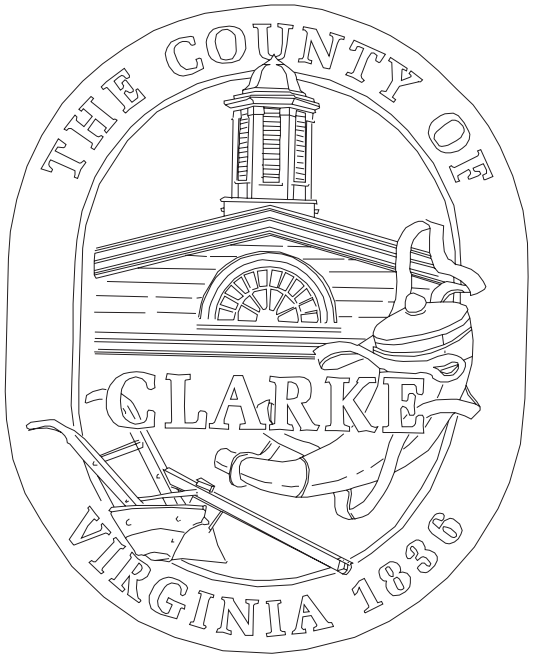
SURFACE WATER RESOURCES PLAN

Adopted

December 7, 1999



Clarke County Comprehensive Plan Implementing Component

Article 5b

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Executive Summary: Surface Water Resources Plan

The Surface Water Resources Plan is one of two sections of the Water Resources Plan, an implementing component of the Clarke County Comprehensive Plan. This section specifically addresses issues relating to surface water, including surface water contamination from both point and nonpoint sources, off stream water use such as domestic supply and irrigation, and recreational uses.

Efforts to improve surface water quality throughout the region have been driven by the regional need to improve water quality in the Chesapeake Bay. Water quality degradation caused by nutrient over enrichment has played a key role in the decline of the living resources of the Chesapeake Bay and its tributaries. The need to reduce the nutrient flow from tributaries into the Chesapeake Bay prompted states, including Virginia, to enter into the Chesapeake Bay Agreement in 1987. This agreement contains a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000. The Shenandoah/Potomac River Basins Nutrient Reduction Strategy was developed as a result of this commitment. The strategy outlines programs and provides increased funding opportunities to localities to improve water quality on a voluntary basis. As an implementing component of the Comprehensive Plan, the Surface Water Resources Plan reflects Clarke County's desire to participate in the regional cleanup process as well as protect our natural resources for our own benefit. This is clearly stated in Objective 3: "Protect natural resources, including soil, water, air, scenery, and fragile ecosystems."

The Virginia Department of Conservation and Recreation Division of Soil and Water Conservation (DCR-DSWC) and the Department of Environmental Quality (DEQ) are responsible for monitoring, assessing, and compiling data collected about State waterways. Members of Friends of the Shenandoah River (FOSR) collect additional water chemistry data.

Known Contamination Problems

Nutrients, specifically nitrates and phosphorus, are being discharged into waterways by sewage treatment facilities, ultimately degrading the water quality of the Chesapeake Bay. In areas where livestock have unlimited access to tributaries and there is septic system failure, coliform contamination is occurring. At present, the major impact of fecal pollution in Clarke County is the degradation of recreational water quality in both the streams and the Shenandoah River. This pollution reduces the quality of recreational pursuits and represents a health risk for all types of water-contact activities. In addition, reducing the fecal loading in surface waters is a critical step in protecting ground and drinking waters. Contaminated surface waters have been shown to degrade groundwater quality, which in turn will degrade well water. Contamination from point and nonpoint sources has been identified in three waterways and is likely in many others.

DEQ has evaluated Spout Run, Opequon Creek, and the Shenandoah River. Spout Run has been listed as an impaired waterway due to high fecal coliform bacteria counts. The impairment source is listed as nonpoint source (NPS)-agriculture, based on the assessment by DCR of this waterbody's having a high potential for nonpoint source pollution from agricultural lands. Although listed as nonpoint agriculture, source differentiation tests were not conducted. Preliminary sampling by the County has identified human sources below Millwood and contamination from failing or inadequate sewage disposal in Millwood as a probable source for

this contamination. The Opequon Creek impairment is designated as a moderately impaired benthic community, attributed by DCR to nonpoint source urban runoff. The Shenandoah River impairment cause is listed as PCBs generated from the former Avtex Fibers Plant in Front Royal. The Virginia Department of Health has issued a Health Advisory, recommending that fish from the river not be consumed.

Streams Susceptible to Contamination

DCR-DSWC prepared the 1997 Virginia Nonpoint Pollution Assessment Report, which provides a comparative evaluation of State waters on a watershed basis, to assist in targeting nonpoint source (NPS) pollution minimization activities and resources. The report was developed from two types of data: inventory and water quality monitoring. The inventory data consist of livestock inventories, land use, and soil erosion rates and were collected and compiled by DCR to address the NPS potential from three major land use categories: agricultural, urban, and forestry. DCR evaluates the susceptibility to surface water contamination for all streams on a watershed basis and gives each a priority ranking. Of the two watersheds completely within Clarke County, which encompass 72% of the land area, the report identified Spout Run (40%) as a high priority, and the Lower Shenandoah (32%) as a low priority. Actual contamination levels within these watersheds can be determined only by water sampling.

Water Quality Improvement Activities

Providing for and maintaining riparian buffers, in conjunction with reducing or eliminating contamination sources, are the most effective ways to improve surface water quality in Clarke County. The Virginia Agricultural Best Management Practices (BMP) Cost-Share Program encourages the voluntary use of agricultural BMPs to improve water quality by reducing the transport of pollutants such as sediments and nutrients from the land to our waters. Between 1989 and 1997, 34 farms participated in the Cost-Share Program, creating a total of 1,900 acres of riparian buffer. This action has resulted in a reduction of 29,964 pounds of nitrates and 4,540 pounds of phosphorus from reaching the waterways of Clarke County. With the increase in funding levels over the last two years, approximately 20 additional farms will begin installing a variety of BMPs designed to improve water quality. This level of participation provides a clear indication that the farming community is interested in protecting the natural environment.

The Page Brook Watershed Restoration Project was initiated in 1996, with receipt of a $75,000 EPA Section 319 grant to conduct a watershed study examining practical approaches of BMP installation to improve water quality. Approximately 2.5 miles of fencing were installed on four farms in the watershed. The effectiveness of the BMP installation was determined by analyzing water samples collected monthly throughout the project. Within one year, fecal coliform bacteria counts collected at sites within fenced buffer areas were reduced by an average of 92%. Initially, coliform bacteria counts were at levels high enough to declare the stream impaired, but since fencing and other BMPs have been installed, coliform levels have been reduced below the impairment level.

Implementation Steps
Eleven actions are recommended in this Plan in order to protect the County's surface water resources. They are, in order of priority:

1. Establish a Stream Protection Overlay District and adopt regulations to protect designated areas.

2. Amend the Zoning Ordinance to require 100 foot building setbacks from perennial streams and springs, and 50 foot building setbacks from intermittent streams, as identified on the 7.5 minute USGS topographical maps, in the Agricultural-Open Space (AOC) District.

3. Establish a Countywide surface water monitoring network to effectively monitor changes in water quality over time. This program would include routine testing of and official reporting for all perennial streams for coliform and water chemistry.

4. Encourage upgrading of sewage treatment plants to reduce nutrient discharge into surface waters.

5. Encourage installation of Best Management Practices (BMPs) to reduce access of livestock to riparian buffer zones.

6. Identify locations of individual onsite sewage disposal systems discharging into State waterways and replace them with conventional septic systems where possible.

7. Consider adopting a Shenandoah River Recreation Plan.

8. Increase funding to multijuridictional Minimum Instream Flow study so that the data necessary to declare a Surface Water Management Area are available as soon as possible.

9. Conduct a comprehensive study in cooperation with the USGS to fully characterize tributary stream flow patterns, discharge rates, and floodplains.

10. Update the 1988 Water Supply Plan to ensure that adequate water resources are available for Clarke County residents.

11. Conduct additional dye tracing studies to increase understanding of the interrelationship between ground and surface waters in the County.

I. Introduction

The residents of Clarke County are proud of their community- its rural character, open space, and scenic beauty. The rivers and streams enhance that beauty and are significant resources for many reasons. The Shenandoah River is the largest surface water feature in the County. It is a designated State Scenic River and is a major recreational attraction. Opequon Creek also offers a variety of recreational opportunities. Smaller tributaries provide water for livestock, and a few are large enough for swimming and fishing. A clean and adequate water supply is a reflection of the overall health of the County's natural environment, and maintaining the quality of our water resources is integral to our quality of life.

But there are problems with the County's waters. Nutrients, specifically nitrates and phosphorus are being discharged into waterways by sewage treatment facilities, ultimately degrading the water quality of the Chesapeake Bay. In areas where livestock have unlimited access to tributaries, coliform contamination is occurring. At present, the major impact of fecal pollution is the degradation of recreational water quality in both the streams and the Shenandoah River. This pollution reduces the quality of recreational pursuits and represents a health risk for all types of water contact activities. In addition, reducing the fecal loading in surface waters is a critical step in protecting ground and drinking waters (Hagedorn 1999). Contaminated surface waters have been shown to degrade groundwater quality, which in turn will degrade well water (Bickie and Brown 1991, Ritter and Chirnside 1984; Townsend et. al., 1996; Gold et. al. 1990; Cook et. al. 1996; Howell 1995; Tornley 1985). Contamination from point and nonpoint sources has been identified in three waterways and is likely in many others.

Efforts to improve surface water qualities throughout the region have been driven by the regional need to improve water quality in the Chesapeake Bay. Water quality degradation caused by nutrient over enrichment has played a key role in the decline of the living resources of the Chesapeake Bay and its tributaries. The need to reduce the nutrient flow from tributaries into the Chesapeake Bay prompted states, including Virginia, to enter into the Chesapeake Bay Agreement in 1987. This agreement contains a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000. The Shenandoah/Potomac River Basins Nutrient Reduction Strategy was developed as a result of this commitment. This strategy outlines programs and provides increased funding opportunities to localities to improve water quality, but makes it clear that Virginia prefers a voluntary, cooperative approach to implement the program. Therefore, to reducing nutrient loads and participating in the Bay cleanup is a local decision (Commonwealth of Virginia 1996).

The primary threats to water quality within Clarke County come from point source discharge of sewage treatment facilities and nonpoint agricultural and urban runoff. The agricultural community has demonstrated its commitment to protecting the land and water quality in many ways. Between 1989 and 1997, 34 farms participated in the Cost-Share Program, creating a total of 1,900 acres of riparian buffer. The Virginia Agricultural Best Management Practices Cost-Share Program encourages the voluntary use of agricultural BMPs to improve water quality by reducing the transport of pollutants such as sediments and nutrients from the land to our waters. The program is funded with State and Federal monies through local soil and water conservation districts. Practices eligible for cost sharing include animal waste-control facilities, sod waterways, stream protection, winter cover crops, buffer strip cropping, and terracing, among others (Commonwealth of Virginia 1996). With the increase in funding levels over the last two

years, approximately 20 additional farms will begin installing a variety of BMPs, including stream fencing, riparian plantings, and off-site watering, designed to improve water quality. Agriculture is an integral part of the historic and economic makeup of the County and is valued as a principal land use. Efforts to reduce surface water contamination from agricultural nonpoint sources must be carefully considered to minimize any possible negative impact on the agricultural community.

Historically, surface water management in Clarke County has been overshadowed by groundwater management activities. Groundwater protection has been emphasized, as 75% of County residents rely on groundwater as their source for drinking water, and groundwater is particularly susceptible to contamination. This is especially true in the Valley region of the County, the geologic region located west of the Shenandoah River. Carbonate rocks such as limestone and gypsum underlie this region. This type of geology is characterized by the presence of solution-enlarged sinkholes, conduits, and caves, geologic features that constitute what is known as karst terrane. The generally high permeability of these rocks facilitates the infiltration and transport of contaminants from the land surface to the groundwater reservoir. This interaction became particularly evident in 1994, when the State Health Department declared Prospect Hill Spring under the influence of surface water, mandating the construction of a disinfection and filtration system. Prospect Hill Spring is the only public water supply administered by the County it serves 300 households and businesses in the communities of Boyce, Millwood, the Waterloo Commercial District, and White Post. The high degree of interaction between ground and surface waters is an important reason to increase efforts to improve surface water quality.

The Surface Water Resources Plan section of the Clarke County Comprehensive Plan is designed to provide a planning strategy that will allow for adequate surface water quality and quantity for County residents in the future.

II. Purpose and Scope

The purpose of the plan is to protect and improve surface waters throughout the County by minimizing the adverse impacts of human land use activities. Benefits of having clean surface waters include the protection of public water supplies, groundwater protection, safe water based recreation, and decreased nutrient enrichment of the Chesapeake Bay.

As an implementing component of the Clarke County Comprehensive Plan (1994), the Surface Water Resources Plan reflects the County's desire to participate in the regional cleanup process, as well as protect our natural resources for our own benefit. This is clearly stated in Objective 3: "Protect natural resources, including soil, water, air, scenery, and fragile ecosystems." Policies outlined under Objective 3 include: (1) prohibiting land uses that have significant adverse environmental impacts, recognizing the interrelationship among natural resources, especially between ground and surface waters in karst topography; (2) requiring that adverse environmental impacts of activities directly or indirectly related to new construction, including removal of vegetation, cutting of trees, altering drainageways, grading, and filling, are minimized; (3) strengthening, implementing, and enforcing the Erosion and Sedimentation Control Ordinance; (4) managing and protecting surface water resources; (5) recognizing the Shenandoah River as a State Scenic River and one of the County's significant environmental resources; and (6)

protecting local and regional water resources through application of the Chesapeake Bay Management Regulations to environmentally sensitive areas.

This plan describes the surface water resources in the County and the contamination sources, summarizes the many Federal, State, and local activities that are currently in place, and makes recommendations for future steps to protect and improve surface water quality locally. Through the process of describing the contamination concerns and efforts to mitigate surface water degradation, a specific action plan is developed that compiles all available protection strategies in order to improve and protect surface waters in Clarke County.

III. Description of Resources

Clarke County, located in the northern Shenandoah Valley, is approximately 110,000 acres. The eastern third of the County consists of the western slope of the Blue Ridge Mountains. This region is primarily forested and contains portions of 11 perennial tributaries of the Shenandoah River. Approximately 22 miles of the main stem of the Shenandoah River run through, and divide, the County. The western two-thirds of the County are in the northern Shenandoah Valley and are primarily open land in agricultural use. Portions of 10 perennial streams flow eastward through the Valley to the Shenandoah River. Three tributaries flow into the Opequon Creek drainage that forms the western boundary between Clarke and Frederick County, Virginia (figure 1).

The two regions of the County represent two different hydrogeologic areas- the Valley and Ridge and the Blue Ridge physiographic provinces (figure 2)- each underlain by characteristic bedrock types. Bedrock in the Valley region consists of carbonates (limestones and dolomites) and calcareous shales. In the Blue Ridge region, bedrock consists of metamorphic forms of basalt, sandstone, quartzite, slate, and shale. The rocks of the Blue Ridge are more resistant to weathering and erosion, and this resistance is expressed in the more mountainous terrain, compared to the Valley region (Wright 1990).

A large portion of stream flow is from groundwater, with the remainder from surface runoff during rain events. In studies completed in Shenandoah National Park, flow data were collected from streams in geologic formations similar to those found in Clarke County. Data indicated that yields were lowest for streams draining areas with steep slopes and a shallow overburden (unconsolidated material overlying bedrock, such as loose soil, silt, sand, and gravel), where underlying bedrock is resistant to groundwater infiltration and storage (Lynch 1987). In contrast, Valley streams flow over relatively flat topography and have a thick overburden that acts like a sponge to store water that slowly recharges the groundwater system (Wright 1990). In addition, most Valley streams are spring fed from high yielding springs found in the carbonate aquifer. Springs are less prolific on the mountain. Flows are greater in the valley due to the solution-enlarged fractures and bedding planes. Because these features are larger, they hold more water. Fractures and bedding planes have not been enlarged on the mountain, because the rock is not as soluble. Although these generalities hold true, the actual details of interactions among stream flow patterns, runoff, and spring discharge are not fully understood. To characterize more fully the stream flow patterns, discharge rates, and floodplains, more study is needed.

Figure 1. Surface Water Features
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Figure 2. Physiographic Provinces
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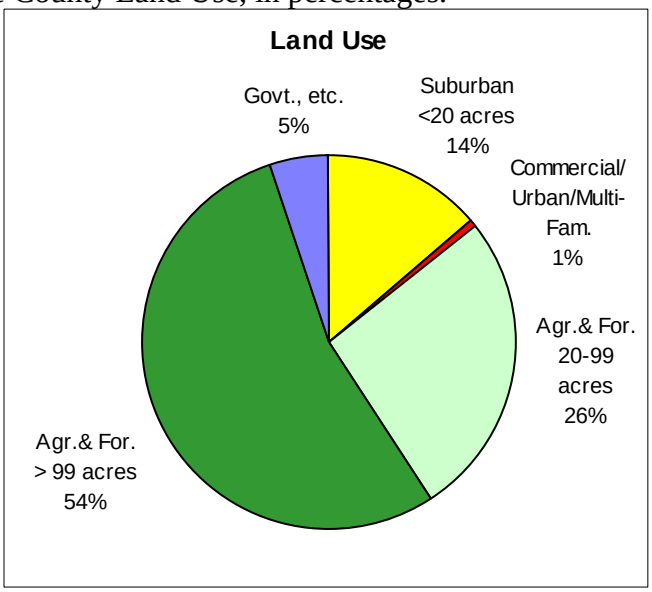
Principal land uses in Clarke County include agriculture, forestry, and residential, commercial, and governmental uses. As indicated in table 1 and figure 3, 80% of the land area in the County is classified as agricultural, including forestal uses. The majority of forestry activities are located on the mountain, east of the Shenandoah River.

Table 1. Clarke County Land Use, in Acres

	Total Number of Parcels	Total Acres	Percent Acreage
Single family residential- urban (in incorporated towns)	1,175	900	1
Single family residential- suburban (not in incorporated towns, less than 20 acres in parcel)	5,311	15,203	14
Multifamily	30	133	<1
Commercial/industrial	289	686	1
Agricultural and forestal (20 to 99 acres in parcel)	668	28,280	26
Agricultural and forestal (over 99 acres in parcel)	338	59,245	54
Exempt (government, churches, etc.)	316	5,619	5
Total	8,127	110,066	100

Source: Clarke County Real Estate Data Base, 1999

Figure 3. Clarke County Land Use, in percentages.



IV. Impacts to Surface Waters and State Agency Assessments of Water Quality

Land use activities represent the largest potential adverse impact to surface waters in Clarke County because of land disturbance that affects the stream corridor or riparian zone. The riparian zone is defined as the land adjacent to a body of water that serves as a transitional environment and directly affects or is affected by the presence of that water. A riparian buffer is an area maintained in permanent vegetation and managed to reduce the impacts of adjacent land uses. "Riparian buffers play a critical role in the landscape, protecting water quality by filtering runoff and removing nutrients and sediment; protecting living resources by supplying food, habitat and temperature-moderating shade; protecting the shoreline integrity from erosion impacts; and moderating flood damages." (Virginia Riparian Forest Buffer Panel 1998). Table 2 describes the contamination sources associated with principal land uses. Providing for and maintaining these buffers, in conjunction with reducing or eliminating contamination sources, are the most effective ways to improve surface water quality in the County.

Table 2. Contamination Threats to Surface Water Associated with Principal Land Uses in Clarke County

LAND USE	LAND USE ACTIVITY	TYPE OF CONTAMINATION
Agriculture	Animal feed lots Manure spreading and pits Grazing with unlimited access to streams Chemical application Chemical storage areas	Coliform bacteria, pesticides, fungicides, fertilizers- nitrates
Residential	Septic systems Lawn chemicals, fertilizers	Coliform bacteria, chemicals, nitrates, fungicides, fertilizers
Commercial and industrial	Auto repair Construction areas Car washes Gas stations Paint shops Road deicing operations Storage tanks Storm water runoff	petroleum chemicals detergents salts fertilizers– nitrates
Other uses	Transportation railroad trucking	Petroleum chemicals variety of contaminants

Source: U. S. Environmental Protection Agency 1989

Clarke County's surface waters are affected by five major impacts: chemical discharges, point source pollution, nonpoint source pollution, instream/offstream conflicts, and development. These five threats are described in more detail in the following subsections (LFPDC 1990).

A. Chemical Discharges

The Virginia Department of Health (VDH) is the State agency responsible for issuing restrictions and health advisories. Two serious industrial discharge problems are known to have occurred upstream of Clarke County; one affected the South Fork of the Shenandoah River, the other affected the main stem of Shenandoah, which flows through Clarke County (VDGIF 1998).

The E. I. DuPont de Nemours and Company synthetic fibers plant in Waynesboro released mercury into the South River and South Fork Shenandoah River from 1929 to 1950. The contamination, discovered in 1977, was found to have contaminated 103 river miles, from the plant to the Page /Warren County line. These areas remain under a Health Advisory for fish consumption due to mercury contamination. The VDH recommends that no more than one meal (1/2 pound) per week of fish from these waters be consumed. Small children and pregnant women are advised not to consume any fish containing mercury. The contamination does not directly affect the Shenandoah in Clarke (VDEQ 1998).

VDH has also issued a public Health Advisory warning against the consumption of fish taken from the South Fork Shenandoah River from the State Route 619 bridge in Warren County downstream to the Shenandoah River headwaters; from the North Fork Shenandoah River at its confluence with Passage Creek downstream to the Shenandoah River; and from the Shenandoah River from the confluence of the North and South Fork Shenandoah Rivers to the Virginia/West Virginia State border. This covers a total of 65 stream miles. This advisory was issued after DEQ monitoring revealed PCB (polychlorinated biphenyls) levels in fish tissue samples above the 2.0 ppm Food and Drug Administration (FDA) action level. The source of this contamination was identified as Avtex Fibers Plant in Front Royal. This plant closed in 1989 following revocation of its Virginia Pollutant Discharge Elimination System (VPDES) permit (VDEQ 1998). On numerous occasions between 1977 and 1989, discharges from Avtex violated permit limits for zinc, arsenic, and chromium (U.S. EPA 1998). The Environmental Protection Agency (EPA) declared the location a Superfund site in 1989. Cleanup efforts were initiated immediately and are ongoing (U.S. EPA 1998).

B. Point Source Discharges

Within the County, two sewage treatment facilities discharge into waterways: the Berryville Sewage Treatment Facility into the Shenandoah River, and the Boyce Sewage Treatment Plant into Roseville Run, which ultimately flows into the Shenandoah River. The Boyce treatment facility, constructed to replace failing and inadequate septic systems in the Town of Boyce, opened in April 1995. Management of the Boyce facility was transferred from the Town to the County in 1998. The Clarke County Sanitary Authority currently manages the plant. A regional waste treatment facility, the Opequon Sewage Treatment Plant, is operated by the Frederick/Winchester Sanitation Authority and discharges into Opequon Creek (figure 4).

The treatment level for these facilities is secondary- that is, it is a biological process relying on naturally occurring microorganisms to break down organic material; aeration tanks are utilized to speed up this process and oxidize ammonia. The Boyce facility uses ultraviolet light and Berryville uses chlorination to kill bacteria before releasing the treated waste water. Effluent

Figure 3. Location of Public Water & Sewer Facilities

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discharged by Berryville and the Boyce treatment facilities meets State water quality standards. However, there is no minimum standard for nitrates or phosphorus and these nutrients are discharged into the Shenandoah River and Roseville Run. DEQ periodically collects water quality samples that measure nutrients including nitrates. In addition, members of the Friends of the Shenandoah River collect water samples from the outflow of these plants. As described in the following charts, these samples have identified high nitrate levels, indicating that sewage treatment plants are contributing to the nutrient enrichment of surface waters (figures 5 and 6).

Figure 5. Outfall data from the Berryville Sewage Treatment Facility, Berryville Virginia.

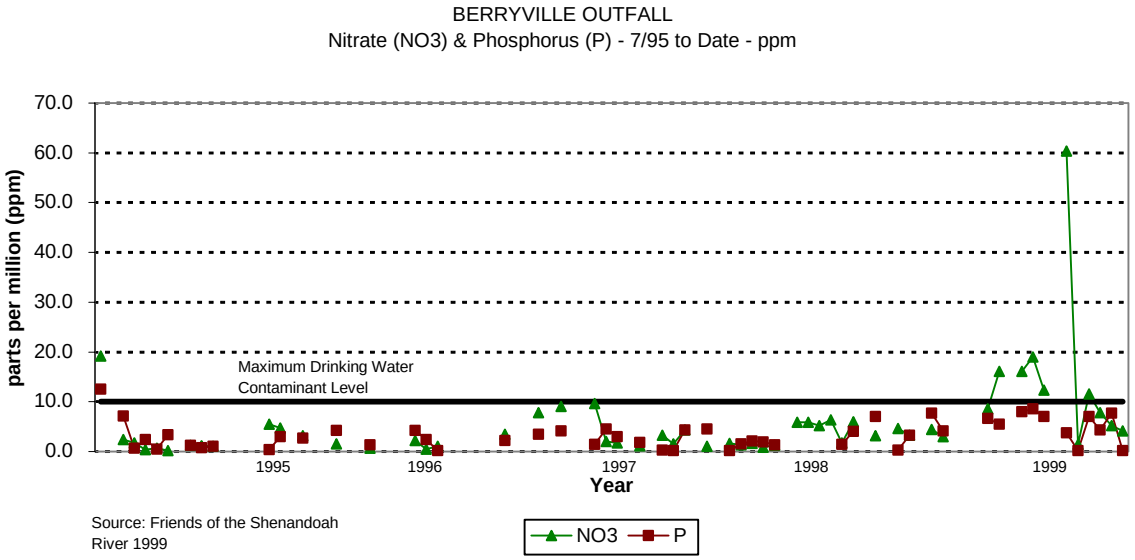
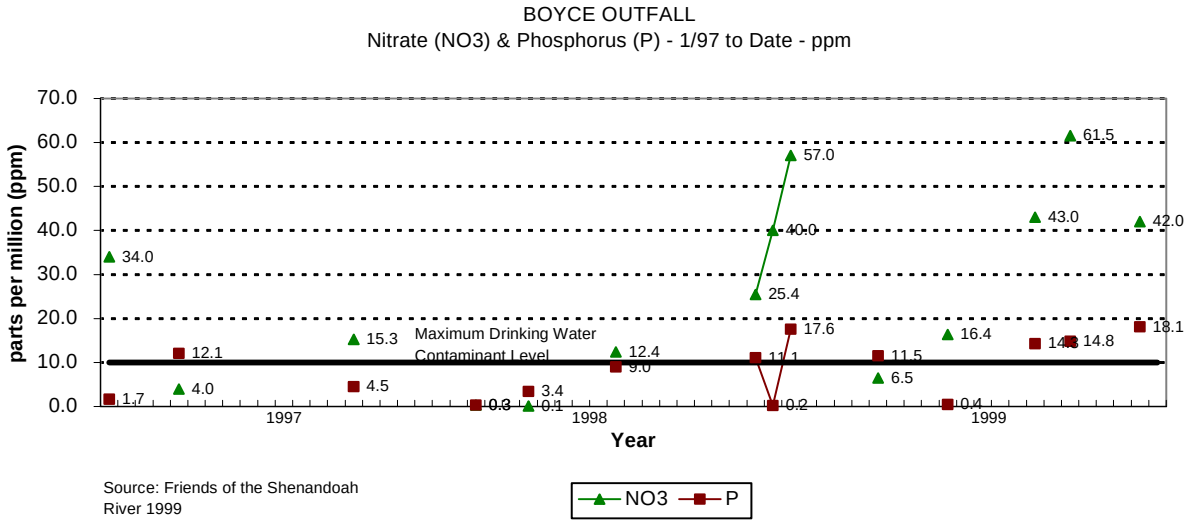


Figure 6. Outfall data from the Boyce Sewage Treatment Facility, Boyce Virginia.



In contrast, of all the stream sample sites (n=12) (figure 7), none exceeded 10 ppm nitrates for any sample (n=800) collected from 1995 to 1999. This finding indicates that agricultural practices are not contributing significantly to the nutrient enrichment of the tributaries that were sampled. Additional data collection is necessary to provide a thorough water quality assessment of all streams in the County. Other point sources may include individual sewage disposal via straight pipes. Although these systems are no longer permitted in the County, some may exist that were installed before the adoption of the Septic Ordinance, in 1987. Additional study is needed to determine the extent of these systems.

C. Nonpoint Source Pollution

Nonpoint source pollution is caused by many diffuse sources. These inputs do not come from a specific, single location but from runoff, precipitation, or percolation. The Department of Environmental Quality (DEQ) and Department of Conservation and Recreation (DCR) are responsible for monitoring, assessing, and compiling data collected in State waterways. When nonpoint source pollution is assessed, streams are evaluated within the context of a watershed. DCR defines a watershed, or hydrologic unit, as a land area drained by a river or stream or a system of connecting rivers and streams such that all water within the area flows through a single outlet (VDCR 1997).

Nonpoint source pollution (NPS) originates from almost all land uses, including farmland, urban areas, construction sites, and forestland. Farms may yield sediment, pathogens, toxic substances, and excess nutrients. Urban and suburban areas may also contribute significant levels of nutrients as well as toxic substances, pathogens, and sediment. City streets and other impervious surfaces yield NPS pollutants such as motor oil, gasoline, antifreeze, and other toxic chemicals. Because these surfaces do not absorb rainwater, runoff from urban areas is nine times greater than from forestland (VDCR 1997).

In determining the impacts of nonpoint sources, local governments rely on State and Federal agencies to assess contamination levels and pollution potential for watersheds within the locality. Ongoing State agency activities used to describe impacts include: nonpoint source pollution assessments (DCR), natural heritage rankings (Department of Natural Heritage (DNH)), total maximum daily load (TMDL) evaluations (DEQ), and the Tributary Strategy Planning Process (DCR, DEQ, and others).

Understanding nonpoint source pollution in Clarke County is important, as most surface water contamination can be attributed to nonpoint sources such as agricultural practices, lawn fertilization, failing septic systems, and road deicing. Understanding the extent of contamination assists the County in allocating limited resources to the watersheds with the highest need for improvement.

1. Nonpoint Source Pollution Watershed Assessment

The DCR Division of Soil and Water Conservation (DSWC) is the lead agency for the management and implementation of Virginia's Nonpoint Source (NPS) Control Programs. Virginia's NPS Program was developed in accordance with Section 319 of the Clean Water Act of 1987.

Figure 4. Friends of the Shenandoah River Monitoring Locations

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The DCR-DSWC developed a NPS Pollution Assessment Report, which was approved by EPA in July 1989. This report was revised in March 1993 and again in 1997. The report delineated 491 watersheds or hydrologic units within Virginia and prioritized them for NPS pollution concerns. The priorities were developed primarily from two types of data. The first type includes inventory data related to specific land uses, animal density, and other related factors. The inventory data consist of livestock inventories, land use, and soil erosion rates. These data are compiled from 1992 Census of Agriculture, 1990 National Survey of Conservation Tillage Practices, 1992 Natural Resource Inventory, and the 1991 Hydrologic Unit Database. These data were further evaluated and updated specifically for each County by representatives from DCR, Natural Resource Conservation Service (NRCS), Soil and Water Conservation District (SWCD), Farm Services Agency (FSA), Cooperative Extension Service (CES), and Department of Forestry (VDOF). The inventory data were collected to address the NPS potential from three major land use categories: agricultural, urban, and forestry. The second type of data consist of available water quality monitoring information. Water quality data were provided to serve as background information and to identify watersheds with known water quality problems (VDEQ 1998). An overall NPS priority is based on a weighted combination of the total priority results from the urban, agricultural, and forestal sources. The prioritization of watersheds is used by the state for allocation of cost-share funds. In all, six hydrologic units, as designated by the State DSWC, are either wholly or partially within Clarke County. These include B08 (Upper Opequon Creek), B09 (Lower Opequon Creek), B55 (Upper Shenandoah River), B56 (Crooked Run), B57 (Shenandoah River/Spout Run), and B58 (Lower Shenandoah River) (figure 8) (VDCR 1997). Table 3 summarizes the rankings as described in the Assessment Report.

Table 3. Overall Nonpoint Source Pollution Priorities

Watershed Name	NPS Agricultural Priority	NPS Urban Priority	NPS Forestry Priority	NPS Overall Priority	TMDL Priority
Upper Opequon Creek	Medium	High	Low	Medium	
Lower Opequon Creek	Medium	High	Low	Medium	Medium
Upper Shenandoah River	Low	High	Low	High	
Crooked Run	Low	High	Low	Medium	
Shenandoah River/Spout Run	Medium	Medium	Low	High	
Lower Shenandoah River	Low	Medium	Low	Low	

Source: Virginia Department of Conservation and Recreation 1997

2. Total Maximum Daily Load (TMDL)

Determining the amount of contamination a stream can assimilate without degrading water quality below the state water quality standards is the purpose of establishing TMDLs. Water quality standards consist of statements that describe water quality requirements. They also contain numeric limits for specific physical, chemical, biological, or radiological characteristics of water. These statements and numeric limits describe water quality necessary to meet and maintain uses such as swimming, fishing, and other water-based recreation, public water supply, and the propagation and growth of aquatic life (VDEQ 1996).

Figure 5. Hydrologic Units
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Those streams whose water quality currently does not meet minimum standards are declared "impaired" waterways. This designation or "priority ranking" is important to localities for targeting limited resources for stream improvements. DEQ in conjunction with DCR has developed the Total Maximum Daily Load (TMDL) Priority List. Under Section 303(d) of the Clean Water Act, water quality is measured by whether or not streams fully support beneficial uses such as fishing and swimming. The TMDL process establishes water quality based controls when streams do not fully support beneficial uses. The TMDL prioritization process complements the Tributary Strategy Planning and NPS Assessment process described above by prioritizing the level of impairment of various watersheds. This process helps to focus the use of limited resources to watersheds that will have the greatest impact on reducing nutrient levels, improving habitat, and reducing bacteria levels.

3. Natural Heritage Resource Priority Ranking

Natural heritage resources are defined by the Virginia Natural Area Preserves Act as "The habitat of rare, threatened, or endangered plant and animal species, rare or significant natural communities or geologic sites, and similar features of scientific interest" (Virginia Code 1998 sec. 10.1-209 et seq.). Hydrologic units are ranked and prioritized by DNH according to the presence of wetland and aquatic natural heritage species. The more species found in a watershed, the higher the priority. These priorities are intended to help direct nonpoint source pollution mitigation efforts and other water quality improvement projects toward those watersheds in which natural heritage resources will benefit from the maintenance or enhancement of water quality (VDCR, 1997) (figure 9).

4. Tributary Strategies

An additional State effort to protect surface waters is the Tributary Strategy Planning process. The need to reduce the nutrient flow from tributaries into the Chesapeake Bay prompted States, including Virginia, to enter into the Chesapeake Bay Agreement in 1987. This agreement contains a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000 by developing tributary-specific strategies for each of the Bay's major tributaries. Virginia's strategy for the Shenandoah and Potomac River Basin was completed in 1996 (Commonwealth of Virginia 1996).

D. Contamination Assessment

Data were collected and compiled by DCR, as described above, to address the NPS potential from three major land use categories: agricultural, urban, and forestry. Water chemistry and biological samples are collected by DEQ to identify watersheds with known water quality problems, but are not collected for all streams in the County. Members of the Friends of the Shenandoah River (FOSR) collect additional water chemistry for several streams and the Shenandoah River. In addition, three watershed restoration projects are ongoing in the Spout Run watershed. Intensive water quality sampling is being conducted to show water quality changes as the result of BMP installation. The following assessments of the watersheds and streams in Clarke County were derived from the available information.

Figure 6. Natural Heritage Resources
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1. Known Contamination Problems (figure 10)
    a. Spout Run

Water quality in the Spout Run watershed is being monitored extensively by the County as part of watershed restoration projects funded by State and EPA grants. The projects are designed to show how installation of BMPs can improve water quality. These studies are described in detail later in this report. Beginning in 1996, water samples were collected from streams, wells, and springs in the study area (figure 11). These samples were analyzed for chemical parameters and coliform bacteria. To date more than 1,700 samples have been processed for fecal coliform (table 4) (Hagedorn 1999).

Table 4. Monitoring Results for Fecal Coliforms in the Spout Run Watershed

Watershed	Well Water Samples		Stream Samples		
Basin	# Samples	#(%) Positive	# Samples	#(%) Positive	#(%) > 1,000
Page Brook (PB)	193	20 (10.4)	203	125 (61.6)	27 (21.6)
Roseville Run (RR)	195	27 (13.8)	188	175 (93.1)	44 (25.1)
Spout Run (SR)	31	2 (6.5)	48	45 (93.8)	9 (20.0)
Total	419	49 (11.7)	439	345 (78.6)	80 (23.2)

The regulatory standard for fecal coliforms is zero for drinking water, and no more than 1,000 per 100 ml for recreational water

In addition, bacterial source tracking (BST) methodology is used to identify sources of fecal pollution. For the Page Brook and Roseville Run segments of the watershed, BST has identified livestock or wildlife as the primary source of contamination. BMPs were implemented in the Page Brook section to limit livestock access to the stream, resulting in large reductions in fecal coliform populations in the stream (Hagedorn 1999). Work is ongoing to identify sources in Spout Run.

The conclusions drawn from these sample results indicate that substantial fecal pollution of well water is not occurring at this time, in this watershed. This finding is in contrast to previous studies conducted County wide in 1986 and 1991, which identified 40% of the wells sampled contaminated by coliform (Wright 1991, Ross et. al. 1991). However, streams in this watershed are highly polluted. Reducing the fecal loading in surface waters is a critical step in protecting ground and drinking waters.

Due to the distances involved fecal pollution in the watershed is not making a substantial contribution to coliform levels in the Chesapeake Bay. At present, the major impact of fecal pollution in the watershed is the degradation of recreational water quality both in the streams and in the Shenandoah River. This degradation reduces the quality of recreational pursuits and represents a health risk for all types of water contact activities (Hagedorn 1999).

Spout Run has been listed as an impaired waterway by DEQ, beginning at the confluence of Roseville Run and Page Brook and extending down to its conflux with the Shenandoah River. The impairment is listed as fecal coliform bacteria. Data collected at the Route 621 bridge indicate moderate impairment. The impairment source is listed as nonpoint source

Figure 7. DEQ Impaired Waters TMDL List
/d1/arcdata/swmgmt5_cmp

Figure 8. Spout Run Monitoring Sites

(NPS)- Agriculture, based on the assessment by DCR of this waterbody's having a high potential for nonpoint source pollution from agricultural lands. Although the source is listed as nonpoint agriculture, source differentiation tests were not conducted. Preliminary sampling by the County has identified human sources below Millwood, and failing or inadequate sewage disposal in Millwood as a probable source for this contamination.

b. Opequon Creek
Impairment begins at the confluence with Abrams Creek just north of Route 7 and continues to the West Virginia State line. Biological monitoring indicated a moderately impaired benthic community. The source is believed by DCR to be nonpoint source urban runoff.

c. Shenandoah River
Impairment begins at the Route 619 bridge in Front Royal and ends at the West Virginia State line. The impairment cause is listed as PCBs generated from the former Avtex Fibers Plant in Front Royal. The Virginia Department of Health has issued a Health Advisory recommending that fish from the river not be consumed.

2. Streams monitored by Friends of the Shenandoah River
In 1995, the Friends of the Shenandoah River (FOSR) developed a Shenandoah River Basin monitoring network to assess the water quality in the Shenandoah River and its tributaries. Water chemistry parameters including nitrates, ammonia, phosphates, pH, dissolved oxygen (DO), turbidity, and coliform are tested. In Clarke County, four sites along the Shenandoah River are monitored, in addition to sites on Page Brook, Spout Run, Lewis Run, and Dog Run. The FOSR also collects samples at the outfall of the Boyce and Berryville sewage treatment facilities. Samples are analyzed at a grant-funded laboratory located at Shenandoah University. As described earlier, the water chemistry parameters evaluated for these streams indicate low nutrient loading impacts. Coliform levels have not been measured, however, and where livestock or failing septic systems are present, contamination may be present. Additional monitoring is required to adequately evaluate the water quality of these streams.

3. Streams Susceptible to Contamination (figures 12 and 13)
In Clarke County, six water monitoring stations are sampled by DEQ: four on the Opequon Creek, one on Spout Run, and one on the Shenandoah River. Contamination levels are known for these three streams. All other streams are evaluated on a watershed basis as to their susceptibility to contamination based on livestock inventories, land use, and soil erosion rates. The following hydrologic units are located at least partly within Clarke County and are characterized as to the potential for surface water contamination in the 1997 Nonpoint Source Pollution Watershed Assessment Report (VDCR 1997). Actual contamination levels within
these watersheds can be determined by water sampling. The following summaries describe each watershed. Land cover data are derived from 1985 aerial photography compiled and evaluated in the Clarke County Geographic Information System (GIS).

a. Shenandoah River/Spout Run (B57)

The Shenandoah River/Spout Run hydrologic unit is located completely within Clarke

Figure 9. NPS Agricultural Ranking

/d1/arcdata/nad83/swmgmt7_cmp

Figure 10. NPS assessment Urban Ranking
/d1/arcdata/nad83/swmgmt8_cmp

County and makes up 41% (46,380 acres) of the total land area. The land cover is 52% forested, 44% agriculture, and 4% urban. The unit encompasses the mountain region from Wileys Neck south to Shenandoah Farms. The Valley portion extends from just south of Berryville to White Post and west to the drainage divide with the Opequon Creek. Boyce, Millwood, and Waterloo are within this unit, as are the major subdivisions of Calmes Neck and Carefree Acres. Perennial tributaries include Lewis Run, Chapel Run, Page Brook, Roseville Run, West Brook, and Spout Run in the Valley region, and Morgans Mill Stream, Wrights Branch, and two unnamed streams in the Mountain region. The DCR NPS assessment report rates this unit as having a medium potential for both agricultural and urban contamination and low for forestry. The overall NPS priority is listed as high based on a weighted calculation of the combined three land categories. As mentioned earlier, DEQ has declared Spout Run impaired based on high fecal coliform counts in water samples taken from the bridge at Route 621. DEQ identified one source as nonpoint agriculture but did not conduct source differentiation tests. Preliminary sampling by the County has identified human sources below Millwood and contamination from failing or inadequate sewage disposal in Millwood as a probable source for this contamination. In addition, fieldwork has identified that many landowners within the impaired segment have already fenced the stream to exclude livestock. Understanding the source of fecal coliform as either human or animal will result in the determining the best use of limited resources to reduce fecal coliform levels in the stream. High human counts will emphasize use of resources towards on-site sewage disposal management and repair, while higher livestock counts may indicate additional fencing is necessary. Extensive water quality monitoring (50 sites) is being conducted by the County as part of three watershed protection projects ongoing in Page Brook and Roseville Run. Friends of the Shenandoah River (FOSR) are sampling Spout, Chapel and Lewis Runs. Establishing sampling sites for the mountain streams is recommended.

b. Lower Shenandoah River (B58)

This watershed encompasses 36,945 acres of Clarke County, or 32% of the land area. The unit extends into Jefferson County, but such areas are downstream of Clarke and therefore do not affect County water quality. Land use in the region is 55% agriculture, 40% forestal, and 5% urban. The area extends from Wileys Neck across to Berryville and north to the West Virginia line. Urban areas include Pine Grove, Shenandoah Retreat, and Berryville. Streams within the watershed include Craig Run, Dog Run, Buck Marsh Run, Wheat Spring Branch, and Long Marsh Run in the Valley region, and Spout Run, a second stream with this name in the County, and four unnamed streams in the Mountain region. NPS assessment rates this unit as having medium potential for agriculture and urban runoff and low potential for contamination from forestry activities. The overall priority is low. DEQ has two sampling sites, one for water chemistry and the other for biological sampling, just north of the Route 7 bridge. Establishing sampling sites for the tributaries is recommended. FOSR samples Dog Run at the Route 621 bridge.

c. Lower Opequon Creek (B09)

The Lower Opequon hydrologic unit extends from Route 7 north to the Virginia/West Virginia State line. This watershed is also located principally in Frederick County (30,788 acres, 63%), with 18,339 acres, or 37%, in Clarke County. The watershed constitutes 14% of the land area in Clarke County. The section of the Opequon Creek flowing through this watershed is impaired by urban nonpoint source pollution as defined by DEQ. The other perennial stream is Dry Marsh Run. The land cover is predominately agricultural (66%), 31% forested, and 3% urban. The inventory data have identified a high potential for urban pollution, medium potential for agricultural pollution, and low potential for forestry pollution. Therefore, it is reasonable to conclude that Clarke County is not contributing significantly to the urban sources but may be contributing to agricultural source contamination of this waterway. The overall priority rating is medium. DEQ samples the Opequon Creek at two locations. Sampling is recommended for Dry Marsh Run.

d. Upper Shenandoah River (B55)

This unit encompasses most of the watersheds south of Route 50, including a portion of the Mountain region that contains Shenandoah Farms. Eight thousand forty-four acres (8,044) or 18% are located in Clarke County; the majority is in Warren County (37,585 acres, 82%). This watershed constitutes 7% of the County land area. Several tributaries to the Shenandoah River are encompassed within this watershed unit. These include Borden Marsh Run, Wolfe Marsh Run, and Long Branch. The land cover is 68% agriculture, 23% forested, and 9% urban. Urban areas include White Post, Double Tollgate, and Shenandoah Farms. This unit has been characterized by DCR as having a low potential for agricultural and forestal contamination and a high potential for urban contamination. The overall priority is high. Clarke County maybe contributing urban runoff from residential areas. Sampling should be conducted in the three tributaries to determine the impact from agricultural activities.

e. Upper Opequon Creek (B08)

The Upper Opequon hydrologic unit extends north from Double Tollgate to just north of Route 7. The watershed is located primarily in Frederick County (34,964.3 acres, or 86%), with 5,665 acres, or 14%, in Clarke County. This watershed encompasses 5% of the land area in the County. This unit has been identified by DCR as having a high potential for urban nonpoint pollution based on inventory data and biological and chemical monitoring. The perennial streams within this unit include Wrights Run, Opequon Creek, and Isaac Run. The Opequon Sewage Treatment Facility is located at the northern end of the watershed. The inventory data have identified a medium potential for agricultural pollution and a low potential for forestry pollution. The overall priority is medium. Land cover for the Clarke County portion of the watershed consists of 75% agricultural, 22% forested, and 3% urban. As with the Lower Opequon Watershed, it is unlikely that Clarke County is contributing significantly to the urban runoff, but it may be contributing to agricultural source contamination of this waterway. DEQ samples the Opequon at two locations. Establishing sampling sites in Wrights Run and Isaac Run is recommended.

f. Crooked Run (B56)

This area represents the smallest hydrologic unit in the County (<1% of the land area). It is located in the southwest corner of the County, just south of Double Tollgate. Only 795 acres, or 3% of the land area, of this basin is within Clarke County. Sixty-one percent is in Frederick County, and 36% is located in Warren County. The land area in Clarke County encompasses the headwaters of Crooked Run, which is identified as an intermittent drainage by the United States Geologic Survey (USGS). Land cover is 88% agricultural, 6% urban, and 6% forested. Overall, the unit has a high potential for urban contamination, a medium potential for agricultural contamination, and a low potential for forestal contamination, with a combined priority rating of medium, according to DCR. Camp 7, a minimum security prison, is located within this area and may contribute to the urban nonpoint source component. No water sampling is conducted within Clarke County, and none is recommended due to the lack of a perennial waterway.

E. Instream/Offstream Conflicts

In 1989, the Virginia General Assembly addressed the problem of instream vs. offstream beneficial uses of water. House Bill 1837 defined "beneficial use" to mean both instream and offstream uses. Instream beneficial uses include fish and wildlife habitat, waste assimilation, recreation, navigation, and cultural and aesthetic values. Offstream beneficial uses include domestic, agricultural, hydropower, commercial, and industrial uses. HB 1837 established State policy to protect instream beneficial uses.

Protection of instream uses requires a sufficient amount of flow, which may vary depending on the particular instream use and on the time of year. Establishment of an instream flow requirement is, therefore, partially a scientific question: how much water various uses require at various times. It is also, however, partially a political question: how much water people desire to allocate to specific uses (LFPDC 1990).

One of the features of the 1989 legislation (in HB 1841) was the proposed designation of Surface Water Management Areas (SWMA). In 1992, the Surface Water Management Area Regulation was adopted. This regulation permitted counties to initiate a SWMA proceeding by submitting a petition that shows a given stream meets the following three criteria: (1) the stream has substantial instream uses; (2) records indicate that damaging low flows could occur; and, (3) current or potential offstream uses are likely to exacerbate natural low flows to the detriment of instream uses. The SWMA designation is designed to establish incremental minimum instream flow rates for the river. Depending on the level of instream flow, water conservation will be required for water users. Conservation may range from voluntary reduction measures to mandatory reductions in water use until stream levels return to or exceed the minimum levels.

In 1990, Clarke and Warren Counties petitioned the Department of Environmental Quality to designate the Shenandoah River in Clarke and Warren Counties as a Surface Water Management Area. Beginning in 1993, a technical committee was formed, and a series of committee meetings were held in 1993 and 1994. These meetings concluded that additional data were needed to determine the minimum flows required to protect beneficial uses of the river during drought periods. In 1994, the Lord Fairfax Planning District Commission (LFPDC) adopted a resolution

of support for local government coordinated planning within the watershed. The LFPDC staff developed a working committee, the Minimum Instream Flow (MIF) Technical Advisory Committee (TAC), whose task was to assemble the background information needed to move toward a basin-focused water-use strategy. The committee consists of representatives from municipal waterworks, State and County governments, environmental organizations, and river outfitters. The committee consulted with various experts to determine a plan for study and in 1995 contracted with the United States Geologic Survey (USGS) to conduct a MIF study of the main stem of the Shenandoah River. Funding was received through grants from the Virginia Environmental Endowment, DEQ, and local government allocations based on water usage. This study, completed in 1998, served to develop procedures for use on the North Fork but was unable to determine the MIF criteria for the main stem (Zappia and Hayes 1998). Further work is therefore needed to on the main stem.

Work to date has identified the North Fork as the most critical water resource. Winchester City, Shenandoah County, Rockingham County, and Frederick County all use this source to some extent. The North Fork is 20% of the main stem flow, whereas these jurisdictions have 63% of the region's population, 112,900 as of 1997. By comparison, Clarke, Page and Warren Counties have 65,100 people or 37% of the region's population and draw water from the more water rich South Fork and main stem (Zappia and Hayes 1998).

Additional study is needed to determine the flows necessary to protect the resources of the Shenandoah River during varying conditions. USGS estimates that, with additional funding, work on the North Fork MIF can be completed in four years. This work would include extensive field data collection proposed through expanded contracts with USGS and Virginia Polytechnic Institute and State University (VPI), in cooperation with the Department of Game and Inland Fisheries. As currently funded, the complete analysis will take 10 years. Increased funding is necessary in order to complete this work in a more timely manner. This information is essential to designating the Shenandoah River a SWMA.

The overall objective of the SWMA designation is to equitably allocate water for all users during low flow conditions and to determine when water conservation measures are essential. If there is already substantial reduction of flow during certain time periods at present, then it only makes sense to plan for more serious problems in the future. This study is the first step in planning for an equitable distribution of what will inevitably become a limited resource in the next century.

F. Development

The County has a population of approximately 13,500. Approximately 4,500 additional building rights are available in the rural portions of the County, so significant growth could occur in the coming decades as pressure from the Washington metropolitan area increases. Approximately 75% of the population is located in the rural portion of the County and is served by onsite well and septic systems. With increases in rural development and growth in and around Berryville, water use will also increase (LFPDC 1990).

Development can affect Clarke's surface water in several ways. Building that occurs near streams can alter their physical appearance, water and habitat quality, and/or recreational value.

Increased wastewater disposal in rural areas may increase groundwater contamination that may ultimately affect surface water as well. Growth around a service area, on the other hand, may result in increased use of surface water for disposal of treated wastewater. Increased demand for offstream water may add to conflicts between offstream and instream uses. Finally, because groundwater provides the base flow in many perennial streams, increased groundwater use may adversely affect instream flows (LFPDC 1990).

V. Issues in Surface Water Management

In addition to contamination threats, comprehensive surface water resource management in Clarke County should address the following issues (LFPDC 1990):

A. the interrelationship of surface water with groundwater;
B. supply of water for traditional offstream uses, such as domestic supply and agricultural uses;
C. recreational uses and needs; and,
D. resource protection.

A. The Interrelationship of Surface Water with Groundwater

The processes and structures that connect surface water and groundwater influence both the quantity and quality of Clarke County's water resources. Groundwater inputs maintain the base flow in many streams, while groundwater levels in turn depend on recharge from precipitation infiltrating from the surface. Water moving between the surface and subsurface carries with it the chemical and biological constituents that determine its overall quality. Groundwater quality, therefore, is influenced by substances that initially entered surface water, and vice versa. This interrelationship is a basic reality of the County's water resources and must be considered in all water management decisions. These decisions are, however, complicated, requiring more technical information than is currently available. Better understanding of this interrelationship, therefore, should be a continuing objective of the County (LFPDC 1990).

B. Supply of Water for Traditional Offstream Uses, Such As Domestic Supply and Agricultural Uses

Section 62.1-44.38 of the Code of Virginia authorizes the State Water Control Board (currently DEQ) to prepare water supply plans for each river basin in the State. In 1988, the Shenandoah Water Supply Plan was published (VWCB 1988). The plans there in are intended to "encourage, promote and secure the maximum beneficial use and control thereof" of State water resources (VWCB 1988, p. xxiv) and include: (1) an estimate of current and projected water withdrawals and use for agriculture, industry, domestic use, and other significant categories of water users; (2) an estimate, for each major river and stream, of the minimum instream flows necessary during drought conditions to maintain water quality and avoid permanent damage to aquatic life in streams, bays, and estuaries; (3) an evaluation, to the extent practicable, of the ability of existing subsurface and surface waters to meet current and future water uses, including minimum instream flows, during drought conditions; (4) an evaluation of the current and future capability of public water systems to provide adequate quantity and quality of water; (5) identification of water management problems and alternative water management plans to address such problems; and 6) evaluation of hydrologic, environmental, economic, social, legal, jurisdictional, and other aspects of each alternative management strategy identified (VWCB

1988).

The Water Supply Plan defines demand centers as "a service area or combination of service areas with concentrated water use." (VWCB 1988, Ch. 2, p. 1). In Clarke County, the Plan evaluated surface water use of the Berryville demand center and the Boyce/Millwood/White Post demand center, and listed no existing or projected supply problems. However, the plan was based on slow growth projections through 2030, which now are predicted to be exceeded by 2005. The Plan was to have been updated periodically to reevaluate water use based on current data, but to date no update has been completed. A severe drought in 1999 prompted localities to look at regional water supply planning, which may result in solutions to predicted water deficit problems in the future. Periodic update of the section pertaining to Clarke County may be advisable to prevent such water deficits.

Interbasin transfer is yet another concern related to water supply in the Shenandoah River. Water for the City of Winchester is withdrawn from the North Fork of the Shenandoah River in Warren County. Sewage for the City is treated at the Opequon Sewage Treatment Facility and discharged into the Opequon, which is part of the Potomac River Basin. Therefore, the water withdrawn from the Shenandoah River Basin is never returned. Such transfers can degrade the stream flows necessary to perpetuate the aquatic, scenic, and recreational values of surface waters.

C. Recreational Uses and Needs

Recreational uses of surface waters include: multiple uses of the Shenandoah River (including canoeing, fishing, swimming, bird watching, and others), multiple uses of Opequon Creek during adequate flow conditions, and use of a few secondary streams (primarily for swimming and fishing).

A Shenandoah River Recreational Use Plan is currently being developed to fulfill an objective of the Tourism Destination Development Strategy of the Northern Shenandoah Valley Regional Partnership Strategic Plan. In an effort to identify and address the issues related to recreational use on the Shenandoah River, the Lord Fairfax Planning District Commission formed a steering committee in March 1998 to formulate the plan for the portion of the river basin that includes the Counties of Clarke, Warren, Frederick, Page, and Shenandoah. The plan will include balancing multiple uses, making recommendations for a system of public access sites, use areas, and support facilities, and recommending management prescriptions for each river segment. Once developed, a plan will be distributed to the local governments to consider adopting it.

D. Resource Protection

Maintaining a vegetated riparian buffer zone is essential to ensuring water quality. A vegetated buffer acts as a filter strip between contamination sources and the waterway, capturing and removing pollution before it gets to the stream. Many secondary streams are used for watering livestock. Allowing livestock unlimited access to streams reduces vegetation due to grazing, increases sedimentation in the water as banks are broken down, and decreases water quality by direct deposit of fecal material. Development and other land disturbance within the riparian corridor also reduce vegetation, allowing urban contaminants such as lawn fertilizers and septage to pollute waterways. In addition, impervious surfaces can adversely affect flood zones and

reduce groundwater recharge. Regionally, efforts to protect riparian zones are mandated in coastal areas of Virginia and encouraged throughout the Bay watershed to reduce contaminants entering the Chesapeake Bay.

The Chesapeake Bay Preservation Act calls for the identification and protection of certain lands called Chesapeake Bay Preservation Areas (CBLAD 1997). The regulations governing these areas "establish criteria for use by local governments in granting, denying, or modifying requests to rezone, subdivide, or to use and develop land in Chesapeake Bay Preservation Areas" (CBLAD 1997, sec. 9VAC10-20-30). Currently, only the localities with tidal shoreline are required by State law to adopt the Preservation Area Regulations. However, all localities within the Bay watershed are encouraged by CBLAD to adopt pertinent portions of the regulations. Chesapeake Bay Preservation Areas are divided into Resource Protection Areas (RPAs) and Resource Management Areas (RMAs). Resource Protection Areas are the most sensitive areas and those where development and disturbance activity are most heavily regulated under current Bay Regulations. In Clarke County, these include buffer areas not less than 100 feet wide along both sides of any perennial stream or wetland areas adjacent to those streams. Resource management areas include floodplains, highly erodible soils, highly permeable soils, and nontidal wetlands not included in the RPAs (figure14).

Clarke County has already adopted several measures, including requiring 100% reserve areas for septic systems, amending the erosion and sediment control ordinance so that land disturbance exceeding 2,500 square feet is reviewed, and requiring building setbacks of 100 feet for perennial streams in the Mountain region. Additional regulations for consideration include mandatory septic pump-out, enhanced stormwater management regulations, and requiring 100-foot vegetated building setbacks from perennial streams within the Valley region of the County. These setbacks would serve to limit encroachment within the stream corridor, allowing contaminants from surface runoff to be filtered before entering the waterway.

VI. Current and Past Surface Water Quality Improvement Activities in Clarke County

Clarke County has been working to improve surface water quality as part of the Chesapeake Bay Cost-Share Program since 1985. The Cost-Share Program supports using various Best Management Practices (BMPs) in conservation planning for animal waste treatment, cropland, pastureland, and forested land. The Cost-Share Program pays a percentage up to 75%, with landowners responsible for the remaining 25% of the total cost of the BMP installation. In Clarke County, efforts have been directed toward installing BMPs on farms to reduce surface runoff into streams. Between 1989 and 1997, 34 farms participated in the Cost-Share Program to create a total of 1,900 acres of riparian buffer. With the increase in funding levels over the last two years, approximately 20 additional farms will begin installing a variety of BMPs designed to improve water quality. Since 1995, as part of the Tributary Strategy process, DWSC has recorded the reduction in amounts of nitrogen and phosphorus resulting from the installation of BMP's. Between 1985 and June 1999, farms in Clarke County have reduced the amount of nitrogen by 29,962 pounds and phosphorus by 4,540 pounds that would have entered the County's

Figure 11. Chesapeake Bay Preservation Areas

waterways. This level of participation provides a clear indication that the farming community is interested in and has had a significant impact in protecting the natural environment.

In addition, the County has adopted specific ordinances that protect both ground and surface waters from urban source pollution. These include the County Septic, Well, Sinkhole, and Erosion and Sediment (E&S) Control Ordinances. The County Septic Ordinance requires increased siting requirements that exceed current State requirements and installation of a 100% reserve area and sets forth provisions for mandatory septic pump-out. The Well Ordinance increases standards for grouting and casing and establishes setbacks from known sources of pollution. The Sinkhole Ordinance serves to increase awareness of the potential to contaminate groundwater through sinkholes and imposes penalties for illegal dumping. The E&S Ordinance establishes a minimum disturbance area of 2,500 square feet that may require an E&S plan approved by the Division of Soil and Water Conservation.

The County has added sections to the Zoning Ordinance that require a minimum 100-foot building setback to perennial streams and springs, 50 feet to intermittent streams, and minimal clearing within these setback areas in the Forestal -Open Space -Conservation (FOC) District.

The County has also explored the possibility of installing zero discharge waste water treatment facilities in the County to dispose of septage and sewage. Approximately 60,000 gals./day could be processed and the effluent used as irrigation water rather than being discharged into area tributaries.

Watershed Protection Efforts

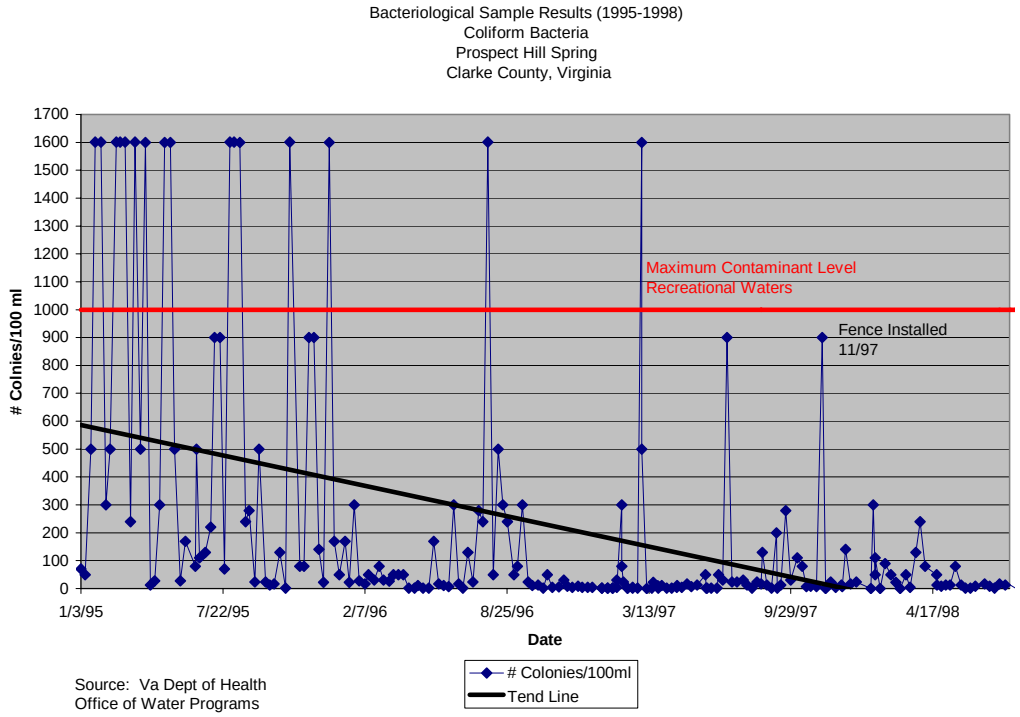
Two EPA Section 319 grants and one Water Quality Improvement Fund (WQIF) grant requests have been funded to improve water quality within the Spout Run watershed. Spout Run is a priority watershed for the County, because Prospect Hill Spring is within this basin and serves as a public water supply for 300 households. This spring has recently been determined to be under the influence of surface waters and therefore must comply with EPA's Surface Water Treatment Rule. Both the Clarke County Planning Commission and Sanitary Authority have determined that overall watershed protection is critical to maintaining the viability of this Spring as a public water supply. Recent efforts to reduce coliform bacteria in the Spring have included acquiring a 7 acre buffer area upslope of the Spring. This area was fenced, and 400 hardwood seedlings were planted in 1997. That effort has resulted in a significant decrease of coliform bacteria present in the Spring (figure 15). This outcome further highlights the effectiveness of vegetative buffers in protecting water quality.

In addition, as indicated previously, the Shenandoah River/Spout Run watershed has been identified as a high priority in the Statewide Nonpoint Source Pollution Potential Priorities and Impaired Waters Listing and Natural Heritage Priority Ranking for 1996. The watershed is also listed as a TMDL priority, as impaired water, the source of impairment being listed as NPS agriculture. Spout Run has a medium Natural Heritage Ranking.

The first EPA grant was for Page Brook, a tributary of Spout Run. This project was initiated in 1996, with receipt of $75,000 to conduct a watershed study, which examines practical approaches of BMP installation to improve water quality. Approximately 2.5 miles of fencing

was installed on four farms in the watershed. The effectiveness of the BMP installation was determined by analyzing water samples collected monthly throughout the project. Dr. Charles Hagedorn, a professor in the Soil and Crop Environmental Sciences Department at Virginia Tech, analyzed fecal coliform bacteria. After analyzing the data, he concluded that coliform bacteria counts collected at sites within fenced buffer areas were reduced by an average of 92% from August-October 1997 to August-October 1998. Initially, coliform bacteria counts were at levels high enough to declare the stream impaired, but since fencing and other BMPs have been installed, coliform levels have been reduced below the impairment level. Final reports and conclusions of this study will be available in early 2000.

Figure 15. Water sampling results, Prospect Hill Spring, Clarke County, Virginia.



A second EPA grant was approved in 1998 for Roseville Run, the other main tributary of Spout Run. This grant was for the amount of $65,250 to improve water quality in this section of the watershed by installing BMPs similar to the work conducted in Page Brook. A WQIF grant request for $45,150 was also funded to improve water quality in the main stem of Spout Run. This study will emphasize stream fencing but will also address the impact that failing septic systems and discharge of sewage treatment plants have on water quality.

VII. PLAN IMPLEMENTATION

Clarke County has already initiated efforts to improve surface water quality as described above. However, more can be done to address threats to surface waters. The following is a list of recommended actions to improve surface water quality, in order of priority.

1. <u>Establish a Stream Protection Overlay District</u> and adopt regulations to protect those designated areas.
The Chesapeake Bay Act requires Tidewater counties to implement the Chesapeake Bay Preservation Area Regulations to reduce nutrient loading in the Bay. Localities outside of the coastal areas are encouraged to implement components of the Act that will be most effective in reducing pollutants entering tributary streams that ultimately enter the Bay. Clarke County should adopt an overlay district described as the Stream Protection Overlay District. The intent of this district is to provide stream buffers for the purposes of filtering nonpoint source pollution from runoff, preventing erosion, moderating stream temperature, and providing for the ecological integrity of stream corridors and networks. The establishment of the district will encourage the long-term protection of surface waters and help to prevent the contamination of groundwater, the principal source of drinking water in the County.

2. Amend the Zoning Ordinance to <u>require 100 foot building setbacks from perennial streams and springs, and 50 foot building setbacks from intermittent streams</u> identified on the 7.5 minute USGS topographical maps within the Agricultural –Open Space - Conservation District.
Preserving stream and river riparian corridor zones is essential for protecting water quality. Building setbacks from streams have been in place in the FOC zoning district since 1994. Requiring these same setbacks in AOC will serve to protect stream corridors in the Valley region of the County.

3. <u>Establish a Countywide surface water monitoring network</u> to effectively monitor changes in water quality over time. This program would include routine testing of and official reporting for all perennial streams for coliform and water chemistry.
Several streams in the County are currently monitored, but most are not. Identifying which streams are contaminated is necessary to allocate limited resources effectively.

4. <u>Encourage upgrading of sewage treatment plants</u> to reduce nutrient discharge into surface waters.
In general, wastewater treatment plants contribute a significant amount of nutrients to State waters. Past discussions in the County have involved upgrading the Boyce treatment facility to reduce nutrient discharges. Upgrades may include zero discharge or land application, biological nutrient removal (BNR) treatment, or other methods. Over time, these upgrades would have a considerable impact in the reduction of nutrients entering the Shenandoah River Basin. In addition, the County should encourage and support the Town of Berryville when upgrades for the Berryville Treatment Facility are considered.

5. <u>Encourage installation of Best Manangement Practices (BMPs)</u> to reduce livestock access to riparian buffer zones.
Efforts should be directed at working closely with the Soil and Water Conservation District to encourage use of Cost-Share Programs on a farm-by-farm basis. Priorities established as a result of other planning efforts detailed in this report will aid in focusing limited resources. Two important County roles would be to increase awareness of the nonpoint source (NPS) problem and solutions and to help coordinate local efforts by the various State agencies.

6. Identify locations of individual on-site sewage disposal systems discharging into State waterways and replace them with conventional septic systems where possible.
Although these systems are no longer permitted in the County, some may exist that were installed before the adoption of the Septic Ordinance. Identifying the type and location of all sewage disposal systems in the County is a priority outlined in the Groundwater Resources Plan. These systems can be upgraded to eliminate sources of contamination.

7. Consider adopting a Shenandoah River Recreation Plan.
Efforts are under way to develop a recreational use plan for the Shenandoah River. This plan will serve the entire basin, but each river segment will be evaluated individually. Professional recreation planners from DCR are assisting with the plan formulation. Each locality within the basin will need to hold public hearings and have the plan adopted by the Board of Supervisors. At that time, the County may wish to insert goals or objectives specific to Clarke County. These could include sections relating to the scenic river designation, protection of aesthetic values, and establishment of vegetative riparian buffers.

8. Increase funding to the multijurisdictional Minimum Instream Flow Study so that the data necessary to declare a Surface Water Management Area are available as soon as possible.
As currently funded, a complete MIF study will take10 years. Requests for increased funding are necessary to complete this work in a more timely manner. This information is essential to designating the Shenandoah River a SWMA, for which Clarke County petitioned the State in 1990.

9. Conduct a comprehensive study in cooperation with the USGS to characterize tributary stream flow patterns, discharge rates, and floodplains.
Determining surface water flow patterns and discharge rates provides invaluable data as to the amount of water available for instream and offstream uses. Healthy stream habitats depend on adequate flow to assimilate pollutants from sources impacting surface waters. Baseline data can be incorporated into determining TMDL rankings for all County tributaries, not just those selected by the State. Once ranked, resources can be allocated to those streams with the highest potential for degradation.

10. Update the 1988 Water Supply Plan to ensure that adequate water resources are available for Clarke County residents.
The 1988 Water Supply Plan outlined water supply needs and projected shortfalls through 2030. To date, no update has been completed or is planned. Periodic update of the section pertaining to Clarke County may be needed to prevent water deficits in the future.

11. Conduct additional dye tracing studies to increase understanding of the interrelationship between ground and surface waters in the County.
The groundwater surface water interrelationship is complicated, requiring more technical information than is currently available. Several dye tracer studies have been conducted to aid in determining groundwater flow patterns. Surface waters can also be tested to determine the extent of interaction within drainage basins. In addition, flow discharge measurements can be utilized in identifying flow rate losses to groundwater within streams. Concentrated efforts

should be initiated within the Spout Run watershed to help further define flow patterns to Prospect Hill Spring.

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