on municipal water. However, a portion of that population is serviced by nonmunicipal community water systems that consumed 0.095120 MGD. Therefore, 1.183575 MGD minus 0.095120 MGD yields 1.08846 MGD of water that is estimated to service the remaining 2008 County population. This amount is estimated to increase at the rates provided for the towns (12.19 percent by 2020, 11.66 percent by 2030, and 9.91 percent by 2040). The County estimates of water use for populations not serviced by community water systems are reflected in the demand figures.

In summary, the existing and projected water demand for Page County is as follows:

2010 1.154 MGD

2020 1.1702 MGD
2030 1.1924 MGD
2040 1.2169 MGD

Based on the ubiquitous nature of groundwater underlying Page County, future demands are anticipated to be met with groundwater wells. A summary of Page County future water demands is presented below:

Page County Projected Water Demand

Page County Projected Annual Average & Peak Demand

Year	Projected Population	Projected Population on Wells (Minus Service Areas)	Resultant Demand (gpd)	Estimated Annual Average Well Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted System Capacity (MGD)	
2008	**23,177**	15321	1149075	1.149		n/a	
2010	**24,042**	15352	1151400	1.151		n/a	
2020	**24,523**	15603	1170225	1.17		n/a	
2030	**25,014**	15898	1192350	1.192		n/a	
2040	**25,515**	16225	1216875	1.217		n/a	

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

Projected Disaggregated Demand

2008 Disaggregated Water Use Data

Year	Projected Disaggregated Water Demand (MGD)							
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Self Supplied Users (gpd)	Estimated Livestock Use (gpd)	Ag Users (estimated) (gpd)	Total (gpd)	
2008		547,000		1149075	275,500	32,000	2,003,575	
2010		547,000		1151400	275,500	32,000	2,005,900	
2020		547,000		1170225	275,500	32,000	2,024,725	
2030		547,000		1192350	275,500	32,000	2,046,850	
2040		547,000		1216875	275,500	32,000	2,071,375	

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of Luray:

All future uses for water in Luray Town are anticipated to be met by the existing water supplies and permitted capacity to the year 2040. The peak demand for 2040 potentially exceeds the permitted

capacity by 2030; however, daily consumptive uses could implement conservation to extend the supply of the sources to satisfy future uses.

Town of Luray Projected Annual Average & Peak Demand

Year	Projected Population/ Service Area	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted System Capacity (MGD)
2008	5,020	163.94		0.823	1.234	1.235
2010	5,025	163.94		0.824	1.236	1.224
202	5,074	163.94		0.832	1.248	1.224
2030	5,124	163.94		0.84	1.261	1.224
2040	5,174	163.94		0.848	1.27	1.224

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

Disaggregated water use was available for the Town of Luray and is presented below:

Water System Name	System Total (MGD)	Residential (MGD)	Commercial Institutional Light Industrial (gpd)	Heavy industrial (MGD)	Unaccounted for Losses
Luray	.944	0.392 (80 gpd x 4,895 residents in 2010)	(0.152 MGD) 650/conn - Comm 1,225 /conn - Lt Ind (or 4 new connections))	0.45/user (0.07% increase or 2 new connections)	0.331 (averages 35%)

The Luray Town water usage projections included the following assumptions of water use. The Luray estimated residential water use rate is 80 gpd per user or 200 gpd per connection for a dwelling unit. An increase of 0.1% is anticipated in residential usage amounts for future projections. Commercial use of water for Luray is 650 gpd. The Town of Luray has a an expected 0.13% increase in both users and usage amount. The small industrial water users in Luray use 2,125 gpd per user connection. Approximately four new light industrial users are expected to be added to the Town distribution system by 2040. The water demand will increase by 8,500 gpd. The heavy industrial user in Luray demands 450,000 gpd per user connection. The Town expects a 0.07% increase in the usage amount and anticipates two new large industrial users by 2040. Unaccounted for water loss varies in Luray between 15% to 50%. On average, the Town assumes 35% for unaccounted loss.

Town of Shenandoah:

Even with a higher than average per capita usage, the Town of Shenandoah is anticipated to have all future water demands met by their exiting supplies. See the summary below of future use projections.

Town of Shenandoah Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.5)	VDH Permitted Capacity (MGD)
2008	1,403	133.3	187,020	0.187	0.2805	0.601
2010	1,422	133.3	189,553	0.189	0.2835	0.601
2020	1472	133.3	196,218	0.196	0.294	0.601
2030	1517	133.3	202,216	0.202	0.303	0.601
2040	1563	133.3	208,348	0.208	0.312	0.601

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County
population of 2008

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.187	187,020	133.3

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	3.2	n.i.	n.i.
February	3.13	n.i.	n.i.
March	3.19	n.i.	n.i.
April	3.09	n.i.	n.i.
May	3.18	n.i.	n.i.
June	3.16	n.i.	n.i.
July	3.11	n.i.	n.i.
August	3.73	n.i.	n.i.
September	2.6	n.i.	n.i.
October	2.92	n.i.	n.i.
November	3.05	n.i.	n.i.
December	3.13	n.i.	n.i.
Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand	**3.124**	**4.686**	**1.5**

2008 Disaggregated Water Use Data

Year	Projected Disaggregated Water Demand (MGD)	SSU

	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	estimates
2008	0.187							0.187
2010	0.189							0.189
2020	0.196							0.196
2030	0.202							0.202
2040	0.208							0.208
Notes: Assumed categorical water use percentages would remain consistent through the projection period.								

Town of Stanley:

Future water demands are anticipated to be met by existing water supplies for the Town of Stanley through 2040 based on projected uses presented below:

Town of Stanley Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (Estimated 1.5)	VDH Permitted System Capacity (MGD)
2008	2,274	188.000		0.428	0.642	0.806
2010	2,373			0.446	0.669	0.806
2020	2,504			0.471	0.706	0.806
2030	2,605			0.489	0.735	0.806
2040	2,683			0.504	0.757	0.806

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Disaggregated Water Use Data

Residential gpd)	*Commercial Institutional Light Industrial CIL (gpd)*	*Heavy Industrial (gpd)*	*Military (gpd)*	*Other (gpd)*	*Production Processes (gpd)*	*Unaccounted for Losses (gpd)*

Year	Projected Disaggregated Water Demand (MGD)						
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Total (gpd)

2008	0.428						0.428
2010	0.446						0.446
2020	0.471						0.471
2030	0.489						0.489
2040	0.504						0.504

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Shenandoah County, Towns of Edinburg, Mt. Jackson, New Market, Strasburg, Toms Brook, and Woodstock:

In Shenandoah County the municipal residential community water use serves the Towns of Edinburg, Mount Jackson, New Market, Strasburg, Toms Brook, Woodstock, and Shenandoah County (Stoney Creek Sanitary District serving the village of Basie-Bryce Mountain Resort). In 2008, the nonmunicipal community water users relied on groundwater wells except Battleground Trailer Park on spring fed water and George's Chicken which also uses surface water purchased from the Town of Woodstock, in addition to groundwater wells. The Toms Brook – Maurertown Sanitary District provides water to the Town of Toms Brook and outlying area in the County.

The disaggregated water use for Stoney Creek is presented below.

Water System Name	System Total (MGD)	Residential (MGD)	Commercial Institutional Light Industrial (MGD)
Stoney Creek Shenandoah County	0.228	0.221	0.007

The large Self-Supplied nonagricultural users include Bryce Resort, Shenvalee Lodge, and the Strasburg Quarry. Thirteen documented large agricultural, Self-Supplied users withdraw water (data for water use is not available). Small Self-Supplied users (those using less than 300,000 gallons of water per month) include Valley Lunch Restaurant, Virginia Department of Transportation office complex, Bowman Apple Products Company Inc., Community Christian School, Columbia Gas Transmission Corporation, and Valley Baptist Christian School.

An estimated 24047 people were not serviced with municipal CWS. Multiplying the that population times an average 75 gallons per day per capita yielded 1.1803525 MGD not on municipal water. However, a portion of that population is serviced by nonmunicipal residential community water systems that consumed 0.2208 MGD. Therefore, 1.1803525 MGD minus 0.2208 MGD yields 0.95955 MGD of water that is estimated to service the remaining 2008 County population. This amount is estimated to increase at the rates provided for the towns (12.19 percent by 2020, 11.66 percent by 2030, and 9.91 percent by 2040).

In the unincorporated areas of Shenandoah County, the water use is met by a combination of individual well water and Sanitary Districts. Based on future water use in the County as presented below, the existing water supplies from Stoney Creek Sanitary District and groundwater wells are anticipated to meet future water use. It is assumed that future development outside water supply service areas will require well development to support housing in rural areas.

Shenandoah County Projected Annual Average & Peak Demand

Year	Projected Population	Population Minus Towns	Population Minus Stoney Creek Service Area (0.228)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD)	Stoney Creek VDH Permitted System Capacity (MGD)
2008	**40,609**		0.228	75			0.393
2010	**41,993**	21996	0.228	75	1.422		0.393
2020	**49,427**	27250	0.228	75	1.186		0.393
2030	**56,927**	31383	0.228	75	2.126		0.393
2040	**66,906**	36885	0.228	75	2.538		0.393

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.245	0.326	
February	0.248	0.33	
March	0.229	0.275	
April	0.224	0.303	
May	0.236	0.327	
June	0.254	0.287	
July	0.265	0.332	
August	0.281	0.324	
September	0.267	0.323	
October	0.162	0.27	
November	0.15	0.214	
December	0.178	0.289	
Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand		**3.6**	
2008 Disaggregated Water Use Data	**0.228**	**0.3**	**1.316**

Year	Projected Disaggregated Water Demand (MGD)						
	Private CWS Residential (MGD)	Residential Wells (MGD)	Commercial Institutional Light Industrial SSU (MGD)	Heavy Industrial (gpd)	Private SSU (MGD)	Production Processes (gpd)	Total (gpd)
2008	0.228		33.403		14.9288		
2010	0.228	1.422	33.403		14.9288		
2020	0.228	1.186	33.403		14.9288		
2030	0.228	2.126	33.403		14.9288		
2040	0.228	2.538	33.403		14.9288		

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of Edinburg:

Future Water uses, as presented below, are anticipated to be met by the existing water supplies in the Town of Edinburg.

Town of Edinburg Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.5)	VDH Permitted System Capacity (MGD)
2008	1001	162		0.162	0.243	.24 (Max 0.432)
2010	1,050	162		0.170	0.255	0.432
202	1,186	162		0.192	0.288	0.432
2030	1,366	162		0.221	0.332	0.432
2040	1,606	162		0.260	0.390	0.432

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.162		162

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.145	0.227	
February	0.157	0.226	
March	0.149	0.238	

	April	0.133	0.215	
	May	0.155	0.214	
	June	0.137	0.166	
	July	0.142	0.206	
	August	0.2	0.364	
	September	0.233	0.272	
	October	0.2	0.264	
	November	0.146	0.223	
	December	0.145	0.17	
	Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand		**1.942**	**2.785**	
2008 Disaggregated Water Use Data		**0.162**	**0.232**	**1.43**

Year	Projected Disaggregated Water Demand (MGD)							
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Total (gpd)
2008	0.162							0.162
2010	0.170							0.170
2020	0.192							0.192
2030	0.221							0.221
2040	0.260							0.260

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of Mount Jackson:

The Town of Mount Jackson will have all water demands met by existing supplies. The per capita water usage rate was fairly low for Mount Jackson. The peaking rate was also low for the Town, at 1.2.

Town of Mount Jackson Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.2)	VDH Permitted System Capacity (MGD)
2008	2,290	116.59		0.267	0.324	0.6992
2010	2,368	116.59		0.276	0.331	0.6992
2020	2,788	116.59		0.325	0.39	0.6992
2030	3,211	116.59		0.374	0.449	0.6992
2040	3,773	116.59		0.439	0.527	0.6992

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.267		116.59

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.301	0	
February	0.294	0	
March	0.57	0.29	
April	0.294	0	
May	0.27	0	
June	0.302	0.315	
July	0.297	0	
August	0.305	0.324	
September	0	0	
October	0.331	0	
November	0.445	0	
December	0.279	0	
Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand	**3.688**	**0.929**	
2008 Disaggregated Water Use Data	**0.307**		

Year	Projected Disaggregated Water Demand (MGD)							
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Total (gpd)
2008	0.267							0.267
2010	0.276							0.276
2020	0.325							0.325
2030	0.374							0.374
2040	0.439							0.439

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of New Market:

The Town of New Market will have all future water demands up through 2040 satisfied by existing Town water sources. By 2040, there will be a surplus of 1.238 MGD on peak days and a surplus of 1.779 MGD on average daily usage days. Projected demand usage is presented below.

Town of New Market Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.5)	VDH Permitted System Capacity (MGD)	
2008	2,477	276.54		0.685	1.028	2.92	
2010	2,570	276.54		0.7107	1.066	2.92	
202	2,995	276.54		0.828	1.242	2.92	
2030	3,450	276.54		0.954	1.431	2.92	
2040	4,055	276.54		1.121	1.682	2.92	

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.685		

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.624	1.224	
February	0.635	1.184	
March	0.607	1.001	
April	0.645	1.007	
May	0.75	1.227	
June	0.712	1.039	
July	0.679	1.383	
August	0.683	1.018	
September	0.76	1.144	
October	0.81	1.079	
November	0.682	1.034	
December	0.628	1.096	
Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand	**8.215**	**13.436**	
2008 Disaggregated Water Use Data	**0.685**	**1.12**	**1.64**

Residential gpd)	*Commercial Institutional Light Industrial CIL (gpd)*	*Heavy Industrial (gpd)*	*Military (gpd)*	*Other (gpd)*	*Production Processes (gpd)*	*Unaccounted for Losses (gpd)*	*Water Sold (gpd)*

Year	Projected Disaggregated Water Demand (MGD)

	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Total (gpd)
2008	0.685							0.685
2010	0.7107							0.7107
2020	0.828							0.828
2030	0.954							0.954
2040	1.121							1.121
Notes: Assumed categorical water use percentages would remain consistent through the projection period.								

Town of Strasburg:

The Town of Strasburg will have water demands met through Town supplies throughout the planning period of 2040. Based on increased permitted source to 3 MGD it is estimated that given the usage presented below, by 2040 the Town will have a surplus of 1.72 MGD for average daily use and a surplus of 1.55 MGD for peak days.

Town of Strasburg Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.13)	VDH Permitted System Capacity (MGD)	
2009	6,242	120.21		0.750	0.84	1	
2010	6398	120.21		0.769	0.8691.039	1	
2020	7573	120.21		0.910	1.029	3	
2030	8963	120.21		0.99	1.119	3	
2040	10609	120.21		1.275	1.441	3	

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0..75		120.21

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	0.846	0.967	
February	0.848	0.969	
March	0.813	0.969	

April	0.839	0.968	
May	0.856	0.968	
June	0.891	0.969	
July	0.928	0.969	
August	0.905	0.968	
September	0.874	0.968	
October	0.838	0.967	
November	0.814	0.965	
December	0.784	0.954	
	Avg 2008 Water Withdrawal Peaking Factor		
Projected Disaggregated Demand	**10.236**	**11.601**	
2008 Disaggregated Water Use Data	**0.853**	**0.967**	**1.13**

Year	Projected Disaggregated Water Demand (MGD)							
	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Total (gpd)
2008	0.75							.75
2010	.769							.769
2020	.91							.91
2030	.99							.99
2040	1.275							1.275

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of Toms Brook:

The Sanitary District has a permitted capacity of 0.298 MGD. Calculated future water use for the Town of Toms Brook will be met throughout the planning horizon of 2040 with a surplus of water from the existing source, Sanitary District.

Year	Town Projected Population (Sanitary District population projection to be serviced)	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted System Capacity (MGD)
2008	251 (540 Toms Brook-Maurertown Sanitary District service area)		200	0.107	0.161	0.2416
2010	252 (550)		200	0.107	0.161	0.2416
2020	321 (600)		200	0.117	0.161	0.2416
2030	370 (650)		200	0.127	0.161	0.2416
2040	435 (700)		200	0.137	0.161	0.2416

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.107		200

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January		0.168	
February		0.182	
March		0.17	
April		0.167	
May		0.157	
June		0.156	
July		0.169	
August		0.157	
September		0.167	
October		0.184	
November		0.15	
December		0.127	
Avg 2008 Water Withdrawal Peaking Factor		**1.954**	

Projected Disaggregated Demand **0.163**

2008 Disaggregated Water Use Data

Residential gpd)	***Commercial Institutional Light Industrial CIL (gpd)***	***Heavy Industrial (gpd)***	***Military (gpd)***	***Other (gpd)***	***Production Processes (gpd)***	***Unaccounted for Losses (gpd)***	***Water Sold (gpd)***	***Total (gpd)***
0.107								

Year	Projected Disaggregated Water Demand (MGD)								
	***Residential gpd)**	**Commercial Institutional Light Industrial CIL (gpd)**	**Heavy Industrial (gpd)**	**Military (gpd)**	**Other (gpd)**	**Production Processes (gpd)**	**Unaccounted for Losses (gpd)**	**Water Sold (gpd)**	**Total (gpd)**
2008	107,000	0	0	0	0	0	0	0	0
2010	107,000								
2020	107,000								
2030	107,000								
2040	107,000								

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

*Assume - water service area stays at 400

Town of Woodstock:

The Town of Woodstock will be able to satisfy all water demands through 2040 from the Town intake on the Shenandoah River, based on water usage presented below. Based on demand calculations, there will be a water surplus of 0.137 MGD by 2040 on peak days and a surplus of 0.191 MGD on average daily use days.

Town of Woodstock Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Annual Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (1.5 assume)	VDH Permitted System Capacity (MGD)
2008	5,837	118		0.689	1.03	2.02
2010	6,097	118		0.719	1.078	2.02
2020	6,969	118		0.823	1.23	2.02
2030	8,027	118		0.947	1.421	2.02
2040	9,434	118		1.113	1.67	2.02

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor

Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
0.689		118

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD) Used 1.5	Peak Day / Avg Day (MGD)
January	0.6775	1.016	
February	0.68	1.05	
March	0.636	0.954	
April	0.634	0.951	
May	0.687	1.031	
June	0.687	1.031	
July	0.716	1.074	
August	0.849	1.274	
September	0.786	1.179	
October	0.737	1.106	
November	0.585	0.878	
December	0.588	0.882	
Avg 2008 Water Withdrawal Peaking Factor			
Projected Disaggregated Demand	**8.263**	**12.426**	
2008 Disaggregated Water Use Data	**0.689**	**1.036**	**1.504**

Year	Projected Disaggregated Water Demand (MGD)

	Residential gpd)	Commercial Institutional Light Industrial CIL (gpd)	Heavy Industrial (gpd)	Military (gpd)	Other (gpd)	Production Processes (gpd)	Unaccounted for Losses (gpd)	Water Sold (gpd)	Total (gpd)
2008	0.689								0.689
2010	0.719								0.719
2020	0.823								0.823
2030	0.947								0.947
2040	1.113								1.113
Notes: Assumed categorical water use percentages would remain consistent through the projection period.									

Warren County

In Warren County the residential community water use is supplied by stream intakes servicing the Town of Front Royal. In 2008, the Town of Front Royal consumed an average water withdrawal 4.318 MGD. The two large Self-Supplied nonagricultural users were golf clubs withdrawing groundwater with a combined water demand of 0.0929 MGD during 2008. One large agricultural Self-Supplied user, Front Royal Fish Culture Station, in 2008 had a non-consumptive water use of 0.727 MGD from Passage Creek surface water. Seven businesses comprise the small Self-Supplied water use in 2008 including North Fork Resort #7, Shenandoah National Park – Dickey Ridge Center, Skyline Caverns, Inc., Front Royal River Campground, Christendom College, Hidden Springs Senior Living Facility, North American Housing Corporation, and Shenandoah Valley Golf Club offices. The combined small Self-Supplied users for nonagricultural demand were estimated at 0.77 MGD.

An estimated 18,827 people were not serviced with residential community water supply. Multiplying the that population times an average 75 gallons per day per capita yielded 1.41203 MGD not on municipal water. An additional portion of that population is serviced by one other residential nonmunicipal community water systems that consumed an estimated 0.0106 MGD. Therefore, 1.41203 MGD minus 0.0106 MGD yields 1.40143 MGD of water that is estimated to service the remaining 2008 County population. This amount is estimated to increase at the rates provided for the towns (12.19 percent by 2020, 11.66 percent by 2030, and 9.91percent by 2040). The County estimates of water use for populations not serviced by community water systems are reflected in the demand figures.

In addition, to the above demand, a natural gas generating facility owned by Dominion Power was permitted and is expected to go on-line in 2015. The Town of Front Royal plans to provide water to Dominion Power . Assuming average daily use, the annual volume of water for Dominion Power would be 146,000,000 gallons (0.4 MGD) to be provided by Front Royal Town starting in the year 2015. The following water use for the plant is added to water demand in Warren for Dominion use by 2015:

Peak Demand - 652,320 gpd Water

Peak Demand - 295,260 gpd Sewer
Average Demand - 400,000 gpd Water
Average Demand - 160,000 gpd Sewer

The projected future water demands in Warren County are presented in the tables below. In general, additional rural development will require groundwater well construction to meet future needs in areas outside community water service systems.

Year	Projected Population	Projected Population on Wells (Minus Service Areas)	Resultant Demand (gpd)	Estimated Residential Average Well Water Demand (MGD)	Estimated Peak Water Demand (MGD)	VDH Permitted System Capacity (MGD)	
2008	**31,584**		**75**			N/A	
2010	**37,575**	23135	**75**	1735125	1.735	N/A	
202	**45,722**	29653	**75**	2223975	2.224	N/A	
2030	**53,092**	35549	**75**	2666175	2.666	N/A	
2040	**65,143**	45189	**75**	3389175	3.389	N/A	

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

Projected Disaggregated Demand based on

2008 Disaggregated Water Use Data

Year	Projected Disaggregated Water Demand (MGD)						
	Private CWS (gpd)	Commercial Institutional Light Industrial SSU (gpd)	Heavy Industrial (gpd)	Self Supplied Users (gpd)	Estimated Livestock Use (gpd)	Ag Users (estimated) (gpd)	Total Private Estimated (gpd)
2008	1,620,000	770,000		1735125	104000	727,000	4,956,125
2010	1,620,000	770,000		1735125	104000	727,000	4,956,125
2020	1,620,000	770,000		2223975	104000	727,000	5,444,975
2030	1,620,000	770,000		2666175	104000	727,000	5,887,175
2040	1,620,000	770,000		3389175	104000	727,000	6,610,175

Notes: Assumed categorical water use percentages would remain consistent through the projection period.

Town of Front Royal:

Projected water use in the Town of Front Royal was calculated from 2008 water average daily water use of 2.048 MGD and peak day usage in 2008 was 3.35 MGD. Based on projected uses, the Town of Front Royal will meet residential water use and peak uses through 2040 with a permitted capacity of 4 MGD.

It should be noted that disaggregated water use for other sectors such as business and system losses is not included in this estimated demand (was not reported for by most Towns).

Town of Front Royal Projected Annual Average & Peak Demand

Year	Projected Population	Water Use Factor (gpcd)	Resultant Demand (gpd)	Estimated Residential Average Water Demand (MGD)	Estimated Peak Water Demand (MGD) (Estimated 1.1)	VDH Permitted System Capacity (MGD)
2008	14,270	125		1.784	1.962	3
2010	14,440	125		1.805	1.986	3
202	16,069	125		2.008	2.209	3
2030	17,543	125		2.193	2.412	3
2040	19,954	125		2.494	2.743	3

Notes: Per capita Method: estimated water demand = projected population x gpcd water use factor
Assumed industry standard peaking factor of 1.5 because peak days are not recorded by County

2008 Per Capita Water Use Factor

2008 Water Use (MGD)	2008 Per Capita Water Use (MGPCD)	2008 Per Capita Water Use (gpcd)
2.264	158	

2008 Water Withdrawal Peaking Factor

	2008 Average Day Withdrawal (MGD)	2008 Peak Day Withdrawal (MGD)	Peak Day / Avg Day (MGD)
January	2.197	2.347	
February	2.218	2.325	
March	2.123	2.371	
April	2.13	2.412	
May	2.103	2.539	
June	2.363	2.585	
July	2.39	2.611	
August	2.394	2.664	
September	2.273	2.652	
October	2.306	2.642	
November	2.287	2.541	
December	2.384	2.225	
Avg 2008 Water Withdrawal Peaking Factor		29.914	
		29.914	
	2.264	**2.493**	**1.1**

The overall projected demand for the planning region is based on projected populations as summarized below.

NSRVC Water Supply Plan: Population & Projections

	Decennial Census Count					Projected Population*			% County Population		Avg. % of County Population 2000-2010
County/*Town*	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**	**2030**	**2040^**	**2000**	**2010**	
Clarke County	**8,102**	**9,965**	**12,101**	**12,652**	**14,034**	**18,320**	**21,230**	**26,027**			
Berryville				2,963	4,185	4,877	5,651	6,928	23.4%	29.8%	26.6%
Boyce				426	589	693	803	984	3.4%	4.2%	3.8%
Frederick County	**28,893**	**34,150**	**45,723**	**59,209**	**78,305**	**95,648**	**114,539**	**142,853**			
Middletown				1,015	1,265	1,626	1,947	2,428	1.7%	1.6%	1.7%
Stephens City (Town)				1,146	1,829	2,009	2,405	3,000	1.9%	2.3%	2.1%
Page County	**16,581**	**19,401**	**21,690**	**23,177**	**24,042**	**25,659**	**27,038**	**28,539**			
Luray				4,871	4,895	5,311	5,597	5,908	21.0%	20.4%	20.7%
Shenandoah (Town)				1,878	2,373	2,309	2,433	2,568	8.1%	9.9%	9.0%
Stanley				1,326	1,689	1,642	1,730	1,826	5.7%	7.0%	6.4%
Shenandoah County	**22,852**	**27,559**	**31,636**	**35,075**	**41,993**	**49,427**	**56,927**	**66,906**			
Edinburg				813	1,041	1,186	1,366	1,606	2.3%	2.5%	2.4%
Mount Jackson				1,664	1,994	2,323	2,676	3,145	4.7%	4.7%	4.7%
New Market				1,637	2,146	2,422	2,789	3,278	4.7%	5.1%	4.9%
Strasburg				4,017	6,398	7,573	8,963	10,609	11.5%	15.2%	13.4%
Toms Brook				255	258	345	398	468	0.7%	0.6%	0.7%
Woodstock				3,952	5,097	5,783	6,660	7,828	11.3%	12.1%	11.7%
Warren County	**15,301**	**21,200**	**26,142**	**31,584**	**37,575**	**45,722**	**53,092**	**65,143**			
Front Royal (1)				13,589	14,440	16,069	17,543	19,954	20.0%		

Front Royal (2)				13,589	14,440	19,660	22,830	28,011	43.0%	38.4%	40.7%
Winchester (City)	**14,643**	**20,210**	**21,947**	**23,585**	**26,203**	**29,339**	**32,485**	**36,571**		
Region (Total)	**106,372**	**132,485**	**159,239**	**185,282**	**222,152**	**264,115**	**305,311**	**366,039**		

Notes:

*Projected using US Census 1970-2010 and Virginia Employment Commission (2020, 2030) for extrapolated straightline projection from 2000 to 2030

^2040 population estimated using % change 2000 to 2030

Population estimates for Mount Jackson, New Market, Strasburg and Woodstock in Shenandoah County include an additional 20% projected future growth rate increase

Front Royal (1) Assumes 20% of the County population resides within the town

Front Royal (2) assumes trend of average % of county population 2000-2010

6.0 WATER DEMAND MANAGEMENT

This section of the report documents a survey, titled Form 110, of the localities, as stipulated in Section 9 VAC 25-780-110. A detailed compilation of the survey is presented in Table 2: NSVRC Combined Results of Survey Form 110, appended to this report. Section 110, entitled Water Demand Management Information, includes a survey of water efficiency practices, water conservation (raising awareness and financial incentives), and water loss reduction efforts in use by the localities. Subsection B addresses future planning efforts of water use demands, pursuant to Section 100 D of the code. Future water planning analyses of population estimates and demand uses will address and incorporate water conservation practices, techniques, and technologies available. Below is a summary of the Form 110 surveys in our region which is presented in Table 1, listing the yes or no response to questions within the categories. Detailed answers to the individual survey questions are presented in Table 6.2.

Table 6.1: Summary of Form 110 Answers for Localities in the Northern Shenandoah Valley Regional Commission

Locality	Water Use Efficiency	Water Conservation	Water Loss Reduction
Clarke County	1 - Y, 8 - N	5 - Y, 9 - N	6 - Y, 3 - N
Frederick County	0 - Y, 9 - N	2 - Y, 12 - N	3 - Y, 5 – N, 1- I
Page County (Old Farms)	1 - Y, 7 – N, 1-NA	0 - Y, 14 - N	1 - Y, 8 - N
Page County (Egypt Bend)	1 –Y, 6 –N, 2-NA	1 –Y, 12 –N, 1 –NA	4 –Y, 5 - N
Page Public Water Systems	0 - Y, 8 – N, 1-NA	0 - Y, 10 – N, 4- NA	0 - Y, 6 – N, 3-NA
Shenandoah County	0 - Y, 9 - N	0 - Y, 14 - N	4 - Y, 5 - N
Stoney Creek	0 - Y, 9 – N	1 –Y, 13 - N	6 -Y, 3 - N
Warren County	1 - Y, 8 - N	4 - Y, 10 - N	0 - Y, 9 - N
Winchester City	3- Y, 5 – N, 1-NA	7 - Y, 7 - N	6 - Y, 3 - N
Town of Berryville	1 - Y, 8 - N	4 - Y, 10 - N	6 - Y, 3 - N
Town of Boyce	0 - Y, 9 - N	4 - Y, 10 - N	4 - Y, 3 – N, 1-NA, 1-NV
Town of Edinburg	0 - Y, 9 - N	3 - Y, 11 - N	5 - Y, 4 - N
Town of Front Royal	0 - Y, 8 – N, 1- NA	6 - Y, 8 - N	7 - Y, 2 - N
Town of Luray	1 - Y,6 – N, 2- NA	3 - Y, 8 – N, 3- NA	1 - Y, 7 – N, 1- NA
Town of Middletown	1 - Y, 8 - N	7 - Y, 7 - N	6 - Y, 3 - N
Town of Mount Jackson	1 - Y, 7 – N, 1- NA	2 - Y, 9 – N, 3- NA	4 - Y, 4 – N, 1- NA

Town of New Market	0 - Y, 8 – N, 1- NA	0 - Y, 14 - N	4 - Y, 5 - N
Town of Shenandoah	0 - Y, 9 - N	1 - Y, 13 - N	4 - Y, 5 - N
Town of Stanley	1 - Y, 6 – N, 2- NA	3 - Y, 8 – N, 3 - NA	1 - Y, 7 – N, 1- NA
Town of Stephens City*	1 - Y, 0 – N, 8 - NA	2 - Y, 0 – N, 12 -NA	1 - Y, 2 - N
Town of Strasburg	0- Y, 9 - N	3 - Y, 11 - N	6 - Y, 3 - N
Town of Toms Brook	0 - Y, 9 - N	1 - Y, 13 - N	6 - Y, 3 - N
Town of Woodstock	0 - Y, 8 – N, 1 - NA	1 - Y, 13 - N	4 - Y, 5 - N
Y - Yes answers, N - No answers, NA – Not Applicable, I – Incomplete, *- Needs Verification			

6.1 Water Use Efficiency:

In general, the localities had the least measures in place addressing water use efficiency practices listed by DEQ in the survey form; although several localities are considering adopting practices to improve water efficiency. Most of the localities have adopted the Virginia Uniform Statewide Building Code, but it is enforced through the County (example, the six Towns of Shenandoah County do not have Town Codes to that effect because it is enforced through Shenandoah County). Clarke County and Towns had water-efficient landscaping ordinances or site plans encouraging xeriscaping. No localities had homeowner associations with low water use known, and several rural areas had no homeowner associations. Two localities adopted ordinances declaring wasteful water use unlawful. In response to whether the localities implemented practices for irrigation efficiency, only one had irrigation measured but at least three others were considering metering irrigation. Only one locality had a water supplier listed on U.S. EPA's Water Sense partners list. In addition to the water efficiency practices listed by DEQ, alternative practices were implemented throughout several localities.

6.2 Water Conservation:

Fourteen questions address water conservation measures within the planning area, conserving water through a reduction in water use. These questions include financial incentives and educational awareness, among other water reduction measures. Five localities have an ordinance to address water conservation through reduced water use and at least three are considering adopting such an ordinance. Three locality water suppliers developed and implemented water conservation plans and two are considering conservation plans. Over half the localities adjusted their standard operating procedures to improve water conservation and have low flow fixtures. Two localities used State Clean Water revolving funds to upgrade their wastewater treatment and one uses the return water system on wastewater treatment to irrigate landscaping at the town facilities. No revolving funds were used to promote water conservation, and most were unaware that option was available. Only one locality offers yard taps to customers to reduce outdoor water use, although another locality is considering outdoor faucets. Thirteen localities have implemented public education programs to raise awareness about water usage.

No localities offer funding incentive programs (rebates, tax breaks, vouchers, etc.) to encourage customers to reduce water use although seven water suppliers implements a rate structure that discourages excessive water use.

6.3 Water Loss Reduction:

Form 110 includes nine questions that address water loss through leak detection maintenance and repair programs. Seventeen localities have source and service water connection meters. Thirteen localities implement operating strategies for leak detection and regularly schedule periodic water audits. No localities have an ordinance in place to repair leaking water fixtures, appliances, or plumbing, although one jurisdiction removes sewer charges if proof of leak repair is provided. No localities have used Clean Water State revolving funds or Drinking Water State revolving funds to install water meters in the distribution system. The majority of localities have the following measures: policies to prohibit unauthorized water hydrant connections, strategies to repair main leaks, include dedicated funds on capital improvement plans or master plans to upgrade existing facility infrastructure to reduce water loss. Nine localities have developed and implemented public education programs to reduce customer water loss. Four jurisdictions implement water loss reduction practices in addition to others listed by DEQ on the survey form.

6.4 Summary:

In conclusion, the process of gathering data for the surveys resulted in raising locality awareness of water efficiency practices and ordinances they could consider. Overall, it was noted during individual meetings with jurisdictions the survey increased concepts of water conservation practices available. The region's jurisdictions show varying levels of water demand management. In general, the results indicate that the localities had the greatest number of measures in place addressing water loss reduction, primarily through their leak detection maintenance programs. It was noted that repairs are necessary and since the survey, several localities have since contacted the NSVRC Executive Director to assist in investigating use of economic stimulus funds for water distribution repairs. Of the three categories, water use efficiency was the area with the least measures in place. The NSVRC hosted a Water Conservation workshop for locality land use managers, planners, and public works to present expertise in drought management, water efficiency best practices, and drought ordinances. It is anticipated that the increased awareness in water conservation will continue throughout the water supply planning process and result in increased water efficiency.

6.5 Practices to Address Water Loss

Unaccounted for water losses is water lost throughout the distribution system in leaks, unnecessary system use, theft, or wasted water. Control measures to monitor and ultimately minimize water loss can be implemented by localities to reduce water loss. The best step is to conduct a detailed water efficiency audit to determine what constitutes the water lost for each locality. Then a comprehensive leak detection and repair program would be promoted to improve water efficiency. Capital projects and Community Development Block Grant opportunities for funding such leak improvements could be sought after. Meter upgrades and routine performance detections would be useful. Offering leak

detection for all residents is a service each locality should offer to assist each homeowner / renter in identifying water leak issues and encourage remediation. For example, a locality could offer a five percent water bill savings for a month if the resident included a receipt for a water leak repair. In addition, water conservation practices could be implemented by citizens by raising awareness of water loss and conservation practices. The low water energy efficient appliances could be encouraged to retrofit older homes. The Virginia Uniform Statewide Building Code sections that limit the maximum flow of urinals, water closets, and appliances in 1994 will be adopted in all new building and houses.

The primary actions to assist in water conservation include educational measures and installation of water conservation fixtures such as improved source and connection meters, improved maintenance for meters, line replacements, and other practices or policies to track unauthorized water loss (theft, hydrant flushing, etc.). Localities are encouraged to join free on-line journals for recommendations to reduce water losses such as Center for Water Efficiency Newsletter or the Journal for Water Resource Management found at http://www.waterefficiency.net/subscription/water-efficiency-subscription-form-14598.aspx The Center for Water Efficiency members can pay a fee and receive access to leak detection services and recommended water conservation actions.

7.0 DROUGHT RESPONSE and CONTINGENCY PLANS

The mandated Water Supply Plan, set forth in 9 VAC 25-780-120, requires a locality to specify how a drought or low water condition is declared, what actions they will implement to conserve water under such a condition, and how they will enforce water conservation actions. This Drought Response Plan is a section of the Northern Shenandoah Valley Regional Water Supply Plan and also is a stand-alone document that establishes a coordinated response to drought for the City of Winchester and the five Counties of Clarke, Frederick, Page, Shenandoah, and Warren. The Plan identifies duties and responsibilities of localities to manage water resources during drought and low water events (such as equipment failure or contamination) to minimize adverse impacts on public health and safety, economic activity, and environmental resources; and help preserve the water supply throughout the planning area.

This Regional Drought Response Plan is divided into the following sections:

A. Drought Stages
B. Locality Declaration
C. Actions in Response to Drought Stage

A. Drought Stages

State regulations stipulate a minimum of three drought stages be included in the Water Supply Drought Response Sections. The Northern Shenandoah Valley Regional Water Supply Plan's Drought Response Section includes these three graduated stages of a drought:

Drought Stage	Description	Action
Watch	Drought potential if conditions persist	Increase water conservation awareness; voluntary actions by citizens
Warning	Onset of drought is imminent	Water conservation awareness; precautionary measures voluntary but encouraged by localities
Emergency	Significant drought or low water event	Mandatory responses for water conservation by localities and public

Jurisdictions will have varied declarations of a drought in part due to water sources, water demands, upstream water withdrawals, groundwater's delayed response to reflect low precipitation, equipment failure, and local variations in meteorology and soil moisture.

Local ordinances adopted by the localities within this planning region are appended to the Drought Response Section of the Water Supply Plan. The ordinances document jurisdictional commitment to water conservation implementation and enforcement of the Drought Response Section.

B. **Locality Declaration of a Drought Stage**

A drought is a period of time characterized by deficits in precipitation, low soil moisture, and surface and subsurface water levels below normal. The physical water shortages adversely affect people, crops, and animals.

A drought phase will be declared when conditions exist that less water is present than under normal streams flows under specific meteorological situations. Public declaration of the drought stage will be determined by the local water purveyor, Chief Administrative Officer (CAO), or designee as determined by the locality. A water purveyor is a public utility, municipal water company, county water district, or municipality that delivers drinking water to customers. Any localities purchasing water from another locality shall follow all drought stage declarations made by the local water purveyor and CAO/designee of the jurisdiction where water is purchased.

The Northern Shenandoah Valley Regional Commission (NSVRC) will act as a clearinghouse to assemble local drought stage designations and broadcast results to the general public and all jurisdictions within the planning region through electronic communication and website postings. The NSVRC staff will communicate with the upper headwaters area in the Central Shenandoah Planning District Commission area and will convey upstream drought conditions to the Northern Shenandoah Valley region jurisdictions. Results of upstream water supply conditions will also be posted on the NSVRC website to provide a comprehensive watershed-wide assessment of drought declarations within the Shenandoah Valley to facilitate localities' awareness of their water declarations.

When one or more of the following conditions are present, the local water purveyor, CAO, or designee may consider a Drought Stage declaration:

Drought Watch Stage

- A local trigger indicates watch level (at a predetermined level) or
- DEQ drought website indicates 2/4 boxes **yellow** for the area http://www.deq.virginia.gov/watersupplyplanning/drought/shenandoah/current.html, or
- A nearby subwatershed trigger indicates watch levels

Drought Warning Stage

- A local trigger indicates warning level (at a predetermined level), or
- DEQ drought website indicates 2/4 boxes **orange** for the area http://www.deq.virginia.gov/watersupplyplanning/drought/shenandoah/current.html, or
- A nearby subwatershed trigger indicates warning levels

Drought Emergency Stage

- A local trigger indicates emergency level (predetermined level), or
- DEQ drought website indicates 2/4 boxes **red** for the area http://www.deq.virginia.gov/watersupplyplanning/drought/shenandoah/current.html, or
- A nearby subwatershed trigger indicates emergency levels

Local Water Sources

Twenty localities in the planning region draw their water supply from three subwatersheds in the Shenandoah River basin: the North Fork of the Shenandoah River watershed, the South Fork of the Shenandoah River watershed, and the watershed of the main stem of the Shenandoah River. Water sources within the region's subwatersheds vary and include groundwater, stream intakes, quarries, and water purchased from another jurisdiction. The water sources and subwatersheds for each locality within the region are shown in Table 1, below (Note: stream surface water = SW, groundwater = GW, quarry = Q). Table 1 lists the watershed where the source intake is located, not necessarily the watershed of the jurisdiction using the water. For example, the City of Winchester is located in the subwatershed of the main stem of the Shenandoah River; however, the City's source intake is located in the subwatershed of the North Fork of the Shenandoah River in Strasburg.

TABLE 7. 1: Water Source's Intake Watershed

Locality Served	North Fork of the Shenandoah River Watershed	South Fork Shenandoah River Watershed	Main Stem Shenandoah River Watershed
Shenandoah County	GW		
New Market	GW		
Mt Jackson	GW		
Edinburg	GW		
Woodstock	SW		
Toms Brook	GW		

Strasburg	SW		
Page County		GW	
Shenandoah Town		GW	
Stanley		GW	
Luray		GW	
Warren County	GW	GW	
Front Royal		SW	
Frederick County	Quarry & Purchase from Winc SW / GW)		
Middletown	Purchase (SW) From Winc		
Stephens City	Purchase (SW/GW) From FCSA		
City of Winchester	SW		
Clarke County			GW
Boyce			Purchase From CCSA
Berryville			SW

Additional water source data for each locality is presented in Appendix A.

Local Triggers:

Each locality has selected local triggers to monitor and use to declare a drought or low water condition. Typically triggers include a stream level measured at a gage or a groundwater level measured at a specified level in a well, if available. A locality may assume a trigger is activated when either their local trigger has reached a predetermined level and / or a trigger from a neighboring jurisdiction within the same subwatershed has been reached. Table 2 summarizes local triggers and subwatershed triggers to be used when considering a drought stage declaration. The USGS stream gage website http://va.water.usgs.gov/duration_plots/daily/dp01634000.htm includes daily streamflow percentiles (10-25th%, 5th – 10th%, and below 5th%) of historic flows for a specific date. For localities with trigger levels set at percentile flows not posted on the website, the water purveyor will calculate flows to assess if conditions warrant a drought stage declaration.

Drought Trigger Table for the Northern Shenandoah Region:

TABLE 2: LOCAL TRIGGERS FOR WATER LEVELS						
Locality	**Drought or Low Water Stage**	**Groundwater/ Spring**	**Surface Water/ Reservoir**	**Other***		**Local Triggers/Gages**
Clarke County	**Watch**	GW levels fall between the 10th & 25th percentile and the DEQ Drought website Watch stage	Stream flows fall between the 10th and 25th percentile			Clarke County will declare a drought / low water stage when two or more indicate low water. The resources will include the County monitoring well network; the DEQ Drought Website page; Spout Run USGS gage; and Main Stem Millville USGS gage
	Warning	GW levels fall between the 5h & 10th percentile and the DEQ Drought website Warning stage	Stream flows fall between the 5h & 10th percentile			
	Emergency	GW levels fall below the 5th percentile and the DEQ Drought website Emergency stage	Stream flows fall below the 5th percentile			
Frederick County	**Watch**			Quarry elevation measures 657 ft (SC); 502 ft at CB Quarry		Elevation for Stephens City (SC) Quarry and Clearbrook Quarry (CB); and USGS Gage North Fork Shenandoah at Strasburg; will consider Winchester drought declaration
	Warning			Quarry elevation measures 650 ft (SC); 495 ft at CB Quarry		
	Emergency			Quarry elevation measures 645 ft (SC); 495 ft at CB Quarry		
Page County	**Watch**	GW levels fall between the 10th & 25th percentile	Stream flows fall between the 10th and 25th percentile			USGS Gage South Fork Shenandoah in Luray;
	Warning	GW levels fall between the 5h & 10th percentile	Stream flows fall between the 5h & 10th			Rockingham County USGS GW Well 41Q 1
	Emergency	GW levels fall below the 5th percentile	Stream flows fall below the 5th			
Shenandoah County	**Watch**	Groundwater capacities in local wells fall between 10th and 20th percentile and DEQ Drought website				Thresholds for actions at how much water can be extracted from local wells based upon demand,

	Warning	Groundwater capacities in local wells fall between 5th and 10th percentile and DEQ Drought website				pumping capacities and not solely on the level of water in the well, which will also be a factor. Therefore, if while pumping 22 hours a day(8 percentile of capacity) for a period of time for whatever reason but the well head is still at 25% of normal, warning measures would be enacted.
	Emergency	Groundwater capacities in local wells fall below 5th percentile				
Warren County	**Watch**		Stream flows fall between the 10th and 25th percentile			USGS Gage South Fork in Front Royal, USGS Gage North Fork Shenandoah at Strasburg, USGS Gage Passage Creek
	Warning		Stream flows fall between the 5th & 10th percentile			
	Emergency		Stream flows fall below the 5th percentile			
City of Winchester	**Watch**		Stream flows fall between the 10th and 15th percentile (or below 80 cfs) for a period of 5 consecutive days.			USGS Gage North Fork Shenandoah North Fork near Strasburg
	Warning		Stream flows fall between the 5th and 10th percentile (or below 72 cfs) for a period of 5 consecutive days.			
	Emergency		Stream flows fall below the 5th percentile (or below 63 cfs) for a period of 5 consecutive days.			
Town of Berryville	**Watch**		Stream flows fall between the 10th and 25th percentile			USGS Gage on Shenandoah River at Millville
	Warning		Stream flows fall between the 5th & 10th percentile			
	Emergency		Stream flows fall below the 5th percentile			
Town of Boyce	**Watch**	GW levels fall between the 10th & 25th percentile				Follow drought declaration by Clarke County based on Clarke County Monitoring Well Network
	Warning	GW levels fall between the 5th & 10th percentile				

	Emergency	GW levels fall below the 5th percentile				
Town of Edinburg	**Watch**	DEQ Drought Website for Shenandoah County				
	Warning	DEQ Drought Website, plus weekly monitoring of Well #1				
	Emergency	Static head of water in Well #1 drops below 10 feet for seven consecutive days (water monitored several times a day). Town will lower the pump in the well to assist with water delivery and downgrade to a Drought Warning depending upon Well #1 water level and the DEQ website.				
Town of Front Royal	**Watch**		400 cfs, voluntary			Per Town DEQ withdrawal permit based upon flow in the river at various flow rates for the USGS Gage South Fork in Front Royal
	Warning		340 cfs, Mandatory			
	Emergency		240 cfs, Mandatory			

Town of Luray	**Watch**	10% Overall Reduction in Available Water (Source Water, Finished Water, and/or Stored Water); 1.8" decrease in the Static Level of Hite Spring*; 6" decrease in the Static Level of Lake Arrowhead; DEQ Website – 4 Square for Page County; and Local Well** and Local Surface Water Data				Note: *Static Water Level in Hite Spring is measured at least one (1) hour after the pumping. **Local Well Data includes an evaluation of the static water level in Well #6 at least one (1) hour after the pumping. Surface water references USGS Gage South Fork in Luray. Luray Town will consider all data sources listed and what other towns are doing before making a declaration of a drought / low water stage based on a collective evaluation of all relevant data sources before the decision is made
	Warning	15% Overall Reduction in Available Water (Source Water, Finished Water, and/or Stored Water); 2.76" decrease in the Static Level of Hite Spring*; 12" decrease in the Static Level of Lake Arrowhead; DEQ Website – 4 Square for Page County; and Local Well** and Local Surface Water Data				
	Emergency	20% Overall Reduction in Available Water (Source Water, Finished Water, and/or Stored Water); 3.6" decrease in the Static Level of Hite Spring*; 18" decrease in the Static Level of Lake Arrowhead; DEQ Website – 4 Square for Page County; and Local Well** and Local Surface Water Data				
Town of Middletown	**Watch**		Stream flows fall between the 10^{th} and 25^{th} percentile			Follow drought declaration from Winchester; Passage Creek, Buckton USGS gage
	Warning		Stream flows fall between the 5^{h} & 10^{th} percentile			
	Emergency		Stream flows fall below the 5^{th} percentile			
Town of Mt Jackson	**Watch**	DEQ Drought Website for Shenandoah County				
	Warning	DEQ Drought Website				

	Emergency	Static head of water in local wells drops below the 5th percentile of historic records				
Town of New Market	**Watch**	DEQ Drought Website for Shenandoah County				USGS gaging station at Cootes Store, Broadway and/or Smith Creek to be used in conjunction with local well head levels for drought / low water emergency trigger
	Warning	DEQ Drought Website				
	Emergency	Static head of water in local wells drops below the 5th percentile of historic records	Stream flows fall below the 5th percentile			
Town of Shenandoah	**Watch**	GW levels fall between the 10th & 25th percentile	Stream flows fall between the 10th and 25th percentile			USGS Gage South Fork Shenandoah in Luray, &
	Warning	GW levels fall between the 5h & 10th percentile	Stream flows fall between the 5h & 10th percentile			Rockingham County USGS GW Well 41Q1
	Emergency	GW levels fall below the 5th percentile	Stream flows fall below the 5th percentile			
Town of Stanley	**Watch**	GW levels fall between the 10th & 25th percentile	Stream flows fall between the 10th and 25th percentile			USGS Gage South Fork Shenandoah in Luray and
	Warning	GW levels fall between the 5h & 10th percentile	Stream flows fall between the 5h & 10th percentile			Rockingham County USGS GW Well 41Q1
	Emergency	GW levels fall below the 5th percentile	Stream flows fall below the 5th percentile			
Town of Strasburg	**Watch**		Stream flows fall between the 10th and 25th percentile (or below 70 cfs) for 7 consecutive days			USGS Gage North Fork Shenandoah at Strasburg (or below 50 cfs) for 7 consecutive days (Note: triggers for existing Strasburg intake only; new stream intake will have new drought triggers)
	Warning		Stream flows fall between the 5h & 10th percentile (or below 60 cfs) for 7 consecutive days			
	Emergency		Stream flows fall below the 5th percentile (or below 50 cfs) for 7 consecutive days			
Town of Stephens City	**Watch**		Stream flows fall between the 10th and 25th percentile			Follow drought declaration from Frederick County; USGS Gage Spout Run near Millwood
	Warning		Stream flows fall between the 5h & 10th percentile			

	Emergency		Stream flows fall below the 5th percentile			
Town of Toms Brooks	**Watch**					Local well monitoring, See triggers for Shenandoah County, since water purveyor is Toms Brook-Maurertown Sanitary District
	Warning					
	Emergency					
Town of Woodstock	**Watch**		Stream flows fall between the 10th and 25th percentile/			USGS Gage North Fork Shenandoah at Strasburg
	Warning		Stream flows fall between the 5h & 10th percentile			
	Emergency		Stream flows fall below the 5th percentile			

DEQ Drought Indicator Analysis Website

The DEQ drought indicator analysis website uses a four-square icon that is color-coded to indicate drought stage in the Shenandoah River Basin:

(http://www.deq.virginia.gov/watersupplyplanning/drought/shenandoah/current.html). The icon addresses groundwater, surface stream flow, precipitation, and Palmer Drought Severity Index. The icon color yellow indicates drought watch stage, orange denotes a drought warning stage, and red represents drought emergency stage. Localities may reference this website when making drought stage determinations. When two or more squares are colored yellow, orange, or red, a drought stage declaration may be considered by a locality.

Governor Declaration:

A drought stage may also be triggered by a declaration by the Commonwealth's Governor. Droughts declared by the Governor are based on the Virginia Drought Assessment and Response Plan and the professional judgment of the Virginia Drought Monitoring Task Force (Task Force). The Task Force includes representatives from several state, federal and local agencies, as well as universities and non-government organizations. The Task Force monitors stream flows, lake levels, precipitation, groundwater levels and other climatic indicators. In the event the Governor declares an emergency drought, there will be an automatic emergency drought designation. Likewise, gubernatorial declaration can rescind a drought stage.

C. Drought Response Actions

While some drought response actions are applicable to all jurisdictions in the planning region (see list below), other drought response actions are individually determined by each locality based upon the

environmental setting and their position within the watershed, water source, and political circumstances. Local water managers and staff will be apprised of Drought Stage declarations through the use of automated crew messaging / emergency notification. **Note:** In the event of a prolonged, multi-seasonal drought emergency, the locality reserves the right to institute a program of water rationing. It is also important to note that in addition to climate, drought refers to any low water event such as a mechanical failure, water theft, and other conditions rendering water unavailable at necessary flow to meet users in the distribution.

The NSVRC will act as a clearinghouse and provide public notification of any drought stage declaration within the region. The public notices will serve to build and raise awareness of the drought status and educate the public of early water conservation steps individuals and localities can implement. Public notification will occur through the newspaper, public service announcements, notices with water bills, and the NSVRC website. The locality websites will also the list drought stage and water conservation actions. The NSVRC website will define the drought stage with a notice that the public will be informed as to appropriate actions, as listed above. Violators of water use may have names printed in the newspaper listing the amount of water used during a drought stage.

Drought stage downgrading will be conducted by the local water purveyor, jurisdictional CAO, or designee as determined by each locality. Decisions to downgrade a stage will be based on the local trigger, DEQ, and other designated triggers as precipitation increases and soil moisture content and water levels rise in streams and wells.

Proposed Drought Response Actions

1. Drought Watch Actions:

The following are the regional actions to be taken by the respective localities when a Drought Watch stage is declared by the local water purveyor, CAO, and/or designee of a locality in the Northern Shenandoah Valley water supply planning region. Water conservation actions listed below will be encouraged when a Drought Watch is declared. It is possible that the increased public awareness of water conservation activities during a drought watch may reduce water use up to 5%.

- A Drought Watch notification will be publicized through the general news media or any other appropriate method for making such notification public. These include newspapers of general circulation such as Northern Virginia Daily, Winchester Star, Daily News Record, radio 92.5 WINC FM, television 3, etc.
- Localities will include water conservation information on their website on a northern Shenandoah Valley webpage nsvenvironment hyperlinked to the NSVRC.Com website.
- Localities will contact the Northern Shenandoah Valley Regional Commission (NSVRC) office when a drought stage is implemented. The NSVRC will update the locality's drought status on the regional drought website and nsvenvironment webpage.
- All citizens, including private well users, will be encouraged to begin voluntary water conservation actions (see below).

- Locality staff will continue to monitor drought trigger indicators on a monthly basis and report significant changes to local officials.
- Localities will increase water use efficiency and/or promote use reclaimed water for public facility landscaping.
- Leak detection consults by localities will be conducted upon request, as staff can support.
- Public waterworks and Self-Supplied water users who withdraw more than 10,000 gallons per day are asked to review and voluntarily implement existing drought water conservation methods as outlined in this plan.
- The public will continue conservation until water storage (source and distribution) is replenished.

Voluntary Water Conservation Actions:

- Mow lawns to 2 inches or more and leave clippings (higher cut encourages grass roots to grow deeper to hold soil moisture better than closely clipped lawn.).
- Use mulch around plants to reduce evaporation.
- Aerate lawn to reduce evaporation.
- Avoid over fertilizing your lawn. Fertilizer applications increase the need for water. Apply fertilizers that contain slow-release, water-insoluble forms of nitrogen.
- Place rain barrels under gutter downspouts to collect water for plants, car washing, or general cleaning projects.
- Plant native or dry-loving (xeric) plants in landscaping.
- Do not use the garbage disposal.
- Use automatic dishwasher only when load is full.
- Limit showers to 5 to 10 mins / day / person.
- Avoid running water to get cold temp, keep a pitcher of cold water in fridge.
- Wrap hot water heater and pipes with insulating material.
- Install faucet aerators.

2. Drought Warning Actions:

When a Drought Warning stage is declared by the local water purveyor, CAO, and/or designee of a locality in the Northern Shenandoah Valley water supply planning region, the following are the regional actions to be taken by the respective localities. Water conservation actions and the reduction or elimination of non-essential water uses will be encouraged when a Drought Watch is declared. It is intended that water conservation measures listed will generally result in reductions of water use of 5 to 10%.

- A Drought Warning notification shall be publicized through the general news media or any other appropriate method for making such notification public in newspapers of general circulation and radio and television.
- Localities will include water conservation information on their website.

- Localities will contact the Northern Shenandoah Valley Regional Commission (NSVRC) office when the Drought Warning stage is implemented. The NSVRC will update the locality's drought status on the regional drought website and nsvenvironment webpage.
- Public waterworks and Self-Supplied water users who withdraw more than 10,000 gallons per day will initiate voluntary water conservation measures.
- All local government offices and institutions should consider the reduction or elimination of non-essential water uses with the goal of reducing water usage by 5 to 10%.
- Locality staff will continue to monitor drought triggers monthly to indicate levels and report significant changes to local officials.
- Leak detection consults by localities will be conducted upon request, as staff can support.
- Continue conservation until water storage (source & distribution) is replenished.
- All citizens, including private well users, will be encouraged to voluntarily reduce or eliminate non-essential water uses (see under Drought Emergency Actions) and follow the water conservation actions.

Voluntary Water Conservation Actions:

In addition to those actions listed under the Drought Watch section:

- Use a broom instead of a hose to clean driveways, walks and patios.
- Do not wash hard surfaces or buildings.
- Turn off ornamental fountains or other such structures, unless the water is recycled.
- Reduce lawn watering to no more than 2 times a week, between the hours of 9:00 p.m. and 10:00 a.m.
- Reduce vegetable garden watering by watering only when needed, between the hours of 9:00 p.m. and 10:00 a.m.
- Apply water directly to plants by using soil-soakers or drip irrigation. Avoid use of sprinklers.
- Do not plant new landscaping or grass.

3. Drought Emergency Actions:

The following mandated actions will be implemented when a Drought Emergency is declared by the local water purveyor, CAO and/or designee of a locality in the Northern Shenandoah Valley water supply planning region. The non-essential uses listed below are prohibited during the drought emergency stage.

- A Drought Emergency notification shall be publicized through the general news media or any other appropriate method for making such notification public.
- Localities will include water conservation information on their website.
- Localities will contact the Northern Shenandoah Valley Regional Commission (NSVRC) office when the Drought Warning stage is implemented. The NSVRC will update the locality's drought status on the regional drought website.

- All citizens, including private well users, will initiate the mandatory non-essential water use restrictions listed below and follow the water conservation actions listed under the Drought Watch and Warning sections above.
- Public waterworks and Self-Supplied water users who withdraw more than 10,000 gallons per day will initiate the mandatory non-essential water use restrictions listed below and follow the water conservation actions listed under the Drought Watch and warning sections above.
- All local government offices and institutions will initiate the mandatory non-essential water use restrictions listed below with the goal of reducing water usage by 10 to 15%.
- Localities will be authorized to adopt local ordinances to enforce the mandatory non-essential water use restrictions listed below and to establish, collect, and retain fees for violations of these restrictions.
- Locality staff will continue to monitor drought indicators on a monthly basis and report significant changes to local officials.
- Localities may consider developing increased conservation rate charges or surcharges to respond to drought conditions.
- All users continue conservation until water storage (source & distribution) is replenished.
- Commercial customers are to follow the mandatory non-essential water use restrictions listed below, where appropriate.
- All other residential, business and industrial water users; whether supplied by public water supplies, Self-Supplied sources, or private water wells; who do not normally utilize water for any of the non-essential uses listed below are requested to voluntarily reduce water consumption by at least 10%. This reduction may be the result of elimination of other non-essential water uses, application of water conservation practices, or reduction in essential water uses.

Non-Essential Water Uses

The following non-essential water uses will be prohibited during periods of declared drought emergencies. Below each non-essential use is a list of exceptions. These prohibitions and exceptions will apply to uses from all sources of water and will only be effective on an individual locality basis when a locality in the Northern Shenandoah Valley water supply planning region declares a Drought Emergency. The conservation actions listed in the Drought Watch and Warning section of the Northern Shenandoah Valley Drought Plan become mandatory during the Drought Emergency stage.

Local governments and public waterworks may impose water use restrictions more or less stringent than the mandatory non-essential water use restrictions listed below consistent with local water supply conditions at any time. Nothing contained in this drought response plan should be construed to limit the powers of the local governments to adopt and enforce local emergency ordinances as necessary to protect the public welfare, safety, and health.

Water use restrictions shall not apply to the agricultural production of food or fiber, the maintenance of livestock including poultry, nor the commercial production of plant materials so long as best management practices are applied to assure the minimum amount of water is utilized.

1. Unrestricted non-commercial watering (public or private)
Lawn Irrigation Exceptions-
- Newly sodded and seeded areas may be irrigated to establish cover on bare ground at the minimum rate necessary for no more than a period of 60 days. Irrigation rates may not exceed one inch of applied water in any 7 day period. Consider delaying seeding or sodding of new lawns.
- Gardens, bedding plants, trees, shrubs and other landscape materials may be watered with hand held containers not exceeding three (3) gallons in capacity. Watering may be done between the hours of 9:00 p.m. and 10:00 a.m. to avoid the heat of the day. Do not use sprinklers.

Golf Course Irrigation Exceptions-
- Tees and greens may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. at the minimum rate necessary.
- Fairways may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. at the minimum rate necessary not to exceed one inch of applied water in any ten-day period.
- All allowed golf course irrigation must be applied in a manner to assure that no runoff, puddling or excessive watering occurs.

Athletic Field Irrigation Exceptions-
- Athletic fields may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. at a rate not to exceed one inch per application or more than a total of one inch in multiple applications during any ten-day period. All irrigation water must fall on playing surfaces with no outlying areas receiving irrigation water directly from irrigation heads.
- Athletic fields may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. during necessary overseeding, sprigging or resodding operations at the minimum rate necessary for a period that does not exceed 60 days. Irrigation rates during this restoration period may not exceed one inch of applied water in any seven-day period.
- All allowed athletic field irrigation must be applied in a manner to assure that no runoff, puddling or excessive watering occurs.
- Irrigation is prohibited on athletic fields that are not scheduled for use within the next 120-day period.

2. Use of Fire Hydrants
Exceptions-
- Except for necessary governmental operations such as firefighting, health protection purposes, or certain testing and drills by the fire department as approved by the local government or waterworks operator

3. Washing of paved surfaces such as streets, roads, sidewalks, driveways, garages, parking areas, tennis courts, and patios; flushing of sewers and hydrants
Exceptions-

- Surfaces may be washed with hand held containers not exceeding three (3) gallons in capacity. Washing should not occur during the heat of the day.
- As needed to ensure public health and safety, and approved by the local government or waterworks operator

4. Washing or cleaning of mobile equipment including automobiles, trucks, trailers and boats
Exceptions-
- Mobile equipment may be washed at car washes that utilize reclaimed water as part of the wash process or reduce water consumption by at least 10% when compared to a similar period when water use restrictions were not in effect. Any facility operating a reclaimed water system must prominently display, in public view, a sign stating that such a recycling system is in operation.
- Mobile equipment may be washed using hand held containers not exceeding three (3) gallons in capacity or hand held hoses equipped with automatic shutoff devices provided that no mobile equipment is washed more than once per calendar month and the minimum amount of water is utilized.
- Automobile dealers and rental agencies may wash cars that are in inventory no more than once per week utilizing hand held containers not exceeding three (3) gallons in capacity, hoses equipped with automatic shutoff devices, automated equipment that utilizes reclaimed water as part of the wash process, or automated equipment where water consumption is reduced by at least 10% when compared to a similar period when water use restrictions were not in effect.

5. Use of water for the operation of ornamental fountains, artificial waterfalls, misting machines, and reflecting pools
Exceptions-
- Fountains and other means of aeration necessary to support aquatic life are permitted.

6. Filling and topping off outdoor swimming pools
Exceptions-
- Newly built or repaired pools may be filled to protect their structural integrity.
- Outdoor pools operated by commercial ventures, community associations, recreation associations, and similar institutions open to the public may be refilled as long as:
  - Levels are maintained at mid-skimmer depth or lower,
  - Any visible leaks are immediately repaired,
  - Backwashing occurs only when necessary to assure proper filter operation,
  - Deck areas are washed no more than once per calendar month (except where chemical spills or other health hazards occur),
  - All water features (other than slides) that increase losses due to evaporation are eliminated, and
  - Slides are turned off when the pool is not in operation.
- Swimming pools operated by health care facilities used in relation to patient care and rehabilitation may be filled or topped off.

7. Serving of water in restaurants, clubs, or eating-places

Exceptions-

- May only be allowed at the specific request of the customer

The NSVRC staff will continue to receive monthly reports from system operators maintain database; share information for local jurisdictions; monitor the Virginia Department of Environmental Quality (DEQ) and U.S. Geological Survey (USGS) websites; serve as a regional liaison assisting localities to publish notices of alert levels and water restrictions. In addition, staff will maintain a list of mandatory water conservation actions on the NSVRC website and news media.

Local governments and water utilities may impose more stringent watering schedules. Citizens are encouraged to contact their local water providers for more specific guidance. The water use restrictions during an emergency stage will be enforced by the locality and a violation of the ordinance will be a misdemeanor with a penalty fine determined by the locality where the violation occurred.

This Drought Response Plan is designed to present the best available practices to date; however, the plan remains flexible to incorporate best technologies as available and actual practices that were determined to be most suitable in response to real droughts. The contents of this Drought Response Plan are subject to revision a minimum of every five years, in accordance with state regulations. In addition, in the event of a drought, practices and actions that best support drought remediation will be substituted in future plans.

The Counties of Clarke and Warren currently have a drought response plan in place. In addition, Frederick County has a FCSA Drought management Plan.

Addenda to Chapter 7: Water supply systems

(Surface Water = SW, Groundwater = GW)

North Fork Shenandoah Watershed by Locality from South to North on the North Fork of the Shenandoah River

- Town of New Market – Groundwater wells (6 wells)
- Town of Mount Jackson – GW wells (5 wells)
- Town of Edinburg – GW wells (2 wells)
- Town of Woodstock – SW intake on North Fork Shenandoah River
- Shenandoah County – Stoney Creek Sanitary District GW wells (7 wells)
- Town of Toms Brook – GW wells (2 wells)
- Town of Strasburg – SW intake on North Fork Shenandoah River
- City of Winchester – SW intake on the North Fork Shenandoah

South Fork Shenandoah Watershed by Locality from South to North on the South Fork of the Shenandoah River

- Town of Shenandoah – GW wells (3 wells)
- Town of Stanley – GW wells (6 wells)
- Town of Luray – 2 Springs and 1 GW well
- Page County - provided by town of Stanley & GW well system
- Warren County
- Town of Front Royal – SW intakes on Sloan Creek, Happy Creek, South Fork of the Shenandoah River

Main Stem of the Shenandoah Watershed by Locality from South to North on the Main Stem Shenandoah River

- Town of Middletown – purchase water from City of Winchester
- Town of Stephens City – purchase water from Frederick County Sanitation Authority (FCSA)
- Frederick County – FCSA Quarries, 3 GW wells, purchase from Winchester
- City of Winchester – SW intake on the North Fork of the Shenandoah River
- Clarke County – Spring water
- Town of Boyce – from Clarke County Service Authority (CCSA)
- Town of Berryville – SW stream intake Shenandoah River (main stem)

8.0 STATEMENT OF NEED

Winchester:

The City of Winchester has two water sources (river intake and a spring) with a combined maximum capacity of 15 MGD. The future growth scenarios increase the demand to 9.11 MGD. This demand can be met by the existing sources, with an estimated 5.9 MGD surplus in water supply, as presented below.

Clarke County, Towns of Berryville and Boyce:

Town of Berryville:

Berryville will meet future projected water needs through 2040 based on uses presented below. However, peak water usage in 2040 exceed the current VDH permitted capacity of water. Therefore, a new permit would be necessary for increased water withdrawal. In addition, implementation of water conservation techniques will decrease water use by 20% thereby, resulting in future peak days demands to be met by existing sources.

Town of Boyce:

The existing supplies and permits for water for the Town of Boyce will meet future water demands to 2040 based on water uses projected below. It should be noted that a decrease in per capita usage of 132 gpd/user would also decrease water demand. A peak factor of 1.2 was used to predict water use on peak days. If a peaking rate of 1.5 were used, the peak day water use by 2040 would not be met, although the annual water demand for 2040 would be satisfied.

Frederick County, Towns of Middletown and Stephens City:

In Frederick County there are two towns, both of which purchase water from another locality or entity. The Town of Middletown purchases water from the City of Winchester. The Frederick County Sanitation Authority provides water wholesale to the Town of Stephens City. In addition, Frederick County Sanitation Authority provides water to County residents located in the vicinity near the City of Winchester.

Estimates of future water demand for those serviced by the Frederick County Sanitation Authority include residential water demand, commercial demand, sales to Stephens City, and unaccounted for losses. Several assumptions were made including the demand by commercial light industrial users and will remain the same from 2008 through 2040. The quantity of water to be sold to Stephens City will remain the same from 2008 through 2040, and the unaccounted for system losses will remain the same from 2010 through 2040, assuming appliance efficiency and distribution upgrades occur. The projected number of residents to be serviced by the Frederick County Sanitation Authority was assumed to remain proportionate to the overall County population from 2008 and 2010. If the Sanitation Authority service area increases based on the projections below and the assumptions of water loss, sales, and commercial demand remain static, the demands projected through 2040 are as follows.

The permitted design capacity for the Frederick County Sanitation Authority is 4.928 MGD. The Bartonsville well site has a capacity of 0.5 MGD totaling 5.42 MGD capacity. The Frederick County

Sanitation Authority also purchases up to 2 million gallons a day (MGD) from the City of Winchester. Given the sum total of water available through existing water sources of 7.92 MGD, a deficit of water in Frederick County is anticipated to occur between 2020 and 2030. If the Frederick County Sanitation Authority service area continues to serve the same percent of the County population as it increases over time, there will be a proportional increase in residents served by the Sanitation Authority. However, it should be noted that the Virginia Department of Health recommends that once a locality's water demand exceeds 80% of the source capacity, additional water should be secured. The water demand projected for 2020 is 7.83 MGD which exceeds 80% of the 7.92 source capacity. Therefore, it is recommended that between present time and 2020, Frederick County plan for additional water supplies to meet future demands. Either the Sanitation Authority will have to expand their water supply capacity and / or the service area will have to remain at or near the number of 2010 residential connections. Or, as population increases in the County, more residences will need to be required to use groundwater wells.

Town of Middletown:
The Town of Middletown is anticipated to use water at the rates projected below. Given those rates, the Town will need to look for sources of water by 2030 to meet the demand that will exceed the existing water purchase contract with the City of Winchester. The existing water contract is capped for Middletown at 0.238 MGD. It should be noted, these preliminary projections of water are based on a per capita water daily demand that exceeds state averages (152 gallons per day). Calculations using state averages of 125 gpd per person would lower the demand. Measures of conservation and other reduction implementation strategies could also significantly reduce the water demand and thereby not necessitate additional water supplies for the future planning period.

Town of Stephens City:
The Town of Stephens City has water supplied by the Frederick County Sanitation Authority. Based on projections, the Town of Stephen City water use is expected to be met by the existing water system and supplies through 2040.

<u>Page County, and Towns of Luray, Shenandoah, and Stanley</u>

Based on the ubiquitous nature of groundwater underlying Page County, future demands are anticipated to be met with groundwater wells.

Town of Luray:
All future users for water in the Town of Luray are anticipated to be met by the existing water supplies and permitted capacity to the year 2040. The peak demand for 2040 potentially exceeds the permitted capacity by 2030; however, daily consumptive uses could implement conservation to extend the supply of the sources to satisfy future uses.
Disaggregated water use was available for the Town of Luray and is presented below:

Water System Name	System Total (MGD)	Residential (MGD)	Commercial Institutional Light Industrial	Heavy industrial (MGD)	Unaccounted for Losses

			(gpd)		
Luray	.944	0.392 (0.1% increase expected) (80 gpd x 4,895 residents in 2010)	(0.152 MGD) 650/conn - Comm 2,125 /conn - Lt Ind (.13% = 4 new expected)	0.45/user (0.07% increase expected or 2 new)	0.331 (averages 35%)

Town of Shenandoah:
Even with a higher than average per capita usage, the Town of Shenandoah is anticipated to have all future water demands met by their exiting supplies. See the summary below of future use projections and have a surplus of 0.3 MGD.

Town of Stanley:
Future water demands are anticipated to be met by existing water supplies for the Town of Stanley through 2040 with a surplus of 0.05 MGD for peak days by 2040.

Shenandoah County, Towns of Edinburg, Mt. Jackson, New Market, Strasburg, Toms Brook, and Woodstock:
Based on future water use in Shenandoah County the existing water supplies from Stoney Creek Sanitary District and groundwater wells are anticipated to meet future water use. It is assumed that future development outside water supply service areas will require well development to support housing in rural areas.

Town of Edinburg:
Future Water uses are anticipated to be met by the existing water supplies in the Town of Edinburg through the planning period to 2040. As is (with no conservation practices implemented), the 2040 average demand would be met by existing wells supplies with a surplus of 0.172 MGD.

Town of Mount Jackson:
The Town of Mount Jackson will have all water demands met by existing supplies. The per capita water usage rate was fairly low for Mount Jackson. The peaking rate was also low for the Town, at 1.2. The Town will have a surplus of 0.26 MGD in 2040 for average daily use, and a surplus of 0.172 MGD for peak days by 2040.

Town of New Market:
The Town of New Market will have all future water demands up through 2040 satisfied by existing Town water sources. By 2040, there will be a surplus of 1.238 MGD on peak days and a surplus of 1.779 MGD on average daily usage days.

Town of Strasburg:
The Town of Strasburg will have water demands met through Town supplies throughout the planning period of 2040. Based on increased permitted source to 3 MGD it is estimated that given the usage

predicted in this Plan, by 2040 the Town will have a surplus of 1.72MGD for average daily use and a surplus of 1.55 MGD for peak days.

Town of Toms Brook:
The Sanitary District has a permitted capacity of 0.298 MGD. Calculated future water use for the Town of Toms Brook will be met throughout the planning horizon of 2040 with a surplus of water from the existing source, Sanitary District.

Town of Woodstock:
The Town of Woodstock will be able to satisfy all water demands through 2040 from the Town intake on the Shenandoah River. Based on demand calculations, there will be a water surplus of 0.137 MGD by 2040 on peak days and a surplus of 0.191 MGD on average daily use days.

Warren County and the Town of Front Royal:
The projected future water demands in Warren County are anticipated to be met through 2040. In general, additional rural development will require groundwater well construction to meet future needs in areas outside community water service systems.

Town of Front Royal:
Projected water use in the Town of Front Royal was calculated from 2008 water average daily water use of 2.048 MGD and peak day usage in 2008 was 3.35 MGD. Based on projected uses, the Town of Front Royal will meet residential water use and peak uses through 2040 with a permitted capacity of 4 MGD. It should be noted that disaggregated water use for other sectors such as business and system losses is not included in this estimated demand (was not reported for by most Towns).

NSRVC Water Supply Plan: Population & Projections

	Decennial Census Count					Projected Population*			% County Population		Avg. % of County Population 2000-2010
County/*Town*	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**	**2030**	**2040^**	**2000**	**2010**	
Clarke County	**8,102**	**9,965**	**12,101**	**12,652**	**14,034**	**18,320**	**21,230**	**26,027**			
Berryville				2,963	4,185	4,877	5,651	6,928	23.4%	29.8%	26.6%
Boyce				426	589	693	803	984	3.4%	4.2%	3.8%
Frederick County	**28,893**	**34,150**	**45,723**	**59,209**	**78,305**	**95,648**	**114,539**	**142,853**			
Middletown				1,015	1,265	1,626	1,947	2,428	1.7%	1.6%	1.7%
Stephens City (Town)				1,146	1,829	2,009	2,405	3,000	1.9%	2.3%	2.1%
Page County	**16,581**	**19,401**	**21,690**	**23,177**	**24,042**	**25,659**	**27,038**	**28,539**			
Luray				4,871	4,895	5,311	5,597	5,908	21.0%	20.4%	20.7%

Shenandoah (Town)				1,878	2,373	2,309	2,433	2,568	8.1%	9.9%	9.0%
Stanley				1,326	1,689	1,642	1,730	1,826	5.7%	7.0%	6.4%
Shenandoah County	**22,852**	**27,559**	**31,636**	**35,075**	**41,993**	**49,427**	**56,927**	**66,906**			
Edinburg				813	1,041	1,186	1,366	1,606	2.3%	2.5%	2.4%
Mount Jackson				1,664	1,994	2,323	2,676	3,145	4.7%	4.7%	4.7%
New Market				1,637	2,146	2,422	2,789	3,278	4.7%	5.1%	4.9%
Strasburg				4,017	6,398	7,573	8,963	10,609	11.5%	15.2%	13.4%
Toms Brook				255	258	345	398	468	0.7%	0.6%	0.7%
Woodstock				3,952	5,097	5,783	6,660	7,828	11.3%	12.1%	11.7%
Warren County	**15,301**	**21,200**	**26,142**	**31,584**	**37,575**	**45,722**	**53,092**	**65,143**			
Front Royal (1)				13,589	14,440	16,069	17,543	19,954		20.0%	
Front Royal (2)				13,589	14,440	19,660	22,830	28,011	43.0%	38.4%	40.7%
Winchester (City)	**14,643**	**20,210**	**21,947**	**23,585**	**26,203**	**29,339**	**32,485**	**36,571**			
Region (Total)	**106,372**	**132,485**	**159,239**	**185,282**	**222,152**	**264,115**	**305,311**	**366,039**			

Notes:

*Projected using US Census 1970-2010 and Virginia Employment Commission (2020, 2030) for extrapolated straightline projection from 2000 to 2030

^2040 population estimated using % change 2000 to 2030

Population estimates for Mt Jackson, New Market, Strasburg and Woodstock include an additional 20% projected future growth rate increase

Front Royal (1) Assumes 20% of the County population resides within the town

Front Royal (2) assumes trend of average % of county population 2000-2010

9.0 ALTERNATIVES ANALYSIS

Improvements to existing water supply sources will increase the water yield available for many localities. In the table below, the limiting capacity for sources is noted, with likely yields available as noted on Virginia Department of Health engineering design sheets.

Locality	Source	Capacity MGD	Notes
Clarke County	Prospsect Hill Intake	0.18	
	Private CWS Groundwater	0.0728	
Berryville Town	Shenandoah River intake	0.864	
Boyce Town	CCSA (incl above)		
Frederick County	Quarries	6	
	FCSA 3 Groundwater wells	1.993	Combined permitted (not used)
	Winchester purchase	2	
	Private CWS Combined Groundwater	0.749	
Middletown Town	Purchase from Winchester	0.238	Currently averging 0.11 MGD
Stephens City Town	Purchase from Fred Co Sanitation Authority		
Page County	Private CWS Groundwater	0.101	
Luray Town	Yager Spring	8.0+	Currently not developed.
Shenandoah Town	Wells combined	0.601	
Stanley Town	Wells combined	0.806	
Shenandoah County	Sanitary District CWS wells	0.393	
	Private CWS	0.129	Max design Capacity = 0.609
	George's Chicken Private CWS	14.98	
Edinburg Town	Wells combined	0.24	Max design = 0.432
Mount Jackson Town	Wells combined	0.699	Plus 2 additional wells not in system but permitted
New Market Town	Wells combined	2.92	Some well yields unknown
Strasburg Town	Intake, Shenandoah River	1	New intake permitted 3MGD
Toms Brook Town	Purchase from Sanitary District wells	0.298	
Woodstock Town	intake Shenandoah River	2.02	
Warren County	Private CWS combined Groundwater	0.387	Max 0.4104 MGD
Front Royal Town	Intakes combined on South Fork	3	(Additional Spring purchased, not on-line)
Winchester City	Shenandoah River Intake North Fork	14	
	2 Springs Faye		not tied into system, located 3-4 miles north of City

To meet long-term water supply demands, decision-makers can consider the following options, or

combinations of these options, to supplement existing water resources: water conservation, water reuse, groundwater recharge, and desalination. Water conservation is an effective method where saved water can compensate for additional demand. A gallon of water that is conserved by one user essentially 'creates' a gallon of water for another user. Ensuring water conservation not just during drought but also during normal years requires public education programs. However, conservation by itself is unlikely to meet increased water demand.

Water reuse is another option. Currently, reclaimed water is reused in industry and agriculture in the U.S. and other countries. Similar to water conservation, each gallon of reused water substitutes for a gallon of water that from natural sources. An example of a successful water reuse strategy is the Occoquan reservoir system in northern Virginia. The Upper Occoquan Sewage Authority (UOSA) Water Reclamation Facility is one of the nation's largest and most successful projects for the indirect reuse of reclaimed water to supplement a public surface water supply. Implementation of reuse strategies in other localities involves revisions to public perception and public policy.

Preservation and restoration of groundwater aquifers is another water conservation option. Elements of long-term water supply planning should include protecting aquifer recharge zones, and increasing subsurface infiltration and groundwater recharge by implementing low-impact development techniques such as forestation and bioretention in urban and suburban areas. Underground storage of excess water in half-empty aquifers during wet periods and artificial recharge of highly treated wastewater are options to be studied for their potential to meet future water demand.

There are several measures, or a combination of measures, that Virginia can implement to meet future water demand. However, some of the conventional methods to meet future water demands may not be considered practical or economical any longer. For example, building dams and reservoirs, one of the popular water storage and supply measures, may not be viable solutions because of the high cost of acquiring land, and meeting environmental and regulatory requirements. During past decades, interwatershed water transfer has supplied water to some regions of the state. However, long-term economic, environmental, regulatory, and societal implications of future water transfer projects remains uncertain. Some localities are working on alternative options to meet future water needs should such an event arise. Specifically, he Town of Edinburg has considered four alternative water supplies in the event that would be needed to meet future water demands. The four alternatives are listed below:

1. The current Well #1 is located over an underground aquifer pooled as in an underground lake. The Town has discussed enlarging the well at this site to allow for more water withdrawal, since the water treatment plant is also on site and could treat more water if it was available.

2. The Town has discussed going back to using our mountain springs as part of the Town Source wellhead protection plan. The Town still owns 14 acres of land with the springs within the National

Forest. The water lines are still in place connecting to an old Town reservoir. If pursued, this alternative would require infrastructure improvements to the pipes. The plan would be to use an existing 500,000 gallon concrete reservoir as a raw water tank and place a small treatment plant on the site for finished water. The Town currently has a 100,000-gallon storage tank at the site and could construct additional storage there for finished water. This would be sent to Town in the existing water line that crosses the River from the reservoir property.

3. A third alternative water supply the Town has considered is the location of a large spring less than a quarter mile from Edinburg's current Water Treatment Plant. It is estimated at 1,000,000 gallons a day and is not directly associated with the Town's current wells. A pump station could be constructed at this spring and a raw water line installed to convey the water to the current water treatment plant.

4. A fourth alternative includes the possibility of joining interconnections with the Town of Woodstock's water supply. A recent line construction has moved Woodstock's system closer to Edinburg, which was sized to allow for future extension south, toward Edinburg.

Appendices

Threatened and Endangered Species in the

Northern Shenandoah Valley Planning Region Aquatic Habitats

VaFWIS Search Report Compiled on 1/6/2010, 2:45:00 PM

Database Search in (840) Winchester City [County], VA

73 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 29) (29 species with Status* or Tier I**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
030062	ST	I	Turtle, wood	Glyptemys insculpta		BOVA,HU6
040096	ST	I	Falcon, peregrine	Falco peregrinus	Yes	CBC
040129	ST	I	Sandpiper, upland	Bartramia longicauda		BOVA
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus	Yes	BOVA,HU6,CBC
100155	FSST	I	Skipper, Appalachian grizzled	Pyrgus wyandot		BOVA,HU6
040093	FSST	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,HU6,CBC
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA
100248	FS	I	Fritillary, regal	Speyeria idalia idalia		BOVA,HU6
100256	FS	II	Crescent, tawny	Phyciodes batesii batesii		BOVA,HU6
040372	SS	I	Crossbill, red	Loxia curvirostra	Yes	CBC
040306	SS	I	Warbler, golden-winged	Vermivora chrysoptera		BOVA,HU6
040213	SS	II	Owl, northern saw-whet	Aegolius acadicus	Yes	HU6,CBC
040266	SS	II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,CBC
040094	SS	III	Harrier, northern	Circus cyaneus	Yes	BOVA,HU6,CBC
040204	SS	III	Owl, barn	Tyto alba pratincola	Yes	BOVA,HU6,CBC

040270	SS	III	Wren, sedge	Cistothorus platensis		HU6
030012	CC	IV	Rattlesnake, timber	Crotalus horridus		HU6
040264	SS	IV	Creeper, brown	Certhia americana	Yes	BOVA,HU6,BBA,CBC
040364	SS		Dickcissel	Spiza americana		BOVA
040366	SS		Finch, purple	Carpodacus purpureus	Yes	BOVA,CBC
040285	SS		Kinglet, golden-crowned	Regulus satrapa	Yes	BOVA,CBC
040112	SS		Moorhen, common	Gallinula chloropus cachinnans		BOVA
040262	SS		Nuthatch, red-breasted	Sitta canadensis	Yes	BOVA,CBC
040210	SS		Owl, long-eared	Asio otus	Yes	CBC
040278	SS		Thrush, hermit	Catharus guttatus	Yes	BOVA,CBC
040314	SS		Warbler, magnolia	Dendroica magnolia		BOVA
050045	SS		Otter, northern river	Lontra canadensis lataxina		BOVA
040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius	Yes	BOVA,CBC
040319		I	Warbler, black-throated green	Dendroica virens		BOVA

VaFWIS Search Report Compiled on 1/6/2010, 2:51:11 PM

Database Search in (069) Frederick [County], VA

91 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 38) (38 species with Status* or Tier I**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
050023	FESE	I	Bat, Indiana	Myotis sodalis		HU6
070001	FTST	II	Isopod, Madison Cave	Antrolana lira		HU6
040267	SE	I	Wren, Bewick's	Thryomanes bewickii	Yes	BOVA,BBS
060006	SE	II	Floater, brook	Alasmidonta varicosa		HU6

060201	FSSE	II	Springsnail, Appalachian	Fontigens bottimeri	Yes	HU6,TEWater
030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes	BOVA,HU6,Collections,TEWater
040096	ST	I	Falcon, peregrine	Falco peregrinus	Yes	BOVA,BBA,CBC
040129	ST	I	Sandpiper, upland	Bartramia longicauda	Yes	BOVA,HU6,BBA,BBS
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus	Yes	BOVA,HU6,BBA,BBS,CBC,Collections
100155	FSST	I	Skipper, Appalachian grizzled	Pyrgus wyandot		BOVA,HU6
040093	FSST	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,HU6,CBC
060081	ST	II	Floater, green	Lasmigona subviridis	Yes	HU6,Collections
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA
100248	FS	I	Fritillary, regal	Speyeria idalia idalia		BOVA,HU6
100343	FS	II	Beetle, thin-neck cave	Pseudanophthalmus parvicollis		HU6
100256	FS	II	Crescent, tawny	Phyciodes batesii batesii		BOVA,HU6
060029	FSSS	III	Lance, yellow	Elliptio lanceolata		HU6
040372	SS	I	Crossbill, red	Loxia curvirostra	Yes	CBC
040306	SS	I	Warbler, golden-winged	Vermivora chrysoptera		BOVA,HU6
040213	SS	II	Owl, northern saw-whet	Aegolius acadicus	Yes	HU6,CBC
040266	SS	II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,CBC
040094	SS	III	Harrier, northern	Circus cyaneus	Yes	BOVA,HU6,CBC,Collections
040204	SS	III	Owl, barn	Tyto alba pratincola	Yes	BOVA,HU6,BBA,CBC,Collections
040270	SS	III	Wren, sedge	Cistothorus platensis		HU6
060071	SS	III	Lampmussel, yellow	Lampsilis cariosa		HU6

030012	CC	IV	Rattlesnake, timber	Crotalus horridus		HU6
040264	SS	IV	Creeper, brown	Certhia americana	Yes	BOVA,HU6,BBA,CBC,Collections
040364	SS		Dickcissel	Spiza americana	Yes	BOVA,BBA
040366	SS		Finch, purple	Carpodacus purpureus	Yes	BOVA,CBC
040285	SS		Kinglet, golden-crowned	Regulus satrapa	Yes	BOVA,CBC
040112	SS		Moorhen, common	Gallinula chloropus cachinnans		BOVA
040262	SS		Nuthatch, red-breasted	Sitta canadensis	Yes	BOVA,CBC
040210	SS		Owl, long-eared	Asio otus	Yes	CBC
040278	SS		Thrush, hermit	Catharus guttatus	Yes	BOVA,CBC
040314	SS		Warbler, magnolia	Dendroica magnolia		BOVA
050045	SS		Otter, northern river	Lontra canadensis lataxina		BOVA
040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius	Yes	BOVA,CBC
040319		I	Warbler, black-throated green	Dendroica virens		BOVA

To view **All 91 species** View 91

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

****** I=VA Wildlife Action Plan - Tier I - Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need

View Map of All Query Results from All Observation Tables

Anadromous Fish Use Streams

N/A

Impediments to Fish Passage

(22 records - displaying first 20)

View Map of All Fish Impediments

ID	Name	River	View Map
1086	BUTLER DAM	BABBS RUN	Yes
1089	CHEROKEE DAM	KECKLEY RUN	Yes
1096	COVE DAM #2	TR-LAUREL RUN	Yes
1090	COVE LAKE DAM #1	TR-LAUREL RUN	Yes
1143	FRESHWATER POND	MINES SPRING RUN	Yes
1095	HIGH VIEW MANOR DAM	HOGUE RUN	Yes
1099	IZAAK WALTON PARK POND	TR-OPEQUON CREEK	Yes
1097	LAKE FREDRICK DAM	CROOKED RUN	Yes
1104	LAKE ISAACS DAM	ISAAC CREEK	Yes
1103	LAKESIDE LAKE	TR-OPEQUON CREEK	Yes
1091	LEHMANS DAM	GOUGH RUN	Yes
1094	MEADOWLAKE DAM	HUGUE CREEK	Yes
1093	PLEASANT VALLEY LAKE DAM	TR-FURNACE BRANCH	Yes
1100	SEVEN VISTAS DAM	TR-CEDAR CREEK	Yes
1092	SHEPPARD LAKE DAM	TR-OPEQUON CREEK	Yes
1087	SILVER LAKE DAM	PARRISH RUN	Yes
1088	ST. CLAIR DAM	BABBS RUN	Yes
1145	STEPHENS PARK DAM	TR-CROOKED RUN	Yes
1098	SUMMIT DAM	ISAACS CREEK	Yes
1144	TAILINGS POND	MINES SPRING RUN	Yes

To view **All 22 Fish Impediment records** View 22

Colonial Water Bird Survey

N/A

Threatened and Endangered Waters

(35 Reaches - displaying first 20)

View Map of All Threatened and Endangered Waters

Stream Name	T&E Waters Species						View Map
	Highest TE*	BOVA Code, Status*, Tier**, Common & Scientific Name					
Buffalo Marsh Run (02070006)	FSSE	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
		060201	FSSE	II	Springsnail, Appalachian	Fontigens bottimeri	
Buffalo Marsh Run (02070006)	FSSE	060201	FSSE	II	Springsnail, Appalachian	Fontigens bottimeri	Yes
Unnamed trib. of Hogue Creek (02070004)	FSSE	060201	FSSE	II	Springsnail, Appalachian	Fontigens bottimeri	Yes
Albin Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Babbs Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Back Creek (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Bear Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Brush Creek (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Cedar Creek (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Crockett Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes

Dry Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Duck Run (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Fall Run (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Froman Run (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Furnace Run (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Gap Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Gravel Springs Run (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Green Spring Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Hogue Creek (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Isaacs Creek (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Laurel Run (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes
Little Brush Creek (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta		Yes

To view **All 35 Threatened and Endangered Waters records** View 35

VaFWIS Search Report Compiled on 1/6/2010, 2:53:56 PM

Database Search in (043) Clarke [County], VA

86 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 33) (33 species with Status* or Tier I**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
070001	FTST	II	Isopod, Madison Cave	Antrolana lira	Yes	HU6,Collections
060006	SE	II	Floater, brook	Alasmidonta varicosa		HU6
030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes	BOVA,HU6,TEWater

040096	ST	I	Falcon, peregrine	Falco peregrinus	Yes	CBC
040129	ST	I	Sandpiper, upland	Bartramia longicauda	Yes	BOVA,HU6,BBA,Collections
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus	Yes	BOVA,HU6,BBA,CBC,Collections
100155	FSST	I	Skipper, Appalachian grizzled	Pyrgus wyandot		HU6
040093	FSST	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,HU6,BBA,CBC,Collections
060081	ST	II	Floater, green	Lasmigona subviridis		HU6
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA
100248	FS	I	Fritillary, regal	Speyeria idalia idalia		BOVA,HU6
100256	FS	II	Crescent, tawny	Phyciodes batesii batesii		HU6
040372	SS	I	Crossbill, red	Loxia curvirostra	Yes	CBC
040306	SS	I	Warbler, golden-winged	Vermivora chrysoptera	Yes	BOVA,HU6,BBA
040213	SS	II	Owl, northern saw-whet	Aegolius acadicus	Yes	HU6,CBC,Collections
040266	SS	II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,CBC
040094	SS	III	Harrier, northern	Circus cyaneus	Yes	BOVA,HU6,CBC
040204	SS	III	Owl, barn	Tyto alba pratincola	Yes	BOVA,HU6,CBC
040270	SS	III	Wren, sedge	Cistothorus platensis		BOVA,HU6
030012	CC	IV	Rattlesnake, timber	Crotalus horridus		HU6
040264	SS	IV	Creeper, brown	Certhia americana	Yes	BOVA,HU6,CBC,Collections
040364	SS		Dickcissel	Spiza americana	Yes	BOVA,BBA
040366	SS		Finch, purple	Carpodacus purpureus	Yes	BOVA,CBC,Collections
040238	SS		Flycatcher, yellow-bellied	Empidonax flaviventris	Yes	Collections
040285	SS		Kinglet, golden-crowned	Regulus satrapa	Yes	BOVA,CBC,Collections

040112	SS		Moorhen, common	Gallinula chloropus cachinnans		BOVA
040262	SS		Nuthatch, red-breasted	Sitta canadensis	Yes	BOVA,CBC,Collections
040210	SS		Owl, long-eared	Asio otus	Yes	BOVA,CBC
040278	SS		Thrush, hermit	Catharus guttatus	Yes	BOVA,CBC,Collections
040314	SS		Warbler, magnolia	Dendroica magnolia	Yes	BOVA,Collections
050045	SS		Otter, northern river	Lontra canadensis lataxina		BOVA
040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius	Yes	BOVA,CBC,Collections
040319		I	Warbler, black-throated green	Dendroica virens	Yes	BOVA,Collections

To view **All 86 species** View 86

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

****** I=VA Wildlife Action Plan - Tier I - Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need

View Map of All Query Results from All Observation Tables

Anadromous Fish Use Streams

N/A

Impediments to Fish Passage

(1 records)

View Map of All Fish Impediments

ID	Name	River	View Map
1085	SHORT HILL FARM DAM	CRAIG RUN	Yes

Colonial Water Bird Survey

N/A

Threatened and Endangered Waters

(1 Reaches)

View Map of All
Threatened and Endangered Waters

Stream Name	T&E Waters Species						View Map
	Highest TE*	BOVA Code, Status*, Tier**, Common & Scientific Name					
Opequon Creek (02070004)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes

Cold Water Stream Survey (Trout Streams)
Managed Trout Species

VaFWIS Search Report Compiled on 1/6/2010, 2:57:50 PM

Database Search in (139) Page [County], VA

103 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 39) (39 species with Status* or Tier I**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
020045	FESE	I	Salamander, Shenandoah	Plethodon shenandoah	Yes	BOVA,HU6,Collections
050023	FESE	I	Bat, Indiana	Myotis sodalis		HU6
050035	FESE	II	Bat, Virginia big-eared	Corynorhinus townsendii virginianus		HU6
200010	FEST		Rock-cress, shale barren	Arabis serotina	Yes	Collections
060006	SE	II	Floater, brook	Alasmidonta varicosa		HU6
030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes	BOVA,HU6,Collections,TEWater
040096	ST	I	Falcon, peregrine	Falco peregrinus	Yes	BOVA,HU6,Collections
040129	ST	I	Sandpiper, upland	Bartramia longicauda		BOVA
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus	Yes	BOVA,HU6,BBA,BBS,CBC,Collections
100155	FSST	I	Skipper, Appalachian grizzled	Pyrgus wyandot		HU6

040093	FSST	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,HU6,Collections
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA
100248	FS	I	Fritillary, regal	Speyeria idalia idalia	Yes	BOVA,HU6,Collections
070011	FS	II	Amphipod, Luray Caverns	Stygobromus pseudospinosus		HU6
100329	FS	II	Beetle, Avernus cave	Pseudanophthalmus avernus		HU6
100337	FS	II	Beetle, Hubbard's cave	Pseudanophthalmus hubbardi		HU6
100344	FS	II	Beetle, Petrunkevitch's cave	Pseudanophthalmus petrunkevitchi		HU6
040372	SS	I	Crossbill, red	Loxia curvirostra	Yes	BBA,CBC
040306	SS	I	Warbler, golden-winged	Vermivora chrysoptera	Yes	BOVA,HU6,BBA
040213	SS	II	Owl, northern saw-whet	Aegolius acadicus	Yes	HU6,CBC
040266	SS	II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,HU6,BBA,CBC,Collections
030063	CC	III	Turtle, spotted	Clemmys guttata		HU6
040094	SS	III	Harrier, northern	Circus cyaneus	Yes	BOVA,HU6,CBC
040204	SS	III	Owl, barn	Tyto alba pratincola	Yes	BOVA,HU6,BBA,CBC,Collections
060071	SS	III	Lampmussel, yellow	Lampsilis cariosa		HU6
030012	CC	IV	Rattlesnake, timber	Crotalus horridus		HU6
040264	SS	IV	Creeper, brown	Certhia americana	Yes	BOVA,HU6,CBC,Collections
040364	SS		Dickcissel	Spiza americana		BOVA
040366	SS		Finch, purple	Carpodacus purpureus	Yes	BOVA,CBC
040285	SS		Kinglet, golden-crowned	Regulus satrapa	Yes	BOVA,BBA,CBC

040112	SS		Moorhen, common	Gallinula chloropus cachinnans		BOVA
040262	SS		Nuthatch, red-breasted	Sitta canadensis	Yes	BOVA,BBA,CBC
040210	SS		Owl, long-eared	Asio otus	Yes	CBC
040278	SS		Thrush, hermit	Catharus guttatus	Yes	BOVA,CBC,Collections
040314	SS		Warbler, magnolia	Dendroica magnolia		BOVA
050045	SS		Otter, northern river	Lontra canadensis lataxina		BOVA
030040		I	Pinesnake, northern	Pituophis melanoleucus melanoleucus		HU6
040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius	Yes	BOVA,CBC
040319		I	Warbler, black-throated green	Dendroica virens	Yes	BOVA,BBA,Collections

To view **All 103 species** View 103

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

****** I=VA Wildlife Action Plan - Tier I - Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need

View Map of All Query Results from All Observation Tables

Anadromous Fish Use Streams

N/A

Impediments to Fish Passage

(5 records)

View Map of All Fish Impediments

ID	Name	River	View Map

1107	DRY RUN DAM #101	DRY RUN	Yes
1106	DRY RUN DAM #102	NORTH DRY RUN	Yes
1109	LURAY	S FK SHENANDOAH R	Yes
1108	NEWPORT	S FK SHENANDOAH R	Yes
1148	SHENANDOAH DAM	SOUTH FORK SHENANDOAH RIVER	Yes

Colonial Water Bird Survey

N/A

Threatened and Endangered Waters

(1 Reaches)

View Map of All
Threatened and Endangered Waters

Stream Name	T&E Waters Species						View Map
	Highest TE*	BOVA Code, Status*, Tier**, Common & Scientific Name					
Passage Creek (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes

Cold Water Stream Survey (Trout Streams)
Managed Trout Species

VaFWIS Search Report Compiled on 1/6/2010, 3:01:07 PM

Database Search in (171) Shenandoah [County], VA

104 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 44) (44 species with Status* or Tier I**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
050023	FESE	I	Bat, Indiana	Myotis sodalis	Yes	BOVA,HU6,Collections
050035	FESE	II	Bat, Virginia big-eared	Corynorhinus townsendii virginianus		HU6
200010	FEST		Rock-cress, shale barren	Arabis serotina	Yes	Collections

060006	SE	II	Floater, brook	Alasmidonta varicosa	Yes	BOVA,HU6,Collections,TEWater
060201	FSSE	II	Springsnail, Appalachian	Fontigens bottimeri	Yes	HU6,TEWater
030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes	BOVA,HU6,Collections,ObsBook,TEWater
040096	ST	I	Falcon, peregrine	Falco peregrinus	Yes	BOVA,HU6,BBA,CBC,Collections
040129	ST	I	Sandpiper, upland	Bartramia longicauda	Yes	BOVA,HU6,Collections
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus	Yes	BOVA,HU6,BBA,BBS,CBC,Collections
100155	FSST	I	Skipper, Appalachian grizzled	Pyrgus wyandot		HU6
040093	FSST	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,HU6,CBC,Collections,ObsBook
060081	ST	II	Floater, green	Lasmigona subviridis	Yes	BOVA,HU6,Collections,TEWater
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA
100248	FS	I	Fritillary, regal	Speyeria idalia idalia		BOVA,HU6
060050	FSSS	II	Pigtoe, Tennessee	Fusconaia barnesiana		BOVA
100329	FS	II	Beetle, Avernus cave	Pseudanophthalmus avernus		HU6
100340	FS	II	Beetle, mud-dwelling cave	Pseudanophthalmus limicola		HU6
100343	FS	II	Beetle, thin-neck cave	Pseudanophthalmus parvicollis		HU6
110278	FS	II	PSEUDOSCORPION, CAVE	Mundochthonius holsingeri		HU6
110281	FS	II	PSEUDOSCORPION, CAVE	Chitrella superba		HU6
060029	FSSS	III	Lance, yellow	Elliptio lanceolata		HU6
040372	SS	I	Crossbill, red	Loxia curvirostra	Yes	BBA,CBC

040306	SS	I	Warbler, golden-winged	Vermivora chrysoptera	Yes	BOVA,HU6,BBA,BBS,Collections
020027	SS	II	Salamander, Cow Knob	Plethodon punctatus		BOVA,HU6
040213	SS	II	Owl, northern saw-whet	Aegolius acadicus	Yes	HU6,CBC,Collections
040266	SS	II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,CBC
030063	CC	III	Turtle, spotted	Clemmys guttata		HU6
040094	SS	III	Harrier, northern	Circus cyaneus	Yes	BOVA,HU6,CBC,ObsBook
040204	SS	III	Owl, barn	Tyto alba pratincola	Yes	BOVA,HU6,CBC
060071	SS	III	Lampmussel, yellow	Lampsilis cariosa	Yes	HU6,Collections
030012	CC	IV	Rattlesnake, timber	Crotalus horridus		HU6
040264	SS	IV	Creeper, brown	Certhia americana	Yes	BOVA,HU6,BBA,CBC,Collections
040364	SS		Dickcissel	Spiza americana	Yes	BOVA,Collections
040366	SS		Finch, purple	Carpodacus purpureus	Yes	BOVA,CBC
040241	SS		Flycatcher, alder	Empidonax alnorum		BOVA
040285	SS		Kinglet, golden-crowned	Regulus satrapa	Yes	BOVA,CBC
040112	SS		Moorhen, common	Gallinula chloropus cachinnans		BOVA
040262	SS		Nuthatch, red-breasted	Sitta canadensis	Yes	BOVA,CBC
040210	SS		Owl, long-eared	Asio otus	Yes	CBC,Collections
040278	SS		Thrush, hermit	Catharus guttatus	Yes	BOVA,CBC
040314	SS		Warbler, magnolia	Dendroica magnolia		BOVA
050045	SS		Otter, northern river	Lontra canadensis lataxina		BOVA

040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius	Yes	BOVA,CBC
040319		I	Warbler, black-throated green	Dendroica virens	Yes	BOVA,BBA

To view **All 104 species** View 104

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

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View Map of All Query Results from All Observation Tables

Anadromous Fish Use Streams

N/A

Impediments to Fish Passage

(10 records)

View Map of All Fish Impediments

ID	Name	River	View Map
1153	BURNSHIRE DAM	NORTH FORK SHENANDOAH RIVER	Yes
1123	CARROLL DAM	ALUM RUN	Yes
1127	CHAPMAN	N FK SHENANDOAH	Yes
1128	EDINBURG DAM	NORTH FORK SHENANDOAH RIVER	Yes
1141	MCCAFFREY DAM	NORTH FORK SHENANDOAH RIVER	Yes
1124	SEVEN FOUNTAINS DAM	TR-PASSAGE CREEK	Yes
1122	STONY CREEK DAM #9	STONY CREEK	Yes
1126	STRASBURG DAM	LITTLE PASSAGE CREEK	Yes
1125	WOODSTOCK DAM	LITTLE STONY CREEK	Yes

1129	WUNDER POND DAM	HOLMANS CREEK	Yes

Colonial Water Bird Survey

N/A

Threatened and Endangered Waters

(23 Reaches - displaying first 20)

View Map of All
Threatened and Endangered Waters

VaFWIS Search Report Compiled on 1/6/2010, 3:16:37 PM

Database Search in (187) Warren [County], VA

89 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 36) (36 species with Status* or Tier I**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
050023	FESE	I	Bat, Indiana	Myotis sodalis		HU6
070001	FTST	II	Isopod, Madison Cave	Antrolana lira	Yes	HU6,Collections
040267	SE	I	Wren, Bewick's	Thryomanes bewickii		BOVA
060006	SE	II	Floater, brook	Alasmidonta varicosa	Yes	BOVA,HU6,Collections,TEWater
030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes	BOVA,HU6,Collections,TEWater
040096	ST	I	Falcon, peregrine	Falco peregrinus	Yes	BOVA,HU6,CBC
040129	ST	I	Sandpiper, upland	Bartramia longicauda	Yes	BOVA,HU6,Collections
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus	Yes	BOVA,HU6,BBA,CBC,Collections
100155	FSST	I	Skipper, Appalachian grizzled	Pyrgus wyandot		HU6
040093	FSST	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,HU6,CBC
060081	ST	II	Floater, green	Lasmigona subviridis	Yes	HU6,Collections,TEWater
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA

100248	FS	I	Fritillary, regal	Speyeria idalia idalia		BOVA,HU6
100344	FS	II	Beetle, Petrunkevitch's cave	Pseudanophthalmus petrunkevitchi		HU6
040372	SS	I	Crossbill, red	Loxia curvirostra	Yes	CBC
040306	SS	I	Warbler, golden-winged	Vermivora chrysoptera	Yes	BOVA,HU6,BBA
040213	SS	II	Owl, northern saw-whet	Aegolius acadicus	Yes	HU6,CBC
040266	SS	II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,HU6,CBC
030063	CC	III	Turtle, spotted	Clemmys guttata		HU6
040094	SS	III	Harrier, northern	Circus cyaneus	Yes	BOVA,HU6,CBC
040204	SS	III	Owl, barn	Tyto alba pratincola	Yes	BOVA,HU6,CBC
040270	SS	III	Wren, sedge	Cistothorus platensis		HU6
060071	SS	III	Lampmussel, yellow	Lampsilis cariosa	Yes	HU6,Collections
030012	CC	IV	Rattlesnake, timber	Crotalus horridus		HU6
040264	SS	IV	Creeper, brown	Certhia americana	Yes	BOVA,HU6,BBA,CBC,Collections
040364	SS		Dickcissel	Spiza americana		BOVA
040366	SS		Finch, purple	Carpodacus purpureus	Yes	BOVA,CBC
040285	SS		Kinglet, golden-crowned	Regulus satrapa	Yes	BOVA,CBC
040112	SS		Moorhen, common	Gallinula chloropus cachinnans		BOVA
040262	SS		Nuthatch, red-breasted	Sitta canadensis	Yes	BOVA,CBC
040210	SS		Owl, long-eared	Asio otus	Yes	CBC
040278	SS		Thrush, hermit	Catharus guttatus	Yes	BOVA,CBC,Collections
040314	SS		Warbler, magnolia	Dendroica magnolia		BOVA

050045	SS		Otter, northern river	Lontra canadensis lataxina		BOVA
040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius	Yes	BOVA,CBC
040319		I	Warbler, black-throated green	Dendroica virens	Yes	BOVA,BBA

To view **All 89 species** View 89

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

****** I=VA Wildlife Action Plan - Tier I - Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need

View Map of All Query Results from All Observation Tables

Anadromous Fish Use Streams

N/A

Impediments to Fish Passage

(13 records)

View Map of All Fish Impediments

ID	Name	River	View Map
1138	APPLE MOUNTAIN LAKE DAM	OREGON HOLLOW	Yes
1139	APPLE MOUNTAIN UPPER LAKE DAM	OREGON HOLLOW	Yes
1135	COOLEY DAM	MOLLY CAMEL RUN	Yes
1133	DEER DAM	TR-HOWARDSVILLE BRANCH	Yes
1134	FRONT ROYAL DAM	SLOAN CREEK(OFF STREAM)	Yes
1131	LAKE JOHN DAM	MOLLY BOOTH RUN	Yes
1130	LAKE OF THE CLOUDS DAM	VENUS BRANCH	Yes
1140	LOCH LINDEN DAM	TR-OREGON HOLLOW	Yes

1141	MCCAFFREY DAM	NORTH FORK SHENANDOAH RIVER	Yes
1132	SPRING LAKE DAM	TR-VENUS BRANCH	Yes
1136	SULLIVAN DAM	DRY RUN	Yes
1137	WARREN	SHENANDOAH R	Yes
1147	WINCHESTER WATER SUPPLY DAM	NORTH FORK SHENANDOAH RIVER	Yes

Colonial Water Bird Survey

N/A

Threatened and Endangered Waters

(3 Reaches)

View Map of All
Threatened and Endangered Waters

Stream Name	T&E Waters Species						View Map
	Highest TE*	BOVA Code, Status*, Tier**, Common & Scientific Name					
North Fork Shenandoah River (02070006)	SE	060006	SE	II	Floater, brook	Alasmidonta varicosa	Yes
		060081	ST	II	Floater, green	Lasmigona subviridis	
Cedar Creek (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes
Passage Creek (02070006)	ST	030062	ST	I	Turtle, wood	Glyptemys insculpta	Yes

Cold Water Stream Survey (Trout Streams)
Managed Trout Species

MAP 2.1


Frederick Co.
Winchester
Berryville
Clarke Co.
Boyce
Stephens City
Middletown
Strasburg
Warren Co.
Front Royal
Toms Brook
Shenandoah Co.
Woodstock
Stoney Creek/ Bryce Restort
Edinburg
Mt. Jackson
New Market
Luray
Page Co.
Stanley
Shenandoah
N
Type of Water Source
Reservoir
Waterline
Purchase
Ground Water/Spring
Figure 2.1
Municipal Water Sources in the NSVRC Area
0 5 10 Miles
NSVRC