Brown Mountain Creek upstream of Pedlar Reservoir, the primary source of drinking water for the City of Lynchburg

The State of Our Water

Managing and Protecting the Drinking Water Resources of the George Washington National Forest

A study conducted by Wild Virginia

WILD VIRGINIA

EXECUTIVE SUMMARY

Forested lands are critical for producing clean water. A 2008 report by the National Research Council states that streamflow from forests provides two-thirds of this country's clean water supply. The U.S. Forest Service recognizes the importance of forests in providing clean water. The agency's Strategic Plan for Fiscal Years 2004-08 lists "Improve watershed condition" as one of its six major goals. This goal is consistent with the Weeks Act of 1911, which established eastern national forests "for the purpose of conserving the forests and the water supply of the States" and "for the protection of the watersheds of navigable streams."

The George Washington National Forest (GWNF) lies entirely within the Chesapeake Bay watershed. As a source of water that feeds the James and Potomac Rivers and ultimately flows through the Washington, DC, Richmond and Hampton Roads metropolitan areas, millions of people rely on these waters for a variety of purposes. Almost 4 million residents downstream of the GWNF obtain drinking water from the James and Potomac Rivers.

The GWNF and its surface waters are extremely important as a local and regional source of drinking water.

The local need for clean water is acute, as several localities rely solely on water originating in the GWNF for domestic use. Five reservoirs located within the GWNF provide drinking water to area residents, with the watersheds of these reservoirs comprising roughly 7.1% of the GWNF in Virginia. Thirteen area localities and organizations obtain drinking water from rivers whose watersheds include part of the GWNF. These thirteen watersheds represent approximately 37.4% of the GWNF in Virginia. The combined 425,874 acres within public drinking watersheds represent roughly 44.5% of all the GWNF land in Virginia. Twenty-two localities and more than 260,000 residents of western Virginia obtain drinking water from surface waters of the GWNF (see table, page 3).

There is cause for concern about water quality in the GWNF. Data from the Virginia Department of Environmental Quality in 2006 lists 6 reservoirs and 50 streams or rivers within the GWNF as impaired (though none were considered impaired as a public water supply). **Four of the six impaired reservoirs occur within drinking watersheds, with drinking water being directly drawn from two of them.** The drinking watersheds contain more miles of impaired streams than would be expected based on the land area they occupy. While many of the causes of impaired waters are beyond the control of the Forest Service, the presence of so many impaired streams, rivers and reservoirs indicates that more attention should be paid to water quality protection in the GWNF.

Management of the GWNF does not differ significantly between drinking watersheds and other areas of the forest. Of the total land area in the drinking watersheds, 34.4% is "suitable for timber production" (per the 1993 Forest Plan for the GWNF) compared to 34.8% of the land area outside the drinking watersheds. Road and trail densities on the GWNF reveal no consistent differences or pattern when comparing drinking watersheds to the rest of the forest.

The 1993 Forest Plan does very little to address drinking water resources. The plan identifies drinking water reservoirs, but does not address the watersheds within which the reservoirs occur. No other public drinking water sources are identified or discussed. The Forest Service must do more to protect water resources in the GWNF. Merely meeting state standards and best management practices, as called for in the 1993 Forest Plan, should not be a management goal. These standards represent minimum levels of acceptable management and should be greatly exceeded. National forests should produce the cleanest, purest water possible and establish the highest of standards that other land management organizations can strive to meet.

Managing for watershed protection produces many benefits beyond drinking water protection. Reservoirs function for longer periods of time due to decreased sedimentation. Many aquatic species, terrestrial species, and natural communities benefit from sound ecological watershed management. Outdoor recreational opportunities, scenic resources, biological diversity, and other forest features are enhanced as well.

The Forest Plan for the George Washington National Forest is currently being revised. The new Plan will guide management of the national forest for the next ten to fifteen years.

This is the optimal time to assess current management strategies and adjust them to enhance and protect the many values these public lands possess. Direct, explicit management of drinking watersheds must be part of the plan.

> Ground disturbing activities such as logging and road building should not be conducted near streams that are impaired or subject to other physical stresses.

OUR RECOMMENDATIONS

1) The Forest Service should **FORMALLY IDENTIFY ALL THE DRINKING WATERSHEDS LYING WITHIN THE GWNF AND DESCRIBE THEM IN THE FOREST PLAN**. The rivers and streams within these watersheds should be considered a public water supply.

2) Forest management should address entire watersheds, not just riparian areas. Specific management objectives should be developed for all drinking watersheds.

3) **IMPAIRED STREAMS, RESERVOIRS, AND THEIR WATERSHEDS NEED SPECIAL ATTENTION AND SHOULD BE A PRIORITY FOR RESTORATION EFFORTS.** Ground disturbing activities such as logging and road building should not be conducted near streams that are impaired or subject to other physical stresses.

4) More information is necessary to adequately describe and assess watershed conditions. The Forest Service should **DEVELOP A PLAN TO MONITOR ALL EXISTING WATER QUALITY** and related programs and obtain all data pertinent to water quality and watershed conditions. There is great potential for cooperative efforts with other agencies, organizations, local communities, and volunteers.

5) The Forest Service should develop a plan to increase its own efforts to **MONITOR WATER QUALITY IN THE GWNF.** Macroinvertebrate sampling is important but should be augmented with other programs. Particular attention should be paid to sedimentation in streams and rivers. Direct measures of the impact that ground disturbing activities and projects have on water quality and sedimentation are needed.

6) **THE FOREST SERVICE AND LOCALITIES THAT OBTAIN DRINKING WATER FROM GWNF MUST COMMUNICATE MORE EFFECTIVELY**. Strong working relationships and partnerships should be developed.

7) **DRINKING WATERSHEDS SHOULD BE PROTECTED AND MANAGED APPROPRIATELY.** Improving existing water quality while permanently protecting and enhancing future quality are obvious goals with which to begin. The potential impacts of timber harvesting and road construction (including temporary roads) must be fully examined. The Forest Service, local communities, and the larger public should work together to establish policies and develop management plans for the drinking watersheds.

The North River, flowing into Elkhorn Lake. Photo: Marjorie Seigel

LOCALITY	EST. POPULATION SERVED BY GWNF SOURCES	WATER OBTAINED DIRECTLY FROM RESERVOIR IN GWNF	WATER OBTAINED DIRECTLY FROM LOCAL RIVER FLOWING FROM GWNF	OBTAINS WATER FROM ANOTHER LOCALITY OR ORGANIZATION USING WATER FROM GWNF
Alleghany County	6,149			Yes
Amherst, Town of	5,000		Buffalo	
Augusta County	9,058	Coles Run Reservoir		Yes
Bedford County	17,300			Yes
Bridgewater, Town of	682		North	
Broadway, Town of	3,200		North Fork *Shenandoah River*	
Campbell County	269			Yes
Clifton Forge, Town of	4,679	Smith Creek Reservoir		
Covington, City of	7,300		Jackson	
Frederick County	12,649			Yes
Front Royal, Town of	12,500		South Fork *Shenandoah River*	
Harrisonburg, City of **	44,500	Switzer Lake	North, Dry	
Iron Gate, Town of	386			Yes
Lexington, City of	7,200		Maury	Yes
Lynchburg, City of	76,000	Pedlar Reservoir	James	
Middletown, Town of	1,120			Yes
Rockbridge County	2,764			Yes
Rockingham County *(city-rural customers of Harrisonburg)*	4,253		North, Dry	Yes
Staunton, City of	11,066	Staunton Reservoir		
Strasburg, Town of	4,500		North Fork *Shenandoah River*	
Winchester, City of	28,071		North Fork *Shenandoah River*	
Woodstock, Town of	3,952		North Fork *Shenandoah River*	
TOTAL	**262,598**			

List of Virginia localities that obtain some or all of their drinking water from resources within the George Washington National Forest (GWNF). Estimated population data is from the years 2006 through 2008.

**The City of Harrisonburg owns and manages Switzer Lake. The water intake facility on the Dry River for the City of Harrisonburg is a few miles downstream of Switzer Lake. No water is drawn directly from Switzer Lake.

INTRODUCTION

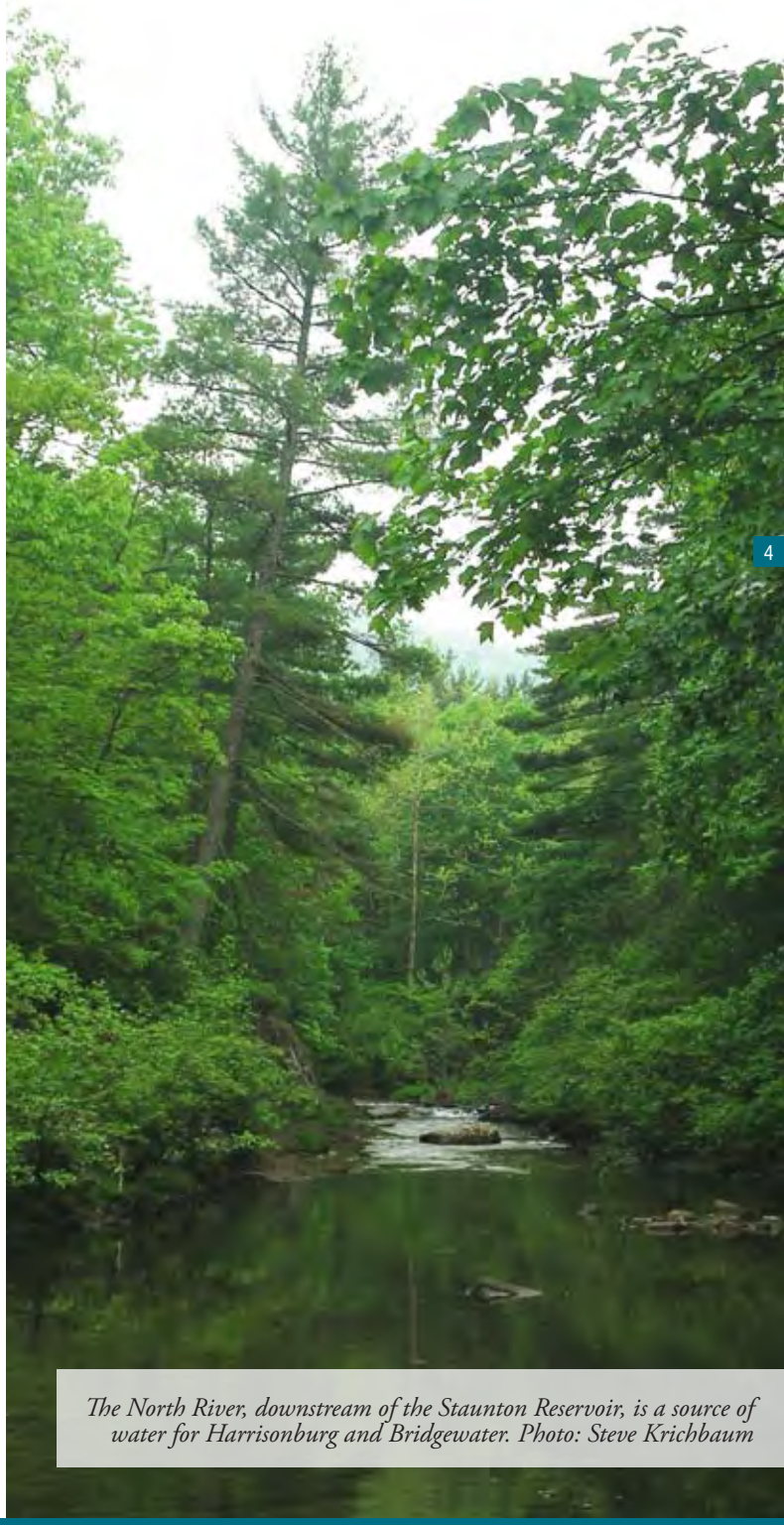
Forested lands play a critical role in providing clean, safe drinking water to healthy, thriving communities in Virginia and around the world. While it is well known that many Virginians depend on the George Washington National Forest (GWNF) for drinking water, to our knowledge, no thorough research exists on the importance of the national forest to such resources or the level of protection, or lack thereof, afforded these critical watersheds.

In this report, Wild Virginia closely examines the role of the GWNF in supplying drinking water to communities in western Virginia and cities and towns downstream in the James and Potomac watersheds.

The importance of water cannot be overstated. Simply put, it is necessary for human existence and for almost all life on our planet. Because it is essential for individual and societal well-being, inadequate supplies of clean water often result in human conflict. The legal debate involving the states of Florida and Georgia in the aftermath of Atlanta's water shortage in 2007 is a recent example of the conflict that can occur.

Americans are concerned with the state of the nation's water supplies. Clean water is necessary for recreation, commerce, transportation, agriculture, energy development, a source of food, and many other uses. The public has consistently demanded legally defined and enforceable standards for the quality of our potable and non-potable water. Enactment of the Clean Water Act in 1972 and passage of the Safe Drinking Water Act in 1974 were the result of long-standing concerns. Both laws have been amended over the years. The Safe Drinking Water Act requires protection of drinking water and its sources: rivers, lakes, reservoirs, springs, and wells that serve more than 25 people. The Clean Water Act remains the cornerstone of surface water protection in the United States.

Water quality and supply issues, particularly related to drinking water, are a focus of attention at many levels, from small communities to the state and national level. In Virginia, the Local and Regional Water Supply Planning Regulation (9 VAC 25-780) was finalized in 2006. Administered by the Virginia Department of Environmental Quality (DEQ) and the State Water Control Board, the law requires all local governments to develop water supply plans that are environmentally sound and provide for current and future water needs. Local governments can develop strategies and plans individually or as part of a larger geographic region. The first of the plans is scheduled for completion in November of 2008.



The North River, downstream of the Staunton Reservoir, is a source of water for Harrisonburg and Bridgewater. Photo: Steve Krichbaum

Virginia's water planning regulation reflects the public's concerns about water issues. Gallup conducted its annual Environment Survey in March of 2008. Of the 12 environmental concerns listed in the national survey, the top four concerns related to water quality. Pollution of drinking water was the number one concern.

Only a few days after the survey results were released, an Associated Press story surprised many Americans by revealing that large numbers of pharmaceutical products had been found in the drinking water supplies of at least 41 million U.S. residents (Donn et al. 2008). Though the concentrations were tiny, the products were worrisome and included antibiotics, anti-convulsants, mood stabilizers, and sex hormones.

Over time, there has been a growing awareness in the scientific community and the general public that forested lands are critical for the production of clean water. Forests and their underlying soils filter and slow the speed of precipitation before much of it is delivered into rivers and streams. A recent report by the National Research Council (2008) states that streamflow from forests provides two-thirds of this country's clean water supply. Changes in forested headwater areas affect the quantity and quality of water downstream. The report concludes that a sustainable supply of clean water is as important as any commodity or resource produced by our forests, and that our forests should be managed accordingly.

The U.S. Department of Agriculture-Forest Service (Forest Service) recognizes the importance of forests in providing clean water. The Forest Service Strategic Plan for Fiscal Years 2004-08 estimates that 3,400 towns and cities across the country depend upon National Forest System watersheds for their public water supplies. "Communities that draw source water from national forests and grasslands provide water to 60 million people, or one-fifth of the Nation's people." (USDA Forest Service 2004a) Recognizing the importance of water quality, and with demand for water almost certain to increase through time, the strategic plan lists "Improve watershed condition" as one of its six major goals.

This goal is consistent with the Weeks Act of 1911, which authorized the federal government to purchase forest lands in the eastern United States. This law complemented earlier legislation that established "forest reserves" in the western U.S., the forerunner to the current National Forest System. The Weeks Act established eastern national forests "for the purpose of conserving the forests and the water supply of the States" and "for the protection of the watersheds of navigable streams."

Though the primary intent of the Weeks Act was to protect navigable waters from sedimentation, other intentions and benefits were clearly part of the bill's purpose. A government circular written by Forest Service Chief Henry Graves shortly after the Weeks Act was passed provides more detail about the bill's purpose. Though the flow of navigable streams was the fundamental purpose, "other benefits . . . will be kept in view. Among these are protection against disastrous erosion of the soil on mountain slopes", "preservation of the purity and regularity of flow of the mountain streams, with a view to their use for the water supply of towns and cities", and "preservation of the beauty and attractiveness of the uplands for the recreation and pleasure of the people."

The circular singles out the Appalachian Mountains and the need to protect water resources there. "The sources of the navigable streams which have their origin in the Rocky Mountains or the mountains nearer the Pacific coast are already to a large extent protected by National Forests. The Appalachian Mountains, including the White Mountains, are for the most part without such protection. Because of their altitude, steepness, and lack of protection they are in a class by themselves in their need for the action authorized under this law."

Clean water is one of the many "ecosystem services" produced by forested areas. Ecosystem services are products and benefits that natural systems provide to humans. Awareness of ecosystem services has grown in recent years among the general public and the scientific community. The Forest Service, Virginia Department of Forestry, and many other organizations have published information about essential services that forests provide to the public. Clean water is always among the first services described. Air purification, biological diversity, flood control, recreational resources and scenic landscapes are among other services provided at no direct public cost.

Localities are increasingly aware of the ecological services provided by forested natural areas. Many are aware of the huge economic cost to clean and purify water before making it available for domestic use. This is especially true when the quality of the water is poor to begin with. As a result, many cities have decided to protect their water supply at its source rather than bear the cost of developing and maintaining the infrastructure necessary to cleanse it.

New York City may be the most well known example. In 1997, New York City entered an agreement with 7 counties, 72 municipalities, New York State, EPA, and numerous

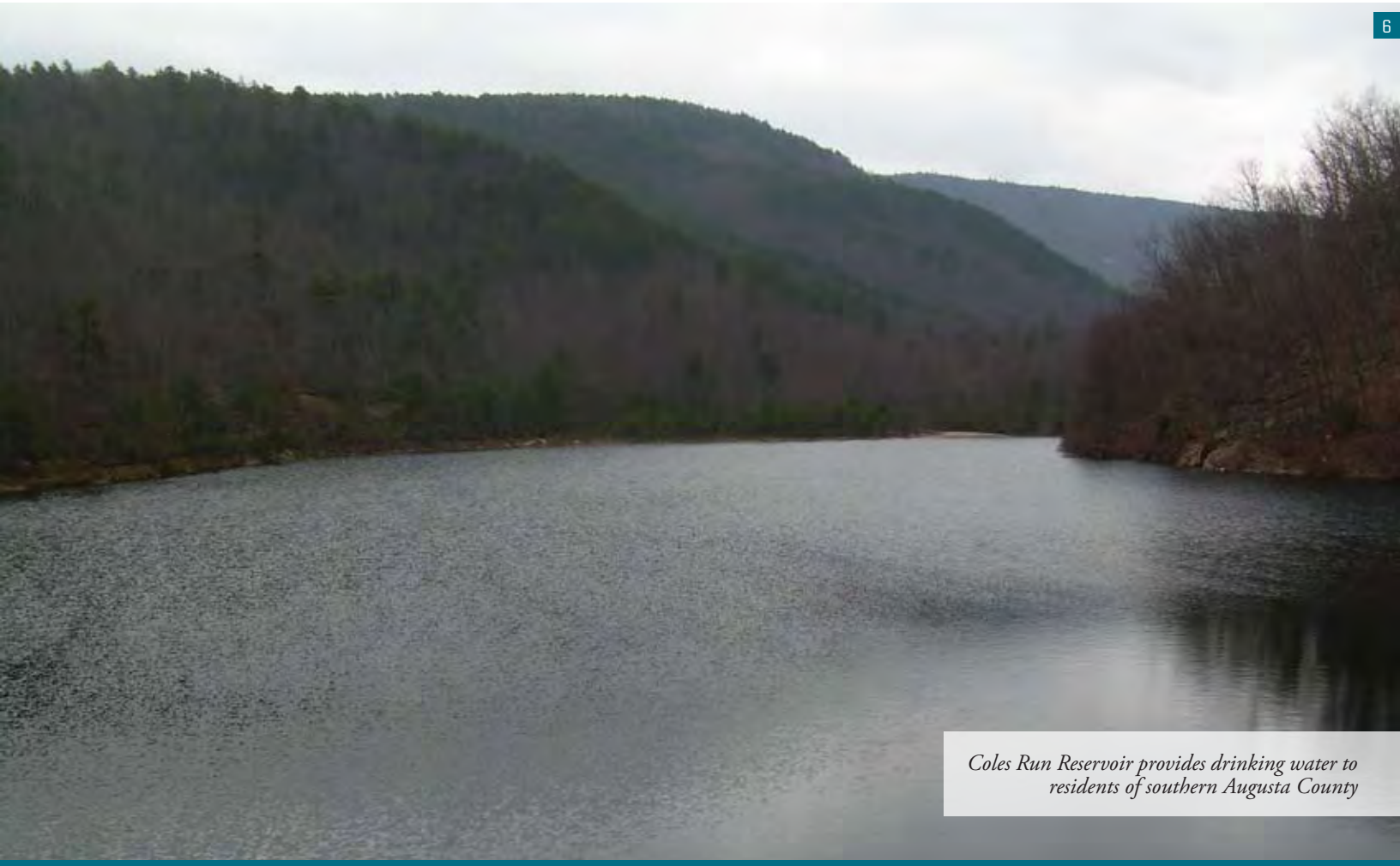
> A recent report by the National Research Council (2008) states that streamflow from forests provides two-thirds of this country's clean water supply...a sustainable supply of clean water is as important as any commodity or resource produced by our forests...our forests should be managed accordingly.

organizations to protect water quality in the drinking watershed of the City. Protection of the 1,969 square mile watershed that is west and north of the City has increased since then, and today serves more than 8 million residents.

By employing watershed protection measures, the City avoided the approximately $6 billion cost of a water filtration plant, plus an estimated $300 million per year operating cost.

The $1.5 billion cost to protect the watershed resulted in a net savings of approximately $4.5 billion (Mates and Reyes 2006).

Other cities have also adopted this strategy, recognizing the economic savings as well as open space protection and other benefits that result. Some of these cities are located in the southern Appalachian Mountains. Asheville, NC established a conservation easement in 1996 on a 17,356 acre tract of land along the Blue Ridge Parkway, which is the drinking water source for the city. Greenville, SC has also protected its drinking watershed with a conservation easement. In May 2008, the City of Roanoke, VA donated a conservation easement on 6,185 acres of Carvins Cove Natural Reserve, thus protecting a significant portion of its drinking watershed. The remainder of the natural area is targeted for protection in the future.



Coles Run Reservoir provides drinking water to residents of southern Augusta County

ABOUT THIS PROJECT

The GWNF lies entirely within the Chesapeake Bay watershed. Though it contains headwaters for the Potomac and Shenandoah Rivers to the north and the James River to the south, the great importance of the GWNF is often overlooked. Of the GWNF lands in Virginia, roughly 39% fall within the Potomac-Shenandoah watershed and 61% in the James River watershed. Figure 1 (page 21) shows the James and Potomac watershed locations relative to Virginia and the GWNF.

As a source of water that ultimately flows through the large population centers of the Washington, DC, Richmond and Hampton Roads metropolitan areas, millions of people rely on these waters for a variety of purposes. The City of Richmond and three surrounding counties – Henrico, Hanover, and Chesterfield – obtain their drinking water from the James River. Approximately 500,000 residents of these localities are served by the James (City of Richmond 2008).

Many more people in the Washington, DC area rely on water that originates in part in the GWNF. The Potomac River provides approximately 75% of the drinking water used by residents of the metropolitan Washington, DC area (Interstate Commission on the Potomac River Basin 2005). With an estimated 2007 population of 4,633,400 residents (Metropolitan Washington Council of Governments 2007), roughly 3,475,000 Washington area residents rely on the Potomac River for their drinking water. Coupled with the Richmond area estimates, almost 4 million residents downstream of the GWNF obtain drinking water from the main stems of the James and Potomac Rivers.

This report documents the importance of the GWNF as a local and regional drinking water source. Part of the effort was to determine how many communities and citizens in close proximity to the GWNF depend on national forest lands for their drinking water. Another focus was to identify and map lands within the GWNF that are sources of drinking water, and to describe them and how they are managed. Some comparisons between drinking watersheds and all other lands in the GWNF were made.

Drinking water reservoirs and their watersheds were an obvious focus area. Watersheds that fall either partially or entirely within the GWNF, and from which drinking water is taken, were also a focus. For example, the Town of Woodstock obtains its drinking water from the North Fork of the Shenandoah River (NFSR). Though the water intake point is outside of the GWNF, the headwaters of the NFSR are within the GWNF. This project quantified how much of this and similar, local watersheds are on national forest land.

Compiling information about water sources and supplies for localities involved communicating with many individuals and agencies. Staff from the Virginia Department of Health (VDH), DEQ, four regional planning districts, and numerous local government organizations provided information and assistance. All the water source and supply data were from calendar year 2006 through July 2008. The most recent available data were always used.

Much of the information in this report originated from the Forest Service, both in the form of publications, raw data, and communication with staff. A Geographic Information System (GIS) was instrumental in performing much of the analysis. Most of the GIS data used were developed by and obtained from the Forest Service.

This report covers only the portion of the GWNF that lies within Virginia, representing 90% of the total land base of the GWNF (roughly 956,222 of the total 1,061,080 acres - USDA Forest Service 2008). No information applies to West Virginia. Only residential water users were included in our analysis. Commercial, industrial, institutional, agricultural, and other non-residential uses of water were excluded. Nevertheless, the supply and quality of water for non-residential uses is very important and deserving of attention in its own right.

Only surface waters were considered in this report. No groundwater or springs that provide public drinking water were included, even though they play a large role in regional water supplies. "Groundwater-sheds" are not known with great precision, especially in areas of underlying, largely impermeable and/or fractured bedrock. Much of the GWNF is characterized by these conditions, which makes identifying groundwater recharge areas problematic. Research to model groundwater dynamics is ongoing, so efforts to incorporate groundwater resources may be more practical in the future.

In analyzing watershed and other geographical data, only national forest lands were considered. Private inholdings and other non-national forest lands occur within the boundaries of the GWNF but were not included in this report. For example, both the Cities of Lynchburg and Harrisonburg own land surrounding the reservoirs they use as sources of drinking water. These are not part of the land base included in describing and analyzing the drinking watersheds. Unless otherwise noted, GIS was used to compute area figures (acres, square miles) and lengths (feet, miles) that are used in the report. These figures are generally accurate, but should not be considered precise or official. The Forest Service reports approximately 956,222 acres of the GWNF lying within Virginia; our base calculation is 956,990 acres (a difference of 0.08%) and is the figure that is used for this report.

The GIS data obtained for Management Areas in the GWNF did not include Management Area 18, "Riparian Areas with Ecological Widths." According to the 1993 Land and Resource Management Plan for the GWNF (Forest Plan), 21,000 acres (1.98%) of the GWNF is within Management Area 18 (the acreage and percentage figures include both Virginia and West Virginia lands in the GWNF, USDA Forest Service 1993b).

FINDINGS

DRINKING WATER SUPPLIES AND SOURCES

Using drinking water facilities data from the VDH, we identified localities that obtain at least part of their drinking water from the GWNF. The facilities are water intake points that are located either (1) on a reservoir within the GWNF, or (2) on a stream or river downstream of the GWNF whose watershed includes a portion of the GWNF. Water source and supply data collected from other sources confirmed these intake points.

Of the roughly 956,990 acres of GWNF within Virginia, approximately 68,086 acres comprise the watersheds of the five reservoirs that are sources of drinking water. These reservoir watersheds occupy 7.1% of GWNF land. Approximately 357,788 acres comprise the watersheds for drinking water intakes on area rivers, representing 37.4% of GWNF land. The combined 425,874 acres within public drinking watersheds represents roughly 44.5% of all the GWNF land in Virginia. Figure 2 (page 22) illustrates the extent of the GWNF in Virginia that comprises local drinking watersheds.

Drinking water sources either within or in the immediate geographic vicinity of the GWNF serve more than 260,000 Virginia residents. Twenty-two area localities obtain some or all of their drinking water from these sources. Table 1 lists the areas served by the five reservoirs in the GWNF. Table 2 lists the areas that draw their water from rivers immediately downstream of the GWNF, and whose watersheds includes part of the GWNF (river intake watersheds). Table 3 lists the localities that indirectly receive some or all of their drinking water from the GWNF. These localities are sometimes called "consecutive users," and obtain water (usually by purchasing) from localities listed in Tables 1 and 2.

Estimates for the population served by water from the GWNF were determined. Localities provide an estimate of the population they serve to VDH. Methods for determining these numbers often vary. Some localities use census or other population data. When possible, the actual population estimates as determined by the localities were used.

Some localities simply track the number of accounts (water meters) they service and multiply by the average number of people per household to estimate the size of the population served. Augusta County uses the figure of 2.58 people per household to estimate population served (pers. comm., J. Hoover, W. Hasan), and Alleghany County indicated that figure would be appropriate for estimating population served in that county (pers. comm., J. Lanford). Campbell County uses a figure of 2.47 people per household to estimate population served (pers. comm., M. Damron). For purposes of this report, 2.47 people per household were used to estimate the population served in Campbell County. For all other localities where this method of estimation was necessary, 2.58 people per household were used.

Some localities have more than one source of drinking water. For example, Lynchburg and Harrisonburg both maintain reservoirs for drinking water, but also have water intakes on the James and North Rivers respectively. The cities thus appear in both Tables 1 and 2. The estimated population served is based on the percentage of the total water supply obtained from each source. In 2007 for instance, Lynchburg obtained 75.5% of its drinking water from the Pedlar Reservoir and 24.5% from its two intake points on the James River. Table 1 assigns an estimated population served of 57,380 to Lynchburg, (75.5% of the 76,000 total population) while Table 2 assigns an estimated population served of 18,620.

Still other localities obtain a portion of their drinking water from GWNF and non-GWNF sources. Staunton and Bridgewater are two examples. Staunton obtains water from both the Staunton Reservoir (43.3% of its total drinking water in 2006) and Gardner Spring (56.7% in 2006). As described above, the estimated population served of 11,066 reflects 43.3% of the estimated total Staunton population of 25,557 (Table 1).

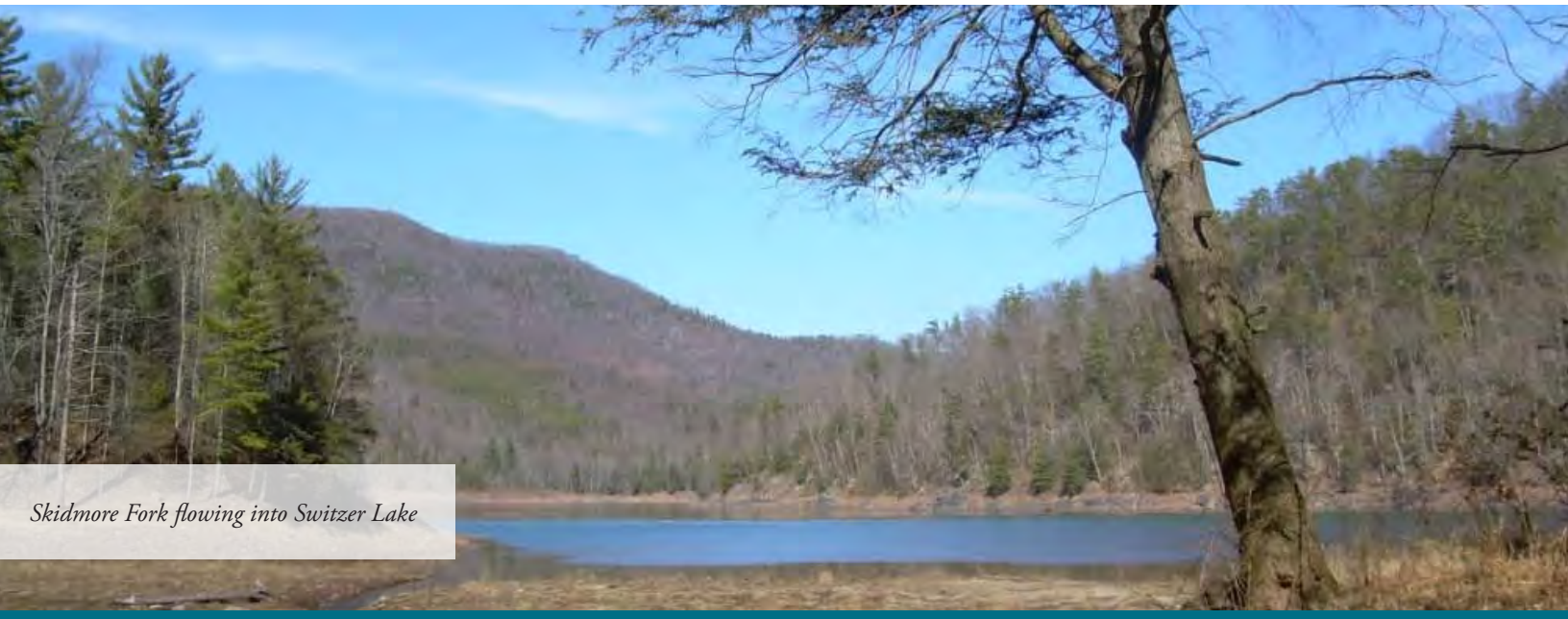
TABLE 1: Localities that maintain reservoirs in the GWNF that are used for drinking water

LOCALITY	RESERVOIR	SURFACE WATER SOURCE	ESTIMATED POPULATION SERVED	RESERVOIR SERVES OTHER LOCALITIES?	LOCALITY HAS OTHER SOURCE OF DRINKING WATER?
Lynchburg, City of	Pedlar Reservoir	Pedlar River	57,380	Yes	Yes
Harrisonburg, City of **	Switzer Lake	Skidmore Fork, Dry River	19,224	Yes	Yes
Staunton, City of	Staunton Reservoir	North River	11,066	Yes	Yes
Augusta County	Coles Run Reservoir	Coles Run	5,707	No	Yes
Clifton Forge, Town of	Smith Creek Reservoir	Smith Creek	4,679	Yes	No
		TOTAL SERVED	98,056		

** The water intake facility on the Dry River for the City of Harrisonburg is a few miles downstream of Switzer Lake. No water is drawn directly from Switzer Lake. The watershed for the intake facility includes all of Switzer Lake, the Skidmore Fork watershed, and a portion of the Dry River watershed.

TABLE 2: Localities or organizations that obtain domestic drinking water from river intake watersheds - rivers in the immediate vicinity of GWNF and whose watershed occurs at least partially within the GWNF.

LOCALITY OR ORGANIZATION	SURFACE WATER SOURCE	ESTIMATED POPULATION SERVED	LOCALITY/ORG. HAS OTHER SOURCE OF DRINKING WATER?
Winchester, City of	North Fork Shenandoah River	28,071	No
Strasburg, Town of	North Fork Shenandoah River	4,500	No
Woodstock, Town of	North Fork Shenandoah River	3,952	No
Broadway, Town of	North Fork Shenandoah River	3,200	No
Food Processors Water Cooperative Inc.	North Fork Shenandoah River	40	No
Front Royal, Town of	South Fork Shenandoah River	12,500	No
Harrisonburg, City of	North River	25,276	Yes
Rockingham County, city-rural customers of Harrisonburg	North River, Dry River	2,995	No
Bridgewater, Town of	North River	682	Yes
Lynchburg, City of	James River	18,620	Yes
Covington, City of	Jackson River	7,300	No
Amherst, Town of	Buffalo River	5,000	No
Maury Service Authority	Maury River	25	No
	TOTAL SERVED	112,161	



Skidmore Fork flowing into Switzer Lake

> Local public drinking watersheds represent roughly 44.5% of all the GWNF land in Virginia. Twenty-two localities in western Virginia, and more than 260,000 residents, obtain some or all of their drinking water from surface waters of the GWNF.

Staunton is one of several localities that sell drinking water to other communities (Table 3). The water is transferred after having been combined from the two sources and processed at its water treatment plant (pers. comm., N. Litteral). When determining the population served by consecutive users, only 43.3% of the water supplied by Staunton is used in the calculation. The same process is used as applicable with other water transfers.

Table 3 lists all the localities that obtain some or all of their drinking water from localities or organizations with the GWNF as a source. Combining the information from Tables 1-3 indicates that 24 different localities or organizations in western Virginia draw water from the GWNF.

TABLE 3: Localities that obtain drinking water from the GWNF via purchase or transfer from localities in Tables 1 or 2 (often referred to as "consecutive users").

LOCALITY	OBTAINS WATER FROM	ESTIMATED POPULATION SERVED	LOCALITY HAS OTHER SOURCE OF DRINKING WATER?	COMMENTS
Bedford County	City of Lynchburg	17,300	Yes	Lynchburg provides water for Forest Central Waterworks. The other 11 districts served by Bedford County Public Service Authority have other sources of water.
Frederick County	City of Winchester	12,649	Yes	
Lexington, City of	Maury Service Authority	7,200	No	
Alleghany County	Town of Clifton Forge, City of Covington	6,149	Yes	Six districts in Alleghany County obtain water from these sources.
Augusta County	City of Staunton	3,351	Yes	Staunton provides some or all drinking water for three districts in the Augusta County Service Authority.
Rockbridge County	Maury Service Authority, City of Lexington	2,739	Yes	Rockbridge County Public Service Authority serves two districts with this water.
Rockingham County	City of Harrisonburg, Town of Bridgewater	1,218	Yes	Rockingham County Public Works serves four districts with this water.
Middletown, Town of	City of Winchester	1,120	No	
Iron Gate, Town of	Alleghany County	386	No	Alleghany County obtains this water from Clifton Forge.
Campbell County	City of Lynchburg	269	Yes	Lynchburg serves 109 connections.
	TOTAL SERVED	52,381		

WATER QUALITY

Virginia's Impaired Waters

Water quality assessments are conducted statewide every two years by Virginia DEQ. Rivers, streams, lakes, reservoirs and estuaries are assessed to determine their suitability for six designated uses (where applicable): aquatic life, fish consumption, shellfish consumption, swimming, public water supplies and wildlife. If a water body does not meet specific standards, its water quality is considered "impaired." Unfortunately, impaired waters are not uncommon. Data from the 2006 DEQ assessment (Virginia DEQ 2006) indicate 9,002 miles of rivers and streams in Virginia are impaired for at least one of the six designated uses.

The list of impaired waters helps illustrate the overall picture of water quality in the GWNF. In the 2006 report, portions of 50 rivers and streams within the GWNF, with a total length of approximately 154 miles, were considered impaired (see Appendix A for complete list). The impairments included:

- *Escherichia coli (bacteria)*
- *fecal coliform bacteria (human and animal waste)*
- *low pH levels (acidity)*
- *high temperature of water*
- *benthic macroinvertebrate assessments (instream aquatic biota)*
- *mercury in fish tissue (1 river, heavy metal contamination)*

Table 4 compares the length of impaired streams in different areas of the GWNF. The streams within the five reservoir watersheds have a higher degree of impairment than would be expected based on the land area the watersheds occupy. These watersheds occupy 7.1% of the total area of the GWNF, but contain 12.9% of the total length of the impaired streams in the GWNF. The combined drinking watersheds (reservoir and river intake watersheds) were compared to the area outside the drinking watersheds. The length of impaired streams in each of the two areas is comparable (49.1% vs. 50.1% of all the impaired streams), even though the drinking watersheds comprise only 44.5% of the GWNF land in Virginia. In short, the drinking watersheds contain more miles of impaired streams than would be expected based on the land area they occupy.

TABLE 4: Totals for impaired streams and rivers within the GWNF in Virginia.

GEOGRAPHIC AREA OF THE GWNF	NUMBER OF IMPAIRED STREAMS	NUMBER OF MILES	PERCENTAGE OF TOTAL LENGTH OF IMPAIRED STREAMS IN GWNF	PERCENTAGE OF TOTAL LAND BASE OF GWNF
Area within the five reservoir watersheds	4	19.86	12.9%	7.1%
Area within all drinking watersheds	21	75.82	49.1%	44.5%
Area outside the drinking watersheds	29	78.48	50.9%	55.5%
All the GWNF in Virginia	50**	154.29	100%	100%

** Segments of Coles Run and the South Fork of Shenandoah River are located both inside and outside of local drinking watersheds.

Water quality data for reservoirs also reveals impairments. In the 2006 DEQ report, six reservoirs within GWNF were judged to be impaired for not adequately supporting aquatic life. The impairments included:

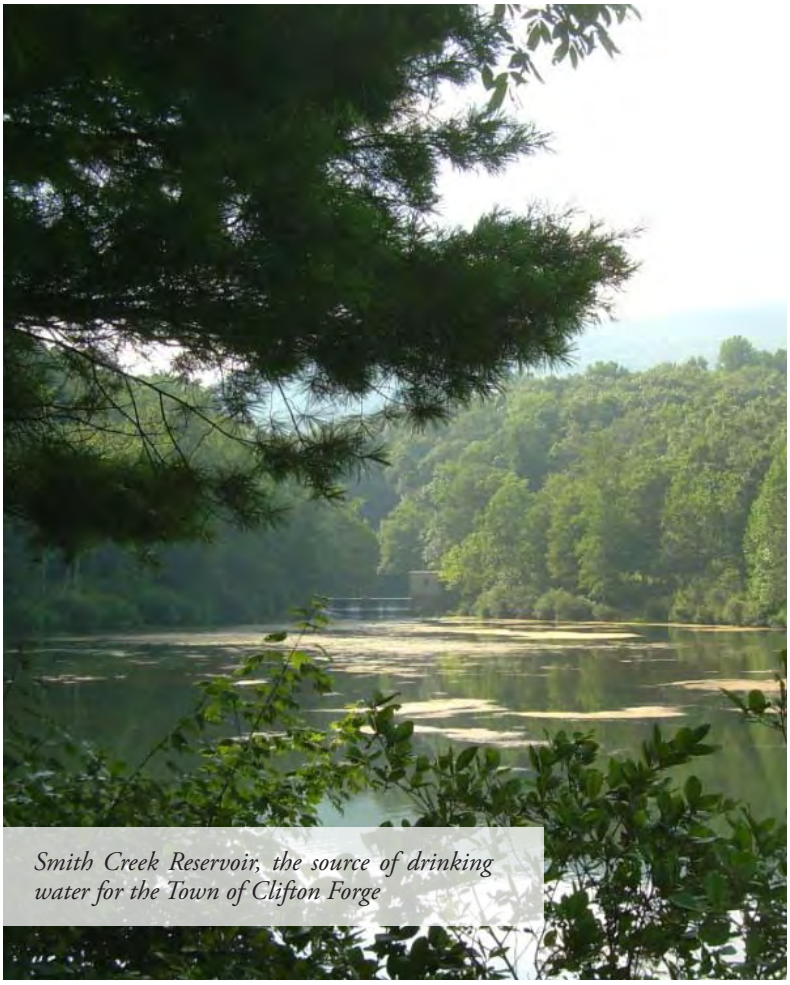
- *low levels of dissolved oxygen (all 6 reservoirs)*
- *pH levels (4 reservoirs)*
- *high temperature of water (1 reservoir)*

Four of these reservoirs are within drinking watersheds on the GWNF, with drinking water being directly drawn from two of them (Pedlar and Staunton Reservoirs). Table 5 lists the reservoirs. It is important to note that none of the reservoirs were impaired for use as a public water supply. Similarly, of the streams and rivers that were assessed as a public water supply, none were found to be impaired for that purpose.

TABLE 5: List of reservoirs within the GWNF determined to be impaired by Virginia Department of Environmental Quality in their 2006 report, covering the years 2000-2004.

RESERVOIR	LOCATED WITHIN LOCAL DRINKING WATERSHED?	LOCALITY OBTAINING DRINKING WATER FROM WATERSHED	DRINKING WATER OBTAINED DIRECTLY FROM THIS RESERVOIR?
Elkhorn Lake	Yes	Staunton	No
Lake Moomaw – Lower	No	n/a	No
Lake Moomaw – Middle	No	n/a	No
Pedlar Reservoir	Yes	Lynchburg	Yes
Switzer Lake	Yes	Harrisonburg	No
Staunton Reservoir	Yes	Staunton	Yes

> On National Forest System land, sedimentation is the primary factor in water quality degradation. Sedimentation may be introduced into stream channels from soil disturbing activities such as timber harvesting and road construction. (USDA Forest Service 2007)



Smith Creek Reservoir, the source of drinking water for the Town of Clifton Forge

The impaired waters data is not presented as a reflection or criticism of forest management in the GWNF. In fact, many of the causes of the impairments are beyond the control of the Forest Service. For example, acid precipitation has caused low pH levels and lower numbers of aquatic organisms in some streams, resulting in their impairment. Some of the impaired streams within the GWNF also run through areas of private land. Natural conditions (e.g., droughts, low water flow in headwaters streams) may sometimes result in a stream being designated as impaired.

Nevertheless, the presence of six impaired reservoirs and so many river and stream miles of impaired waters is troubling and requires attention. Forest management and other activities can result in elevated rates of sedimentation. "Benthic macroinvertebrate assessment" impairments can be related to sedimentation (pers. comm., H. Augustine). Other stresses can also contribute to this impairment. The data from DEQ lacks sufficient detail to ascertain the role of sedimentation in the impaired waters of the GWNF.

Macroinvertebrate Sampling in Streams

Since the early 1990's, the Forest Service has been conducting water quality sampling in streams and rivers in the GWNF. The Macroinvertebrate Aggregated Index for Streams (MAIS) was developed by Smith and Voshell (1997) specifically for the mid-Atlantic highlands region, and the Forest Service has been using a form of this index in its sampling. Macroinvertebrates are insect larvae, snails, worms, mussels, and all other invertebrates that are large enough to be captured by nets or screens of a specific size.

Macroinvertebrate presence (or absence), abundance, and diversity in streams is used as an indicator of overall water quality. These data are not used to assess water for drinking or domestic purposes. The MAIS is a multi-metric index that combines ten measurements into a single score. The Forest Service uses nine metrics to compute their MAIS, with the following range of scores:

MAIS Score	Water Quality
0 – 6	Very Poor
7 – 12	Poor/Fair
13 – 16	Good
17 – 18	Very Good

Table 6 presents some comparisons of MAIS sampling results among different areas of the GWNF. The average MAIS score for the combined drinking watersheds (reservoirs and river intakes) is 15.10 compared to 14.62 for the area outside the watersheds. These scores are near the middle of the "Good" range of 13-16.

The average score from the river intake watersheds (14.88) is only slightly higher than the average score for the GWNF overall (14.81), while the score for the combined watersheds areas is somewhat higher (15.10). The higher score of the combined drinking watersheds is due to the higher MAIS scores in the five reservoir watersheds (15.96). Average MAIS scores from all areas of the GWNF fall in the "Good" category, with no averages reaching the "Very Good" category.

To provide more context for the MAIS data, Table 6 also lists percentiles based on Virginia's Freshwater Probabilistic Monitoring program (Virginia DEQ 2008). The GWNF scores are compared to DEQ results of water quality sampling during the spring from 2001-2006 in the three mountain ecoregions of Virginia – Blue Ridge, Ridge and Valley, and Central Appalachians (pers. comm., J. Hill). For example, the average MAIS score for all of the GWNF (14.81) is higher than 67.1 % of the MAIS scores in the DEQ sample set.

The figures in Table 6 are intended as general information only and should not be interpreted in a strict statistical sense. For instance, MAIS scores are expressed as whole numbers. Statistical comparisons of average scores (or any scores that use decimal figures) may not be appropriate. The wide range of standard deviation values also suggests caution is warranted in interpreting these data.

The location of the reservoir watersheds is likely the key to their higher MAIS and percentile scores. Large sections of the Staunton Reservoir and Switzer Lake watersheds are within Shenandoah Mountain Special Biological Area (SBA), while Coles Run Reservoir watershed lies entirely within the Big Levels SBA. (See Table 8 for acreage amounts.) The designation of these areas as SBAs reflects the presence of rich natural resource values and the undisturbed character of the sites relative to other areas of the forest. The less intensive management (e.g., ground disturbing activities) taking place in these areas probably contributes to the higher water quality as well.

Trout Streams

The presence of brook trout (*Salvelinus fontinalis*), the only trout species native to Virginia, is often considered an indicator of good water quality. Virginia is a very important area for trout in eastern North America, as the state contains more than 2,300 miles of wild trout streams (Reeser and Mohn 2004). Many of these streams occur in the federally owned lands of the GWNF, Jefferson National Forest, and Shenandoah National Park. The Eastern Brook Trout Joint Venture (EBTJV) has documented the decline of brook trout and the streams and watersheds that support them in the eastern United States. Virginia is important to the long-term viability of native brook trout populations, as it has a greater number of subwatersheds (usually containing 25-75 miles of streams) with intact brook trout populations than any state south of New York (EBTJV 2006).

Virginia's Department of Game and Inland Fisheries (DGIF) inventories and assesses cold water streams statewide, including those in the national forests. A coldwater stream is one that can support trout throughout the year. The two primary criteria for trout is the perennial flow of water (or presence of refuges) and temperatures which normally stay below 70 degrees Fahrenheit throughout the summer. Streams are assigned a class ranging from I through VIII. Classes I through IV are considered wild trout streams with adequately reproducing to good populations of wild trout. Class I streams are the highest in quality and are considered exceptional wild trout streams (see Appendix B for list). Classes V through VIII are considered stockable trout streams. Figure 3 (page 23) shows cold water streams in the GWNF based on 2005 data from DGIF.

Forest management can impact the quality of trout streams in a number of ways. The EBTJV (2006) identifies high water temperature as the greatest disturbance to brook trout populations in Virginia. The report also lists poor land management, degraded riparian habitat, grazing, and stream fragmentation (e.g., roads and culverts) as threats. All these threats are present to some degree in the GWNF. Poor land management and degraded riparian habitat can result not only in higher water temperature (with fewer trees to provide shade to streams) but increased sedimentation as well.

Table 7 summarizes the cold water streams occurring in the GWNF. The drinking watersheds contain a higher density of both cold water streams (all classes) and wild trout streams (classes I through IV) than the national forest land outside these watersheds. The reservoir watersheds have a substantially higher density of cold water and wild trout streams than other areas of the forest. For all cold water streams, densities in drinking watersheds are 5.4% higher than for areas outside the watershed. Wild trout stream densities are 11.1% higher in the drinking watersheds.

TABLE 6: Average MAIS scores from sampling conducted by the Forest Service from the early 1990's through June, 2007. Only areas in the GWNF within Virginia are included. Percentiles are based on data from DEQ freshwater probabilistic monitoring from 2001-2006 in the three mountain ecoregions of Virginia.

AREA SAMPLED	No. OF SAMPLING SITES	No. OF SAMPLES	AVERAGE MAIS SCORE	STANDARD DEVIATION	PERCENTILE
All of GWNF within Virginia	333	677	14.81	3.18	67.1
Areas outside drinking watersheds	203	417	14.62	3.30	63.0
Areas within all drinking watersheds	130	260	15.10	2.95	72.3
Areas within river intake watersheds	104	207	14.88	3.09	68.6
Areas within the 5 reservoir watersheds	26	53	15.96	2.15	82.0

Little Stony Creek, a trout stream and tributary of the North Fork Shenandoah River

TABLE 7: The amount (total length) of cold water streams within the GWNF in Virginia, based on 2005 data from Virginia Department of Game and Inland Fisheries. Lengths and densities are approximate.

		ALL COLD WATER STREAMS	WILD TROUT STREAMS (CLASSES I-IV)	EXCEPTIONAL WILD TROUT STREAMS (CLASS I)
AREA WITHIN RESERVOIR WATERSHEDS	Miles	103.685	95.190	0
	Feet	547,455	502,598	0
	Density (mi./sq. mile)	0.975	0.895	n/a
ALL DRINKING WATERSHEDS COMBINED	Miles	321.208	300.894	0
	Feet	1,695,969	1,588,712	0
	Density (mi./sq. mile)	0.483	0.452	n/a
AREA OUTSIDE DRINKING WATERSHEDS	Miles	378.904	333.758	13.174
	Feet	2,000,615	1,762,243	69,558
	Density (mi./sq. mile)	0.457	.402	.016
ALL THE GWNF IN VIRGINIA	Miles	700.112	634.652	13.174
	Feet	3,696,584	3,350,955	69,558
	Density (mi./sq. mile)	0.468	0.424	.009

It is interesting to note that only five exceptional wild trout streams (Class I) occur in the GWNF, and all are outside the drinking watersheds. This is probably because most municipal watersheds were established many years ago in areas where access was important. In contrast, the exceptional trout waters occur in more remote areas.

MANAGEMENT OF THE FOREST

It is well known that ground disturbing activities which result in erosion and sedimentation can have severe negative impacts on water quality. The primary sources of sedimentation include timber harvesting, road construction, and the presence of roads. As a recent Environmental Assessment for a proposed timber sale and prescribed burn on the GWNF explains, "On National Forest System land, sedimentation is the primary factor in water quality degradation. Sedimentation may be introduced into stream channels from soil disturbing activities such as timber harvesting and road construction." (USDA Forest Service 2007). Numerous other Environmental Assessments and similar documents make the same point.

Beyond impacts to water quality, sedimentation can have significant economic implications for communities. High sedimentation rates lead to quicker silting-in and shorter life spans for reservoirs. The cost of restoring water storage capacity in reservoirs, by raising dam levels or dredging, can be huge. In Albemarle County, Virginia, most estimates to dredge the South Fork Rivanna River Reservoir range from $20 to $35 million, with one estimate exceeding $200 million (Rosen 2008).

The Management Areas and Prescriptions in the 1993 Forest Plan dictate how specific areas of the GWNF can be managed. Areas with specific management requirements are also identified. We compared the amount (in land area) of selected management and other areas in the drinking watersheds against the remaining area of the forest. Table 8 presents the results.

There is very little difference between the combined drinking watersheds and the remainder of the GWNF. The proportion of land suitable for timber production (as defined in the Forest Plan) in the two areas is remarkably similar, 34.4% versus 34.8% of their respective total areas. Simply stated, more than one third of the land in the combined drinking watersheds is suitable for timber production. Figure 4 (page 24) shows the locations of land suitable for timber.

The drinking watersheds contain a slightly higher percentage of roadless and Special Biological Areas, but a smaller percentage of wilderness area. The reservoir watersheds have a lower percentage of land subject to intense management, with lower percentage of land suitable for timber production and higher percentages of roadless and Special Biological Areas.

Forest Service data regarding roads and trails were also used to compare areas in the GWNF. Again, only roads and trails on national forest lands were included in the analysis. Table 9 summarizes the results. Roads generally have much greater potential for sedimentation than trails. These data do not include temporary roads constructed during timber sales or other projects. Approximately 279 miles of roads in the GWNF are maintained by agencies other than the Forest Service. Most of these are state roads and are included in the Table 9 figures. Roads and trails often co-occur. As a result, there is approximately 180 miles of overlap in the roads and trails data. That is, 180 miles are considered both a road and a trail. When this occurs, segments are tallied as roads and not as trails, so as not to count the same stretch of road and trail twice.

No clear pattern emerges when comparing road and trail densities in drinking watersheds against the remaining area of the GWNF. There is very little difference in road densities between the two areas, with density in the drinking watersheds being 1.3% higher than in areas outside the watersheds. Trail density in drinking watersheds is 16% lower than in other areas of the forest. Trails are an overall smaller presence in the GWNF when comparing their total length with that of roads.

TABLE 8: Comparison of specific types of management areas within the GWNF in Virginia. All acreages and percentages are approximate.

AREA OF THE GWNF	AREA WITHIN RESERVOIR WATERSHEDS (ACRES)	% OF LAND BASE IN RESERVOIR WATERSHEDS (68,086 ACRES)	AREA WITHIN ALL DRINKING WATERSHEDS COMBINED (ACRES)	% OF LAND BASE IN ALL DRINKING WATERSHEDS (425,874 ACRES)	AREA OUTSIDE THE DRINKING WATERSHEDS (ACRES)	% OF THE LAND BASE OUTSIDE DRINKING WATERSHEDS (531,117 ACRES)
Suitable for Timber Production **	17,386	25.5%	146,613	34.4%	184,728	34.8%
Special Biological Areas	23,885	35.1%	44,687	10.5%	31,442	5.9%
Roadless Areas	25,020	36.7%	115,746	27.2%	117,474	22.1%
Wilderness Areas	62	0.1%	9,715	2.3%	33,136	6.2%

** These areas are suitable for timber production based on the 1993 GWNF Plan. These areas were labeled "Suitable for Timber Production" on maps used in public meetings, July 2008, for revising the Forest Plan.

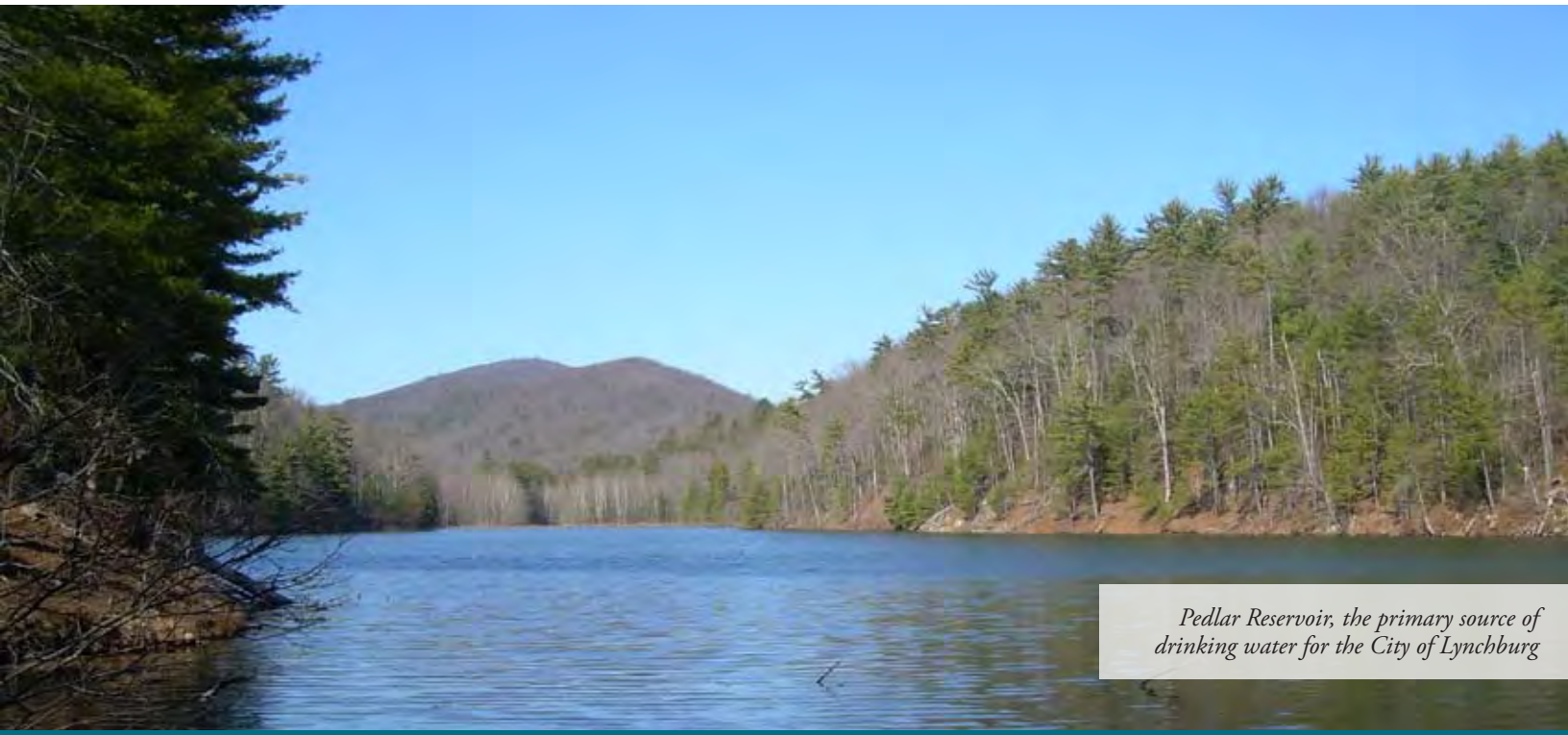
> National forests should produce the cleanest, purest water possible and establish the highest of standards that other land management organizations can strive to meet.

TABLE 9: Roads and trails present within the GWNF in Virginia. Roads and trails data are from U.S. Forest Service. All lengths and densities are approximate.

GEOGRAPHIC AREA OF THE GWNF	TOTAL LENGTH OF ROADS (MILES)	ROAD DENSITY (MILES PER SQUARE MILE)	TOTAL LENGTH OF TRAILS (MILES)	TRAIL DENSITY (FEET PER SQUARE MILE)
Area Inside the 5 Reservoir Watersheds	162.85	1.53	35.61	1,767
Area Inside All Drinking Watersheds	1,036.97	1.56	302.08	2,397
Area Outside the Drinking Watersheds	1,281.46	1.54	448.88	2,856
All the GWNF in Virginia	2,318.43	1.55	750.96	2,652

The 1993 Forest Plan for the GWNF does very little to address drinking water resources in the forest. During the process of creating the Forest Plan, fourteen alternative plans were developed. Eight of the alternatives included Management Area 3, "Sensitive Watersheds/Municipal Watersheds" (p. 2-23, USDA Forest Service 1993a). However, the Forest Plan that was ultimately adopted (Alternative 8A) does not include a Management Area 3. Management Area 18, "Riparian Areas with Ecological Widths," is the only management area dealing specifically with water issues. Forest-wide (including West Virginia), approximately 21,000 acres (1.98% of all GWNF lands) are within Management Area 18.

In contrast, the 2004 Forest Plan for the Jefferson National Forest (USDA Forest Service 2004b) has several management prescription areas dedicated to multiple types of watershed protection or use: 9A1 Source Watershed Protection, 9A3 Watershed Restoration, and 9A4 Aquatic Threatened and Endangered Species Habitat. The degree of protection afforded by these management prescription areas is arguable; for instance, area 9A1 (Source Water Protection) allows logging, road building, and habitat disturbance similar to other management prescription areas. Other prescriptions may be problematic as well.



Pedlar Reservoir, the primary source of drinking water for the City of Lynchburg

SUMMARY

Adequate supplies of clean water are essential for public health. The need for clean water is an issue and concern at many geographic scales and is certain to increase over time. Virginia's Local and Regional Water Supply Planning Regulation is a very positive step toward ensuring drinking water supplies for its citizens. The future is uncertain though, as community and population growth are driven by economic and social factors that are often unpredictable. Even more importantly, climate change could significantly alter future precipitation patterns and disrupt the best of plans.

The local need for clean water is acute, as several localities rely solely on water originating in the GWNF for domestic use. For example, Smith Creek Reservoir in the GWNF is the only source of drinking water for the Town of Clifton Forge. Similarly, the Pedlar Reservoir is the primary (and critical) source of drinking water for the City of Lynchburg. When water is needed to supplement the Pedlar Reservoir, Lynchburg draws it from the James River, whose watershed includes much of the GWNF.

The GWNF is a critically important source of regional drinking water. The five reservoirs located within the GWNF provide drinking water to area residents (Table 1). The watersheds of these five reservoirs – Pedlar, Staunton, Smith Creek, Coles Run, and Switzer Lake - comprise roughly 68,086 acres of national forest land, or 7.1% of the approximately 956,990 acres of the GWNF in Virginia. Thirteen area localities and organizations obtain drinking water from river intake watersheds (Table 2). These thirteen watersheds contain approximately 357,788 acres, or 37.4% of the GWNF in Virginia.

The combined 425,874 acres within public drinking watersheds represent roughly 44.5% of all the GWNF land in Virginia. Twenty-four localities and organizations in western Virginia obtain some or all of their drinking water from surface waters of the GWNF. More than 260,000 Virginia residents receive their drinking water from these localities and organizations.

Water quality information for the GWNF is cause for concern. The 2006 water quality assessment report from DEQ lists 6 reservoirs and 50 streams or rivers within the GWNF as impaired. These data indicate that water quality in the drinking watersheds of the GWNF is lower than other areas of the forest. Four of the six lakes and reservoirs in the GWNF designated as impaired – Pedlar Reservoir, Staunton Reservoir, Switzer Lake, and Elkhorn Lake – occur within drinking watersheds (Table 5). Drinking water is drawn directly from two of these reservoirs – Pedlar and Staunton. Roughly 154 miles of impaired rivers and streams occur within the GWNF (Table 4). Approximately 49.1% of the total length of these impaired rivers and streams occur within drinking watersheds, even though drinking watersheds occupy only 44.5% of the land base of the national forest.

The impaired waters data are not necessarily reflective of Forest Service management practices. Some of the impaired streams run through private lands. Many of the causes of the impairments are beyond the control of the Forest Service (e.g., acid precipitation, natural conditions). However, the presence of so many impaired stream and river miles, plus the six impaired reservoirs, indicates that more attention should be paid to water quality protection in the GWNF. The fact that there are more impaired waters in the drinking watersheds than other areas of the forest (per unit of land area, Table 4) highlights a lack of attention to drinking water resources to date in the GWNF.

Forest Service data, based on macroinvertebrate sampling and MAIS scores (Table 6), indicate the drinking watersheds have higher water quality than the remaining area of the forest. This is largely a result of higher MAIS scores in the five reservoir watersheds. Data on impaired streams and reservoirs contradict this though, as both the reservoir and combined drinking watersheds have higher occurrences of impaired waters than areas outside the drinking watersheds (Tables 4 and 5).

The average MAIS score for the reservoir watersheds (15.96) is substantially higher than the overall average for the GWNF (14.81). The river intake watersheds alone do not differ from the overall forest, with the slightly higher average MAIS scores (14.88 vs. 14.81) not being statistically different. All the average MAIS scores fall in the "Good" category with no averages reaching the "Very Good" category. The higher MAIS scores in the reservoir watersheds are likely due to their location in the forest. Table 8 shows that a high percentage of these watersheds occur in Special Biological Areas. As the Forest Plan describes, this designation is reserved for areas that support biological diversity and typically include high quality natural areas (USDA Forest Service 1993b). The more pristine and remote nature of these areas, combined with less intensive management, no doubt contributes to good water quality.

Information on cold water streams is interesting but does not reveal significant differences between areas of the GWNF. Data from 2005 show a slightly higher occurrence of cold water streams in the drinking watersheds than in other areas of

> Four of the six lakes and reservoirs in the GWNF designated as impaired- Pedlar Reservoir, Staunton Reservoir, Switzer Lake, and Elkhorn Lake -occur within drinking watersheds

the national forest (Table 7). The density of all cold water streams is 5.4% higher in the drinking watersheds, while the density of wild trout streams is 11.1% higher. The five reservoir watersheds have substantially higher densities of cold water and wild trout streams than other areas of the GWNF. Interestingly, the only exceptional wild trout streams in the GWNF occur outside the drinking watersheds. The 13.2 miles of exceptional wild trout streams in the forest represents 1.88% of the 700 mile total.

There is no detectable difference in management of the GWNF when comparing the drinking watersheds with the remainder of the forest. Areas considered "Suitable for Timber Production" in the 1993 Forest Plan illustrate this. Table 8 shows that 34.4% of the land area in the drinking watersheds is suitable for timber production compared to 34.8% of the land area outside the drinking watersheds. These percentages are almost identical despite a smaller percentage of the reservoir watershed lands, 25.5%, being suitable for timber production. It should be noted that "suitable for timber production" refers primarily to commercial sales of timber. Salvage and non-commercial logging activities (e.g., viewshed management, road realignments) can occur in areas not considered suitable for timber production.

Road and trail densities on the GWNF reinforce other data that reflect no consistent differences or pattern in physical conditions and qualities when comparing drinking watersheds to the rest of the forest. Roads are a slightly greater presence in the drinking watersheds, where their density is 1.3% higher than in other areas of the forest. Trails are a smaller presence in the drinking watersheds, where their density is 16% lower than in other areas of the forest.

The 1993 Forest Plan does very little to address drinking water resources. The plan identifies drinking water reservoirs, but does not address the watersheds within which the reservoirs occur. No other public drinking water sources are identified or discussed. Protection of the areas is minimal. As the Forest Plan states, Management Area Prescription 18C "contains those riparian areas in the Forest that are adjacent to or within a distance of one mile upstream of the following municipal water supplies (Lynchburg Reservoir, Coles Run Reservoir, Mills Run Reservoir, Clifton Forge Reservoir, Skidmore Reservoir, Staunton Reservoir, and Elkhorn Lake). The lands within this management area are classified unsuitable for timber production. . . . Adjacent to municipal reservoirs, a lakeside management zone shall exist that extends at least 100 feet from the shore for land slopes of 10 percent or less, 150 feet for slopes of 11 percent to 45 percent, and 200 feet for slopes greater than 45 percent." (p. 3-99, USDA Forest Service 1993b).

Although a Management Area for "Sensitive Watersheds/Municipal Watersheds" was considered when the 1993 Forest Plan was being developed for the GWNF (p. 2-23, USDA Forest Service 1993a), it was not included in the final version of the plan. In contrast, the Forest Plan developed for the Jefferson National Forest in 2004 contains several management prescription areas dedicated to watershed protection or use (USDA Forest Service 2004b).

Overall, there is little difference in water quality when comparing the drinking watersheds with the remainder of the GWNF lands. There is also minimal difference in how the two areas of the national forest are managed. While the five reservoir watersheds have slightly higher water quality than other areas of the forest (per the data in this report), and are managed less intensively than other areas of the forest, no significant differences were detected between the 44.5% of the GWNF within drinking watersheds and the remainder of the national forest. More information and rigorous data analysis is needed to make definitive assessments and judgments of water quality in the GWNF. In particular, more information about sedimentation in the rivers and streams of the GWNF is needed.

Staunton Reservoir, providing drinking water to the City of Staunton and some residents of Augusta County

RECOMMENDATIONS

THE FOREST SERVICE MUST DO MORE TO PROTECT WATER RESOURCES IN THE GWNF. In the 1993 Forest Plan, the desired future for Management Area 18 lands (Riparian Areas with Ecological Widths) includes "Water quality meets or exceeds state standards, for aquatic biodiversity and beneficial downstream uses." (p. 3-93) In discussing water quality, the Forest Plan states "In any project, water quality is protected from nonpoint source pollution through the use of standards that meet or exceed best management practices." (p. 2-31) Given the major presence of impaired waters in the GWNF, these standards are not sufficient to protect water quality.

Merely meeting state standards and best management practices should not be a management goal. These standards represent minimum levels of acceptable management and should be greatly exceeded. National forests should produce the cleanest, purest water possible and establish the highest of standards that other land management organizations can strive to meet.

As a first step toward improved management, the Forest Service should **FORMALLY IDENTIFY ALL THE DRINKING WATERSHEDS LYING WITHIN THE GWNF AND DESCRIBE THEM IN THE FOREST PLAN.** The rivers and streams within these watersheds should be considered a public water supply. The drinking water reservoirs were identified in the 1993 Forest Plan, but their watersheds were not addressed. River intake watersheds were not identified. Obviously, these areas cannot be managed directly and appropriately until they have been identified and delineated.

In the current Forest Plan, most of the attention given to water resources focuses on riparian areas. This is not sufficient. Management should **ADDRESS ENTIRE WATERSHEDS, NOT JUST RIPARIAN AREAS.** The GWNF should meet a major goal of the Forest Service Strategic Plan, which is "Improve watershed condition" (USDA Forest Service 2004a). All the drinking watersheds should be identified and recognized as such in the Forest Plan, and specific management plans developed for them.

IMPAIRED STREAMS, RESERVOIRS, AND THEIR WATERSHEDS NEED SPECIAL ATTENTION and should be a priority for restoration efforts. Special management area designation or specific management prescriptions should be considered for them. Even if some or all of the causes of impairment and degradation are beyond the control of the Forest Service, the agency must refrain from management activities that potentially add cumulative impacts to already stressed or impaired systems. Ground disturbing activities such as logging and road building should not be conducted near streams that are impaired or subject to other physical stresses.

More information will be necessary to adequately describe and assess watershed conditions. The Forest Service should **DEVELOP A PLAN TO SYSTEMATICALLY MONITOR ALL EXISTING WATER QUALITY AND RELATED PROGRAMS AND OBTAIN ALL DATA PERTINENT TO WATER QUALITY AND WATERSHED CONDITIONS.** There is great potential for cooperative efforts with other agencies, organizations, local communities, and volunteers.

The Forest Service must also **DEVELOP A PLAN TO INCREASE ITS OWN EFFORTS TO MONITOR WATER QUALITY IN THE GWNF.** Macroinvertebrate sampling and MAIS scores are important but should be augmented with other monitoring programs. Particular attention should be paid to sedimentation in streams and rivers. Direct measures of the impact that ground disturbing activities and projects have on water quality and sedimentation are needed.

THE FOREST SERVICE AND LOCALITIES THAT OBTAIN DRINKING WATER FROM GWNF MUST COMMUNICATE MORE EFFECTIVELY. There is currently very little communication among these entities. Strong working relationships and partnerships should be developed to ensure that watersheds are managed effectively, appropriately, and for the public good. (See Appendix C for sample resolution language for organizations and local governments.)

DRINKING WATERSHEDS SHOULD BE PROTECTED AND MANAGED APPROPRIATELY. Improving existing water quality while permanently protecting and enhancing future quality are obvious goals with which to begin. The potential impacts of timber harvesting and road construction, even if the roads are to be temporary, must be fully examined. As noted earlier, the Forest Service has identified these two activities as causes of sedimentation and prime factors in water quality degradation. The Forest Service, local communities, and the larger public should work together to establish policies and develop management plans for the drinking watersheds. New York City could serve as an example to study for potential policy and management objectives.

Managing for watershed protection will produce many benefits beyond drinking water protection. Reservoirs may function for longer periods of time due to decreased sedimentation. Many aquatic species, including brook trout, and terrestrial species and natural communities will benefit from sound ecological watershed management. Outdoor recreational opportunities, scenic resources, biological diversity, and other forest features can be enhanced as well.

The Forest Plan for the George Washington National Forest is currently being revised. The new Plan will guide management of the forest for the next ten to fifteen years. This is the optimal time to assess current management strategies and adjust them to enhance and protect the many values these public lands possess. Direct, explicit management of drinking watersheds must be part of the plan.

REFERENCES

Augustine, Harry. Water Quality Assessment Coordinator for Virginia Department of Environmental Quality. Personal communication, October 7, 2008.

City of Richmond. 2008. As found at [http://www.richmond.gov/DPU/water.aspx].

Damron, Mike. Administrator for Campbell County Utilities and Service Authority. Personal communication, June 23, 2008.

Donn, J., Mendoza, M. and J. Pritchard. 2008. "AP Probe Finds Drugs in Drinking Water." Associated Press article as found at [http://www.washingtonpost.com] on 10 March 2008.

Eastern Brook Trout Joint Venture. 2006. Eastern Brook Trout: Status and Threats. As found at [http://www.easternbrooktrout.org/docs/brookiereportfinal.pdf].

Gallup Poll, March 6-9, 2008, +/- 3% Margin of Error, Sample Size= 1,012. As found at [http://www.gallup.com/poll/104932/Polluted-Drinking-Water-No-Concern-Before-Report.aspx] on 17 April 2008.

Hasan, Wafa. Augusta County Service Authority. Personal communication, June 25, 2008.

Hill, Jason. Freshwater Probabilistic Monitoring Coordinator for Virginia Department of Environmental Quality. Personal communication, September 19, 2008.

Hoover, Jennifer. Augusta County Service Authority. Personal communication, June 20, 2008.

Interstate Commission on the Potomac River Basin. 2005. Water Supply Reliability Forecast for the Washington Metropolitan Area – Year 2025. Report # 05-06.

Lanford, John. Director of Public Works, Alleghany County. Personal communication, June 20, 2008.

Litteral, Nate. Water Plant Manager, City of Staunton. Personal communication, May 29, 2008.

Mates , W.J. and J. L. Reyes. 2006. The Economic Value of New Jersey State Parks and Forest. New Jersey Department of Environmental Protection Division of Science, Research & Technology. Issued June 2004, revised version issued November 2006. As found at [http://www.nj.gov/dep/dsr/economics/parks-report.pdf].

Metropolitan Washington Council of Governments. 2007. Economic Trends in Metropolitan Washington: 2003-2007. As found at [http://www.mwcog.org/uploads/pub-documents/8FdaXQ20080709151344.pdf].

National Research Council. 2008. Hydrologic Effects of a Changing Forest Landscape. National Academies Press: Washington, DC. 194 pp.

Reeser, S.J. and L.O. Mohn. 2004. An Analysis of Wild Trout Anglers in Virginia. Pages 214-221 in Wild Trout VII: Proceedings of Wild Trout VIII Symposium, Yellowstone National Park, WY. Sept 20-22, 2004.

Rosen, S. 2008. "An End to Water Debate?" Charlottesville Daily Progress article as found at [http://www.dailyprogress.com/cdp/news/local/article/an_end_to_water_debate/22812/] on 1 June 2008.

Smith, E.P. and J.R. Voshell, Jr. 1997. Studies of benthic macroinvertebrates and fish in streams within EPA Region 3 for development of biological indicators of ecological condition. Part 1. Benthic Macroinvertebrates. Final report for Cooperative Agreement CF821462010. U.S. Environmental Protection Agency, Washington, D.C.

USDA Forest Service. 2008. As found at [http://www.fs.fed.us/r8/gwj/about/index.shtml#facts] on 1 August 2008.

USDA Forest Service. 2007. Environmental Assessment Cubville Project. Warm Springs Ranger District, George Washington & Jefferson National Forests, Bath County, Virginia. 66 pp.

USDA Forest Service. 2004a. USDA Forest Service Strategic Plan for Fiscal Years 2004-08. Washington, DC. FS-810. 32 pp.

USDA Forest Service. 2004b. Revised Land and Resource Management Plan – Jefferson National Forest. Forest Service Southern Region. Management Bulletin R8-MB 115A. January 2004.

USDA Forest Service. 1993a. Final Environmental Impact Statement for the Revised Land and Resource Management Plan – George Washington National Forest. Forest Service Southern Region, January 1993.

USDA Forest Service. 1993b. Final Revised Land and Resource Management Plan – George Washington National Forest. Forest Service Southern Region, January 1993.

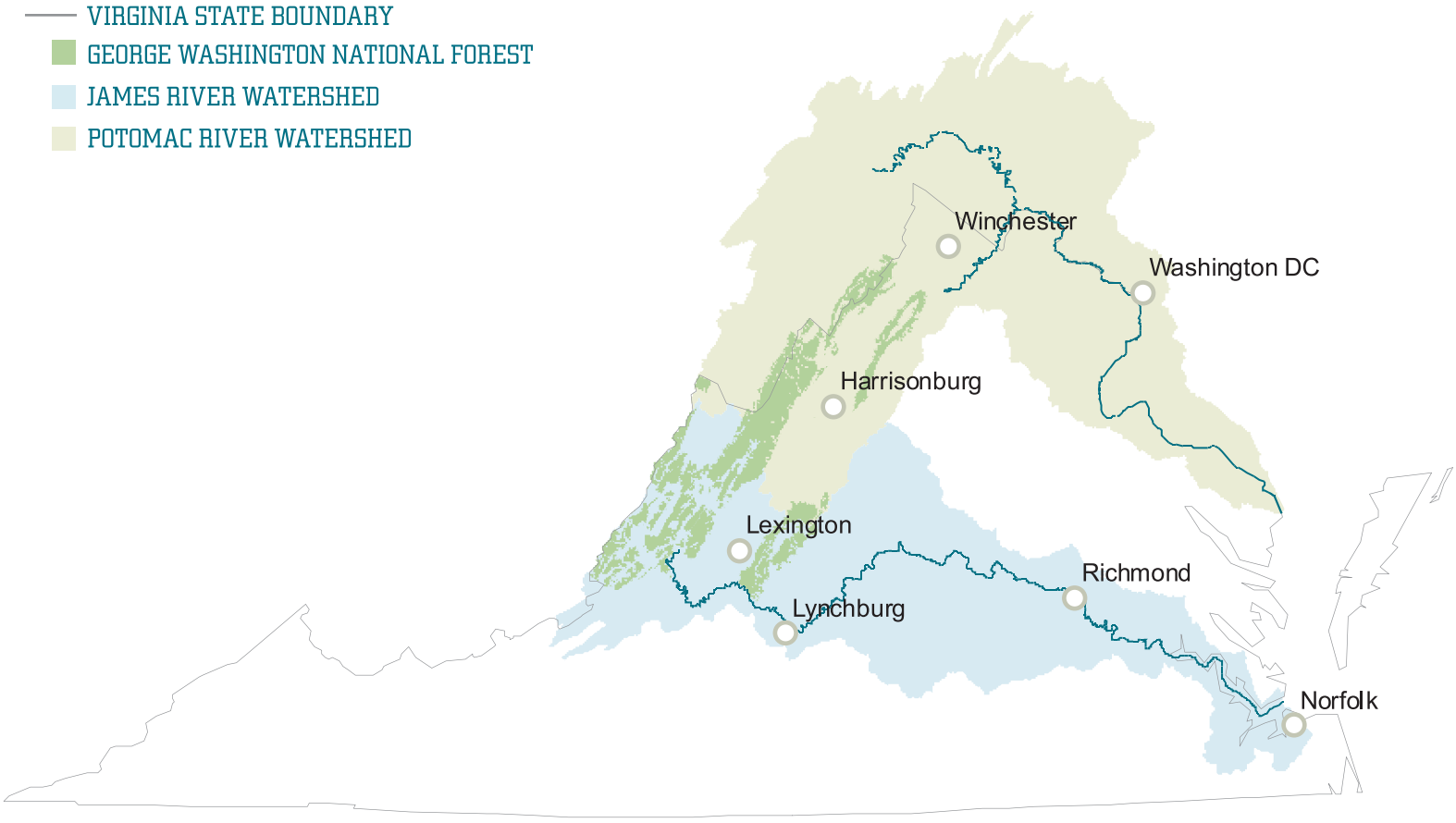
Virginia Department of Environmental Quality. 2008. Draft 2008 305(b)/303(d) Water Quality Assessment Integrated Report. As found at [http://www.deq.state.va.us/export/sites/default/probmon/pdf/ir08_Pt2_Ch2.4_Freshwater_ProbMon.pdf].

Virginia Department of Environmental Quality. 2006. Final 2006 305(b)/303(d) Water Quality Assessment Integrated Report.

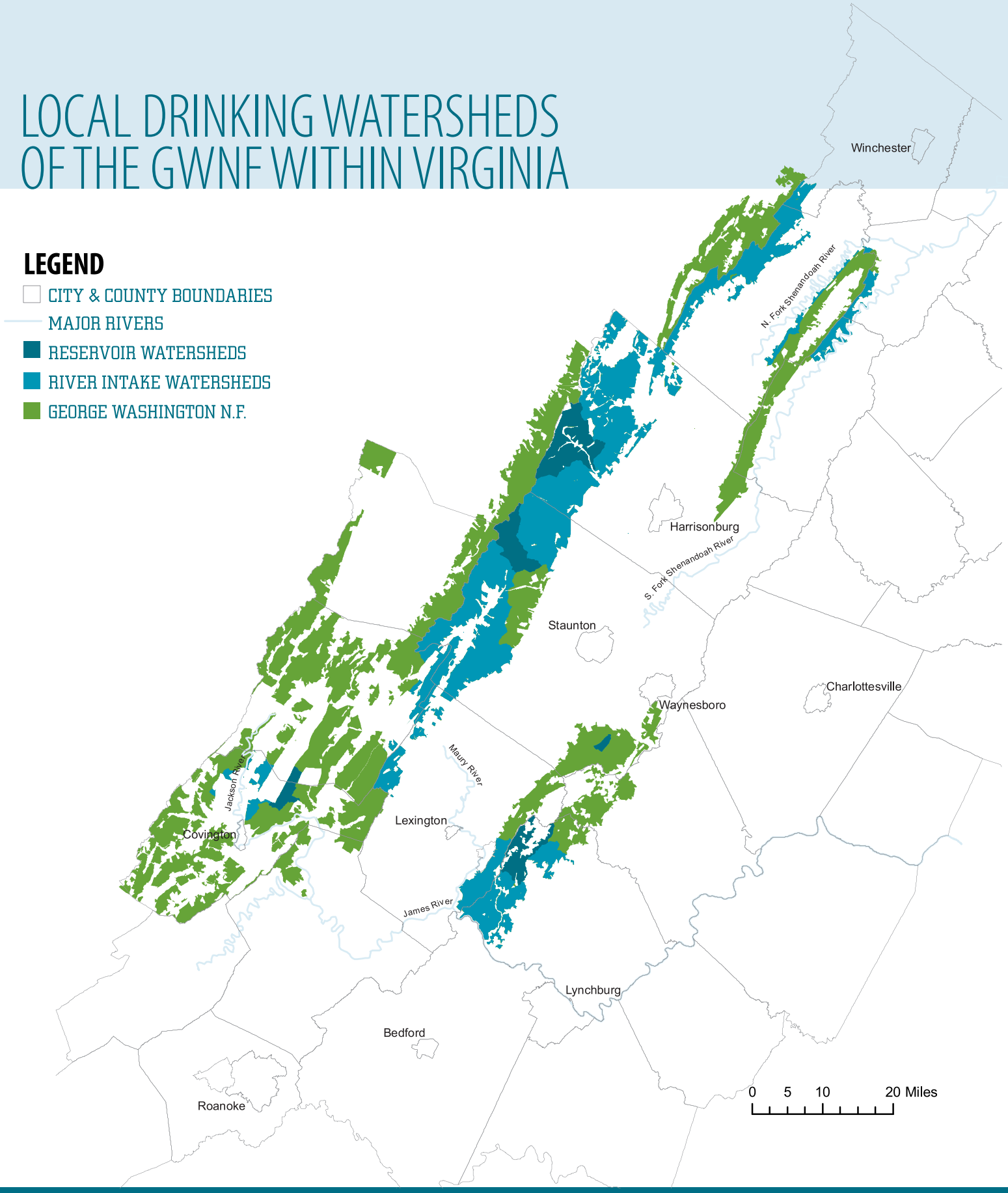
FIGURE 1

THE JAMES AND POTOMAC RIVER WATERSHEDS

The Shenandoah river system is within the Potomac River watershed.



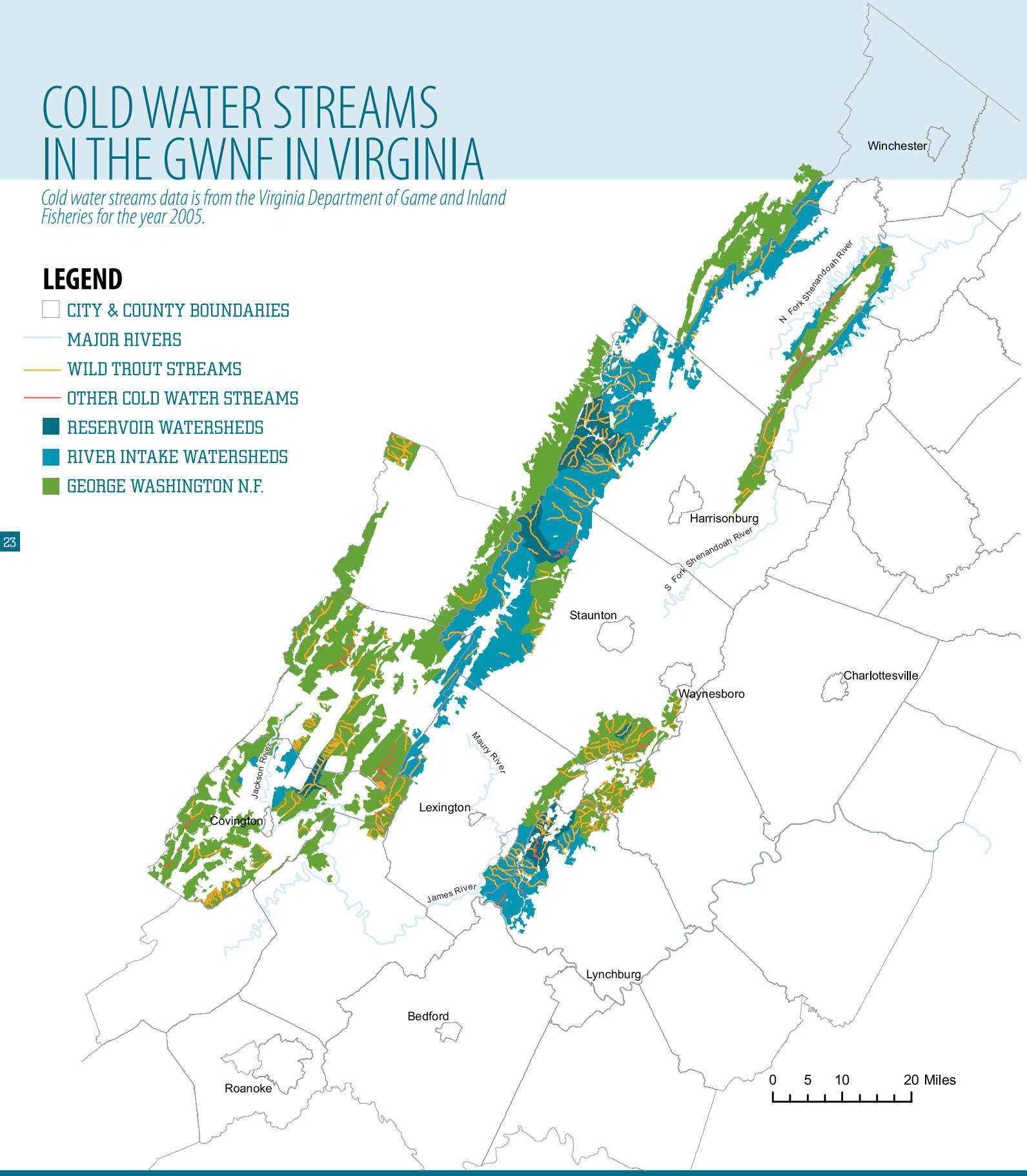
LOCAL DRINKING WATERSHEDS OF THE GWNF WITHIN VIRGINIA



Data used in this map were compiled from Va. Dept. of Health, Va. Dept. of Environmental Quality, Regional Planning District Commissions, various localities, and U.S. Forest Service for the years 2006-2008. Map created by Wild Virginia, October 2008.

COLD WATER STREAMS IN THE GWNF IN VIRGINIA

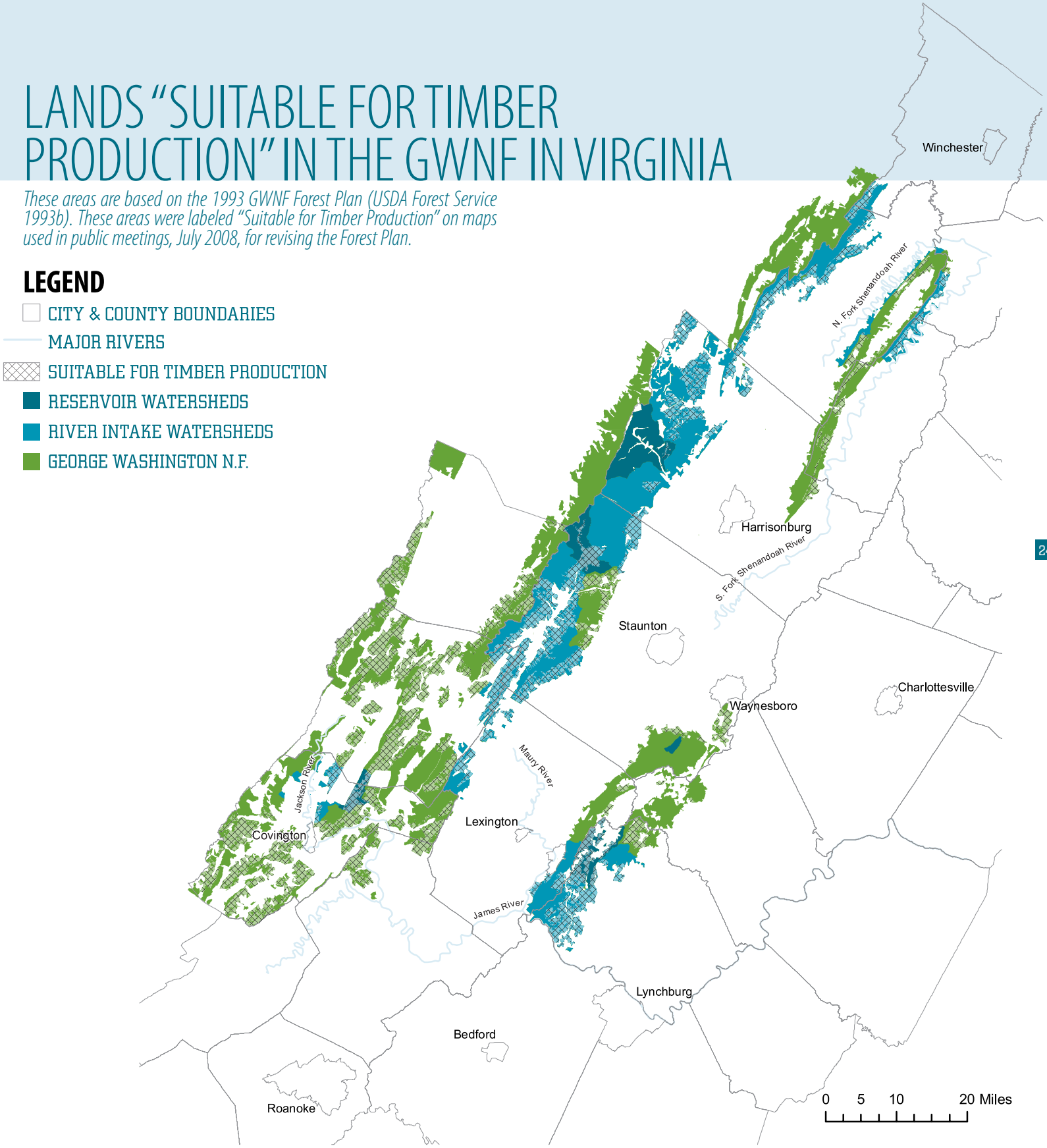
Cold water streams data is from the Virginia Department of Game and Inland Fisheries for the year 2005.



Data used in this map were compiled from Va. Dept. of Health, Va. Dept. of Environmental Quality, Regional Planning District Commissions, various localities, and U.S. Forest Service for the years 2006-2008. Map created by Wild Virginia, October 2008.

LANDS "SUITABLE FOR TIMBER PRODUCTION" IN THE GWNF IN VIRGINIA

These areas are based on the 1993 GWNF Forest Plan (USDA Forest Service 1993b). These areas were labeled "Suitable for Timber Production" on maps used in public meetings, July 2008, for revising the Forest Plan.



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APPENDIX A

APPENDIX A: List of the 50 streams and rivers occurring on lands of the George Washington National Forest in Virginia and listed as "impaired" by the Virginia Department of Environmental Quality in their 2006 report (VA DEQ 2006).

NAME OF IMPAIRED STREAM OR RIVER	OCCURS IN DRINKING WATERSHED	COUNTY	RANGER DISTRICT
Back Creek	No	Augusta	Pedlar
Beaver Creek	Yes	Rockingham	North River
Big Run	No	Page	Lee
Boone Run	No	Rockingham	Lee
Briery Branch	Yes	Rockingham, Augusta	North River
Calfpasture River	Yes	Augusta	North River
Cedar Creek	Yes	Shenandoah	Lee
Coles Run	Yes	Augusta	Pedlar
Cowpasture River	No	Bath	Warm Springs, North River
Cub Run	No	Rockingham, Page	Lee
Dry River	Yes	Rockingham	North River
Falls Hollow	No	Augusta	North River
Fridley Run	No	Rockingham	Lee
Jackson River	No	Bath	Warm Springs
Johns Run	No	Augusta	Pedlar
Kennedy Creek	No	Augusta	Pedlar
Laurel Run	No	Bath	Warm Springs
Laurel Run	Yes	Shenandoah	Lee
Little Calfpasture River	Yes	Augusta	North River
Little Dry River	Yes	Rockingham	North River
Little Stony Creek	Yes	Shenandoah	Lee
Loves Run	No	Augusta	Pedlar
Mill Creek	Yes	Bath, Rockbridge	North River
Mill Creek	Yes	Rockingham	Lee
Mills Creek	No	Augusta	Pedlar

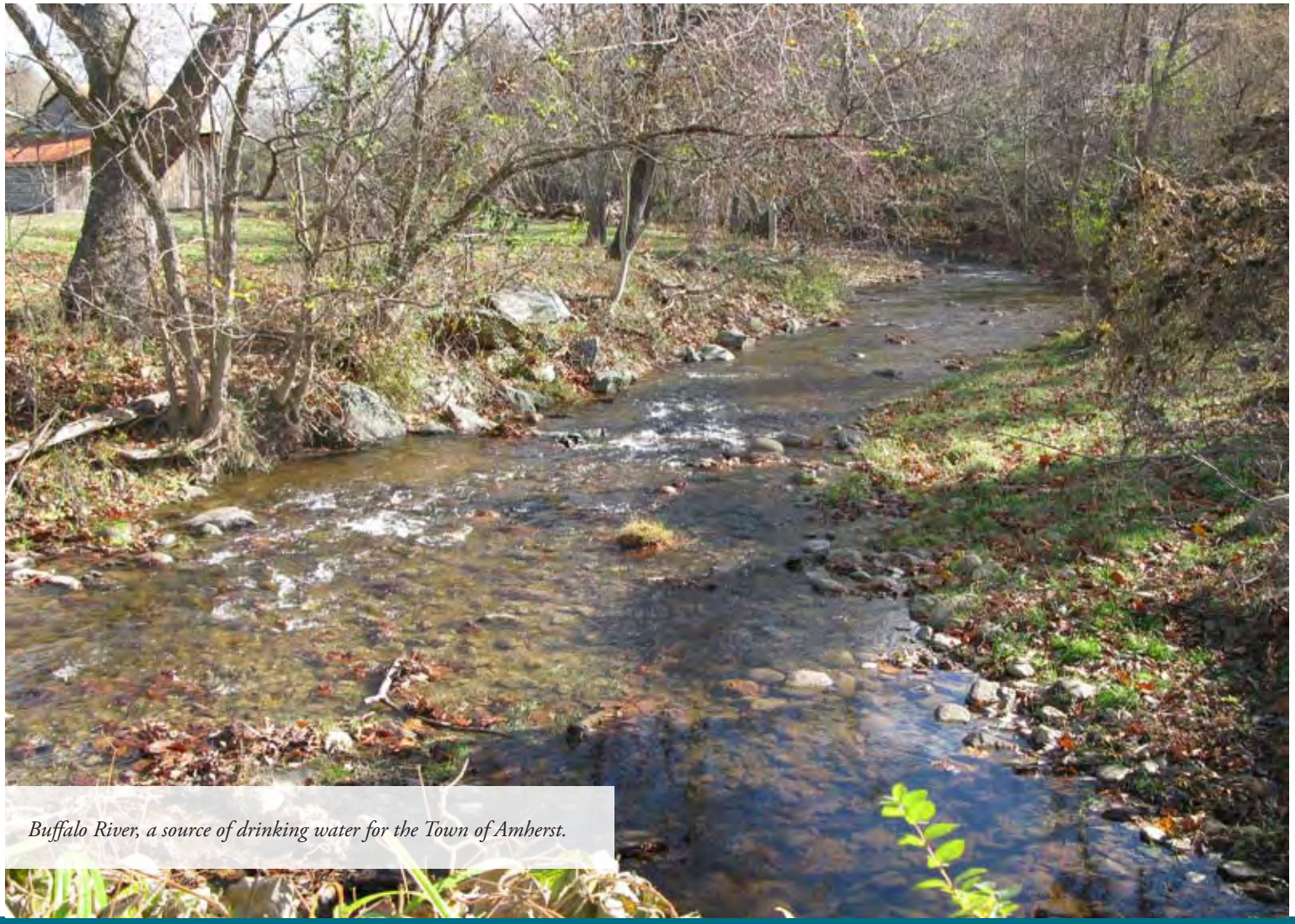
APPENDIX A (continued): List of the 50 streams and rivers occurring on lands of the George Washington National Forest in Virginia and listed as "impaired" by the Virginia Department of Environmental Quality in their 2006 report (VA DEQ 2006).

NAME OF IMPAIRED STREAM OR RIVER	OCCURS IN DRINKING WATERSHED	COUNTY	RANGER DISTRICT
Mountain Run	No	Rockingham	Lee
Narrow Passage Creek	Yes	Shenandoah	Lee
North River	Yes	Augusta	North River
Orebank Creek	No	Augusta	Pedlar
Pads Creek, South Fork	No	Bath	Warm Springs
Panther Run	No	Bath	Warm Springs
Passage Creek	No	Shenandoah, Warren	Lee
Pedlar River	Yes	Amherst	Pedlar
Pheasanty Run	No	Bath	Warm Springs
Pine Run	No	Augusta	Pedlar
Porters Mill Creek	No	Bath	Warm Springs
Potts Creek, Lower	No	Alleghany	James River
Rocky Run	Yes	Rockingham	North River
Saint Mary's River	No	Augusta	Pedlar
Shenandoah River, South Fork	Yes	Page	Lee
Skidmore Fork	Yes	Rockingham	North River
Stony Creek	Yes	Shenandoah	Lee
Straight Fork	No	Highland	Warm Springs
Toms Branch	No	Augusta	Pedlar
Tunnel Hollow tributary	No	Augusta	North River
Tye River	No	Nelson	Pedlar
Tye River, South Fork	No	Nelson	Pedlar
Union Spring Branch	Yes	Rockingham	North River
Wilson Creek, Upper	No	Bath	Warm Springs
Wolf Run	Yes	Augusta, Rockingham	North River

APPENDIX B

APPENDIX B: List of the exceptional wild trout streams in the George Washington National Forest as reported by the Virginia Department of Game and Inland Fisheries for the year 2005.

NAME OF EXCEPTIONAL TROUT STREAM OR RIVER	OCCURS IN DRINKING WATERSHED	COUNTY	RANGER DISTRICT
Louisa Spring Branch	No	Nelson	Pedlar
Mill Creek	No	Bath	Warm Springs
Piney River, North Fork	No	Amherst, Nelson	Pedlar
Saint Mary's River	No	Augusta	Pedlar
Shoe Creek	No	Nelson	Pedlar



Buffalo River, a source of drinking water for the Town of Amherst.

SAMPLE RESOLUTION STATEMENTS FOR ORGANIZATIONS AND LOCAL GOVERNMENTS

DRINKING WATER MANAGEMENT IN THE GEORGE WASHINGTON NATIONAL FOREST

WHEREAS, the U.S. Forest Service is in the process of revising its 1993 Land and Resource Management Plan for the George Washington National Forest.

WHEREAS, the provision of clean safe drinking water is one of the primary benefits that the George Washington National Forest provides to the communities that surround it.

WHEREAS, the U.S. Forest Service's agency-wide Strategic Plan for 2004 – 2008 seeks to achieve six goals, including "Improve watershed condition."

WHEREAS, approximately 44 percent of the land in the George Washington National Forest is within watersheds that provide public drinking water to more than 260,000 residents of western Virginia in 22 communities surrounding the national forest by means of reservoirs and surface waters.

WHEREAS, drinking water sources from within the George Washington National Forest serve an estimated ___,____ residents in _____ County and the City of _____.

WHEREAS, degraded water quality in the George Washington National Forest has been documented in the 2006 Water Quality Assessment report by the Virginia Department of Environmental Quality, which identified fifty (50) streams and six (6) reservoirs within the national forest that are impaired, including the _____ Reservoir serving the City of _____ and some _____County residents.

WHEREAS, the greatest threats to water quality within the George Washington National Forest are ground disturbing activities, such as timber harvesting and road construction, which result in erosion and sedimentation.

WHEREAS, more than one third of land in the drinking watersheds is considered suitable for timber production under the 1993 George Washington National Forest Management Plan, roughly the same percentage of land considered suitable for timber production in areas outside the drinking watersheds

WHEREAS, the 1993 George Washington National Forest Management Plan identifies drinking water reservoirs, but does not address the watersheds that surround these reservoirs or offer distinct management objectives to maintain or improve drinking water quality in these watersheds by controlling erosion and sedimentation.

WHEREAS, the 1993 George Washington National Forest Management Plan does not identify rivers, streams and their surrounding watersheds that serve as drinking water sources for the region nor does the plan offer distinct management objectives to maintain or improve drinking water quality in these watersheds by controlling erosion and sedimentation.

WHEREAS, the 1993 George Washington National Forest Management Plan addresses riparian areas (narrow corridors bordering rivers and streams) and narrow areas bordering reservoirs, but does not provide management objectives for lands within the larger watersheds that determine the health of the water resources in these streams and rivers.

WHEREAS, a 2008 report by the National Research Council (part of The National Academies) states that a sustainable supply of clean water is the most important product or commodity produced by our forests.

WHEREAS, good management of drinking watersheds will provide benefits beyond producing clean drinking water, such as improving habitat for brook trout and other aquatic species.

NOW, THEREFORE, be it resolved that the undersigned hereby support the following revisions to the George Washington National Forest Management Plan to ensure the quality and quantity of drinking water sources within the national forest boundaries:

The U.S. Forest Service shall formally identify all the drinking watersheds serving reservoir and surface water resources within the George Washington National Forest. The rivers and streams within these watersheds shall be considered a public water supply.

The U.S. Forest Service shall establish management objectives that encompass the health of entire drinking watersheds, in order to ensure that conditions within the watersheds will maintain, protect and enhance drinking water quality.

The U.S. Forest Service shall gather more information to describe and assess watershed conditions, develop a plan to systematically monitor water resource programs and obtain all data pertinent to water quality and watershed conditions, in cooperation with other agencies, organizations, local communities and volunteers.

The U.S. Forest Service shall seek to communicate more effectively with the localities that obtain drinking water from sources within the George Washington National Forest in order to ensure that the drinking watersheds are managed effectively, appropriately and for the public good.

The U.S. Forest Service shall work with local communities, agencies and the larger public to establish policies and develop management plans for the drinking watersheds to permanently maintain, protect and enhance drinking water quality.

Adopted by: _____

Signature:_____

Date:_____

FROM THE CONSERVATION DIRECTOR

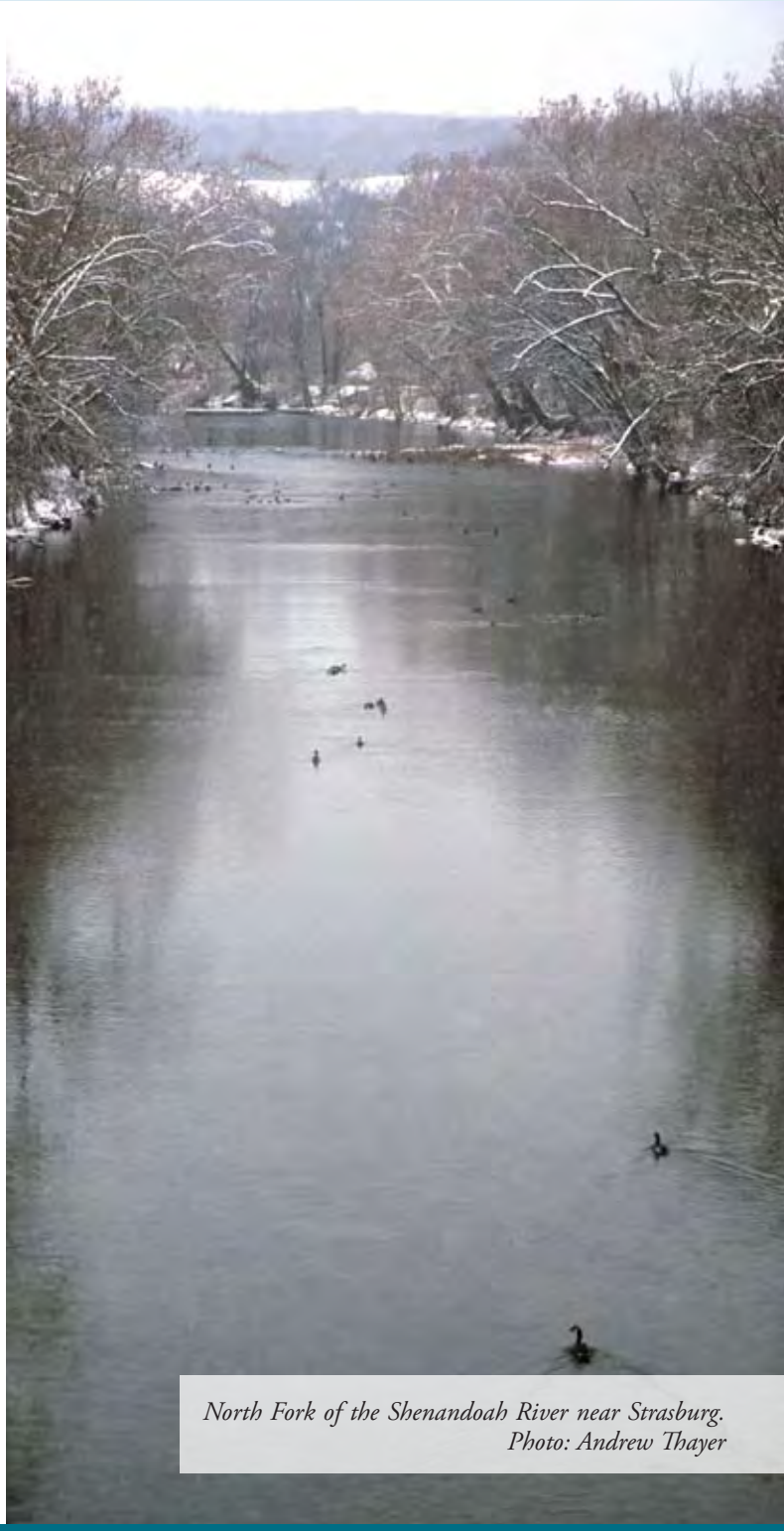
Working on this study was a learning experience and revealing in many ways too. I was surprised to learn that so little attention has been paid to the water resources of the GWNF. Many people assume that water leaving the GWNF is of high quality. That is not necessarily a bad assumption. But it is an assumption. There simply isn't enough information to make thorough, definitive assessments on the quality of water in the GWNF. With so many rivers, streams, and reservoirs within the GWNF considered "impaired" though, there is a need to address water quality.

As we began the study, we found very little information describing the drinking water resources of the GWNF. One of the purposes of the study was simply to gather basic information and document the importance of the GWNF as a source of drinking water to nearby communities. In determining that roughly 44.5% of the GWNF lands are within local drinking watersheds and twenty-two localities with more than 260,000 residents of western Virginia obtain their drinking water from surface waters within (or originating in) the forest, I believe we succeeded.

The Forest Plan for the GWNF is now in the process of being revised. The current Forest Plan, completed in 1993, does very little to address drinking water resources. This is an opportune time to address drinking water issues and make them part of the revised Forest Plan. The recommendations in the report, which I believe are logical, common sense ones, basically call for direct management of the local drinking watersheds. Cooperation and coordination between the U.S. Forest Service and local communities is needed for effective management.

Wild Virginia is very grateful to the many people and organizations that helped by providing much of the information found in this report. From the U.S. Forest Service, to state agencies (primarily VA Department of Health and Department of Environmental Quality) and regional planning commissions, to officials and employees at the counties, cities, and towns covered in this report, almost everyone was responsive and helpful. Without the cooperation of many people, this report could not have been completed. Finally, the Board of Wild Virginia conceived and directed this study.

David Hannah
December, 2008



North Fork of the Shenandoah River near Strasburg.
Photo: Andrew Thayer

ABOUT WILD VIRGINIA

Wild Virginia is a grassroots non-profit organization dedicated to preserving wild forest ecosystems in Virginia's national forests. Since 1995 we have worked to protect one of the last large wild forests remaining in eastern North America, the Shenandoah Mountain area of the George Washington National Forest (GWNF). Through education and outreach, Wild Virginia informs and mobilizes citizens about issues, threats, and opportunities for the GWNF. Wild Virginia is also a "watchdog" in the forest, monitoring all proposed projects (e.g., timber sales, road construction).

Financial support for our work comes from our members, individual donors and grants from private foundations. We are proud to acknowledge support in recent years from the Agua Fund, WestWind Foundation, Patagonia, Fund for Wild Nature, Environmental Systems Research Institute (ESRI), J & E Berkley Foundation, and an anonymous foundation.

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Wood Turtle. Photo: Steve Krichbaum

North Fork Shenandoah River, providing drinking water to six northern Shenandoah Valley localities. Photo: Chris Bolgiano

This report would not have been possible without the vision and funding of the following:

Anonymous Foundation

The Agua Fund

WestWind Foundation

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Graphic Design: Alloy Workshop