Back Creek Watershed Protection Plan

West Virginia and Virginia

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Submitted to:

West Virginia Conservation Agency

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"Investing in Clean Water for a Healthy Life"

CONTENTS

ACRONYMS & ABBREVIATIONS

AOI	Area of Interest
ATV	All-Terrain Vehicle
BHEN	Blue Heron Environmental Network
BMP	Best Management Practice
CFS	Cubic Feet per Second
EPA	US Environmental Protection Agency
EPCD	Eastern Panhandle Conservation District
FFA	Future Farmers of America
FSA	Farm Service Agency
GPS	Global Positioning System
GIS	Geographic Information System
LULC	Land Use Land Cover
NRCS	Natural Resources Conservation Service
NSD	Natural Stream Design
ROW	Right of Way
RTES	Rare, Threatened, and Endangered Species
TEAM	The Easy Assessment Method
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UNT	Un-named Tributary
VADEQ	Virginia Department of Environmental Quality
WMA	Wildlife Management Area
WVCA	West Virginia Conservation Agency
WVDA	West Virginia Department of Agriculture
WVDOF	West Virginia Division of Forestry
WVDOH	West Virginia Division of Highways
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources
WWTP	Waste Water Treatment Plant

INTRODUCTION

Purpose of Report

This Back Creek Watershed Protection Plan is a framework for stakeholders to become more familiar with the water quality issues within the Back Creek Watershed. It is a starting point to focus restoration efforts and enable financial and technical assistance to facilitate improvement strategies and restoration projects in the Back Creek Watershed. This plan is designed to be an evolving document and can be modified to include new data as it becomes available. This restoration process should be assisted by relevant state and local governmental agencies.

This document can be utilized by state agencies or stakeholders to secure funding to implement solutions and protect key conservation areas. Public outreach efforts can be recommended by identifying key water quality issues and their causes. Local Best Management Practices (BMPs) as well as direct aquatic restoration efforts will help the local water resources. This Plan will address concerns related to overall watershed health. The results will identify critical resources to protect (e.g. high-priority forested lands), potential sites to restore (e.g. severely eroding streambanks). This plan will also recommend conceptual solutions, an implementation framework, cost estimates, and a method for evaluation.

The report focuses on the following watershed elements and data:

- The unique forested nature of the watershed and the threatened and endangered species that depend on the water resources of this valley, such as the federally endangered plant harperella (*Ptilimnium nodosum*), wood turtle, eastern cricket frog, green floater mussel, and recently noted freshwater sponge (not yet identified) (WVDNR Natural Heritage Program, 2012; Villella and Nelson, 2008).
- WV Save Our Streams field data gathered by BHEN (WVSOS, 1998-2012).
- Water quality data collected by WVDEP Watershed Assessment Branch and Virginia Department of Environmental Quality.
- Two workshops facilitated by Green Rivers, LLC in order to gather valuable stakeholder input.
- Forestry prioritization maps generated by the WVDOF (Peddicord and Harouff, 2012).
- A stream assessment conducted by WVDEP identifying and prioritizing streambank and riparian area restoration opportunities (Hartman and Cochran, 2012).
- GIS data analysis of land use, impervious surface, core aquatic habitats, agricultural stream buffers and other relevant information.
- Berkeley County Comprehensive Plan 1990 and 2006 Update (Berkeley County Planning Commission, 2006).
- Building upon existing Berkeley County Storm Water Management Ordinance and Subdivision and Land Development Ordinance.

Area of Interest

The Back Creek Watershed, flowing in Berkeley and Morgan Counties, West Virginia and Frederick County, Virginia is comprised of distinctive, high-quality, cold and warm water streams, and unique shale bedrock outcrop topography. Back Creek is one of the few watersheds in the eastern panhandle that does not have water quality impairments on the WV 303(d) list of impaired waters. Back Creek flows north from the headwaters until it joins the Potomac River near McCoy's Ferry (on the Maryland side

along the Chesapeake and Ohio Canal). Back Creek is part of the Chesapeake Bay Watershed and drains 274 square miles at the confluence with the Potomac River. Back Creek is identified by its HUC-10 number 0207000404, and further broken into nine HUC-12 sub-watersheds: Outlet Back Creek, Tilhance Creek, Elk Branch-Back Creek, Warm Springs Hollow-Back Creek, Brush Creek-Back Creek, Isaacs Creek-Back Creek, Mine Spring Run-Back Creek, Babbs Run and Hogue Creek (Figure 1).

Back Creek is described by WV Division of Natural Resources (WVDNR) as a "High Quality Recreational Stream" for fishing, swimming, canoeing, and kayaking. Additionally, the American Whitewater Association (AW) describes a portion of Back Creek from Route 9 Bridge in Hedgesville to the confluence of the Potomac River as "Class II Whitewater". Beginning in 1982, AW considered this section a candidate for Wild and Scenic River designation. Since then, the Blue Heron Environmental Network (BHEN) has been collecting data to formally establish Back Creek as a Wild and Scenic River. This watershed is partially positioned atop karst geology and hydrology (Figure 2). The landscape within the area is diverse, ranging from fertile farmland throughout the valley bottom, to steep forested areas, to housing developments in the northeast portion of the watershed—all within one of the state's most rapidly growing counties between 2000 and 2010 (US Census Bureau).

The Back Creek Watershed is unique in its large areas of undeveloped and forested land. Rare, threatened, and endangered species (RTES) have been documented in ecosystems throughout the WV portion of the watershed, including unique, shale barren ecosystems.

Plants include harperella (*Ptilimnium nodosum*), Shale Barren Goldenrod (*Solidago arguta var. harrisii*), Northeastern Bulrush (*Scirpus ancistrochaetus*), Downy Arrow-wood (*Viburnum rafinesquianum*), False Hop Sedge (Carex lupuliformis), Branching Bur-reed (*Sparganium androcladum*), Grass Leaved Sedge (*Juncus biflorus*), Hairy Rock-cress (*Arabis hirsuta var. pycnocarpa*), Spotted Pond Weed (*Potamogeton pulcher*), Sweet-scented Indian Plantain (*Hasteola suaveolens*), Marsh Speedwell (*Veronica scutellata*), Kate's Mountain Clover (*Trifolium virginicum*), Rusty Woodsia (*Woodsia ilvensis*), Water Pimpernil (*Samolus valerandi ssp. Parviflorus*), Whorled Coreopsis (*Coreopsis verticillata*), Shale Barren Primrose (*Oenothera argillicola*), Sharp-scaled Manna-grass (*Glyceria acutiflora*), and Pussytoes Ragwort (*Packera antennariifolia*).

Mammals include the Allegheny Wood Rat (*Neotoma magister*), Least Shrew (*Cryptotis parva*), Meadow Jumping Mouse (*Zapus hudsonius*), Southern Pygmy Shrew (*Sorex hoyi winnemana*), and Black Vulture (*Coragyps atratus*).

Fish, Reptiles and Amphibians include the Tessellated Darter (*Etheostoma olmstedi*), Northern Red-bellied Cooter (*Pseudemys rubriventris*), Northern Red Salamander (*Pseudotriton ruber*), Wood Turtle (*Glyptemys insculpta*), and Eastern Cricket Frog (*Acris crepitans crepitans*).

Other invertebrates include Cooper's Cave Amphipod (*Stygobromus cooperi*), and Jane's Meadowhawk (*Sympetrum janeae*).

In the Virginia portion of the watershed the Wood Turtle has been documented in all sub-watersheds, except Isaacs Creek; and the Appalachian Springsnail (Fontigens bottimeri) has been documented in the Hogue Creek sub-watershed.

In 2008, a mussel survey of the WV mainstem of Back Creek was submitted by USGS to the WVDNR. The document contains detailed descriptions of stream channel characteristics and aquatic fauna present

during the survey. The survey indicates the presence of seven mussel and four turtle species. The document is an excellent reference to describe the unique habitats and fauna of the watershed as well as morphological characteristics of stream reaches (Villella and Nelson, 2008).

Stakeholder Process

For the purposes of this project, a stakeholder is defined as any individual or group directly or indirectly affected by activities pertaining to water quality within the Back Creek Watershed, such as landowners, businesses, municipalities, county governments, nonprofit organizations, and state and federal agencies.

BHEN, an established local stakeholder group, has demonstrated their commitment to the Back Creek watershed by completing several successful initiatives along Back Creek. BHEN has conducted numerous litter clean-ups, on-going water quality monitoring and environmental education initiatives, and was a driving force in removing a low water crossing in order to construct the Allensville Memorial Bridge.

Stakeholders met at two open meetings to compile local knowledge of the watershed, share concerns about issues facing the watershed, and prioritize conservation and restoration needs in the watershed. These meetings were conducted on August 8th and September 12, 2012. Additionally, relevant state, local and non-governmental organizations with knowledge and interest in the watershed were included in the stakeholder process including WVDEP Nonpoint Source Program, WVDEP Basin Coordinator, NRCS, Farmland Protection Board, WVDNR, Freshwater Institute, Cacapon Institute, BHEN, VADEQ, and the Potomac Conservancy.

For a complete list of the attendees at each of the stakeholder meetings and a summary of the meeting notes and discussion, please refer to the Appendices section.

Berkeley County Comprehensive Plan

The original Berkeley County Comprehensive Plan was developed in 1990. However, the Berkeley County Comprehensive Plan Update was developed in 2006. The Plan brings together a range of information to guide future development in Berkeley County, including: demographics, growth trends, land use analysis, and natural and cultural resources. Many of the conclusions and recommendations from the plan are relevant to this Back Creek Watershed Protection Plan and are included in this report. Furthermore, the Berkeley County Comprehensive Plan has been approved at a county level by the Berkeley County Planning Commission, who has legal authority over development ordinances. The 2006 Update contains 9,825 acres of land designated for high density development which will increase impervious surfaces and is not conducive to watershed protection (Figure 3). This protection plan recommends amending the Comprehensive Plan to eliminate high density development areas in the watershed. The 100 year floodplain coincides with the designated natural resource conservation area shown on the Berkeley County Comprehensive Plan's Growth Management Map with the exclusion of the Sleepy Creek WMA on the western edge of the watershed and therefore should be considered a focus area for protection.

Current Water Data Inventory

- WVDA collected water quality data monthly at the low water bridge on Back Creek from 1/30/2003– 10/27/2004. Water was tested for temperature, dissolved oxygen, pH, conductivity,

nitrate, nitrite, total phosphorous, ammonia and total suspended solids and can be seen in Table 1.

- WVSOS data from the Blue Heron Environmental Network can be seen in Table 2.
- WVDEP data from the Nonpoint Source Division for Escherichia coli, metals, temperature, turbidity, benthic macroinvertebrate (biological), and nutrients can be seen in Tables 3-9.
- A summary of baselines conditions in Back Creek and Tilhance Creek is shown in Table 10.
- VADEQ data for benthic macroinvertebrate (biological) monitoring can be seen in Table 11.
- A map showing the 303 (d) List of Impaired Waters of Virginia stream segments can be seen in Figure 4.

GIS ANALYSIS

Preserving the forested areas of the watershed and key wetland and aquatic resources from development are key priorities of this protection plan. GIS analysis was used to provide maps that prioritize parcels for conservation. These maps can be used as a framework to direct conservation efforts to the high priority areas. Currently, there are 1,694 acres within the WV portion of the watershed protected through the Berkeley County Farmland Protection Board and Conservation Easements. Additionally, Sleepy Creek WMA contains 6,760 acres of protected land. In the Virginia portion of the watershed, there are 2,464 acres of land in Conservation Easements.

Forest Parcel Preservation Prioritization

WV Division of Forestry created GIS maps identifying and prioritizing forested parcels within the watershed for protection. A complete description of the rationale and data management processes for these maps can be found in the Appendix. A map showing forested property parcels color coded by their conservation priority value can be seen in Figure 5. Protection of the high and medium priority forest parcels is an important part of preserving the water quality and ecological assets of the Back Creek Watershed and preventing increased flooding and erosion.

Land Use Analysis

Green Rivers utilized 2006 Land Use Land Cover (LULC) data developed by the Multi-resolution Land Characteristics Consortium to analyze land use in the Back Creek Watershed. The data was analyzed to divide land use into seven (7) categories: Forested, Developed Areas, Agriculture, Grasslands, Wetlands, Open Water, and Barren. The acreage and percentage in each land use category for the entire watershed and for the respective WV and VA portions of the watershed was then determined. The total area of the watershed is 175,190 acres of which 75% is Forested, 6.6% is Developed Areas, 18% is Agricultural, and less than 0.4% combined for Grassland, Wetland, Barren, and Open Water areas. The total area of the watershed in WV is 67,927 acres of which 79% is Forested, 4.5% is Developed Areas, 16% is Agricultural, and less than 0.5% combined for Grassland, Wetland, Barren, and Open Water areas. The total area of the watershed in VA is 107,339 acres of which 72% is Forested, 8% is Developed Areas, 19% is Agricultural, 0.6% is Open Water, and less than 0.4% combined for Grassland, Wetland, and Barren (Figures 6-7). The major trends in the land use analysis show the largest percentage of land as forested area, agriculture as the second largest, and a low percentage of developed area within the watershed. Based on this analysis, preserving the forested nature of the watershed, limiting high density development, and implementing BMPs on agricultural lands are the main strategies for protection of the Back Creek Watershed.

Aquatic Habitat Preservation Prioritization:

Green Rivers created GIS maps identifying and prioritizing parcels that contain important, core aquatic and wetland habitats, and the presence of RTES. The analysis utilizes data sets created by the Conservation Fund's Freshwater Institute which show areas of core aquatic habitat, core wetlands, and wetland connective corridors in the watershed. RTES data was provided by WVDNR's Natural Heritage Program and shows documented locations of these species within the watershed. Back Creek has long been known for its exceptional aquatic diversity and the presence of RTES. The preservation of habitat for these unique species and preservation of key wetland and aquatic habitats is important to protecting the water quality and biodiversity in Back Creek (Figures 8-12). Highest Priority Parcels contain the 100 Year Floodplain and or Core Wetlands. High Priority Parcels contain RTES, Wetland Corridor, and Core Aquatic Habitat areas. Medium Priority Parcels contain two out of the RTES, Wetland Corridor, and Core Aquatic Habitat areas. Lower Priority Parcels contain one out of the RTES, Wetland Corridor, and Core Aquatic Habitat areas. It should be noted that many of the high priority parcels for habitat conservation are located near the confluence of Back Creek with the Potomac River. Much of this area has been designated as a Growth Area and High Density Development Area in the 2006 Berkeley County Comprehensive Plan (Figure 3). These properties should be preserved as soon as possible to prevent development. In the meantime, an overlay of high priority preservation parcels should be added to the Comprehensive Plan to add protection mechanisms for these areas.

BERKELEY COUNTY ASSESSOR INFORMATION:

Tax Map Disclaimer: "Tax Maps are **FOR TAX PURPOSES ONLY.** The tax map was compiled for purposes of taxation from available record evidence and has not been field verified. This map is not a valid survey plat and the data on this map does not imply any official status to such data. The State of West Virginia and county assessor's office assume no liability that might result from the use of this map."

Tax Map Restriction: "All tax maps created under the provisions of reappraisal legislation are the property of the Berkeley County Assessor and the reproduction, copying, distribution, or sale of such maps or any copies thereof without written permission of the Berkeley County Assessor is prohibited by law."

Figures 5, 10-13, and 16-18 of this report contain Berkeley County Tax Maps provided by the Berkeley County Assessor and are subject to the above Disclaimer and Restrictions.

SOURCES OF POINT SOURCE POLLUTION

NPDES Permits

The NPDES Permit system was created under the Clean Water Act as a mechanism for tracking pollutant discharges from facilities into our nation's waterways. All facilities that discharge into a water of the United States must apply for a NPDES permit. NPDES permit information is available via the EPA's Enforcement and Compliance History Online (ECHO) website (http://www.epa-echo.gov/echo/compliance_report.html). Information available includes the history of inspection dates, compliance and violation history, and a list of the amount and type of pollutants allowed through the NPDES permit.

In the WV portion of the Back Creek Watershed, the Woods Subdivision WWTP and LCS Services Landfill are the NPDES permits of greatest concern. The Woods WWTP has recent history of violations while the discharge from the Landfill has been brought up as a concern by stakeholders. In VA, the UNIMIN Sand Plant has a history of releases of the chemical petroleum sodium sulfanate which have caused fish kills (Houff, 2000). There are also several WWTP discharges in the VA portion of the watershed which include schools and housing developments. Volunteer monitoring at NPDES discharge points can be used to alert WVDEP to issues and prompt NPDES inspections.

SOURCES OF NONPOINT SOURCE POLLUTION

Streambank Erosion & Sediment

Unstable streambanks are present throughout the Back Creek Watershed. Problems associated with streambank erosion include increased sedimentation leading to high turbidity, suspended sediment, sedimentation of the stream substrate leading to reduced aquatic habitat, and a loss of valuable land. Sedimentation occurs when soil is washed from the land or streambanks into the streams, and is deposited on the stream bed. Erosion can be natural, but is greatly accelerated when land is disturbed without proper best management practices when houses are built, fields are plowed, and hills are logged (Petty and others, 2005). The use of herbicidal sprays to keep right of ways clear is another concern. The soils in Back Creek are prone to erosion, making this an important issue for Back Creek. An increase in impervious surfaces in the watershed would lead to increased flooding frequency and severity, further increasing erosion.

In order to quantify sedimentation in the entire Back Creek Watershed, an inventory of eroded streambanks is needed. However, a comprehensive inventory of eroded streambanks along the mainstem of the WV portion of Back Creek was completed in summer 2012 by WVDEP as part of the Watershed Protection Plan Development. DEP staff waded and floated the mainstem documenting erosion using TEAM methodology (Adolfson and others, 2012). This inventory showed 28 areas of slight erosion, 120 areas of moderate erosion, and 66 areas of severe streambank erosion. The eroded streambank inventory was mapped to show the physical location and severity of erosion sites (Figure 13). This map should be used to identify locations to perform stream surveys and to develop stream restoration conceptual designs. These projects should be prioritized based on two major factors: (1) the project's potential to reduce sedimentation, and (2) landowner willingness to see the project to successful completion. Other prioritization matrices to be used should include the following: (a) potential to reduce bacteria; (b) potential for training and public outreach; (c) potential for matching funds and in-kind donations; (d) potential for overall success; and (e) physical conditions, including water quality, channel scouring and sediment deposition, channel stability, riparian habitat conditions, stream type, and stream slope characteristics. Future inventorying of eroded streambanks in tributaries to Back Creek is suggested in the Monitoring section of this Plan. This will allow for a wider selection of restoration sites in the watershed.

There are a total of 1,384 mi of streambank within the entire Back Creek Watershed of which 69 miles are mainstem in the WV portion (USGS, 2011). The total length of eroded streambanks along the WV portion of the mainstem of Back Creek is estimated to be 25,079 ft or 4.75 mi (7%). From the Virginia border to just past the confluence with Tub Run, Back Creek streambanks have low areas of erosion although very high levels of fine sediment deposition where observed on the streambed near the Virginia border. One of the heaviest concentrations of eroded streambanks is the relatively straight

section of Back Creek's mainstem upstream and downstream of the confluence with Elk Branch. The mainstem then becomes sinuous down to the Potomac River and exhibits frequent areas of high erosion. Here, implementation of NSD projects will be less effective due to the creek's low gradient and establishing a permanent, vegetated riparian zone is the recommended management measure (Figure 13).

Littering

Litter in the streams, especially tires, was identified as a common source of water quality pollution. The dumping of bags of trash and tires from vehicles over inclines into the floodplain where the refuse will be carried into the river system is estimated to be the largest source of litter. The unexpected closure of the landfill on Saturdays due to maximum waste acceptance levels may cause people who show up with loads of trash to dispose of them illegally when they find the landfill closed (Stakeholder Meeting, 2012). Litter also comes from fishing supplies, food, drink, and tobacco product wrappers, and other garbage left by passing motorists and recreational users of the creek. The Allensville Bridge and Rt. 9 Bridge are high litter areas. The WVDEP Make It Shine program is an excellent program which can assist in cleaning up existing litter and raising local awareness of the issue. Illegal dumping and littering can be reported to the WVDNR and WVDEP enforcement divisions. Relevant contacts are shown in Tables 13and 16.

Fecal Coliform

Fecal coliform comes from human and animal sources and can be a hazard to human health. Failing septic systems, straight pipes, improperly operating wastewater treatment plants, agricultural operations, and wildlife are all potential sources of fecal coliform.

According to WV's water quality standards the "Maximum allowable level of fecal coliform content for Primary Contact Recreation shall not exceed 200 counts/100ml as a monthly geometric mean based on not less than five samples per month; nor to exceed 400 counts/100ml in more than 10 percent of all samples taken during the month." For a complete explanation of WVDEP's fecal coliform monitoring and decision rationale please see the Appendix.

Of the thirty-four (34) in-stream fecal coliform data points collected by WVDEP from June 1998 through May 2008, four (4) data points exceeded 400 cfu/100 mL (Table 5). These monitoring locations are in the mainstem of Back Creek, Tilhance Creek, an UNT of White's Run, and Tub Run (Figure 14). Based on WV's water quality standards, Back Creek and its tributaries have limited data and are not listed on the State's 303d list for fecal coliform.

Virginia designates all of its waters for primary contact; therefore, all waters are required to meet the bacteriological criteria for this use. The criterion applies to all flows. The *E. coli* criteria requires a geometric mean concentration of less than 126 cfu/100 ml of water with no sample to exceed 235 cfu/100 ml of water. In the Back Creek Watershed, Hogue Creek, Little Isaacs Creek, Babbs Run and Parish Run are all listed on the Virginia Section 303 (d) List of Impaired Waters for bacteriological impairments (Figure 4). Hogue Creek has a TMDL for reduction of bacteria that was approved by USEPA in 2007 (Capacasa, 2007).

Roads, Bridges, Recreational Vehicles

Roads create impervious surfaces and are sources of petroleum residue, litter and sediment that can impact water quality. Dirt roads and the clearing of roadside ditches to bare dirt can be significant sediment contributors. Roads in the Back Creek Watershed should be inventoried and prioritized

according to their maintenance needs and pollution potential. This project would be a great undertaking for local research initiatives by volunteers, academics or state agencies. Pennsylvania has a statewide program to combat pollution from dirt and gravel roads that is run through the Center for Dirt and Gravel Road Studies at Penn State University. Publications from this program about methods for environmentally sensitive road management and construction can be found at http://www.dirtandgravel.psu.edu/Resources/technical_bulletins.html. The Forest Service also has a "Field Guide for Environmentally Sensitive Maintenance of Unpaved Roads" available for download at http://www.fs.fed.us/eng/php/library_card.php?p_num=1177%201802P. These materials are excellent resources for any future attempts to inventory and alleviate pollution from dirt and gravel roads in the watershed.

Bridges alter stream hydrology and can create stream scour, sediment deposition, bank erosion, and debris dams. In cooperation with the VA and WV Departments of Transportation, bridges in the Back Creek watershed should be inventoried by their type and older "box culvert" style bridges should be replaced with span bridges when they are scheduled for replacement.

ATV and 4WD drive vehicles driving in the stream bed was brought up as a concern by stakeholders. There are areas in the watershed where these activities are destabilizing streambanks, destroying riparian vegetation and causing sedimentation. Allensville Rd. was identified as a hot spot for ATV use along Back Creek. Continued identification of problem areas and contact with landowners is recommended. Once landowners have been contacted, access ramps can be closed, signage can be posted and law enforcement called when violations occur.

Impervious and Developed Areas

The increase in impervious surface and loss of natural habitat from development transports pollutants such as oil and gasoline from motor vehicles into the creek, increases the frequency and severity of flood events, and reduces the replenishment of the water table. Sedimentation is directly linked to development, which can be quantified by the area of impervious surfaces as found by Petty and others (2005). Imperviousness is an important indicator of water quality, and the quantification of imperviousness threshold levels directly assists in understanding the negative effects of urban runoff on in-stream water quality (Arnold and Gibbons, 1996; Brabec and others, 2002).

Research indicates that streams in catchments with greater than 10% imperviousness have a higher likelihood of experiencing water quality degradation. Common thresholds include catchments that are protected (less than 10%), impacted (10-30%), and degraded (greater than 30%) (Arnold and Gibbons, 1996; Brabec and others, 2002). A more recent tool describes streams with catchments at 8-10% imperviousness as stable but with erosion apparent. This tool also notes a threshold of 20%, at which stream substrate quality decreases and erosion is active (CWP, 1998; 2004). The Back Creek Watershed contains less than one (1) percent impervious surface and therefore, all measures should be taken to maintain this high quality status.

A GIS analysis of impervious surface in the Back Creek Watershed showed a total of 1,169 impervious acres out of 175,219 total acres or 0.67%. In the Virginia section of the watershed, the percentage was 0.86% and in the WV section it was 0.37% (Figure 15). These are low numbers, particularly in comparison to the high growth rate of Berkeley and Frederick Counties. The Back Creek Headwaters, Isaacs Creek, Hogue Creek, and Babbs Run watersheds in Virginia show the highest imperviousness. Expansion of development from Winchester can be seen in the eastern portions of the Babbs Run and

Hogue Run watersheds. In WV, Tilhance Creek watershed and the area bordering Hedgesville show the highest imperviousness. Implementation and enforcement of stormwater ordinances are important parts of the Watershed Protection Plan and will prevent a significant increase in impervious surfaces.

Agriculture

Agricultural activities can be sources of fecal coliform, nutrients, and pesticides and cause erosion and sedimentation. There are currently 554 acres under nutrient management plans in the WV portion of the Back Creek Watershed (Barnes, 2012). Using land use data, a total of 12.4 miles of streams within the WV portion of the watershed and 28.3 miles within the VA section of the watershed border agricultural lands (Figures 16-18). These agricultural lands provide locations to implement BMPs and for land conservation in high priority riparian areas. This type of conservation will build upon the Berkeley County Farmland Protection Board's and Potomac Conservancy's success in implementing conservation easements in the watershed.

Residual Arsenic Pesticides

A map of historic apple orchard locations in the Back Creek Watershed shows areas that have the potential for arsenic soil contamination (Figure 2). The orchard locations are based on GIS data derived by USGS from air photos and topographic maps prepared using information from the time period of extensive use of arsenical pesticides between the 1920s and 1960s. An orchard's presence in this data set does not necessarily indicate the use of arsenical pesticides on the site or that elevated arsenic and metal concentrations are present. Arsenical pesticides may have been used on part, or none, of the land and, under current land use, the land may have been remediated and no longer contain elevated arsenic and metal concentrations in soil (Larkin et al, 2006). Future use of these lands should include Phase I and Phase II environmental site assessments to ensure that any contamination is properly disposed of and not released into the watershed.

LOAD REDUCTIONS

With the exception of Hogue Creek, a TMDL has not been developed for streams in the Back Creek Watershed and existing water quality monitoring data shows that water quality standards for their designated uses are being met. Since water quality criteria are being met in the watershed, this plan focuses on preservation of the exceptional resources of the watershed. "If a TMDL has not yet been developed, the plan (Watershed Protection Plan) should be designed to attain water quality standards if possible, in addition to other environmental goals. If implementation of the watershed plan successfully addresses water quality impairments, a TMDL may not be needed" (EPA Watershed Plan Development Handbook, 2008). Reductions of bacterial loading in listed streams, continued attainment of all other water quality standards, and habitat conservation goals can be attained by implementing specific BMPs listed in this Plan. BMP implementation's effects can be measured using project specific load reductions and other criteria independent of an established TMDL. In the future, if a TMDL is developed for Back Creek, the project specific load reductions and other criteria can be merged into the TMDL.

In the VA portion of the watershed, a TMDL for Hogue Creek was approved by USEPA in 2007. The TMDL calls for reductions in fecal coliform to meet primary contact impairments. A description of the load reductions called for in the Hogue Creek TMDL is located in the Water Quality section of this report (Table 12). Load reductions will be realized through implementation of agricultural BMPs, removal of straight pipes, repairs and upgrades to failing septic systems, and upgrades to wastewater treatment

plants as needed throughout the watershed. VADEQ continues to monitor bacteria load reductions in Hogue Creek as the TMDL is implemented (Capacasa, 2007).

The following load reductions are for watershed wide implementation of agricultural BMPs. Based on the GIS analysis shown in Figures 16-18, in the Back Creek Watershed there are 196 stream segments within agricultural lands in WV totaling approximately 65,350' and 373 stream segments in VA totaling approximately 149,208'. Load reductions were calculated assuming BMPs of cattle exclusion fencing, a 35' riparian buffer on all stream segments, and one stream crossing and one alternative watering source per 1,000' of stream. Sediment load reduction for cattle exclusion fencing and 35' riparian buffers is estimated at 75% and 56%, respectively. (Chesapeake Bay Program, 2007) This results in an 89% total sediment load reduction by assuming the riparian buffer will reduce the remaining post fencing load of 25% by an additional 56%.

Stormwater and low impact development BMP implementation can achieve a wide range of load reductions depending on the practices implemented. Runoff reduction rates range from 0-90% and total phosphorus reduction rates range from 0-75% for individual practices. Multiple practices can be paired on one site to achieve higher load reductions at that site. Table 17 shows the respective load reductions for individual stormwater and low impact development BMPs. The table is for use in the Runoff Reduction Method, "an innovative system for stormwater design that focuses on Best Management Practices' (BMPs') capacity to reduce overall runoff volume as well as remove pollutants. The method also incorporates built-in incentives for Low Impact Development, such as preserving forests and reducing soil disturbance and impervious cover. The CWP and CSN have also been working with the Virginia Department of Conservation and Recreation (DCR) to integrate the Runoff Reduction method into proposed stormwater regulations and updated stormwater management handbook, and have developed Excel-based calculators for estimating runoff reduction for new development and redevelopment."(Region 9) The full suite of tools for planning and calculating site specific load reductions can be accessed from the Region 9 website at http://www.region9wv.com/bay/LIDtools.html.

Natural Stream Design project implementation to reduce sedimentation from bank erosion can be expected to achieve load reductions of 25%. (Zegre, Gaujot)

As a tributary to the Chesapeake Bay, any load reducing actions in the Back Creek Watershed will contribute to the load reductions set forth in the Chesapeake Bay Phase II Watershed Implementation Plan for WV. The entire document can be accessed here: http://www.wvca.us/bay/files/bay_documents/253_WV_WIP_Final-Phase_II_03292012.pdf. It contains useful information on recommended management measures and expected load reductions.

RECOMMENDED MANAGEMENT MEASURES

Preservation & Conservation

Protection of forest, wetland, and farmland properties is seen as a key component in the protection of water quality in Back Creek. Conservation easements are one of the major tools that can be used to ensure property remains in its current development status into the future. Easements are legal documents placing a property in protection while allowing for continued use of the property for managed timber harvest, light residential housing for family members, as well as other uses as determined by the landowner. The easement is placed in the care of a managing entity who is charged

with making sure the easement is followed. A challenge in using easements to reach watershed protection goals is they are voluntary on the part of the landowner. The most important parcels for conservation of forested lands, wetlands, RTES, and core aquatic habitat can be seen in the prioritization maps (Figures 5 and 12). Utilizing the overlain Berkeley County Tax Map data, measures will be taken to approach applicable landowners about entering into easements on their property. Using landowners with existing easements to approach their neighbors about entering into a similar easement will be used as an effective method of landowner communication (Emily Warner, Potomac Conservancy, August 2012 Stakeholder Meeting). Existing conservation easements in WV can be seen in Figure 12 while conservation easements in VA can be seen in Figure 4.

State and Federal Governmental Agencies, as well as non-profit conservation groups offer a variety of easement mechanisms. A description of applicable easements and their administrative entities are provided below and in Table 14.

- West Virginia Land Trust: www.wvlandtrust.org
- Cacapon and Lost River Land Trust: www.cacapon.org
- Potomac Conservancy: www.potomac.org
- Land Trust of the Eastern Panhandle: www.landtrustepwv.org
- Greenbrier Land Conservation Trust
- The Nature Conservancy: www.nature.org
- Trust for Public Land: www.tpl.org
- National Committee for the New River: www.ncnr.org
- Statewide Farmland Protection Authority: www.wvfarmlandprotection.org
- Berkeley County Farmland Protection Board: www.wvfarmlandprotection.org/co_berk_main.cfm
- Forest Legacy Program: www.wvforestry.com/forest_legacy_program.cfm

Planned and Low Impact Development

Zoning and ordinance enforcement are another mechanism that will direct development away from high priority preservation areas (Figures 5 and 12) and prevent increases in impervious surfaces (Figure 15). Much of the watershed is rural and without municipal influence. Therefore, ordinances must originate at the county level with the Berkeley County Planning Commission. The Berkeley County Comprehensive Plan 2006 Update's Planned Development analysis has designated a Natural Resource Protection land use for the 100 year floodplain of Back Creek (Figure 3). Currently many of the large parcels near the confluence of Back Creek and the Potomac which are identified as high priority preservation because of RTES and core aquatic habitat are designated for High Density Development in the Comprehensive Plan. The Comprehensive Plan should be amended so the high priority forest and aquatic habitat preservation parcels identified in Figures 5 and 12 are designated Natural Resource Protection land use, although this may be challenging due to development pressure.

Working with the Berkeley County Planning Commission and Frederick County Planning Commission to ensure preservation of high priority natural areas and strengthen and enforce the existing Storm Water Management Ordinance and Subdivision and Land Development Ordinance is a high priority action in the enactment of this Protection Plan. Enforcement of existing ordinances is also a priority action; the WVDEP Enforcement Division Romney Office's Stormwater and Construction Inspector should be notified of suspected stormwater and construction violations (Table 13).

WVDEP and Region9 collaborated to create a "WV Model Stormwater Ordinance Specifically Designed for Region 9." The Model is designed to: "limit the Post-construction Runoff rates to rates equal to or less than Predevelopment Runoff rates, include provisions that will improve water quality by reducing Nonpoint Source Pollution and nutrients, encourage flexible Best Management Practice (BMP) requirements and Low Impact Development (LID) design criteria, provide an incentives program to encourage BMP features, and address the vast areas of Karst Terrain and specify BMP criteria in these areas." It is strongly recommended that Berkeley County Planning Commission work with Region 9 to update the Berkeley County stormwater ordinance to the standards suggested in the Model. Additionally, Berkeley County qualifies as a MS4 (Municipal Separate Storm Water System) area and is subject to additional stormwater management permit requirements through WVDEP. All communities, municipalities and subdivisions should work with Region 9 and WVDEP's regional stormwater specialist to ensure high quality stormwater management measures are in place. A list of technical and financial assistance providers is found in Table 16.

Existing Berkeley County stormwater ordinance:
http://www.berkeleycountysc.gov/forms/council/code_07-07-44.pdf

WV Model Stormwater Ordinance Specifically Designed for Region 9:
http://www.wvca.us/bay/files/bay_resources_urban/WV_Region_9_Stormwater_Ord_Combined_Final.pdf

WVDEP MS4 program information:
http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/Pages/default.aspx

Additionally, Chesapeake Stormwater Network has issued the CSN TECHNICAL BULLETIN No. 1, STORMWATER DESIGN GUIDELINES FOR KARST TERRAIN IN THE CHESAPEAKE BAY WATERSHED VERSION 2.0. The recommendations of this document should be applied to the karst areas of the Back Creek Watershed as shown in Figure 2.

http://chesapeakestormwater.net/wp-content/uploads/downloads/2012/01/Karst20Working20Draft20Revised2006-05-20091.pdf

Sections of the 2006 Berkeley County Comprehensive Plan pertaining to watershed protection include:
"There are a number of natural features in the county that are particularly sensitive to development, including the 100 year floodplains of the Potomac and smaller streams, steep slopes, and the areas of Karst limestone geology found in the eastern third of the county. The most effective way to ensure their protection is to adopt and enforce ordinances that either prevent development from taking place or, at a minimum, require specific efforts to mitigate the impacts of development. Berkeley County should develop a zoning ordinance that will direct growth away from sensitive areas. The Natural Resource Protection Areas on the Growth Management Map provide a basis for developing a resource protection

district that would prevent permanent uses from being developed within these areas. Overlay zones should be used in the rest of the county to provide adequate protection. An overlay requires that more specific criteria be met in designated areas in addition to that which is normally required. Language in the ordinance should be applied consistently to all development projects" (Berkeley County Planning Commission, 2006; pg. 99). The use of "overlay zones" as described above can be used to protect sensitive areas if Natural Resource Protection Area status cannot be achieved.

"Revise the Berkeley County Subdivision and Land Development Ordinance to include recommendations for Conservation Site Design throughout the county. This design concept begins with an existing resources and site analysis plan that "maps the special environmental, historic, and scenic elements of a property so that the land can be profitably developed with minimum damage to those features and resources." Wetlands, steep slopes, floodplains, and sinkholes should be identified. In addition, large stands of forest, meadows, agricultural fields, or scenic views should also be identified. Once these areas are defined, then the building(s) or building lots would be laid out in such a way as to protect valuable resources" (Berkeley County Planning Commission, 2006; pg. 100-101).

The Berkeley County Comprehensive Plan 2006 Update also includes an analysis of soil suitability for septic systems. "Soils were rated from slight, i.e., few limitations to absorption, to severe, i.e., limitations so difficult to overcome that special designs and additional costs are necessary to safely handle septic waste" (Berkeley County Planning Commission, 2006). A GIS analysis of this soil data shows 99.9995% of soils in the Berkeley County portion of the Back Creek Watershed are rated as severe. This means existing and future development has the potential to cause bacterial pollution to surface and groundwater supplies and strong ordinances regarding the installation of site specific wastewater treatment options are necessary.

These same ordinances and concerns apply to the Frederick County, Virginia and Morgan County, West Virginia portions of the watershed and the appropriate governmental bodies should be engaged to ensure the proper protections are in place to guide development.

Following is a list of stormwater management practices and their estimated costs which can help offset the increased runoff caused by development. These practices promote infiltration, evapotranspiration, and storage of stormwater. For more information on these practices, contact the Potomac Region Stormwater Specialist with WVDEP.

- Pervious or permeable pavements are paved surfaces designed to allow water to flow through. Cost estimates are: Pavers-$5-12/square foot, Porous asphalt- $6-8/square foot, Porous concrete- $6-12/square foot.
- Rain gardens are depressed vegetated areas designed to infiltrate. Cost estimates are: $5-16/square foot.
- Urban trees are trees in developed areas. Cost estimates are: $175-400/tree.
- Stormwater planters are depressed vegetated areas in sidewalks, parking lots, and streets. Cost estimates are: planters- $1-25/square foot Native plants-$0.02-0.13/square foot.
- Green roofs are lined, vegetated areas on rooftops. Cost estimates are: $9-32/square foot.
- Green walls are vertical planters on the sides of buildings. Cost estimates are: $100-125/square foot.
- Rain barrels are small containers to capture runoff for re-use. Cost estimates are: $1-3/gallon capacity.

- Cisterns are large containers to capture runoff for re-use. Cost estimates are $1-3/gallon capacity.
- Bioswales are vegetated shallow ditches. Cost estimates are: $6-24/square foot.
- Downspout disconnection is the disconnection of roof drainage from the sewer system. Cost estimates are: $8-156/spout.
- Terraced planter systems are series of planter boxes stepped into a sloped surface.
- Level spreaders are stormwater structures that support filtering action of riparian buffers.

Low impact development and stormwater management practices will be most useful in existing urbanized areas such as subdevelopments, in Hedgesville, and in the southeast portion of the watershed near Winchester, Virginia and as future development occurs. As seen in Figure 15, these areas have the highest percentages of impervious surface in the watershed. It is unknown the number of these management measures which need to be installed because a survey of existing management measure needs has not been completed in the watershed and future development rates are unknown.

Agriculture

As development pressure increases within the watershed, protecting farmland will be an important part of the Watershed Protection Plan. Agricultural lands that contain or border streams in the watershed are the most important to protect from development. Implementation of agricultural BMPs is also an important step in the protection plan. Farmland parcels that contain and border streams should be prioritized for preservation and targeted for implementation of BMPs to increase riparian buffers and prevent sediment, livestock waste, fertilizers, and pesticides from entering streams. Stream segments within agricultural land use areas that are potential locations for preservation and agricultural BMP implementation are shown in Figures 16-18.

Areas with a high concentration of streams bordering agricultural lands are described below. Figure 17 shows areas in WV that include direct UNTs to the mainstem of Back Creek from the Virginia border down to the confluence with Elk Branch, portions of the mainstem of Back Creek, as well as Elk Branch and its tributaries. Areas seen in Figure 16 include the headwaters of Elk Branch, UNTs to the mainstem of Back Creek and portions of the mainstem, and the Tilhance Creek Watershed. Areas in Virginia are shown on Figure 18. In the Hogue Creek watershed, areas include the Hogue Creek headwaters, all tributaries entering Hogue Creek from the western side, and the headwaters of Gap Run. Areas in the Babbs Run Watershed include the headwaters, and the headwaters and tributaries of Parish Run, Green Spring Run and Cattail Run. Areas in the Back Creek headwaters watershed are Dry Run and the mainstem and UNTs of Back Creek from Gore to the confluence of Isaacs Creek. Areas in the Issacs Creek Watershed are the headwaters of Isaacs Creek including Nixon Run, Yeiders Run and Miller Run, the headwaters of Little Isaacs Creek including Crockett Run, portions of the mainstem of Little Isaacs Creek, and the mainstem of Isaacs Creek just before its confluence with Back Creek. Other areas in VA are UNTs to Brush Creek and UNTs to Back Creek from the confluence of Isaacs Creek to the WV border (Figure 18). Trout are sensitive to sedimentation and warming. As trout streams, Hogue Creek and Tilhance Creek should be targeted for priority implementation of agricultural BMPs to establish riparian buffers and exclude livestock from streams.

The WVCA, EPCD and LFSWCD have staff to assist farmers with technical assistance related to agricultural BMPs. This assistance is provided free of cost. Additionally these agencies provide access to financial resources for BMP implementation and provide equipment such as no till seeders for rent.

Following, is a description of common agricultural BMPs which can prevent water pollution from agricultural practices.

- Riparian buffers: Vegetated buffer zones along streams stabilize the streambanks, intercept and filter runoff from adjacent fields, and provide enhanced instream habitat and water quality by providing shade and detritus. Riparian buffers have been shown to reduce the amount of pesticides, herbicides, nutrients, bacteria and sediment entering receiving streams. Cost is estimated at $1,000 acre.
- Livestock fencing: Fencing livestock out of streams is an important BMP that should be installed in conjunction with riparian buffers. Fencing livestock out of the streams prevents streambank destabilization, prevents animal waste from being deposited in the streams, and prevents grazing of riparian buffer vegetation. Cost is estimated at $2 a linear foot.
- Armored Stream Crossings: Often armored stream crossings must be installed in conjunction with fencing of stream corridors to allow farmers to move livestock between pastures with minimal impact to the stream. Culverts are a preferred method of armoring stream crossings. Cost varies by the size of the stream and width of the crossing to be installed, example installed culvert prices are $1,200 for a 20 foot long 18-inch culvert, $2,800 for a 30 foot long 30-inch culvert, and $5,900 for a 40 foot long 48-inch culvert.
- Alternative Watering Sources: Often alternative watering sources must be installed in conjunction with fencing of stream corridors where the stream was the source of livestock drinking water. Alternatives include creation of hydrologically connected watering ponds outside the buffer zone and the development of springs and ponds. Cost is estimated at $3,000 per alternative source.
- Nutrient Management Plans: Nutrient Management Plans assess factors such as the amount of nutrients being produced by livestock in an operation, the available area for spreading manures, and soil nutrient needs to produce a plan which prevents excess nutrients from entering waterways.
- Cover Crops and No Till Practices: By planting harvested fields in a legume cover crop in the winter season, erosion of soil and nutrients is prevented and soil fertility is improved, reducing fertilizer needs. If fields are spread with manure, legumes may not be the best choice since they add nitrogen to the soil. Similarly, No Till planting practices prevent topsoil loss due to fields being left bare following tilling which leaves them vulnerable to wind and water erosion.

Due to the varied farming practices of individual agricultural operations and the unique aquatic resources within each agricultural land area, implementation costs will likely vary from estimated costs for agricultural BMPs. Outreach to agricultural producers and site visits to determine the type and scope of BMPs needed is necessary to accurately estimate implementation costs on a site by site basis.

The following cost estimates are for watershed wide implementation of agricultural BMPs. Based on the GIS analysis shown in Figures 16-18, in the Back Creek Watershed there are 196 stream segments within agricultural lands in WV totaling approximately 65,350' and 373 stream segments in VA totaling approximately 149,208'. Assuming BMPs of cattle exclusion fencing, a 35' riparian buffer on all stream segments, and one stream crossing and one alternative watering source per 1,000' of stream, estimated costs for implementation would be $749,180 in West Virginia and 1,706,832 in VA for a total of $2,456,012 (Table 18).

Often producers can provide machinery and labor as in-kind contributions to match grant funds. Combining implementation of Agricultural BMPs on several properties and combining implementation with NSD stream restoration projects can reduce individual project costs. Table 14 shows a list of applicable USDA programs which help finance these projects. The EPCD will have knowledge of the most recent programs, funding levels and yearly application deadlines. Individual producers are encouraged to work with the EPCD and Berkeley County Extension Office to tailor BMP implementation to their specific property and business needs. In Virginia, the Lord Fairfax Conservation District is the technical and financial assistance contact for agricultural BMP implementation. A list of technical and financial assistance providers is found in Table 16.

Erosion

Natural Stream Design (NSD) is a hydrologic design and implementation procedure that incorporates the geologic setting, and the form and function of a reference stream and floodplain, onto an impacted area poised for aquatic restoration. NSD techniques are recommended to be integrated into all channel or floodplain restoration and improvement projects within the Back Creek watershed. NSD techniques have been proven to alleviate and repair problems associated with streambank erosion, private stream crossings, bridges and culverts, floodplain and wetland connectivity, sedimentation, invasive species, dam removal, and aquatic habitat creation (Green Rivers 2012).

NSD Techniques include:

- Wood & Rock In-stream Structures
- Toe Wood
- Native Riparian Plantings
- Wetland & Hyporheic Connection
- Brush Mattress
- Sediment & Erosion Control
- Upland, Floodplain, & Channel Restrictions & Exclusions

Pricing for NSD projects, including planning costs can average $300 per linear foot and is based on many factors including:

- Construction Material Availability & Source
- Permitting
- Landowner Constraints
- Contractor Experience
- Proper Construction Oversight
- Design Constraints
- Weather

Average pricing for NSD projects average $100 per linear foot for Design and $200 per foot for Construction. Wetland construction costs average $100,000.00 per acre (Green Rivers, 2012). USEPA Section 319 grant funds administered through the WVDEP is the most common type of funding for NSD projects. Section 319 grants require a 40% match which can come from USDA programs described in

Table 14. More information about 319 funds is available at **www.dep.wv.gov/nonpoint.** The WVDEP Nonpoint Source Program Potomac Basin Coordinator can assist with technical and financial assistance on NSD projects. Additional assistance providers are listed in Table 16.

Although the number of feet of eroding stream bank in the watershed is not known, the TEAM erosion assessment of the mainstem of the WV portion of Back Creek can be used to estimate the costs of NSD project implementation in the watershed. The TEAM study identified 8,445 feet of moderately eroded and 22,765 feet of severely eroded stream bank. The estimated cost of implementing NSD projects on all moderately and severely eroded stream banks in this reach will average $6,829,500. The most cost efficient way to fund NSD projects is to bundle multiple erosion areas into one project reach that will share design, permitting and construction costs. Further study of erosion rates at these eroded stream bank sites should be undertaken to quantify sediment loads being contributed and prioritize restoration funding. As noted, areas of high erosion near the mouth of Back Creek may not be suitable for NSD projects. As TEAM assessments are conducted elsewhere in the watershed, the number of feet of documented eroding stream banks in the watershed will increase.

IMPLEMENTATION SCHEDULE AND TIMELINE

The schedule for implementation of the recommendations of this plan is designed to provide the necessary steps to achieve concrete results while allowing flexibility to deal with the complexities of implementing projects involving multiple stakeholders. The schedule has been divided between the plan's major tasks: implementation of agricultural BMPs, enactment of conservation easements, implementation of NSD projects, and watershed monitoring and community outreach.

Agricultural BMP Implementation Schedule (with proposed year of completion):

Phase I (2014)

- Conduct landowner outreach to identify willing agricultural producers for implementing BMPs at agricultural stream buffer areas as identified in Figures 16-18. (September--November)
- Conduct site visits with willing agricultural producers and identify needed BMPs and appropriate funding sources. (November—December)
- **Milestone:** Identify 5,000 linear feet of streambank with a need for BMP implementation.

Phase II (2015)

- Submit project proposals to NRCS or appropriate agency for funding. (February—March)
- Finalize designs for applicable BMPs. (April—May)
- Conduct pre-implementation monitoring. (June—July)
- BMP construction/implementation. (September—November)
- Post construction monitoring. (ongoing)
- **Milestone:** Implement BMPs on 5,000 linear feet of streambank.

Phase III (2016-2024)

- Repeat Phase I and Phase II on an annual basis.
- **Milestones:** Contact all agricultural producers identified as having agricultural lands bordering streams in the Back Creek Watershed. Implement BMPs on all impaired agricultural stream reaches.

Phase IV (2019)

- Review Project Implementation over the past 5 years. Assess achieved load reductions and prioritize future project needs.
- **Milestone:** BMPs implemented for 25,000 linear feet of streambank with sediment load reductions of 89%.

Phase V (2024)

- Review Project Implementation over the past 10 years. Assess achieved load reductions and prioritize future project needs.
- **Milestone:** BMPs implemented for 50,000 linear feet of streambank with sediment load reductions of 89%.

NSD Project Implementation Schedule:

Phase I (2014/2015)

- Develop a 5, 10 and 20 year NSD Implementation Plan to be reviewed and approved by the Project Team (July--December 2014)
- Continue TEAM assessment of erosion in the watershed on a sub-watershed level. (July 2014—October 2015)
- Conduct landowner outreach to identify willing landowners for implementing NSD projects at TEAM high erosion areas as identified in Figures 13. (September-October 2014)
- Conduct site visits with willing landowners and identify scope of projects. (October—November 2014)
- Bundle identified landowner projects into larger reach scale projects for funding and implementation. (December 2014)
- **Milestones:** Identify 5 willing landowners to implement reach scale NSD restoration. Conduct TEAM assessment in one sub-watershed.

Phase II (2015/2016)

- Conduct 2 public outreach meetings and distribute press releases (January—April 2015)
- Submit project proposal to WVDEP. (May 2015)
- Announcement of 319 incremental funding upon approval by USEPA.
- Conduct pre-construction monitoring, assessment and design of NSD project. (July 2015—December 2015)
- Conduct permitting process. (January 2016—March 2016)
- NSD project bidding, construction and construction oversight. (April 2016—December 2021)
- Post-construction monitoring. (Ongoing through 2021)
- **Milestones:** Implement one reach scale NSD restoration project. Conduct TEAM assessment in one sub-watershed.

Phase III (ongoing through 2031)

- Repeat Phase I and Phase II on a regular basis.
- **Milestones:** Complete TEAM assessment in all sub-watersheds. Contact all landowners identified as having lands containing highly eroded stream banks in the Back Creek Watershed. Implement NSD projects on all willing landowner properties.

Phase IV (2019)

- Review and revise 5, 10 and 20 year NSD Implementation Plans.
- Review projects implemented, assess achieved load reductions and project monitoring results.
- **Milestone:** Develop practical NSD Implementation Plans with input from previous projects.

Phase V (2024)

- Review and revise 5, 10 and 20 year NSD Implementation Plans.
- Review projects implemented, assess achieved load reductions and project monitoring results.
- **Milestone:** Develop practical NSD Implementation Plans with input from previous projects.

Conservation Easement Implementation Schedule:

Phase I (2014)

- Conduct landowner outreach to identify willing landowners for enacting conservation easements on high priority preservation parcels as identified in Figure 5 and Figure 12. (September—October)
- Conduct 2 public outreach meetings and distribute press releases (September—October)
- Utilize landowner outreach for agricultural BMP implementation to identify farmland for conservation under the Berkeley County Farmland Protection Board, Frederick County Conservation Easement Program, Potomac Conservancy or other easement holder. (October—November)
- Approach appropriate entities to administer easements. (November)
- Conduct site visits with landowners to identify landowner needs and wishes. (November—December)
- **Milestone:** Identify 5 willing landowners, pair them with willing administrative entities, and have conservation easement agreements signed.

Phase II (ongoing through 2031)

- Repeat Phase I on a regular basis.
- **Milestones:** Contact all landowners identified as having property designated as high and medium conservation priority in Figure 5, all land owners with highest, high and medium conservation values in Figure 12, and all landowners with agricultural properties. Have all willing landowners enter into conservation easements.

Watershed Monitoring and Community Outreach Implementation Schedule:

Phase I (2014-2016)

- BHEN continues WVSOS monitoring program. (ongoing)
- BHEN conducts community outreach to recruit new members. (ongoing)
- BHEN applies for WVDEP Stream Partner Grant to strengthen funding for monitoring program. (ongoing)
- WVDEP and BHEN conduct WVSOS monitoring training. (ongoing)
- BHEN monitors new NPDES permits in the watershed as published in newspapers and organizes public response. (ongoing)
- Conservation and restoration project successes are publicized in local media. (ongoing)
- Tours of conservation easements, NSD projects and agricultural BMPs are led. (ongoing)
- BHEN applies for grants to build capacity for water monitoring, community outreach, project implementation, and being a watchdog for the watershed. (ongoing)
- Back Creek Watershed Protection Plan is presented to Berkeley County Planning Commission and other local government representatives.

- Removal of planned high density development in the Back Creek Watershed from the Comprehensive Plan and strengthening of the stormwater management ordinance are presented to the Berkeley County Planning Commission.
- Berkeley County Planning Commission and BHEN representatives attend Low Impact Development training workshops as needed.
- Site visits to construction and development sites conducted by BHEN volunteers trained by WVDEP's Stormwater Specialist.
- Outreach efforts are made between WV and VA stakeholders to coordinate efforts.
- **Milestones:** Recruitment and WVSOS training of new members for BHEN. Increased capacity of BHEN through grant procurement and training. Presentation of this plan, LID opportunities, and conservation concerns to the Berkeley County Planning Commission. Publication of media pertaining to watershed issues in Back Creek.

Phase II (2016-2021)

- Ongoing actions from Phase I continue.
- BHEN reviews and expands WVSOS monitoring program.
- Build upon earlier discussions with Berkeley County Commission to continue pressing for pro-conservation ordinances.
- Build upon coordination between WV and VA agencies and volunteers.
- **Milestones:** Recruitment and WVSOS training of new members for BHEN. Expansion of BHEN WVSOS monitoring program. Publication of media pertaining to watershed issues in Back Creek. Involvement of volunteers from VA portion of the watershed in watershed meetings. Coordination of data sharing and project coordination between VA and WV governmental agencies.

MONITORING

The benefits of active volunteer monitoring include providing baseline conditions, tracking water quality trends, alerting WVDEP to monitoring sites that need closer attention to determine a quality standard exceedance, providing in-kind contribution to restoration grants, and tracking beneficial results of restoration projects. Volunteer Water Quality monitoring is also an excellent outreach tool to get residents actively involved in their watersheds.

BHEN will continue and expand its water quality monitoring program in cooperation with the WVDEP Save Our Streams program. Existing monitoring data has focused mostly on WVSCI (Stream Condition Index) which is an important indicator of stream health (Figure 19). Biological integrity monitoring will continue at existing locations to track long term trends in stream health. BHEN's WVSOS monitoring program will also begin collecting data for conductivity, nutrients (Nitrate-Nitrite, Phosphorus), and E. coli/fecal coliform at strategically placed monitoring locations in the watershed. Annual monitoring for most parameters will be sufficient, while E. coli monitoring will be conducted monthly at sites of concern such as White's Run, below The Wood's WWTP. A map of new monitoring locations is shown in Figure 20 and listed in Table 15. These 16 locations coincide with road bridges to allow easy access and are located along the mainstem of Back Creek, near the mouth of major tributaries to Back Creek, and at several locations in the Elks Branch and Tilhance Creek watersheds. This allows for the water quality of various tributaries to be measured along with changes in Back Creek, Elk Branch and Tilhance Creek at various locations. If a significant, negative change in water quality is seen in a tributary or between monitoring locations on a mainstem, causes of the impairment can be narrowed down to a relatively small area. Conversely, positive water quality changes from restoration project implementation can also

be tracked through this plan, though project specific monitoring should also be employed. Near the Virginia border there are numerous small, direct tributaries to Back Creek which are not included in the monitoring plan. However, more of these tributaries will be added to the monitoring plan as resources become available. Evidence suggests many of these streams are spring fed and monitoring for potential trout habitat at strategic locations could be an interesting project for Trout Unlimited to take on. Funds such as the WV Stream Partners Program $5,000 grant and NORCROSS Foundation grants for equipment should be pursued to assist in building monitoring program capacity. The monitoring plan will be discussed with the WVSOS coordinator before final implementation. In addition, a QAPP (Quality Assurance Project Plan) will be developed with the assistance of the WVSOS coordinator. A list of technical and financial assistance providers is found in Table 16.

Figure 19 also shows the locations of WVDEP Watershed Assessment Branch monitoring sites. In 2013 a random selection of these sites is scheduled to be monitored as WVDEP will conduct its regular 5 year cycle sampling in the Potomac Direct Drains watershed. This monitoring will continue on a 5 year cycle and may also include monitoring at the request of the WVDEP Nonpoint Source Program. The Nonpoint Program will be notified of significant changes in water quality discovered through WVSOS volunteer monitoring so that further monitoring can be requested. VADEQ conducts monitoring in the VA portion of Back Creek as shown in Figure 4. VA DEQ will continue its water monitoring efforts in the Back Creek Watershed including E. Coli monitoring in the Hogue Creek watershed to track TMDL progress. WVDEP and VADEQ will share data on water quality and project implementation within the watershed.

WV Department of Agriculture maintained a monitoring program in Back Creek that has been discontinued due to a lack of water quality exceedances. If monitoring reveals nutrient or E. Coli exceedances, WV Department of Agriculture will be notified and requested to resume monitoring in the watershed.

Locations of stream bank erosion on the mainstem of Back Creek were identified and documented by WVDEP using TEAM methodology in the summer of 2012. The location and severity of erosion documented during the assessment are shown as points in Figure 13; each point represents a reach of streambank which may be hundreds of feet long. Yearly monitoring at high bank erosion sites will be implemented to quantify the amount of streambank being lost and sediment loads being contributed to Back Creek through erosion. WVDEP Nonpoint Source Program Natural Stream Design and Riparian Improvement Monitoring Protocol will occur at NSD restoration sites to quantify the load reductions accomplished through NSD projects. Funding for implementation of NSD streambank stabilization projects will include funding for baseline and post-implementation monitoring or include a volunteer monitoring plan as in-kind contribution to the project. WVDEP Nonpoint Source Program Natural Stream Design and Riparian Improvement Monitoring Protocol will be used to assess progress at the project sites prior to, and following, NSD project implementation. The exact locations of project specific monitoring will not be decided until landowner agreements and project designs are finalized.

Pollutants from the LCS Services Landfill and the Unimin Corporation Sand Plant discharges where listed as stakeholder concerns. A specialized sampling plan is needed to identify potential contaminates from NPDES sources. A list of chemicals allowed through the NPDES permit for these, and all other NPDES permits, is available via the EPA's ECHO website (http://www.epa-echo.gov/echo/compliance_report.html). Special funding will be sought to implement sampling of this magnitude because it involves expensive laboratory analysis. Suspected chemical releases will be reported to the WVDEP Enforcement Division as shown in Table13.

OUTREACH AND EDUCATION

Landowner outreach and education will be a key component in the ability of the Protection Plan to be implemented. Preserving farmland, wetlands and forestland through conservation easements and the implementation of NSD streambank protection projects and agricultural BMPs rely on the availability of willing landowners. Strategic outreach to the communities within the watershed will be required, on a continual basis, to raise awareness and interest in participating in the protection of Back Creek and on a cyclical basis to connect willing landowners with annual funding opportunities. The outreach and education strategy will utilize the following avenues: utilizing existing organizations with connections to the agricultural community including the Eastern Panhandle Conservation District, Lord Fairfax Soil and Water Conservation District, Berkeley County Farm Bureau, local 4-H chapters, NRCS, Berkeley County Extension Agency, Berkeley County Farmland Protection Board, and FFA; utilizing landowners with existing easements or conservation practices to approach their neighbors; publishing notices of funding opportunities in local news outlets, and organizing tours of farm or forestlands under easement and existing NSD and BMP sites.

Project team meetings will be held on a quarterly basis to assess and plan implementation, education and outreach. Additionally, the project team will discuss and plan special outreach events as well as the design and dissemination of outreach materials at quarterly meetings. The project team will organize semiannual or annual public meetings to which all stakeholders will be invited. During the public meetings, updates on implementation progress will be provided. The WVCA Conservation Specialist located in the Eastern Panhandle Conservation District will coordinate the project team and public meetings.

The Eastern Panhandle Conservation District regularly sponsors a woodland workshop which is coordinated by WVCA, WVDOF, and the Woodland Owners Association of WV to promote good land management practices and streamside land protection. The project team will work with this group to host such a workshop in the Back Creek watershed in order to engage, educate and encourage stakeholder conservation of forested land. The project team will coordinate other relevant workshops in the watershed such as an Agricultural Field Day to showcase BMP's and to promote cost-share programs and conservation easements. Homeowner workshops will be held to promote proper septic care, lawn and gardening practices, rain gardens and rain barrels, land management, etc. The project team will hold at least one workshop a year within the watershed.

Stakeholders will be reached through press releases, radio broadcasts, dissemination of outreach materials (brochures and flyers), and through personal contact by phone, email, and in-person meetings. Stakeholders to be contacted include all residents of the watershed, agricultural producers, businesses, local government officials, schools, HOA's, county representatives, municipality representatives, BHEN members, community groups, NGOs, and state agency representatives. Stakeholder contact information will be kept on file with the WVCA Conservation Specialist, and used regularly in outreach efforts.

Cooperation with agencies and organizations in the VA and WV portions of the watershed is instrumental to success of the watershed protection plan. The headwaters of Back Creek originate in VA and the water quality in the mainstem of Back Creek is heavily influenced by watershed health in the VA

portion. Coordination between the Lord Fairfax SWCD, Potomac Conservancy, VADEQ and watershed groups will allow for a comprehensive implementation of the protection plan, better tracking of the success of implementation measures, build greater momentum for conservation projects in the watershed, and allow for collaborative funding opportunities.

TECHNICAL AND FINANCIAL RESOURCES

Additional Technical and Financial Resource sources can be found in Table 13.

Technical Resources:

Chesapeake Bay Program – Provides technical resources for implementation of BMPs throughout the Chesapeake Bay Watershed to help meet load reduction goals. Specific to WV is the WV Final Phase II Chesapeake Bay Watershed Implementation Plan.

Eastern Panhandle Regional Planning and Development Council – Provides technical assistance on community planning, low impact development and stormwater management BMPs.

West Virginia Conservation Agency (WVCA) –The WVCA coordinates statewide conservation efforts to conserve natural resources, control floods, prevent impairment of dams and reservoirs, assist in maintaining the navigability of rivers and harbors, conserve wildlife and assist farmers with conservation practices. The WVCA Environmental Specialists (ES) will coordinate with other agencies and work directly with landowners to implement the practices called for in this watershed based plan. They will also produce grant proposals and status reports. The Eastern Panhandle Conservation District covers Back Creek.

Lord Fairfax Soil and Water Conservation District-The LFSWCD coordinates local conservation efforts in the VA portion of the Back Creek Watershed and provides financial and technical assistance to the agricultural community.

The Natural Resources Conservation Service (NRCS) – The NRCS is the federal agency that works directly with farmers for designing and installing practices. The NRCS also implements the Wildlife Habitat Improvement Program (WHIP) and the Conservation Reserve Enhancement Program (CREP).

The Virginia Department of Environmental Quality (DEQ) – The DEQ DEP is the agency with primary responsibility for protecting the environment including stream water quality and coordinates the State's stormwater management program . DEQ is home to Virginia's Section 319(h) Grant Program and Virginia's Nonpoint Source Management Program.

The West Virginia Department of Environmental Protection (DEP) – The DEP is the agency with primary responsibility for protecting the environment including stream water quality. The Nonpoint Source Program (NPS) within the DEP administers the Section 319 grants and the Basin Coordinators in the program work closely with project managers to accomplish the approved watershed based plans including assistance, if needed, with monitoring. The NPS operates the Save Our Streams

volunteer monitoring program and can provide assistance with outreach, education and volunteer monitoring. The NPS program also coordinates the State's stormwater management program.

Financial Resources

Agriculture Enhancement Program – Administered by the WVCA, this program provides cost share for agricultural producers to implement BMPs such as livestock exclusion fencing and altenative watering sources.

Clean Water Act Section 319 Grants – 319 funds are provided to the state by the US Environmental Protection Agency (EPA). In West Virginia these funds are distributed by the DEP for agencies or organizations who are conducting projects related to nonpoint source pollution.

Conservation Reserve Enhancement Program (CREP) – CREP is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. CREP addresses high- priority conservation issues in priority watersheds as designated by the NRCS State Conservationist.

Eastern Panhandle Conservation District - Administers financial assistance programs for agriculture BMP implementation.

Environmental Quality Incentive Program (EQIP) – EQIP is a voluntary conservation program that provides assistance to farmers who face threats to soil, water, air, and related natural resources on their land. The NRCS through EQIP offers financial and technical assistance to eligible participants to install or implement structural and management practices to promote agricultural production and optimize environmental benefits to help farmers meet environmental requirements on eligible agricultural land.

Farmland Protections Programs – Offer financial assistance and easement holding services to protect farmland from development.

Landowners – Farmers will provide 25% matching funds for practices developed on their property. Much of these funds will be in kind for labor, equipment use, and materials. Homeowners who participate in any septic project will provide 40% of the funding.

Lord Fairfax Soil and Water Conservation District- Administers financial assistance programs for agriculture BMP implementation.

National Fish and Wildlife Foundation – Offers grant programs including the Chesapeake Bay Stewardship Fund and Five Star Restoration Grant Programs which could be used in Back Creek.

National Resource Conservation Service – Administers many USDA Farm Bill financial assistance programs.

National Water Quality Initiative (NWQI) – The NWQI will assist farmers to address water resource concerns in high priority small watersheds that are impaired, threatened or critical to impaired waters. States will reserve 5% of EQIP funding for the NWQI. These funds should be targeted for Hogue Creek to assist in achievement of TMDL load reductions.

Virginia Agricultural Best Management Practices Cost Share Program – Locally administered by the Lord Fairfax Conservation District this program offers financial assistance for implementation of BMPs.

Wildlife Habitat Incentive Program (WHIP) - WHIP is a voluntary program for landowners who want to develop and improve wildlife habitat on agricultural land, nonindustrial private forest land, and Indian land.

The WVCA – provides up to 15% cost share for agricultural practices associated with an approved Section 319 grant proposal. Also provides agricultural specific funding opportunities and equipment rentals.

The WV Onsite State Revolving Fund Program (OSLP)- is administered through the DEP. This program can be used to provide loan funding for individual onsite systems as well as homeowner-owned components of decentralized systems

WV Infrastructure and Jobs Development Council (IJDC) - Most sources of public funding for wastewater infrastructure are administered by the IJDC.

ACKNOWLEDGMENTS

Green Rivers would like to thank the many people and organizations whose contributions made this report possible. We would specifically like to thank Suzy Lucas and the WVCA, Tim Craddock, Alana Hartman, Glenn Nelson, Kelley Cochran, and the WVDEP NonPoint Source Program, John Wirts and the WVDEP Watershed Assessment Branch, Herb Peddicord and the WVDOF, Barbara Sargent, Kieran O'Malley, and the WVDNR, Michael Schwartz and the Conservation Fund's Freshwater Institute, William Van Wart and the VADEQ, Sherry Evasic and the Blue Heron Environmental Network, Emily Warner and the Potomac Conservancy, Floyd Kursey and the Berkeley County Farmland Protection Board, and the Berkeley County Assessor's Office.

FIGURES

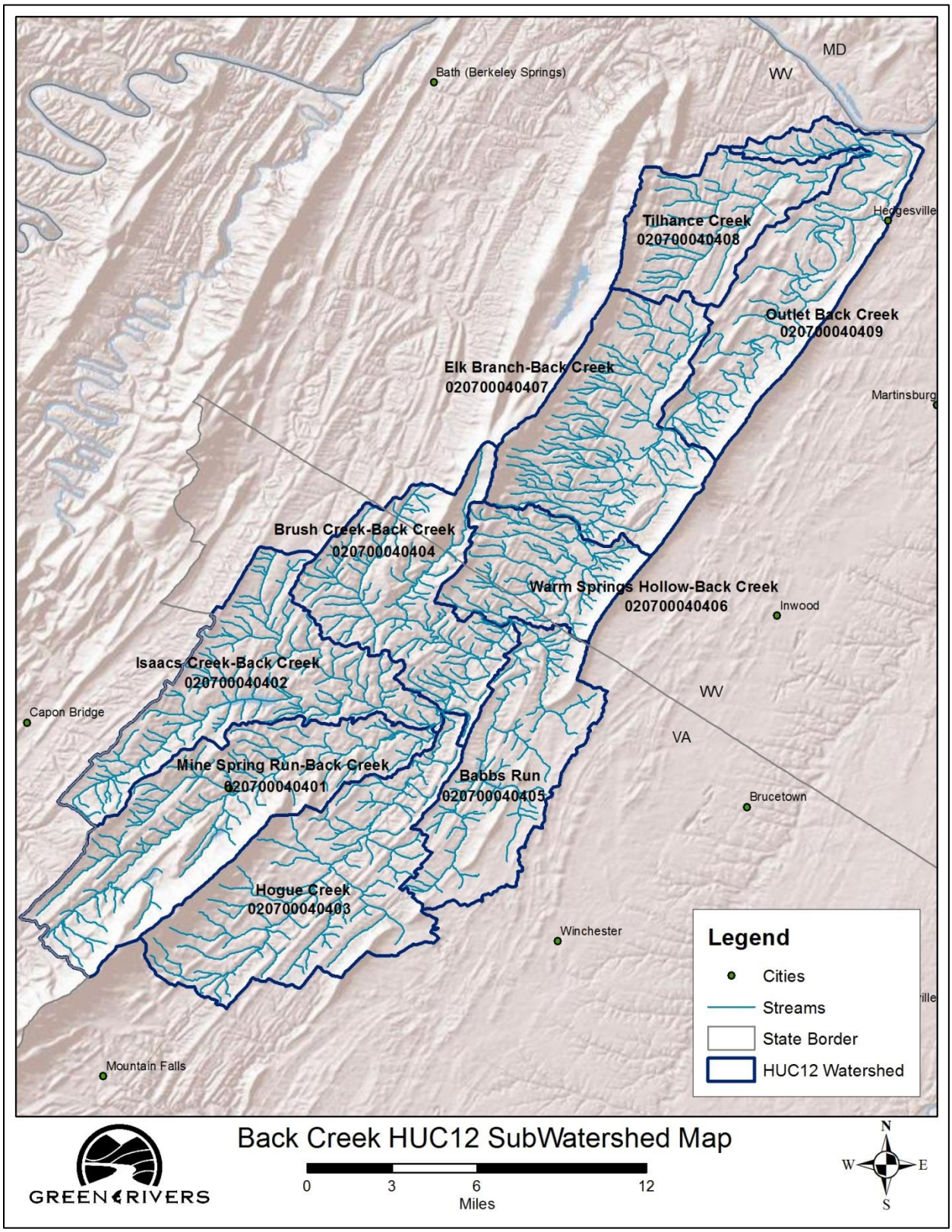

Figure 1.

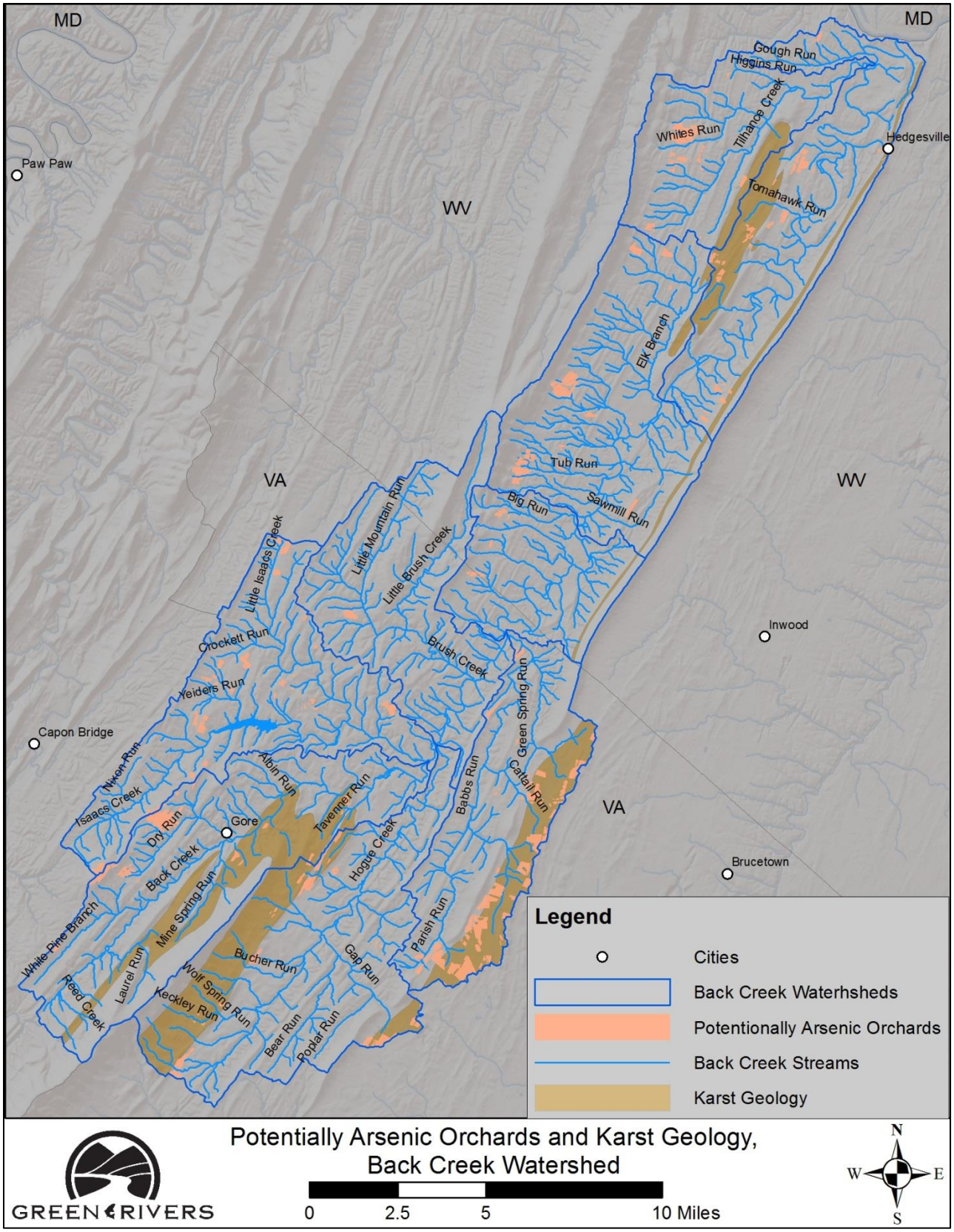
MD
MD
WV
VA
WV
VA
Paw Paw
Hedgesville
Inwood
Capon Bridge
Gore
Brucetown
Gough Run
Higgins Run
Tilhance Creek
Whites Run
Tomahawk Run
Elk Branch
Tub Run
Big Run
Sawmill Run
Little Mountain Run
Little Brush Creek
Little Isaacs Creek
Crockett Run
Yelders Run
Brush Creek
Green Spring Run
Cattail Run
Babbs Run
Parish Run
Hogue Creek
Tavenner Run
Albin Run
Nixon Run
Isaacs Creek
Dry Run
Back Creek
Mine Spring Run
White Pine Branch
Laurel Run
Reed Creek
Wolf Spring Run
Keckley Run
Bucher Run
Gap Run
Bear Run
Poplar Run
Legend
Cities
Back Creek Waterhsheds
Potentionally Arsenic Orchards
Back Creek Streams
Karst Geology
GREEN RIVERS
Potentially Arsenic Orchards and Karst Geology,
Back Creek Watershed
0
2.5
5
10 Miles
N
W
E
S

Figure 2.

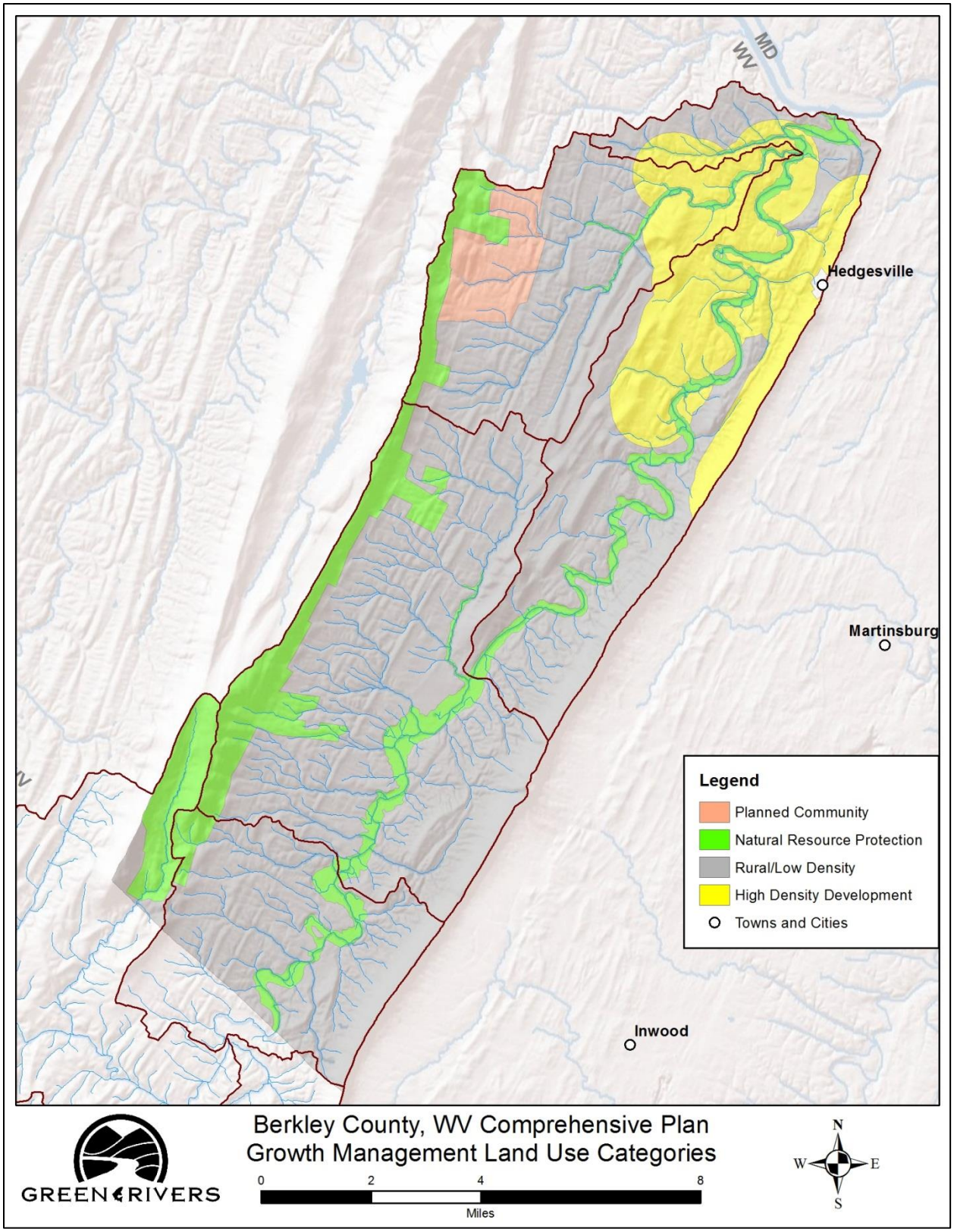
MD
WV
Hedgesville
Martinsburg
Inwood
Legend
Planned Community
Natural Resource Protection
Rural/Low Density
High Density Development
Towns and Cities
Berkley County, WV Comprehensive Plan
Growth Management Land Use Categories
0
2
4
8
Miles
N
W
E
S
GREEN RIVERS

Figure 3.

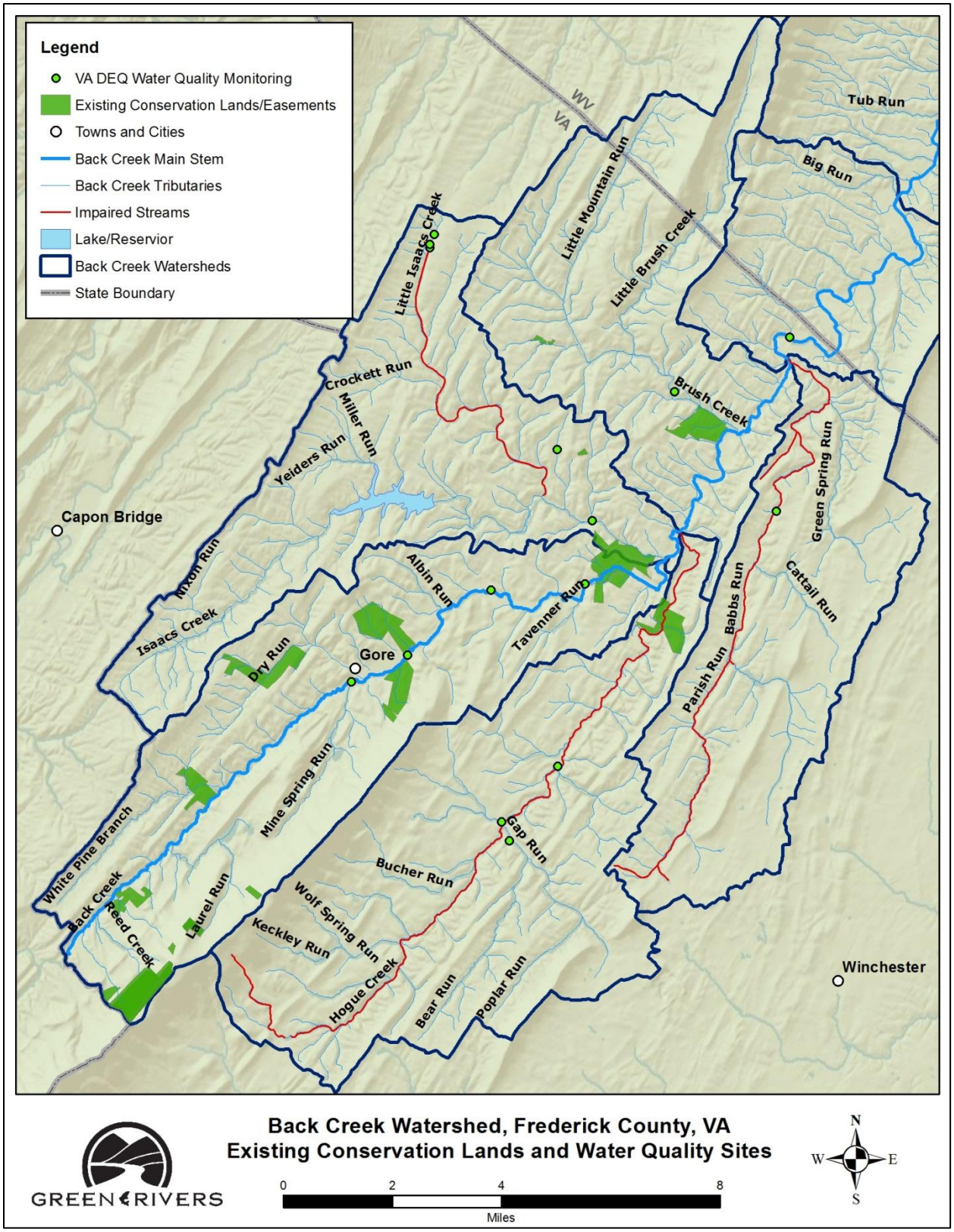
Legend
VA DEQ Water Quality Monitoring
Existing Conservation Lands/Easements
Towns and Cities
Back Creek Main Stem
Back Creek Tributaries
Impaired Streams
Lake/Reservior
Back Creek Watersheds
State Boundary
WV
VA
Tub Run
Big Run
Little Mountain Run
Little Isaacs Creek
Little Brush Creek
Crockett Run
Miller Run
Yeiders Run
Brush Creek
Green Spring Run
Capon Bridge
Nixon Run
Albin Run
Tavenner Run
Isaacs Creek
Dry Run
Gore
Babbs Run
Cattail Run
Parish Run
Mine Spring Run
White Pine Branch
Back Creek
Reed Creek
Laurel Run
Gap Run
Bucher Run
Wolf Spring Run
Keckley Run
Hogue Creek
Bear Run
Poplar Run
Winchester
Back Creek Watershed, Frederick County, VA
Existing Conservation Lands and Water Quality Sites
GREEN RIVERS
0
2
4
8
Miles
N
W
E
S

Figure 4.

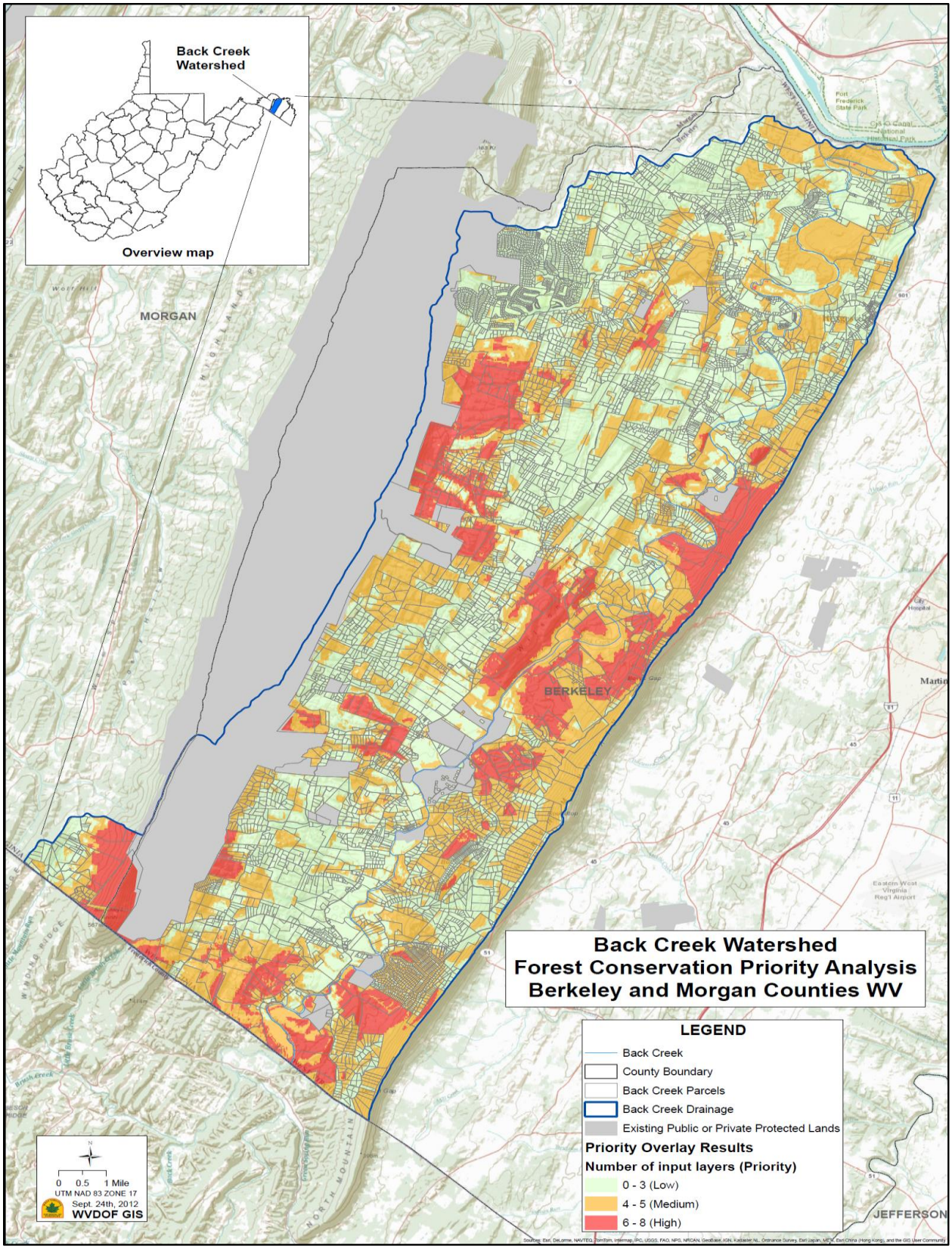
Back Creek Watershed
Overview map
MORGAN
BERKELEY
Back Creek Watershed
Forest Conservation Priority Analysis
Berkeley and Morgan Counties WV
LEGEND
Back Creek
County Boundary
Back Creek Parcels
Back Creek Drainage
Existing Public or Private Protected Lands
Priority Overlay Results
Number of input layers (Priority)
0 - 3 (Low)
4 - 5 (Medium)
6 - 8 (High)
0 0.5 1 Mile
UTM NAD 83 ZONE 17
Sept. 24th, 2012
WVDOF GIS
JEFFERSON

Figure 5.

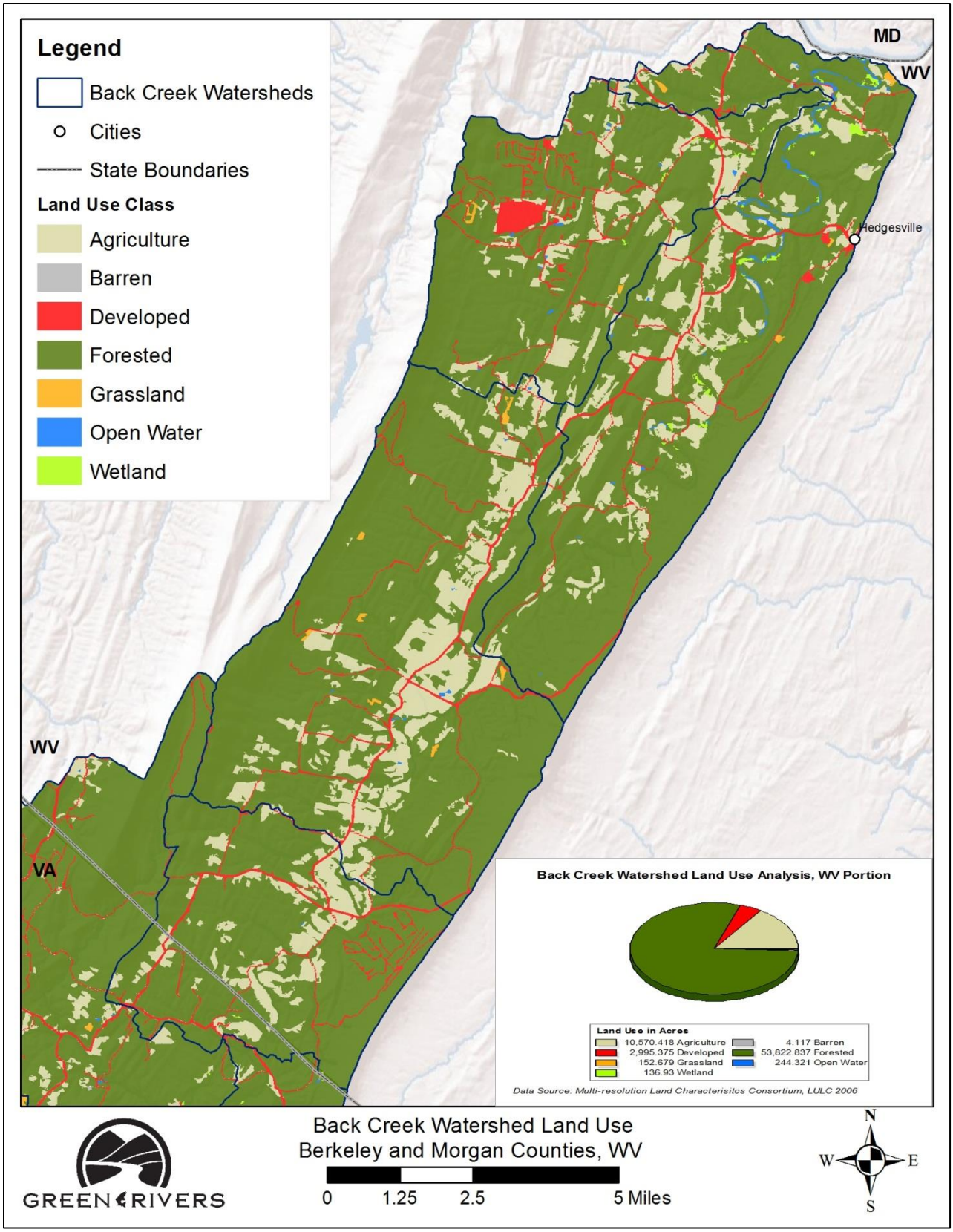
Legend
Back Creek Watersheds
Cities
State Boundaries
Land Use Class
Agriculture
Barren
Developed
Forested
Grassland
Open Water
Wetland
MD
WV
Hedgesville
WV
VA
Back Creek Watershed Land Use Analysis, WV Portion
Land Use in Acres
10,570.418 Agriculture
4.117 Barren
2,995.375 Developed
53,822.837 Forested
152.679 Grassland
244.321 Open Water
136.93 Wetland
Data Source: Multi-resolution Land Characterisitcs Consortium, LULC 2006
GREEN RIVERS
Back Creek Watershed Land Use
Berkeley and Morgan Counties, WV
0
1.25
2.5
5 Miles
N
W
E
S

Figure 6.

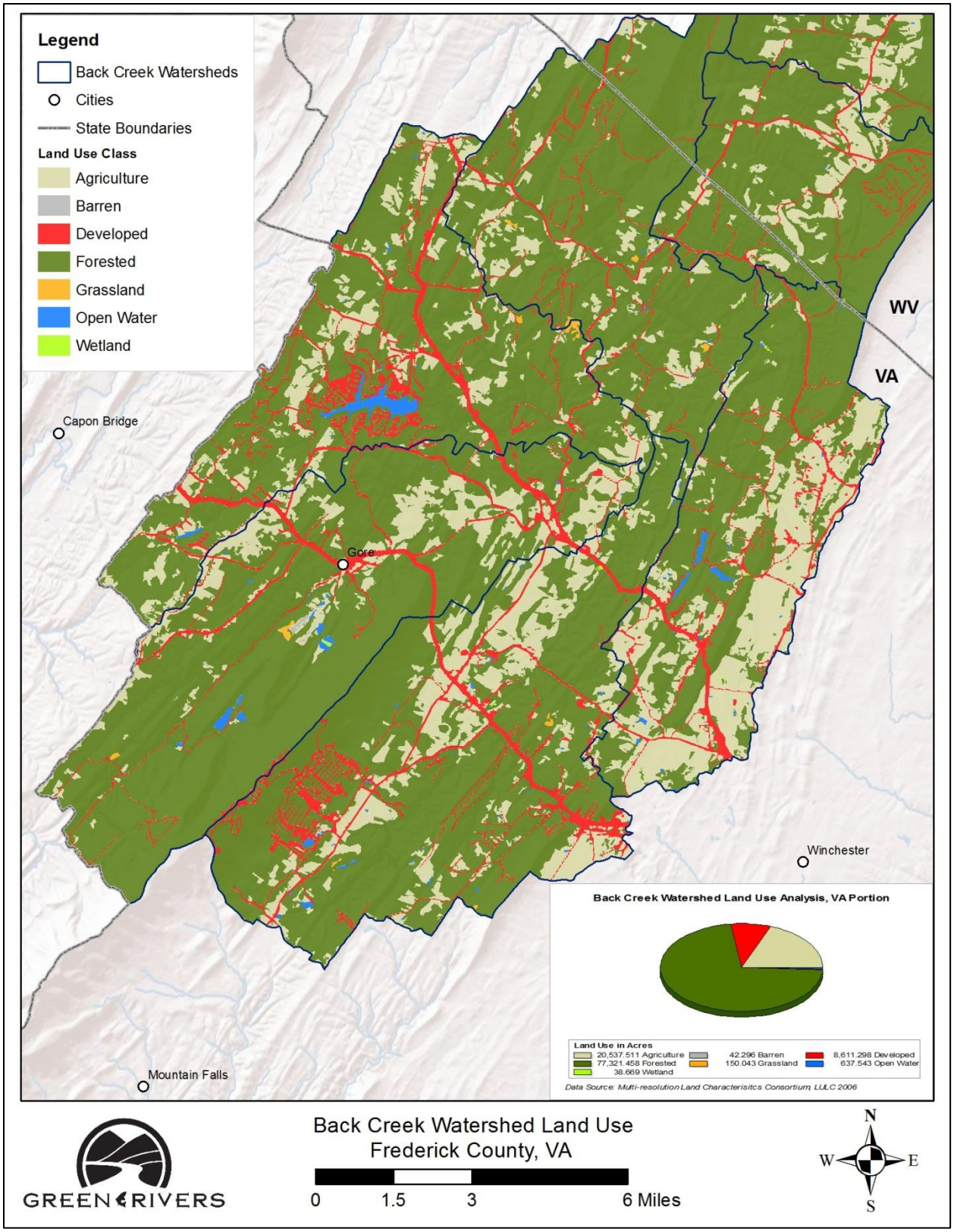
Legend
Back Creek Watersheds
Cities
State Boundaries
Land Use Class
Agriculture
Barren
Developed
Forested
Grassland
Open Water
Wetland
WV
VA
Capon Bridge
Gore
Winchester
Mountain Falls
Back Creek Watershed Land Use Analysis, VA Portion
Land Use in Acres
20,537.511 Agriculture
42.296 Barren
8,611.298 Developed
77,321.458 Forested
150.043 Grassland
637.543 Open Water
38.669 Wetland
Data Source: Multi-resolution Land Characterisitcs Consortium, LULC 2006
GREEN RIVERS
Back Creek Watershed Land Use
Frederick County, VA
0
1.5
3
6 Miles
N
W
E
S

Figure 7.

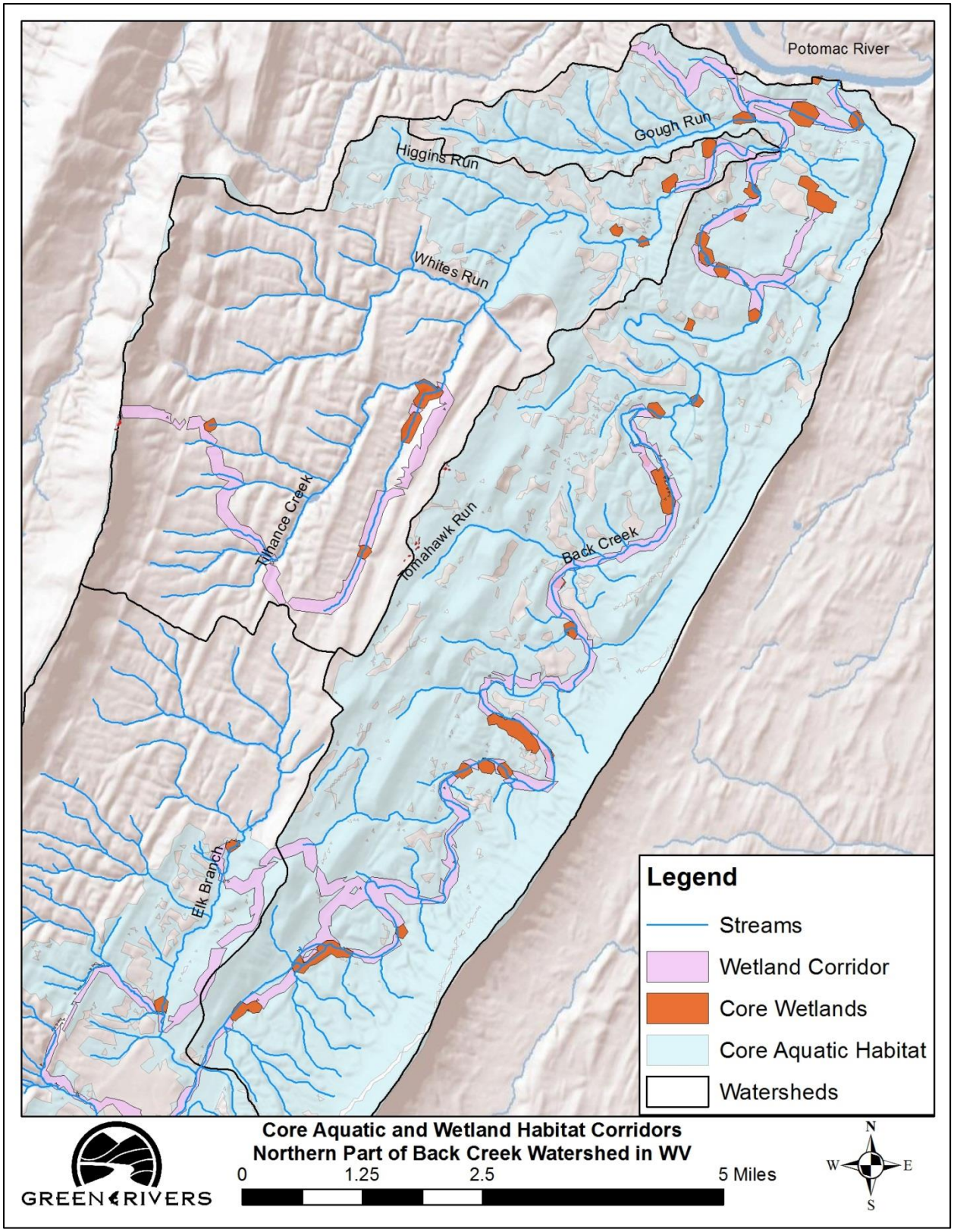
Potomac River
Gough Run
Higgins Run
Whites Run
Tilhance Creek
Tomahawk Run
Back Creek
Elk Branch
Legend
Streams
Wetland Corridor
Core Wetlands
Core Aquatic Habitat
Watersheds
Core Aquatic and Wetland Habitat Corridors
Northern Part of Back Creek Watershed in WV
0
1.25
2.5
5 Miles
N
W
E
S
GREEN RIVERS

Figure 8.

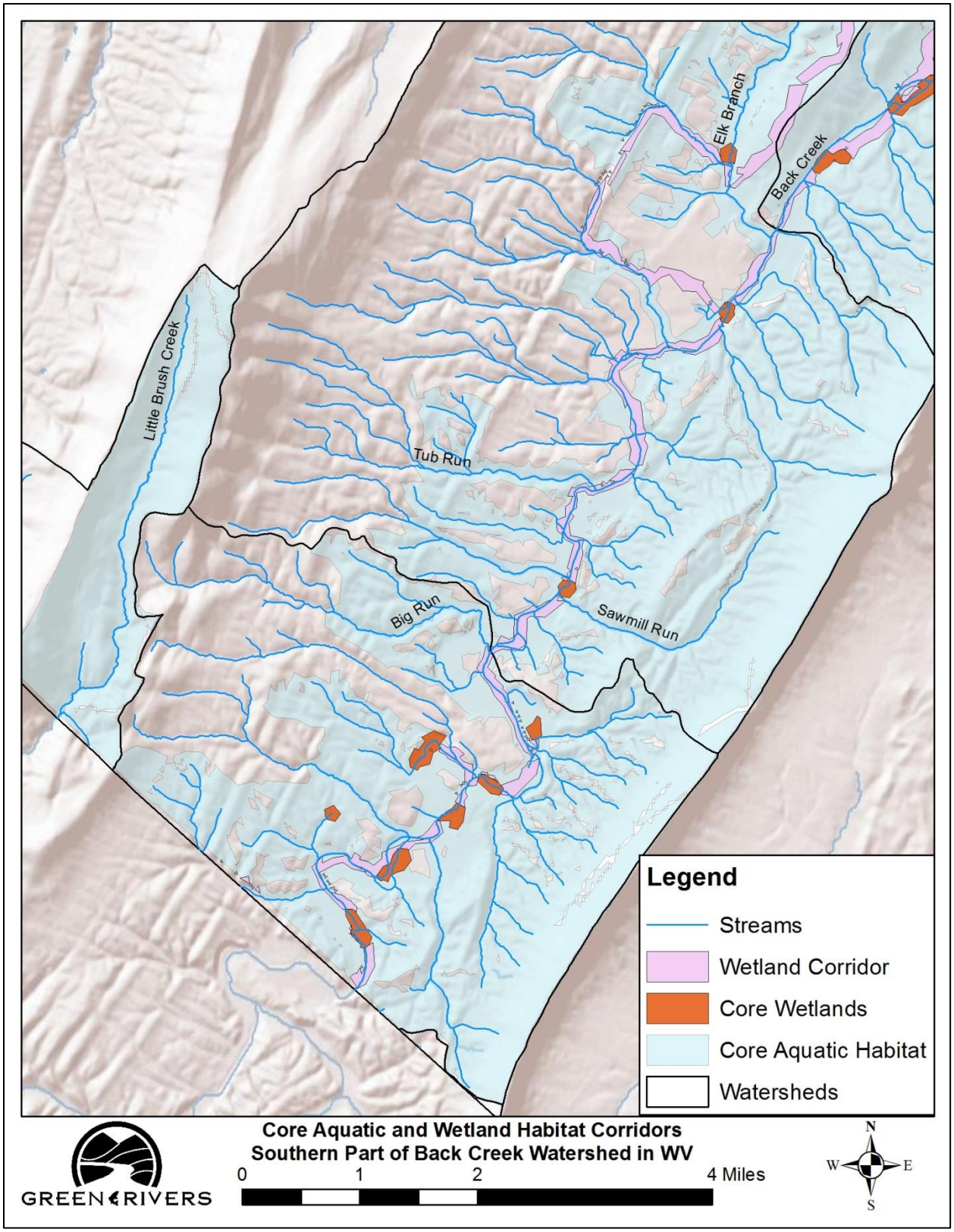
Little Brush Creek
Tub Run
Big Run
Sawmill Run
Elk Branch
Back Creek
Legend
Streams
Wetland Corridor
Core Wetlands
Core Aquatic Habitat
Watersheds
Core Aquatic and Wetland Habitat Corridors
Southern Part of Back Creek Watershed in WV
0
1
2
4 Miles
N
W
E
S
GREEN RIVERS

Figure 9.

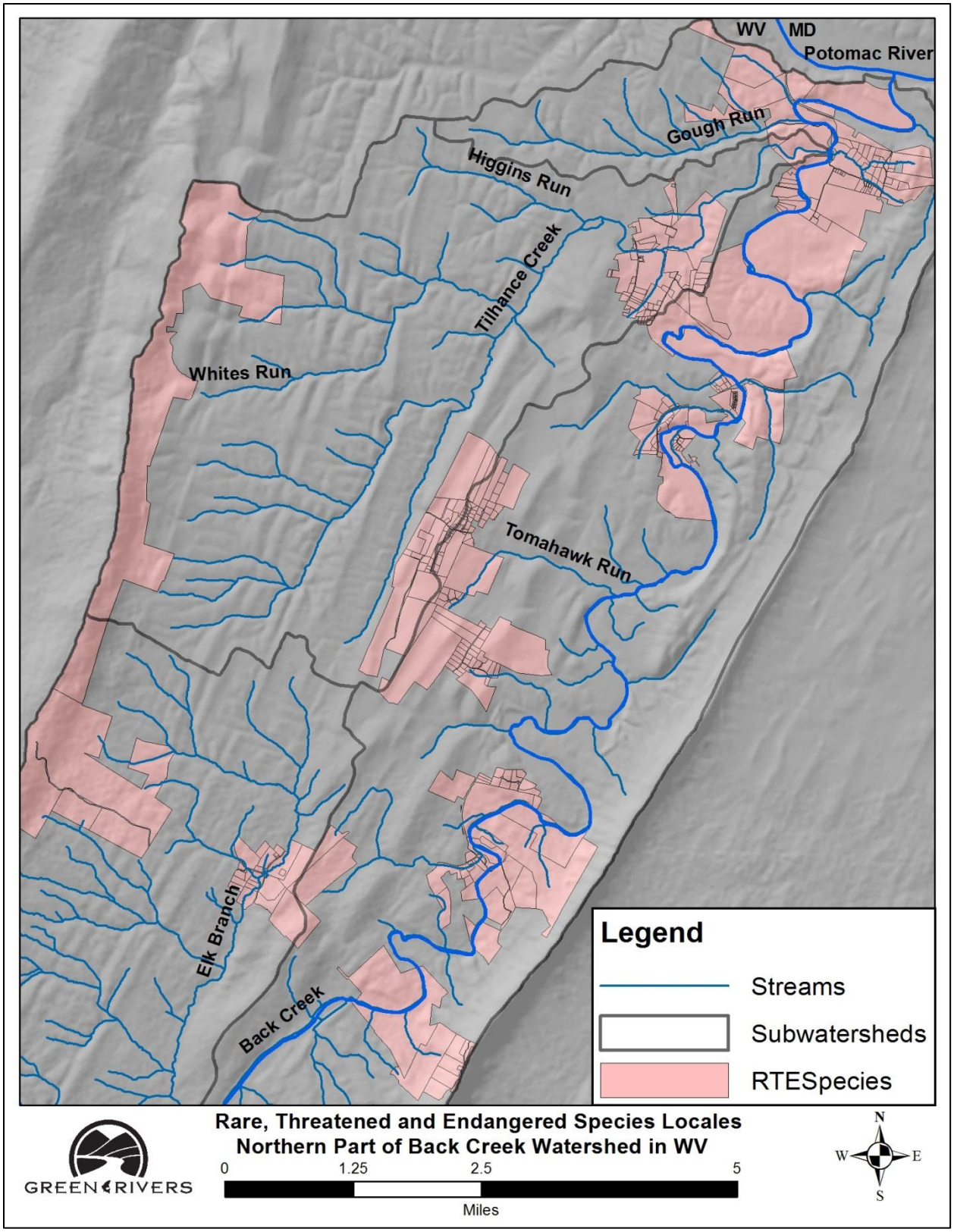
WV
MD
Potomac River
Gough Run
Higgins Run
Tilhance Creek
Whites Run
Tomahawk Run
Elk Branch
Back Creek
Legend
Streams
Subwatersheds
RTESpecies
Rare, Threatened and Endangered Species Locales
Northern Part of Back Creek Watershed in WV
0
1.25
2.5
5
Miles
N
W
E
S
GREEN RIVERS

Figure 10.

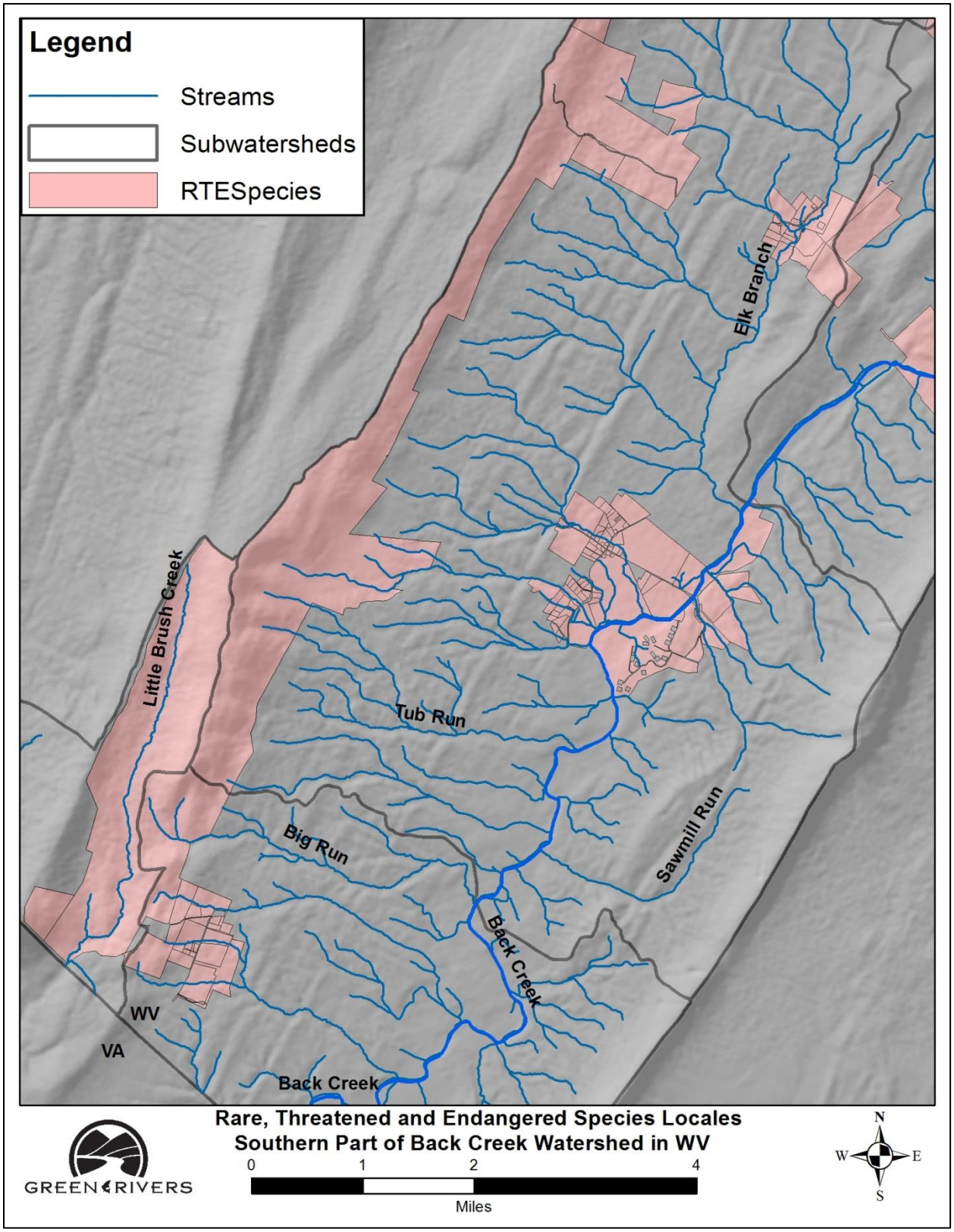
Legend
Streams
Subwatersheds
RTESpecies
Elk Branch
Little Brush Creek
Tub Run
Big Run
Sawmill Run
Back Creek
WV
VA
Back Creek
Rare, Threatened and Endangered Species Locales
Southern Part of Back Creek Watershed in WV
0
1
2
4
Miles
N
W
E
S
GREEN RIVERS

Figure 11.

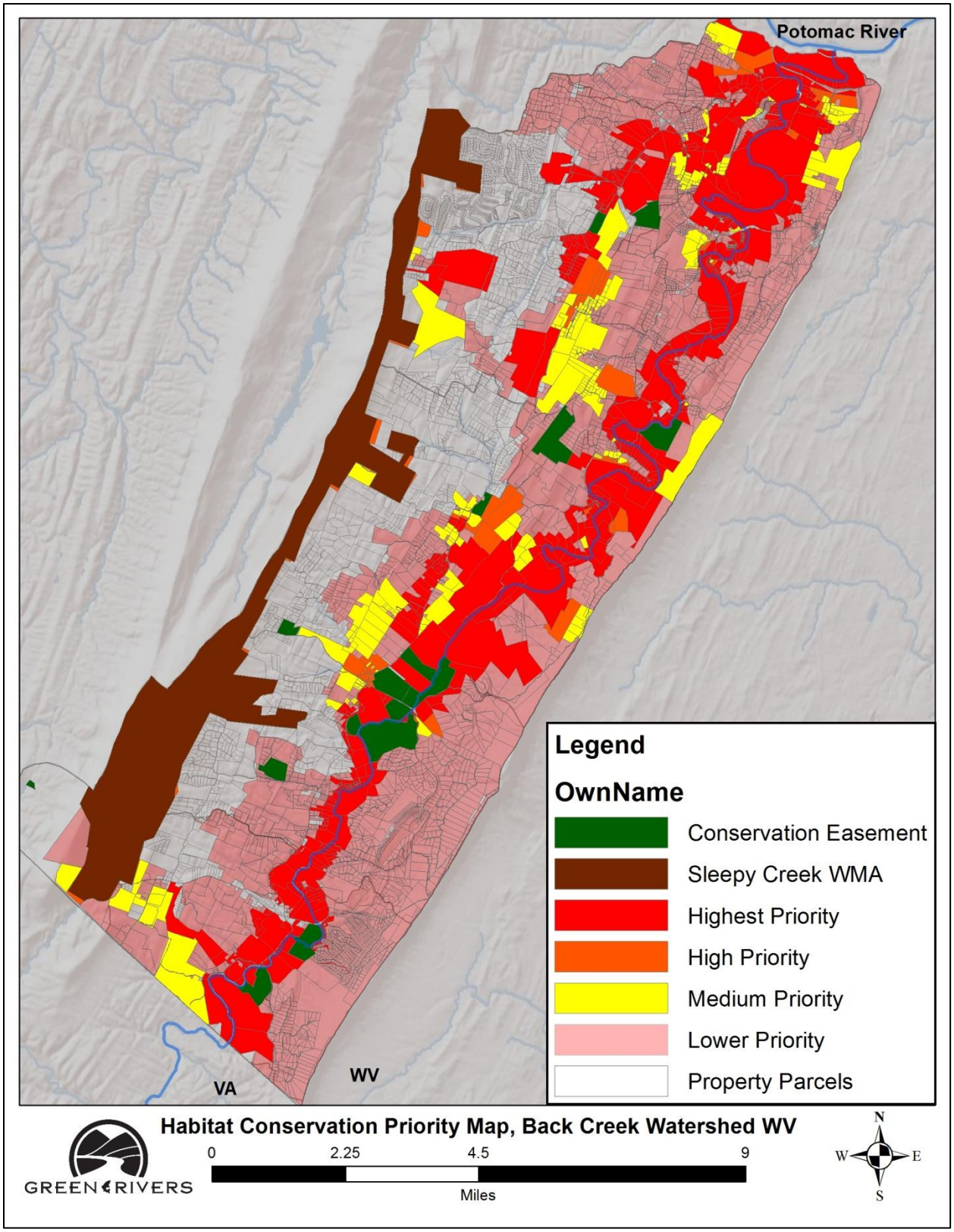
Potomac River
Legend
OwnName
Conservation Easement
Sleepy Creek WMA
Highest Priority
High Priority
Medium Priority
Lower Priority
Property Parcels
VA
WV
Habitat Conservation Priority Map, Back Creek Watershed WV
0
2.25
4.5
9
Miles
N
W
E
S
GREEN RIVERS

Figure 12.

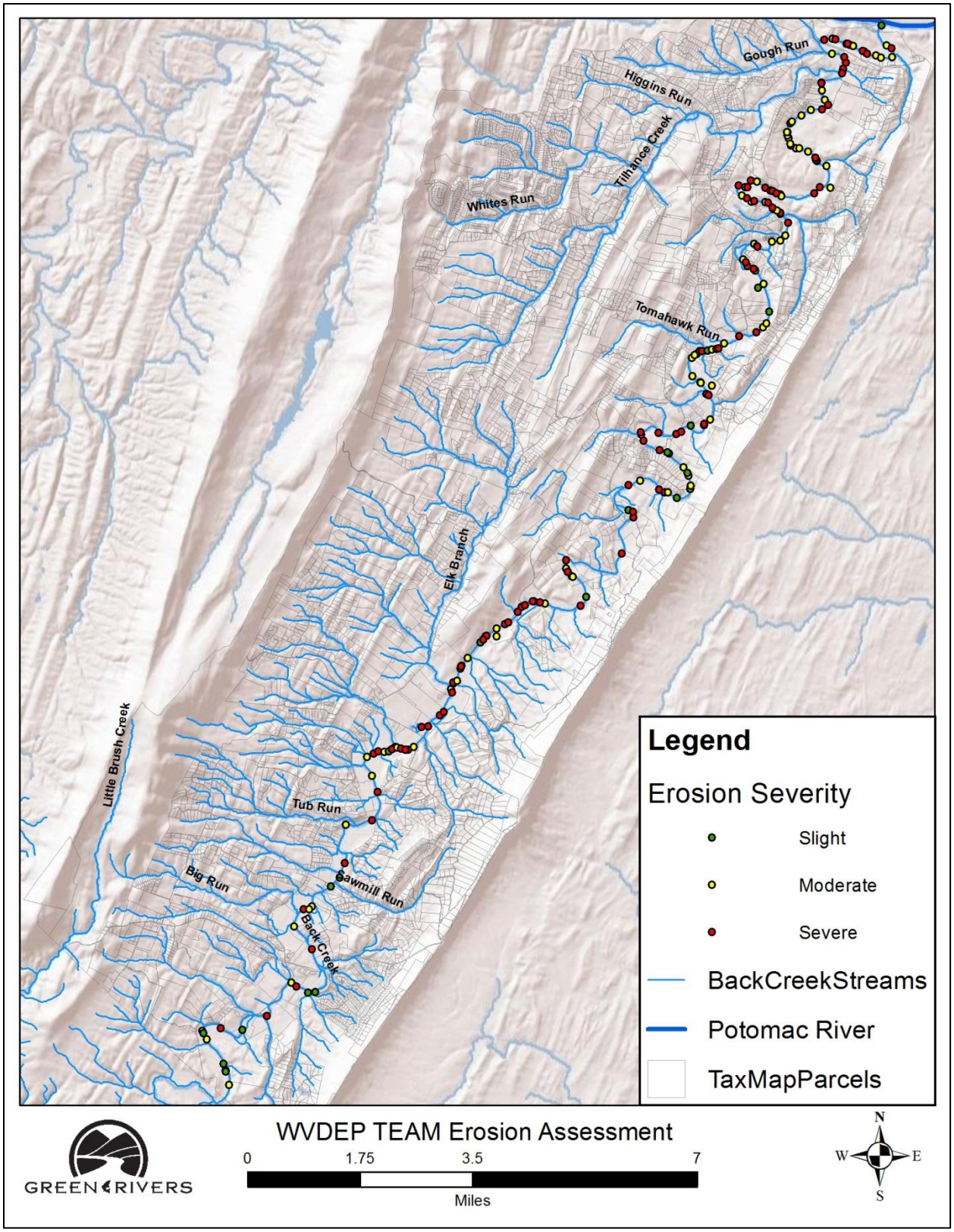
Gough Run
Higgins Run
Tilhance Creek
Whites Run
Tomahawk Run
Elk Branch
Little Brush Creek
Tub Run
Big Run
Sawmill Run
Back Creek
Legend
Erosion Severity
Slight
Moderate
Severe
BackCreekStreams
Potomac River
TaxMapParcels
WVDEP TEAM Erosion Assessment
0
1.75
3.5
7
Miles
N
W
E
S
GREEN RIVERS

Figure 13.

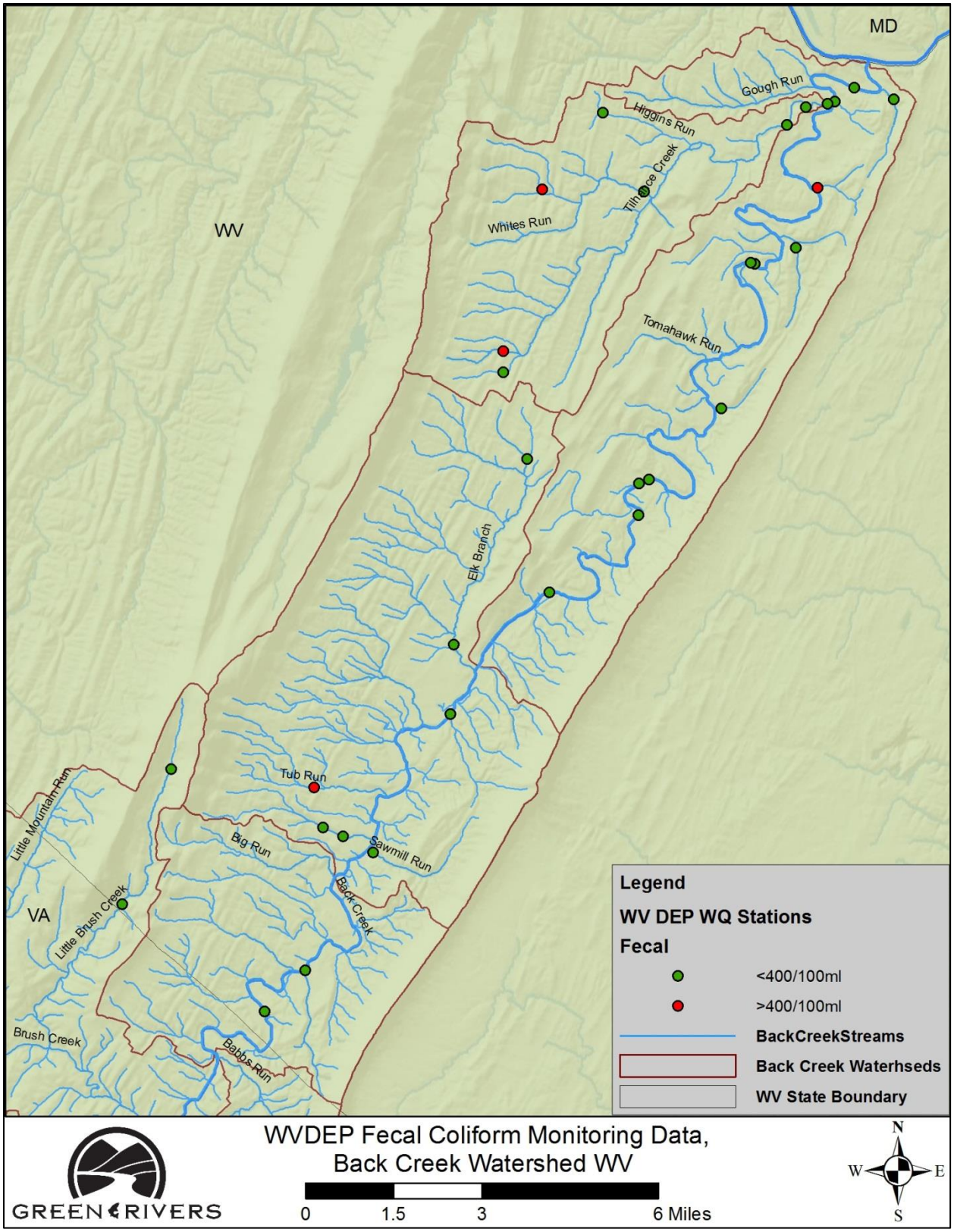
MD
WV
VA
Gough Run
Higgins Run
Tilhance Creek
Whites Run
Tomahawk Run
Elk Branch
Tub Run
Big Run
Sawmill Run
Back Creek
Little Mountain Run
Little Brush Creek
Brush Creek
Babbs Run
Legend
WV DEP WQ Stations
Fecal
<400/100ml
>400/100ml
BackCreekStreams
Back Creek Waterhseds
WV State Boundary
WVDEP Fecal Coliform Monitoring Data,
Back Creek Watershed WV
GREEN RIVERS
0
1.5
3
6 Miles
N
W
E
S

Figure 14.

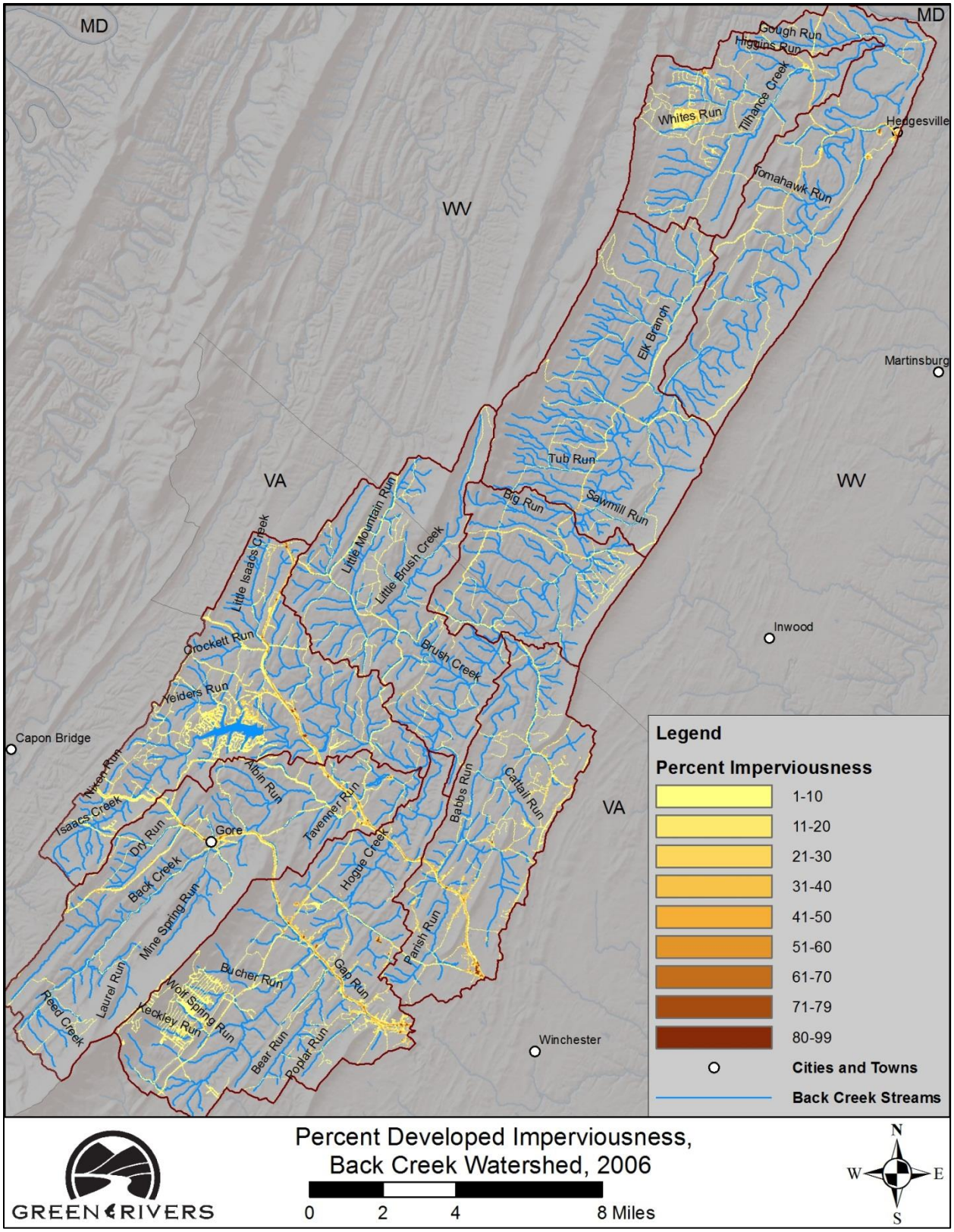
MD
MD
WV
VA
WV
VA
Gough Run
Higgins Run
Whites Run
Tilhance Creek
Hedgesville
Tomahawk Run
Elk Branch
Martinsburg
Tub Run
Big Run
Sawmill Run
Little Mountain Run
Little Brush Creek
Little Isaacs Creek
Brush Creek
Inwood
Crockett Run
Yeiders Run
Capon Bridge
Nixon Run
Isaacs Creek
Dry Run
Gore
Albin Run
Tavenner Run
Hogue Creek
Babbs Run
Catlail Run
Back Creek
Mine Spring Run
Parish Run
Laurel Run
Bucher Run
Gap Run
Wolf Spring Run
Reed Creek
Keckley Run
Bear Run
Poplar Run
Winchester
Legend
Percent Imperviousness
1-10
11-20
21-30
31-40
41-50
51-60
61-70
71-79
80-99
Cities and Towns
Back Creek Streams
GREEN RIVERS
Percent Developed Imperviousness,
Back Creek Watershed, 2006
0
2
4
8 Miles
N
W
E
S

Figure 15.

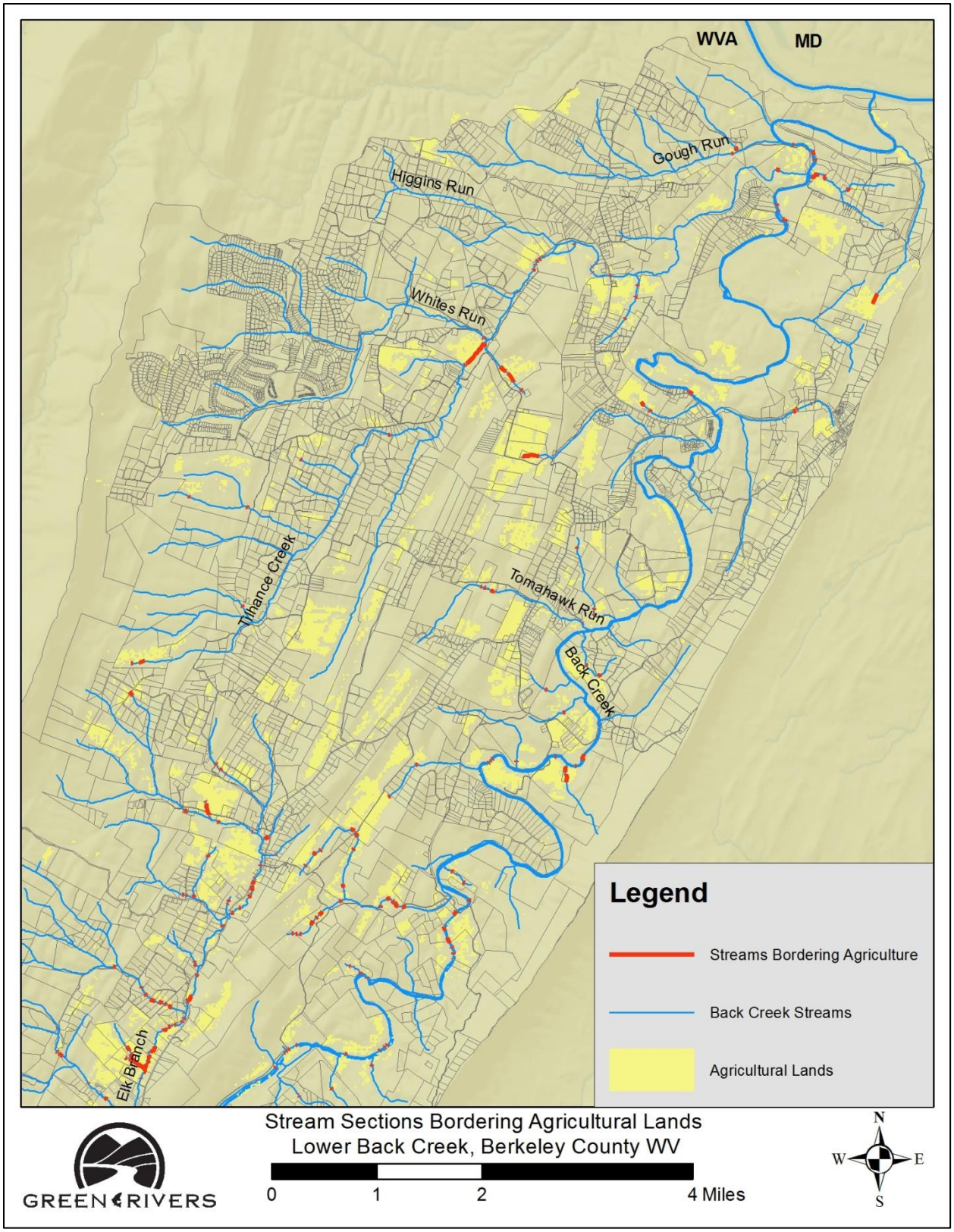
WVA
MD
Gough Run
Higgins Run
Whites Run
Tilhance Creek
Tomahawk Run
Back Creek
Elk Branch
Legend
Streams Bordering Agriculture
Back Creek Streams
Agricultural Lands
Stream Sections Bordering Agricultural Lands
Lower Back Creek, Berkeley County WV
0
1
2
4 Miles
N
W
E
S
GREEN RIVERS

Figure 16.

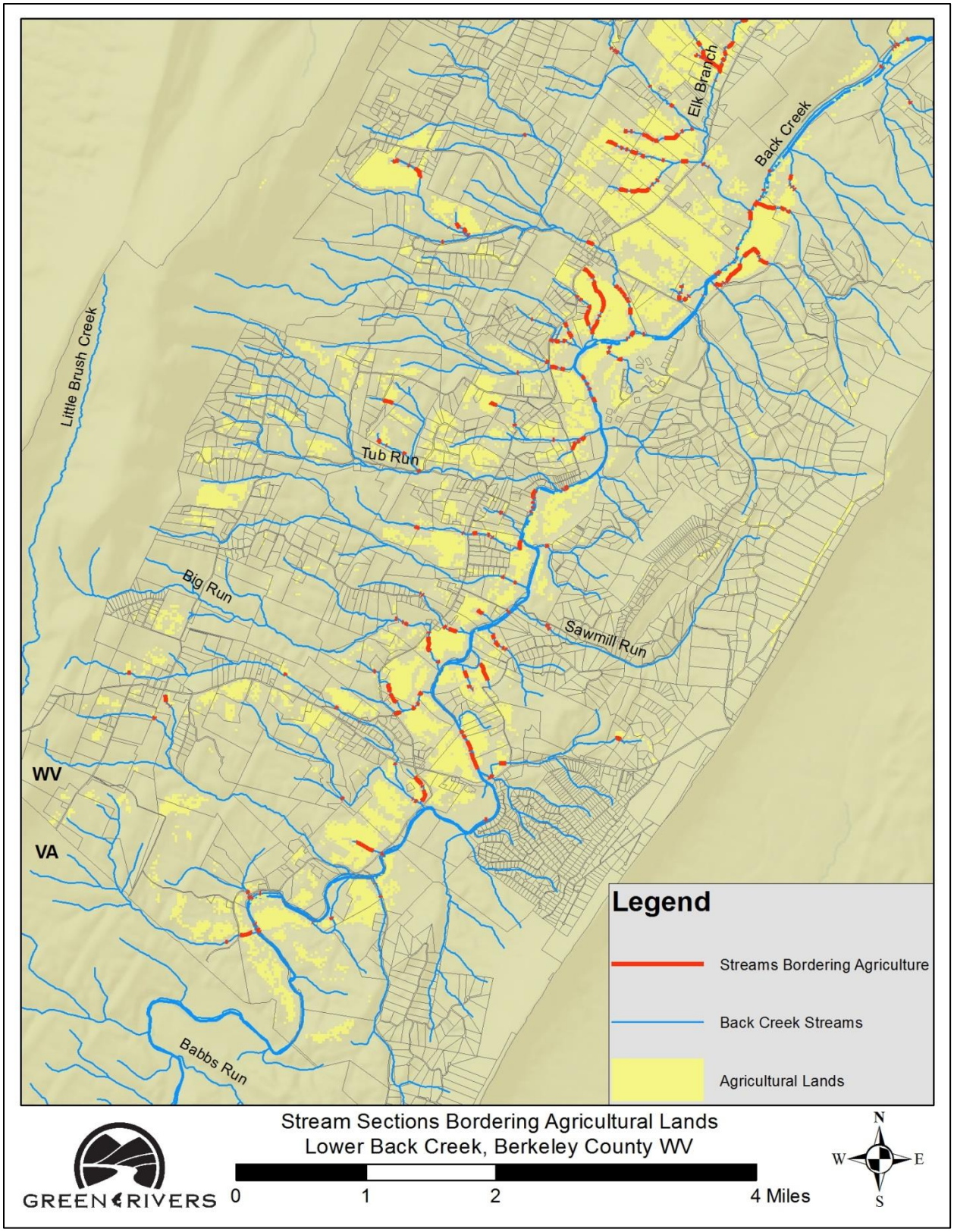
Elk Branch
Back Creek
Little Brush Creek
Tub Run
Big Run
Sawmill Run
WV
VA
Babbs Run
Legend
Streams Bordering Agriculture
Back Creek Streams
Agricultural Lands
Stream Sections Bordering Agricultural Lands
Lower Back Creek, Berkeley County WV
GREEN RIVERS
0
1
2
4 Miles
N
W
E
S

Figure 17.

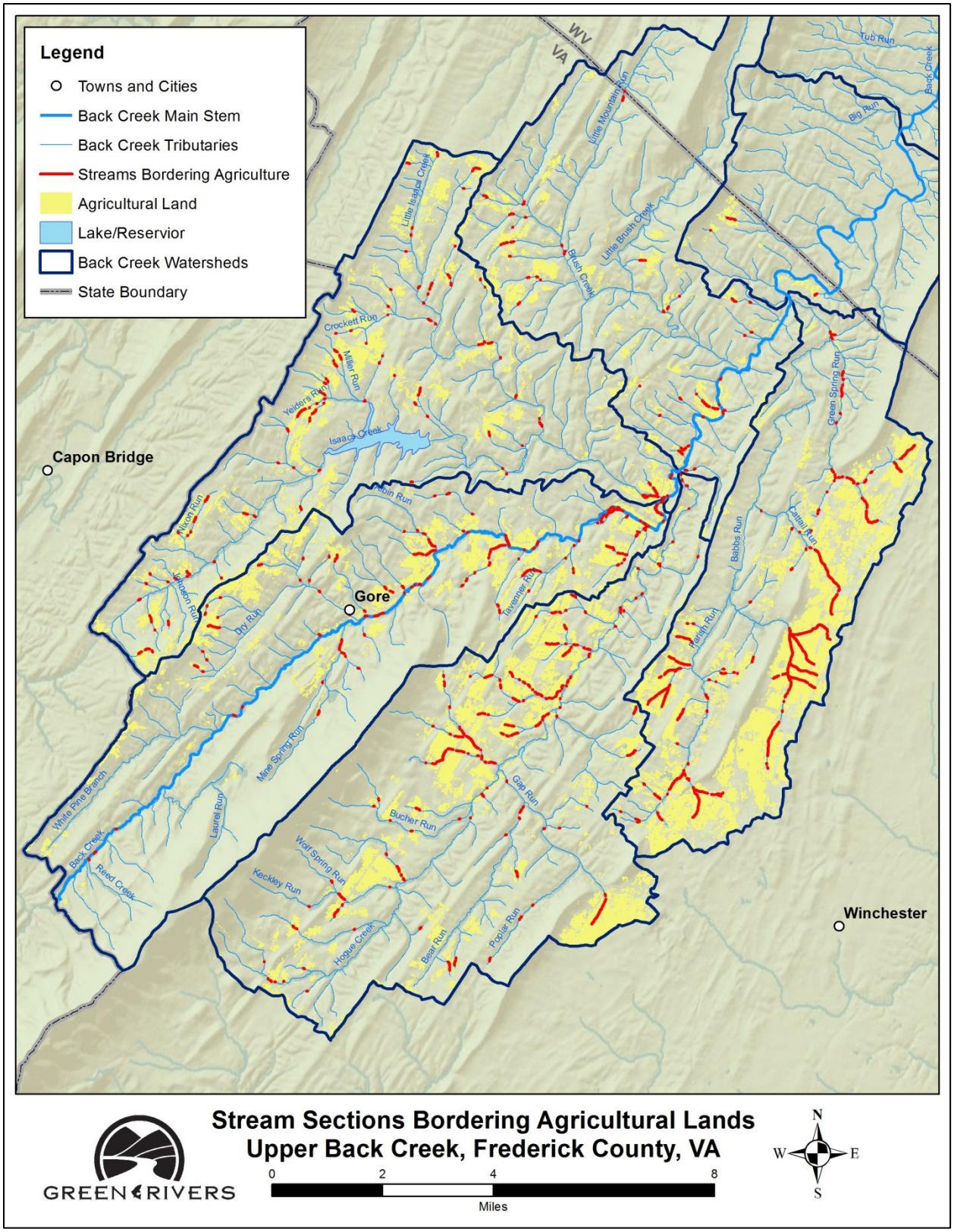
Legend
Towns and Cities
Back Creek Main Stem
Back Creek Tributaries
Streams Bordering Agriculture
Agricultural Land
Lake/Reservior
Back Creek Watersheds
State Boundary
WV
VA
Capon Bridge
Gore
Winchester
Crockett Run
Miller Run
Yeiders Run
Isaacs Creek
Little Isaacs Creek
Little Mountain Run
Tub Run
Back Creek
Big Run
Little Brush Creek
Brush Creek
Green Spring Run
Babbs Run
Canal Run
Parish Run
Tavenner Run
Robin Run
Alkon Run
Johnson Run
Dry Run
Mine Spring Run
White Pine Branch
Back Creek
Reed Creek
Laurel Run
Bucher Run
Gap Run
Wolf Spring Run
Keckley Run
Hogue Creek
Bear Run
Poplar Run
Stream Sections Bordering Agricultural Lands
Upper Back Creek, Frederick County, VA
GREEN RIVERS
0
2
4
8
Miles
N
W
E
S

Figure 18.

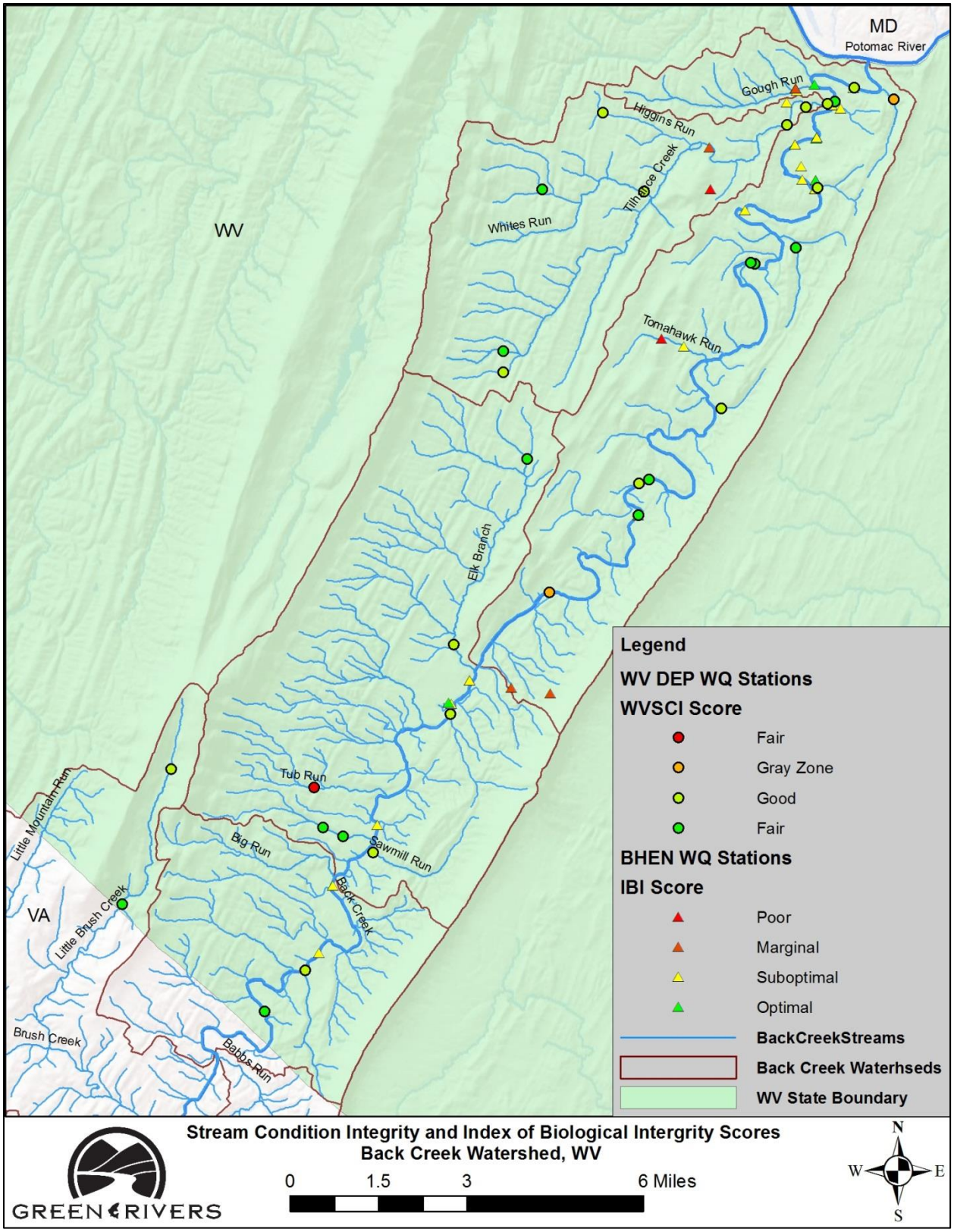
MD
Potomac River
WV
VA
Gough Run
Higgins Run
Tilhance Creek
Whites Run
Tomahawk Run
Elk Branch
Tub Run
Big Run
Sawmill Run
Back Creek
Little Mountain Run
Little Brush Creek
Brush Creek
Babbs Run
Legend
WV DEP WQ Stations
WVSCI Score
Fair
Gray Zone
Good
Fair
BHEN WQ Stations
IBI Score
Poor
Marginal
Suboptimal
Optimal
BackCreekStreams
Back Creek Waterhseds
WV State Boundary
Stream Condition Integrity and Index of Biological Intergrity Scores
Back Creek Watershed, WV
0
1.5
3
6 Miles
N
W
E
S
GREEN RIVERS

Figure 19.

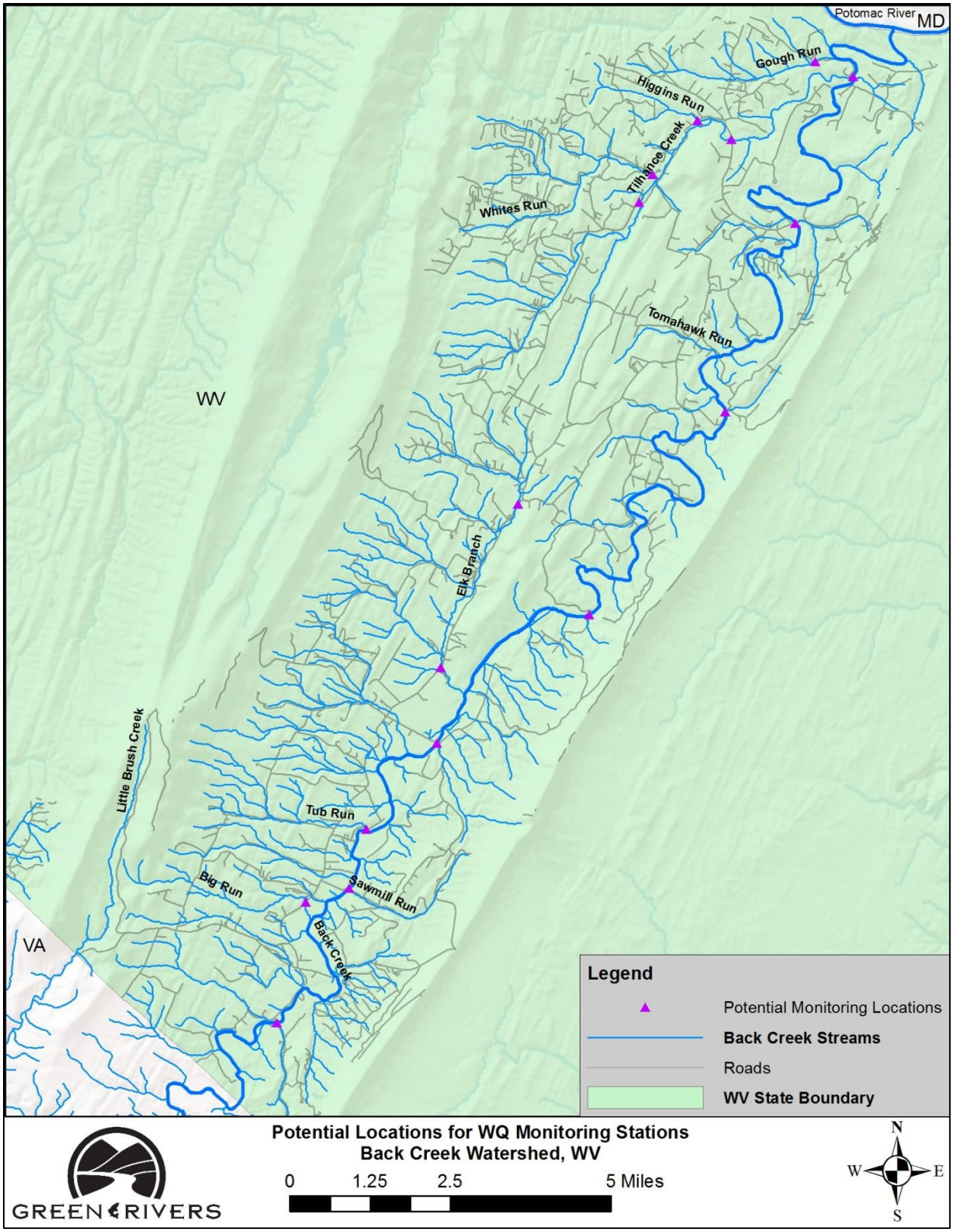
Potomac River
MD
Gough Run
Higgins Run
Tillance Creek
Whites Run
Tomahawk Run
WV
Elk Branch
Little Brush Creek
Tub Run
Big Run
Sawmill Run
Back Creek
VA
Legend
Potential Monitoring Locations
Back Creek Streams
Roads
WV State Boundary
Potential Locations for WQ Monitoring Stations
Back Creek Watershed, WV
0
1.25
2.5
5 Miles
GREEN RIVERS
N
W
E
S

Figure 20.

TABLES

Station ID	Site Description	Lab Number	Date	pH (Field)	Temperature (C) (Field)	Conductivity (µS/cm) (Field)	Dissolved Oxygen (mg/L) (Field)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia-N (mg/L)	Total Phosphorous (mg/L)	Total Suspended Solids (mg/L)
OR12	Back Creek@Low Water Bridge		1/30/2002	8.00	7.8	260.0	12.48	0.200		0.174	0.0081	
OR12	Back Creek@Low Water Bridge		2/5/2002	8.20	1.7	282.0	14.80	1.700		0.136	0.0081	
OR12	Back Creek@Low Water Bridge		2/28/2002	8.10	3.8	292.0	14.34	0.050		0.194	0.0081	
OR12	Back Creek@Low Water Bridge		3/19/2002	7.90	9.6	262.0	11.71	0.050		0.149	0.0291	
OR12	Back Creek@Low Water Bridge		3/26/2002	7.80	7.8	187.9	12.15	0.600		0.165	0.0081	
OR12	Back Creek@Low Water Bridge		4/9/2002	7.70	13.4	177.2	10.60	0.050		0.126	0.0065	
OR12	Back Creek@Low Water Bridge		5/21/2002	8.00	13.4	151.7	10.86	0.200		0.089	0.0030	
OR12	Back Creek@Low Water Bridge		5/29/2002	7.80	21.1	205.0	8.86	0.100		0.074	0.0030	
OR12	Back Creek@Low Water Bridge		6/4/2002	7.70	23.7	202.0	9.08	0.100		0.066	0.0030	
OR12	Back Creek@Low Water Bridge		7/9/2002	8.00	27.6	230.0	8.02	0.050		0.128	0.0065	
OR12	Back Creek@Low Water Bridge		8/6/2002	7.70	26.1	226.0	7.30			0.066	0.0129	
OR12	Back Creek@Low Water Bridge		8/22/2002	7.90	26.9	246.0	7.35			0.062	0.0065	
OR12	Back Creek@Low Water Bridge		9/12/2002	8.10	21.3	280.0	8.39			0.099	0.0033	
OR12	Back Creek@Low Water Bridge		9/24/2002	7.90	13.9	271.0	10.17	0.100		0.095	0.0033	
OR12	Back Creek@Low Water Bridge		10/10/2002		14.3			1.800		0.078	0.0065	
OR12	Back Creek@Low Water Bridge		10/24/2002	8.00	10.3	211.0	12.31	0.400		0.059	0.0065	
OR12	Back Creek@Low Water Bridge		11/7/2002	7.90	7.7	154.0	17.89	0.600		0.101	0.0065	
OR12	Back Creek@Low Water Bridge		11/21/2002	8.20	8.3	118.5	13.26	0.500		0.200	0.0065	
OR12	Back Creek@Low Water Bridge		12/10/2002	8.00	0.3	192.3	17.84	0.500		0.048	0.0065	
OR12	Back Creek@Low Water Bridge		1/22/2003	8.40	0.2	177.5	13.74	0.700		0.161	0.0065	
OR12	Back Creek@Low Water Bridge		1/29/2003	8.10	1.3	184.6		3.000		0.094	0.0065	
OR12	Back Creek@Low Water Bridge	042403OR12	4/24/2003	8.30	11.1	100.7		0.200	0.0082	0.066	0.0130	2.00
OR12	Back Creek@Low Water Bridge	042903OR12	4/29/2003	7.60	17.0	521.0		4.600	0.0041	0.060	0.0162	1.20
OR12	Back Creek@Low Water Bridge	052003OR12	5/20/2003	8.10	14.2	552.0		0.300	0.0074	0.079	0.0097	3.00
OR12	Back Creek@Low Water Bridge	052103OR12	5/20/2003	8.30	14.5	557.0		0.200	0.0079	0.065	0.0162	7.00
OR12	Back Creek@Low Water Bridge	062403OR12	6/24/2003	8.20	21.2	108.0	11.60	0.200	0.0051	0.065	0.0030	7.00
OR12	Back Creek@Low Water Bridge	073003OR10	7/30/2003	8.10	25.7	223.0	9.73	0.200	0.0038	0.047	0.0038	3.00
OR12	Back Creek@Low Water Bridge	082703OR10	8/27/2003	7.90	21.1	74.2		0.700	0.0073	0.138	0.0195	17.50
OR12	Back Creek@Low Water Bridge	092503OR10	9/25/2003	8.00	15.5	75.6		0.300	0.0007	0.006	0.0065	1.20
OR12	Back Creek@Low Water Bridge	102703OR10	10/27/2003	7.90	12.2	149.1		0.050	0.0213	0.645	0.0130	16.20
OR12	Back Creek@Low Water Bridge	112003OR10	11/20/2003	8.30	10.9	250.0		0.374		0.551	0.0130	
OR12	Back Creek@Low Water Bridge	122903OR10	12/29/2003	8.50	3.0	127.9		0.512	0.0002	0.047	0.0097	3.10
OR12	Back Creek@Low Water Bridge	012304OR10	1/23/2004	7.45	0.6	219.0	16.37	0.600	0.0002	0.030	0.0260	1.20
OR12	Back Creek@Low Water Bridge	022604OR10	2/26/2004	7.20	3.7	115.2	14.80	0.540	0.0002	0.081	0.0230	4.00
OR12	Back Creek@Low Water Bridge	031504OR10	3/15/2004	7.50	8.1	145.2	14.20	0.380	0.0006	0.046	0.0060	1.50
OR12	Back Creek@Low Water Bridge	041904OR10	4/19/2004	7.80	17.9	133.0	10.15	0.420	0.0006	0.092	0.0060	6.00
OR12	Back Creek@Low Water Bridge	052404OR10	5/24/2004	8.00	22.9	152.5	7.90	0.290	0.0006	0.093	0.0390	3.00
OR12	Back Creek@Low Water Bridge	061404OR10	6/14/2004	8.00	21.6	165.4	7.68	0.310	0.0033	0.186	0.0420	11.00
OR12	Back Creek@Low Water Bridge	071204OR10	7/12/2004	7.80	26.2	230.0	7.92	0.160	0.0063	0.151	0.0420	28.00
OR12	Back Creek@Low Water Bridge	080904OR10	8/9/2004	8.00	22.5	288.0	8.54	0.005	0.0006	0.067	0.0650	2.50
OR12	Back Creek@Low Water Bridge	092804OR10	9/28/2004	5.90	18.7	50.3	8.10	0.270		0.805	0.0850	112.50
OR12	Back Creek@Low Water Bridge	102704OR10	10/27/2004	8.10	12.4	206.0		0.250	.0006	0.025	0.0200	

Table 1. West Virginia Department of Agriculture Back Creek Water Quality Data

Survey Code	Basin	Stream	Date	Latitude	Longitude	Level	pH	Cond.	RBP	IBI	IBI Rating
WVPDBAC-04021999	Potomac Direct	Back Creek	1999/04/02	39.58916667	78.0025	1			82.5	70.0	Suboptimal
WVPDBAC-04101999	Potomac Direct	Back Creek	1999/04/10	39.59	78.0025	1			82.5	70.0	Suboptimal
WVPDBAC-05062001	Potomac Direct	Back Creek	2001/05/06	39.57055556	78.00694444	1			77.5	70.0	Suboptimal
WVPDBAC-05122001	Potomac Direct	Back Creek	2001/05/12	39.58111111	78.00694444	1			71.3	70.0	Suboptimal
WVPDBAC-05182000a	Potomac Direct	Back Creek	2000/05/18	39.59416667	78.00833333	1			71.3	82.0	Optimal
WVPDBAC-05182000b	Potomac Direct	Back Creek	2000/05/18	39.58111111	78.00694444	1			72.5	70.0	Suboptimal
WVPDBAC-05231998	Potomac Direct	Back Creek	1998/05/23	39.57916667	78.01388889	1			87.5	82.0	Optimal
WVPDBAC-05301998	Potomac Direct	Back Creek	1998/05/30	39.57055556	78.01111111	1			95.0	70.0	Suboptimal
WVPDBAC-06022005	Potomac Direct	Back Creek	2005/06/02	39.59361111	77.99588889	2	8.0	222	75.0	77.8	Suboptimal
WVPDBAC-06151999	Potomac Direct	Back Creek	1999/06/15	39.44444444	78.11138889	1			82.5	70.0	Suboptimal
WVPDBAC-06172000	Potomac Direct	Back Creek	2000/06/17	39.58111111	78.00694444	1			82.5	70.0	Suboptimal
WVPDBAC-06172006	Potomac Direct	Back Creek	2006/06/17	39.58083333	78.00722222	1	8.0	234	67.5	82.0	Optimal
WVPDBAC-06232008	Potomac Direct	Back Creek	2008/06/23	39.48652778	78.05975	1	8.4	205	65.0	82.0	Optimal
WVPDBAC-06232009	Potomac Direct	Back Creek	2009/06/23	39.56277778	78.025	1			NA	NA	
WVPDBAC-07221998	Potomac Direct	Back Creek	1998/07/22	39.57916667	78.01388889	1			85.0	70.0	Suboptimal
WVPDBAC-07221998a	Potomac Direct	Back Creek	1998/07/22	39.58916667	78.0025	1			67.5	70.0	Suboptimal
WVPDBAC-07272005	Potomac Direct	Back Creek	2005/07/27	39.43861111	78.11694444	1	9.0		48.8	70.0	Suboptimal
WVPDBAC-07282001	Potomac Direct	Back Creek	2001/07/28	39.57055556	78.00694444	1			76.3	82.0	Optimal
WVPDBAC-08012002	Potomac Direct	Back Creek	2002/08/01	39.43888889	78.11777778	2	8.1	170	66.3	84.2	Optimal
WVPDBAC-08022004	Potomac Direct	Back Creek	2004/08/02	39.40816667	78.13902778	1	7.0		60.0	70.0	Suboptimal
WVPDBAC-08232000	Potomac Direct	Back Creek	2000/08/23	39.44444444	78.11138889	1			71.3	64.0	Suboptimal
WVPDBAC-08281999	Potomac Direct	Back Creek	1999/08/28	39.58111111	78.00694444	1			85.0	82.0	Optimal
WVPDBAC-09202001	Potomac Direct	Back Creek	2001/09/20	39.37611111	78.15611111	1			67.5	70.0	Suboptimal
WVPDBAC-09251998	Potomac Direct	Back Creek	1998/09/25	39.39277778	78.1525	1			87.5	64.0	Suboptimal
WVPDBAC-10012002	Potomac Direct	Back Creek	2002/10/01	39.57388889	78.01166667	3	7.8	280	73.0	69.4	Suboptimal
WVPDBAC-10142005	Potomac Direct	Back Creek	2005/10/14	39.56261111	78.02897222	1	9.4	260	66.0	64.0	Suboptimal
WVPDBAC-10241998	Potomac Direct	Back Creek	1998/10/24	39.58111111	78.00694444	1			87.5	76.0	Suboptimal
WVPDBAC-10241998a	Potomac Direct	Back Creek	1998/10/24	39.59	78.0025	1			85.0	76.0	Suboptimal
WVPDCOR-09302000	Potomac Direct	Couchman's Run	2000/09/30	39.44944444	77.92444444	1			75.0	50.0	Marginal
WVPDGOR-05011999	Potomac Direct	Goughs Run	1999/05/01	39.59305556	78.01416667	1			77.5	64.0	Suboptimal
WVPDGOR-05152000	Potomac Direct	Goughs Run	2000/05/15	39.59305556	78.01416667	1			70.0	50.0	Marginal
WVPDGOR-06031998	Potomac Direct	Goughs Run	1998/06/03	39.5925	78.01388889	1			87.5	64.0	Suboptimal
WVPDGOR-10262000	Potomac Direct	Goughs Run	2000/10/26	39.59305556	78.01416667	1			81.3	50.0	Marginal
WVPDHAR-07162002	Potomac Direct	Harpers Run	2003/07/16	39.53027778	78.05416667	3			71.0	24.4	Poor
WVPDHER-05182000	Potomac Direct	Hendricks Run	2000/05/18	39.44055556	77.80361111	1			70.0	56.0	Marginal
WVPDHER-05202002	Potomac Direct	Hendricks Run	2002/05/20	38.44611111	77.8125	1			76.3	50.0	Marginal
WVPDHER-05222001	Potomac Direct	Hendricks Run	2001/05/22	39.44055556	77.80361111	2			71.3	67.4	Suboptimal
WVPDHMR-03152004	Potomac Direct	Half Mile Run	2004/03/15	39.5885	77.99972222	1			70.0	79.1	Suboptimal
WVPDKAR-05052001	Potomac Direct	Kates Run	2001/05/05	39.56833333	78.00694444	1			77.5	64.0	Suboptimal
WVPDKAR-05152002	Potomac Direct	Kates Run	2002/05/15	39.56833333	78.00694444	1			85.0	64.0	Suboptimal
WVPDKAR-06292004	Potomac Direct	Kates Run	2004/06/29	39.56833333	78.00694444	3	9.0		82.5	67.9	Suboptimal
WVPDOSR-04142005	Potomac Direct	One Spring Run	2005/04/14	39.52855556	78.04697222	2	6.5		75.0	64.2	Suboptimal
WVPDTIB-10132000	Potomac Direct	Tilhance Creek	2000/10/13	39.5675	78.04027778	1			67.5	38.0	Poor
WVPDTIC-06032005	Potomac Direct	Tilhance Creek	2005/06/03	39.58944444	78.01694444	2	8.0	311	76.7	72.9	Suboptimal
WVPDTIC-07191999	Potomac Direct	Tilhance Creek	1999/07/19	39.57777778	78.04111111	1			85.0	56.0	Marginal
WVPDUNN-11052007	Potomac Direct	UNT Back Creek	2007/11/05	39.44208333	78.08563889	1	8.0	324	82.5	50.2	Marginal
WVPDBAC-11162006	Potomac Direct	UNT Back Creek	2006/11/16	39.44305556	78.09805556	1	7.6		77.5	49.0	Marginal

Table 2. BHEN SOS Volunteer Assessment Database Back Creek Water Quality Data

Sample ID	StationID	Name	ANCODE	Mile Pt.	Date	Ecoregion III	County	Topo	Lat (D)	Lat (M)	Lat (S)	Lon (D)	Lon (M)	Lon (S)	Lon (DD)	Lat (DD)
1478	5602	Back Creek	WVP-6	1.2	02-Jun-98	67 (Ridge and Valley)	Berkeley	Hedgesville	39	35	37.38	77	59	44.17	-77.9956028	39.5937167
17479	5603	Back Creek	WVP-6	2.7	03-Sep-03	67 (Ridge and Valley)	Berkeley	Big Pool	39	35	24.35	78	0	6.49	-78.0018028	39.5900972
1482	5604	Back Creek	WVP-6	9.1	02-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	32	58.12	78	1	31.48	-78.0254111	39.5494778
17480	5605	Back Creek	WVP-6	9.4	09-Sep-03	67 (Ridge and Valley)	Berkeley	Big Pool	39	32	59.45	78	1	36.2	-78.0267222	39.5498472
1479	5606	Back Creek	WVP-6	17.3	03-Jun-98	67 (Ridge and Valley)	Berkeley	Tablers Station	39	29	44.15	78	3	24.2	-78.0567222	39.4955972
17481	5607	Back Creek	WVP-6	17.7	09-Sep-03	67 (Ridge and Valley)	Berkeley	Tablers Station	39	29	40.34	78	3	35.79	-78.0599417	39.4945389
1480	5608	Back Creek	WVP-6	18.4	03-Jun-98	67 (Ridge and Valley)	Berkeley	Tablers Station	39	29	12.36	78	3	34.79	-78.0596639	39.4867667
10549	5611	Back Creek	WVP-6	22.3	30-May-02	67 (Ridge and Valley)	Berkeley	Tablers Station	39	28	1.08	78	5	13.9	-78.0871944	39.4669667
17482	5612	Back Creek	WVP-6	25.3	03-Sep-03	67 (Ridge and Valley)	Berkeley	Tablers Station	39	26	10.17	78	7	2.11	-78.1172528	39.4361583
17483	5614	Back Creek	WVP-6	32.7	03-Sep-03	67 (Ridge and Valley)	Berkeley	White Hall	39	22	18.44	78	9	37.49	-78.1604139	39.3717889
1481	5615	Back Creek	WVP-6	34.7	08-Jun-98	67 (Ridge and Valley)	Berkeley	White Hall	39	21	40.86	78	10	22.1	-78.1728056	39.36135
1483	5616	UNT/Back Creek RM 0.60	WVP-6-0.1A		02-Jun-98	67 (Ridge and Valley)	Berkeley	Hedgesville	39	35	28.52	77	58	58.81	-77.9830028	39.5912556
17484	5617	Tilhance Creek	WVP-6-A	0.1	03-Sep-03	67 (Ridge and Valley)	Berkeley	Big Pool	39	35	22.33	78	0	14.19	-78.0039417	39.5895361
1486	5618	Tilhance Creek	WVP-6-A	0.5	09-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	35	18.69	78	0	39.14	-78.0108722	39.588525
1487	5619	Tilhance Creek	WVP-6-A	1.3	09-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	35	2.53	78	0	59.98	-78.0166611	39.5840361
1488	5620	Tilhance Creek	WVP-6-A	9.4	09-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	31	33.19	78	6	15.71	-78.1043639	39.5258861
1484	5621	UNT/Back Creek RM 5.12	WVP-6-A.2		02-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	34	7.74	78	0	22.43	-78.0062306	39.5688167
10491	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	15-May-02	67 (Ridge and Valley)	Berkeley	Big Pool	39	33	13.96	78	0	45.01	-78.0125028	39.5538778
36367	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	22-May-07	67 (Ridge and Valley)	Berkeley	Big Pool	39	33	13.96	78	0	45.01	-78.0125028	39.5538778
1485	5623	UNT/Back Creek RM 13.11	WVP-6-A.5	0.2	03-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	30	49.09	78	2	4.32	-78.0345333	39.5136361
1489	5624	Higgins Run	WVP-6-A-1	1.6	02-Jun-98	67 (Ridge and Valley)	Berkeley	Big Pool	39	35	7.82	78	4	31.64	-78.0754556	39.5855056
17485	5625	Whites Run	WVP-6-A-2	0.2	03-Sep-03	67 (Ridge and Valley)	Berkeley	Big Pool	39	33	58.85	78	3	41.31	-78.061475	39.5663472
20598	5626	UNT/Whites Run RM 1.63	WVP-6-A-2-C	0.8	03-Jun-04	67 (Ridge and Valley)	Berkeley	Big Pool	39	33	57.95	78	5	37.8	-78.0938333	39.5660972
20678	5628	UNT/Tilhance Creek RM 9.12	WVP-6-A-6	0.5	09-Jun-04	67 (Ridge and Valley)	Berkeley	Big Pool	39	31	14.76	78	6	14.99	-78.1041639	39.5207667
17486	5629	Elk Branch	WVP-6-B	0.7	09-Sep-03	67 (Ridge and Valley)	Berkeley	Tablers Station	39	27	11.95	78	7	1.11	-78.116975	39.4533194
16845	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	09-Jun-03	67 (Ridge and Valley)	Berkeley	Tablers Station	39	29	58.77	78	5	43.99	-78.0955528	39.4996583
42892	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	20-May-08	67 (Ridge and Valley)	Berkeley	Tablers Station	39	29	58.77	78	5	43.99	-78.0955528	39.4996583
51276	11153	Tub Run	WVP-6-C	1.4	02-Jun-10	67 (Ridge and Valley)	Berkeley	Glengary	39	25	0.9	78	9	34.6	-78.1596111	39.4169167
1490	5633	UNT/Back Creek RM 27.95	WVP-6-C.8	0.6	03-Jun-98	67 (Ridge and Valley)	Berkeley	Glengary	39	24	18.54	78	8	59.58	-78.1498833	39.40515
20586	5634	UNT/Back Creek RM 27.95	WVP-6-C.8	1	03-Jun-04	67 (Ridge and Valley)	Berkeley	Glengary	39	24	25.66	78	9	22.81	-78.1563361	39.4071278
1492	5635	Sawmill Run	WVP-6-D		03-Jun-98	67 (Ridge and Valley)	Berkeley	Glengary	39	24	5.11	78	8	24.84	-78.1402333	39.4014194
1491	5635	Sawmill Run	WVP-6-D		03-Jun-98	67 (Ridge and Valley)	Berkeley	Glengary	39	24	5.11	78	8	24.84	-78.1402333	39.4014194
1493	5637	Little Brush Creek	WVP-6-G-1	3.5	02-Jun-98	67 (Ridge and Valley)	Berkeley	Glengary	39	23	11.36	78	13	9	-78.2191667	39.3864889
16949	5638	Little Brush Creek	WVP-6-G-1	6.4	02-Jul-03	67 (Ridge and Valley)	Berkeley	Glengary	39	25	12.64	78	12	18.92	-78.2052556	39.4201778

Table 3. West Virginia DEP Sampling Location Information

ANCODE	Mile Pt.	Date	Temp.	pH	DO	Cond.	Fecal	Acidity	Alkalinity	Hardness	Sulfate	Cl	TSS	P	NO2/NO3	TKN	Al	Ca	Cu	Fe	Mg	Mn	Se	Zn
WVP-6	32.7	03-Sep-03	22.1	7.9	10.7	313	310																	
WVP-6	34.7	08-Jun-98	19.2	8.2	8.8	251	13	1	121	128.59	10	5.23		0.02	0.338		0.05	40	0.01	0.106	6.79	0.015		
WVP-6-0.1A		02-Jun-98	19.8	7.8	8.8	280	240																	
WVP-6-A.3	0.4	15-May-02	13.1	7.7	12.2	151	2	5	49.3	66.2	10.8	9.02	3	0.02	0.1	1	0.12	20	0	0.16	4.07	0.02	0.01	0.01
WVP-6-A.5	0.2	03-Jun-98	15.5	7.7	9.6	154	360	1	65.6	66.6	5	3.42		0.029	0.129		0.05	21	0.01	0.05	3.56	0.01		
WVP-6-A-1	1.6	02-Jun-98	15.3	7.6	8	109	270	1	38.1	35.53	5	6.01		0.02	0.152		0.064	9.3	0.01	0.145	3	0.021		
WVP-6-A-2	0.2	03-Sep-03	21.8	6.9	12.1	204	90																	
WVP-6	1.2	02-Jun-98	24.1	8	9.2	222	41	1	91.9	96.22	9	4.26		0.02	0.214		0.05	31	0.01	0.135	4.75	0.016		
WVP-6	2.7	03-Sep-03	22.9	7.5	12.4	275	360																	
WVP-6	9.1	02-Jun-98	21.8	7.6	8.2	235	161	1	96.1	108.38	9	5.38		0.02	0.259		0.067	34	0.01	0.178	5.46	0.023		
WVP-6	9.4	09-Sep-03	19.9	7.7	8.21	235	40																	
WVP-6	17.3	03-Jun-98	22.4	7.7	8.6	242	100	1	104	107.29	12	4.67		0.02	0.246		0.05	34	0.01	0.128	5.56	0.02		
WVP-6	17.7	09-Sep-03	20	7.7	8.63	233	140																	
WVP-6	18.4	03-Jun-98	22	7.6	7.4	239	106	1	100	99.4	10	6.1		0.02	0.258		0.051	31	0.01	0.178	5.22	0.025		
WVP-6	22.3	30-May-02	20.6	7.6	8.28	180	100	5	58.7	103.66	12.73	11.7	3	0.02	0.14	1.1	0.12	33	0	0.29	4.98	0.03	0.01	0.01
WVP-6	25.3	03-Sep-03	21.9	7.6	11.1	251	5000																	
WVP-6-A	0.1	03-Sep-03	20.1	7.9	13.4	220	600																	
WVP-6-A	0.5	09-Jun-98	14.7	7.8	10.4	310	71	1	160	165.45	8	1.02		0.02	0.402		0.05	58	0.01	0.069	5.19	0.01		
WVP-6-A	1.3	09-Jun-98	14.6	8	9.9	311	65	1	166	173.98	8	3.4		0.02	0.417		0.119	61	0.01	0.178	5.32	0.022		
WVP-6-A	9.4	09-Jun-98	14	8	7.1	60	50	1	11.3	12.09	5	1.03		0.02	0.114		0.05	2.4	0.01	0.056	1.51	0.01		
WVP-6-A.2		02-Jun-98	19.3	7.5	6.8	81	217	1	31.6	29.92	6	1.3		0.02	0.05		0.315	7.6		0.134	2.67	0.028		
WVP-6-A.3	0.4	22-May-07	16	7.5	10.1	172	10	5	52.8	67.8	12	6	2	0.013	0.1	0.5	0.06	19		0.09	4.7	0.006	0	0.005
WVP-6-A-2-C	0.8	03-Jun-04	16.7		7.06	74	410	5	14.9	26.61	8.76	5.83	3	0.02	0.1	1	0.04	5.5		0.06	3.14	0.013	0	0.005
WVP-6-A-6	0.5	09-Jun-04	21.5	7.3	7.56	81	20	5	25.8	33.55	6.98	3.45	3	0.02	0.403	1	0.14	8.9		0.25	2.75	0.024	0	0.007
WVP-6-B	0.7	09-Sep-03	18.7	7.5	8.22	178	150																	
WVP-6-B-8	0.27	09-Jun-03	17.6	6.8	9.19	93	320	5	17.6	25.79	12.9	2.6	5	0.02	0.27	1	0.17	7	0	0.35	2	0.083		0.006
WVP-6-B-8	0.27	20-May-08	12.5	6.8	9.61	85	220	5	23.8	37.32	8	3	4	0.01	0.24	0.6	0.11	10		0.27	3	0.055	0	0.005
WVP-6-C	1.4	02-Jun-10	20.4	7.5	7.55	101	430	5	36	47.52	8	3	2	0.01	0.093	0.5	0.05	13		0.08	3.9	0.025	0	0.005
WVP-6-C.8	0.6	03-Jun-98	19	7.4	8.2	93	156	1	28.1	34.18	10	3.55		0.02	0.18		0.05	8.3	0.01	0.05	3.28	0.01		
WVP-6-C.8	1	03-Jun-04	16.7		7.17	94	10	5	28.5	39.02	9.71	4.03	4	0.02	0.1	1	0.07	9.2		0.1	3.91	0.011	0	0.005
WVP-6-D		03-Jun-98	19.5	7.7	8.5	202	300																	
WVP-6-D		03-Jun-98					250																	
WVP-6-G-1	3.5	02-Jun-98	19.6	6.9	7.5	23	30	5.02	6.7	7.54	5	1.12		0.02	0.05		0.05	1.4	0.01	0.067	1	0.01		
WVP-6-G-1	6.4	02-Jul-03	15.7	6.3	9.33	26	110	5	5	7.44	5	2.53	8	0.02	0.211	1	0.05	1.5	0	0.13	0.91	0.02		0.005

Table 4. West Virginia DEP Water Quality Data

STREAM_NAME	ANCODE	MILE_POINT	SAMPLE_DATE	Fecal
Back Creek	WVP-6	1.2	02-Jun-98	41
Back Creek	WVP-6	2.7	03-Sep-03	360
Back Creek	WVP-6	9.1	02-Jun-98	161
Back Creek	WVP-6	9.4	09-Sep-03	40
Back Creek	WVP-6	17.3	03-Jun-98	100
Back Creek	WVP-6	17.7	09-Sep-03	140
Back Creek	WVP-6	18.4	03-Jun-98	106
Back Creek	WVP-6	22.3	30-May-02	100
Back Creek	WVP-6	25.3	03-Sep-03	5000
Back Creek	WVP-6	32.7	03-Sep-03	310
Back Creek	WVP-6	34.7	08-Jun-98	13
UNT/Back Creek RM 0.60	WVP-6-0.1A		02-Jun-98	240
Tilhance Creek	WVP-6-A	0.1	03-Sep-03	600
Tilhance Creek	WVP-6-A	0.5	09-Jun-98	71
Tilhance Creek	WVP-6-A	1.3	09-Jun-98	65
Tilhance Creek	WVP-6-A	9.4	09-Jun-98	50
Higgins Run	WVP-6-A-1	1.6	02-Jun-98	270
Whites Run	WVP-6-A-2	0.2	03-Sep-03	90
UNT/Whites Run RM 1.63	WVP-6-A-2-C	0.8	03-Jun-04	410
UNT/Tilhance Creek RM 9.12	WVP-6-A-6	0.5	09-Jun-04	20
UNT/Back Creek RM 5.12	WVP-6-A.2		02-Jun-98	217
UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	15-May-02	2
UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	22-May-07	10
UNT/Back Creek RM 13.11	WVP-6-A.5	0.2	03-Jun-98	360
Elk Branch	WVP-6-B	0.7	09-Sep-03	150
UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	09-Jun-03	320
UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	20-May-08	220
Tub Run	WVP-6-C	1.4	02-Jun-10	430
UNT/Back Creek RM 27.95	WVP-6-C.8	0.6	03-Jun-98	156
UNT/Back Creek RM 27.95	WVP-6-C.8	1	03-Jun-04	10
Sawmill Run	WVP-6-D		03-Jun-98	250
Sawmill Run	WVP-6-D		03-Jun-98	300
Little Brush Creek	WVP-6-G-1	3.5	02-Jun-98	30
Little Brush Creek	WVP-6-G-1	6.4	02-Jul-03	110

Table 5. West Virginia DEP Fecal Water Quality Data

Sample ID	Station ID	Name	ANCODE	Mile Pt.	Date	% Dominant	% Chironomidae	% EPT	Biotic Index	EPT Taxa	Total Taxa	WVSCI
1478	5602	Back Creek	WVP-6	1.2	02-Jun-98	40.2	9.2	51.2	4.19	9	16	77.6
17479	5603	Back Creek	WVP-6	2.7	03-Sep-03	44.6	4.1	76.4	3.56	7	14	79.4
1482	5604	Back Creek	WVP-6	9.1	02-Jun-98	63.3	8.3	82.8	3.32	9	17	80.2
17480	5605	Back Creek	WVP-6	9.4	09-Sep-03	36.2	2.7	80.9	3.83	6	16	82.0
1479	5606	Back Creek	WVP-6	17.3	03-Jun-98	56.8	5.5	76.0	3.08	9	18	82.5
17481	5607	Back Creek	WVP-6	17.7	09-Sep-03	44.2	2.5	61.8	3.82	6	12	73.6
1480	5608	Back Creek	WVP-6	18.4	03-Jun-98	65.4	5.1	85.3	3.14	9	15	79.6
10549	5611	Back Creek	WVP-6	22.3	30-May-02	64.0	45.1	47.3	4.42	10	17	66.0
17482	5612	Back Creek	WVP-6	25.3	03-Sep-03	46.1	12.4	71.5	4.11	7	12	73.9
17483	5614	Back Creek	WVP-6	32.7	03-Sep-03	52.9	4.8	78.3	3.80	7	15	77.6
1481	5615	Back Creek	WVP-6	34.7	08-Jun-98	41.5	16.0	62.3	4.02	9	16	78.5
1483	5616	UNT/Back Creek RM 0.60	WVP-6-0.1A		02-Jun-98	77.4	22.2	72.6	3.24	7	13	66.8
17484	5617	Tilhance Creek	WVP-6-A	0.1	03-Sep-03	54.1	20.5	69.2	4.14	6	16	71.6
1486	5618	Tilhance Creek	WVP-6-A	0.5	09-Jun-98	50.3	30.7	53.1	4.58	9	17	71.5
1487	5619	Tilhance Creek	WVP-6-A	1.3	09-Jun-98	55.7	28.6	54.8	4.67	10	20	74.1
1488	5620	Tilhance Creek	WVP-6-A	9.4	09-Jun-98	37.5	5.0	76.7	2.99	10	17	88.5
1484	5621	UNT/Back Creek RM 5.12	WVP-6-A.2		02-Jun-98	48.2	10.4	31.6	3.89	8	15	70.3
36367	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	22-May-07	38.6	18.4	77.1	3.26	12	17	88.0
10491	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	15-May-02	43.9	6.6	84.4	3.22	11	19	90.3
1485	5623	UNT/Back Creek RM 13.11	WVP-6-A.5	0.2	03-Jun-98	58.3	28.3	63.6	3.81	9	18	74.2
1489	5624	Higgins Run	WVP-6-A-1	1.6	02-Jun-98	80.4	14.9	80.4	2.82	10	16	75.8
17485	5625	Whites Run	WVP-6-A-2	0.2	03-Sep-03	60.2	15.7	56.0	5.09	6	19	68.5
20598	5626	UNT/Whites Run RM 1.63	WVP-6-A-2-C	0.8	03-Jun-04	36.4	19.3	68.9	3.88	17	24	90.3
20678	5628	UNT/Tilhance Creek RM 9.12	WVP-6-A-6	0.5	09-Jun-04	66.0	26.6	71.4	4.65	9	14	69.0
17486	5629	Elk Branch	WVP-6-B	0.7	09-Sep-03	31.0	12.3	56.2	4.25	7	18	77.6
42892	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	20-May-08	50.5	9.1	79.6	2.76	8	18	83.7
16845	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	09-Jun-03	41.2	24.5	45.6	5.27	10	21	76.3
51276	11153	Tub Run	WVP-6-C	1.4	02-Jun-10	80.8	29.3	64.4	4.03	5	12	58.1
1490	5633	UNT/Back Creek RM 27.95	WVP-6-C.8	0.6	03-Jun-98	64.6	4.8	88.5	2.62	12	18	87.8
20586	5634	UNT/Back Creek RM 27.95	WVP-6-C.8	1	03-Jun-04	35.6	11.1	84.0	3.65	11	16	88.0
1492	5635	Sawmill Run	WVP-6-D		03-Jun-98	83.5	25.0	70.3	3.26	9	15	68.3
1491	5635	Sawmill Run	WVP-6-D		03-Jun-98	75.0	41.5	51.4	4.11	8	14	60.3
1493	5637	Little Brush Creek	WVP-6-G-1	3.5	02-Jun-98	37.1	16.8	60.5	3.80	12	21	87.3
16949	5638	Little Brush Creek	WVP-6-G-1	6.4	02-Jul-03	52.7	38.3	44.6	4.43	10	19	71.1

Table 6. West Virginia DEP Biological Data

Sample ID	StationID	Name	ANCODE	Mile Pt.	Date	ES	E	VD	CA	SD	RF	CFS	BSL	BSR	BVL	BVR	RBL	RBR	Total	Index
20678	5602	UNT/Tilhance Creek RM 9.12	WVP-6-A-6	0.5	09-Jun-04	15	13	11	20	11	17	16	5	7	6	8	10	10	149	74.5
17486	5603	Elk Branch	WVP-6-B	0.7	09-Sep-03	15	11	17	16	15	13	16	9	9	9	9	6	6	151	75.5
16845	5604	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	09-Jun-03	4	6	9	13	9	18	18	7	6	7	5	4	1	107	53.5
42892	5605	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	20-May-08	10	11	11	15	10	12	16	8	8	9	8	9	6	133	66.5
51276	5606	Tub Run	WVP-6-C	1.4	02-Jun-10	10	8	10	18	9	17	15	8	9	10	9	5	9	137	68.5
1490	5607	UNT/Back Creek RM 27.95	WVP-6-C.8	0.6	03-Jun-98	17	16	11	18	13	17	12	9	9	9	9	10	7	157	78.5
20586	5608	UNT/Back Creek RM 27.95	WVP-6-C.8	1	03-Jun-04	15	15	13	18	9	17	14	7	6	9	9	9	9	150	75.0
1478	5611	Back Creek	WVP-6	1.2	02-Jun-98	16	16	14	18	17	15	18	7	7	5	6	10	9	158	79.0
17479	5612	Back Creek	WVP-6	2.7	03-Sep-03	17	15	16	13	10	16	10	2	6	3	6	8	9	131	65.5
1482	5614	Back Creek	WVP-6	9.1	02-Jun-98	10	15	18	15	7	2	11	1	3	8	9	9	10	118	59.0
17480	5615	Back Creek	WVP-6	9.4	09-Sep-03	10	6	16	17	5	11	17	6	8	8	9	7	8	128	64.0
1479	5616	Back Creek	WVP-6	17.3	03-Jun-98	11	12	13	17	12	13	16	8	6	8	5	9	9	139	69.5
17481	5617	Back Creek	WVP-6	17.7	09-Sep-03	14	15	12	17	12	17	17	6	9	6	9	3	9	146	73.0
1480	5618	Back Creek	WVP-6	18.4	03-Jun-98	15	13	18	17	8	10	15	7	5	8	5	8	1	130	65.0
10549	5619	Back Creek	WVP-6	22.3	30-May-02	14	11	16	19	16	9	19	9	9	9	7	9	7	154	77.0
17482	5620	Back Creek	WVP-6	25.3	03-Sep-03	15	15	14	15	17	17	15	8	6	8	6	8	7	151	75.5
17483	5621	Back Creek	WVP-6	32.7	03-Sep-03	15	13	16	18	11	14	15	9	7	8	8	8	6	148	74.0
1481	5622	Back Creek	WVP-6	34.7	08-Jun-98	14	13	17	16	15	16	17	8	6	9	6	4	8	149	74.5
1483	5622	UNT/Back Creek RM 0.60	WVP-6-0.1A		02-Jun-98	15	14	10	16	16	18	16	9	9	9	9	3	1	145	72.5
17484	5623	Tilhance Creek	WVP-6-A	0.1	03-Sep-03	15	9	16	16	8	12	11	6	6	5	7	3	6	120	60.0
1486	5624	Tilhance Creek	WVP-6-A	0.5	09-Jun-98	18	16	17	19	15	16	15	9	8	7	6	10	10	166	83.0
1487	5625	Tilhance Creek	WVP-6-A	1.3	09-Jun-98	18	14	17	19	14	16	15	9	8	8	6	9	10	163	81.5
1488	5626	Tilhance Creek	WVP-6-A	9.4	09-Jun-98	12	13	8	18	11	16	8	8	7	7	6	9	9	132	66.0
1484	5628	UNT/Back Creek RM 5.12	WVP-6-A.2		02-Jun-98	18	13	13	20	12	18	15	5	8	9	8	10	10	159	79.5
10491	5629	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	15-May-02	16	8	10	18	11	15	12	7	9	9	8	8	5	136	68.0
36367	5630	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	22-May-07	15	16	10	20	17	18	9	9	10	9	10	9	9	161	80.5
1485	5630	UNT/Back Creek RM 13.11	WVP-6-A.5	0.2	03-Jun-98	16	16	10	16	14	18	12	9	9	8	8	9	7	152	76.0
1489	11153	Higgins Run	WVP-6-A-1	1.6	02-Jun-98	17	16	15	20	12	17	14	5	4	8	7	10	10	155	77.5
17485	5633	Whites Run	WVP-6-A-2	0.2	03-Sep-03	16	14	17	18	16	16	16	7	8	8	9	6	6	157	78.5
20598	5634	UNT/Whites Run RM 1.63	WVP-6-A-2-C	0.8	03-Jun-04	11	8	10	16	7	12	15	7	8	6	7	7	9	123	61.5
1492	5635	Sawmill Run	WVP-6-D		03-Jun-98	16	16	17	19	15	16	14	7	9	8	9	2	8	156	78.0
1491	5635	Sawmill Run	WVP-6-D		03-Jun-98	15	16	15	18	15	18	14	8	9	8	8	6	9	159	79.5
1493	5637	Little Brush Creek	WVP-6-G-1	3.5	02-Jun-98	19	15	10	20	15	18	16	9	10	9	9	9	9	168	84.0
16949	5638	Little Brush Creek	WVP-6-G-1	6.4	02-Jul-03	19	11	13	20	7	20	17	5	7	9	9	10	10	157	78.5

Table 7. West Virginia DEP Habitat Data

Sample ID	Station ID	Name	ANCODE	Mile Pt.	Date	Bedrock	Boulder	Cobble	Coarse gravel	Fine gravel	Gravel	Sand	Silt	Clay	% Fines
1478	5602	Back Creek	WVP-6	1.2	02-Jun-98	0	5	60			20	15	0	0	15.0
17479	5603	Back Creek	WVP-6	2.7	03-Sep-03	0	0	30			50	10	10	0	20.0
1482	5604	Back Creek	WVP-6	9.1	02-Jun-98	0	0	35			60	5	0	0	5.0
17480	5605	Back Creek	WVP-6	9.4	09-Sep-03	0	0	10			75	10	5	0	15.0
1479	5606	Back Creek	WVP-6	17.3	03-Jun-98	0	0	40			30	30	0	0	30.0
17481	5607	Back Creek	WVP-6	17.7	09-Sep-03	0	5	30			45	10	10	0	20.0
1480	5608	Back Creek	WVP-6	18.4	03-Jun-98	0	0	60			25	15	0	0	15.0
10549	5611	Back Creek	WVP-6	22.3	30-May-02	0	0	55			30	10	5	0	15.0
17482	5612	Back Creek	WVP-6	25.3	03-Sep-03	0	0	50			30	10	10	0	20.0
17483	5614	Back Creek	WVP-6	32.7	03-Sep-03	0	0	35			40	15	10	0	25.0
1481	5615	Back Creek	WVP-6	34.7	08-Jun-98	0	0	30			45	20	5	0	25.0
1483	5616	UNT/Back Creek RM 0.60	WVP-6-0.1A		02-Jun-98	0	0	60			25	15	0	0	15.0
17484	5617	Tilhance Creek	WVP-6-A	0.1	03-Sep-03	0	0	0			60	30	10	0	40.0
1486	5618	Tilhance Creek	WVP-6-A	0.5	09-Jun-98	0	5	50			40	5	0	0	5.0
1487	5619	Tilhance Creek	WVP-6-A	1.3	09-Jun-98	0	5	30			35	20	10	0	30.0
1488	5620	Tilhance Creek	WVP-6-A	9.4	09-Jun-98	0	20	30			30	15	5	0	20.0
1484	5621	UNT/Back Creek RM 5.12	WVP-6-A.2		02-Jun-98	0	5	55			30	10	0	0	10.0
10491	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	15-May-02	0	0	34			49	14	3	0	17.0
36367	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	22-May-07	0	0	50	25	10	35	5	10	0	15.0
1485	5623	UNT/Back Creek RM 13.11	WVP-6-A.5	0.2	03-Jun-98	0	5	60			25	10	0	0	10.0
1489	5624	Higgins Run	WVP-6-A-1	1.6	02-Jun-98	0	0	40			50	10	0	0	10.0
17485	5625	Whites Run	WVP-6-A-2	0.2	03-Sep-03	0	0	30			60	5	5	0	10.0
20598	5626	UNT/Whites Run RM 1.63	WVP-6-A-2-C	0.8	03-Jun-04	0	0	15	30	40	70	15	0	0	15.0
20678	5628	UNT/Tilhance Creek RM 9.12	WVP-6-A-6	0.5	09-Jun-04	0	0	20	40	20	60	10	0	0	10.0
17486	5629	Elk Branch	WVP-6-B	0.7	09-Sep-03	0	0	55			30	10	5	0	15.0
16845	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	09-Jun-03	0	0	10			35	45	10	0	55.0
42892	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	20-May-08	0	0	5	45	30	75	10	10	0	20.0
51276	11153	Tub Run	WVP-6-C	1.4	02-Jun-10	5	5	10	55	10	65	5	10	0	15.0
1490	5633	UNT/Back Creek RM 27.95	WVP-6-C.8	0.6	03-Jun-98	0	0	60			30	10	0	0	10.0
20586	5634	UNT/Back Creek RM 27.95	WVP-6-C.8	1	03-Jun-04	0	0	50	30	10	40	10	0	0	10.0
1492	5635	Sawmill Run	WVP-6-D		03-Jun-98	0	0	70			15	15	0	0	15.0
1491	5635	Sawmill Run	WVP-6-D		03-Jun-98	0	0	70			15	15	0	0	15.0
1493	5637	Little Brush Creek	WVP-6-G-1	3.5	02-Jun-98	0	10	60			10	20	0	0	20.0
16949	5638	Little Brush Creek	WVP-6-G-1	6.4	02-Jul-03	0	5	40			25	25	5	0	30.0

Table 8. West Virginia DEP Substrate Data

Sampe ID	Station ID	Name	ANCODE	Mile Pt.	Date	Width 1	Width 2	Width 3	Av. Width	Riffle depth	Run depth	Pool depth
1478	5602	Back Creek	WVP-6	1.2	02-Jun-98				22.3	0.15	0.2	
17479	5603	Back Creek	WVP-6	2.7	03-Sep-03	20	10	7	12.3	0.15	0.7	1
1482	5604	Back Creek	WVP-6	9.1	02-Jun-98				4.5	0.2	0.8	2
17480	5605	Back Creek	WVP-6	9.4	09-Sep-03	9.5	8.5	8	8.7	0.2	0.3	0.7
1479	5606	Back Creek	WVP-6	17.3	03-Jun-98				24.8	0.1	0.2	0.3
17481	5607	Back Creek	WVP-6	17.7	09-Sep-03	3.2	9.5	5	5.9	0.17	0.22	0.25
1480	5608	Back Creek	WVP-6	18.4	03-Jun-98				17.3	0.15	0.4	1.5
10549	5611	Back Creek	WVP-6	22.3	30-May-02	15.3	15.7	16.4	15.8	0.29	0.43	0.42
17482	5612	Back Creek	WVP-6	25.3	03-Sep-03	20	15	15	16.7	0.22	0.27	0.3
17483	5614	Back Creek	WVP-6	32.7	03-Sep-03	15	25	20	20	0.22	0.26	0.77
1481	5615	Back Creek	WVP-6	34.7	08-Jun-98				25	0.25	0.35	0.5
1483	5616	UNT/Back Creek RM 0.60	WVP-6-0.1A		02-Jun-98				0.8	0.05	0.1	0.2
17484	5617	Tilhance Creek	WVP-6-A	0.1	03-Sep-03	7	6.5	3.7	5.7	0.16	0.28	0.7
1486	5618	Tilhance Creek	WVP-6-A	0.5	09-Jun-98				15	0.05	0.2	0.5
1487	5619	Tilhance Creek	WVP-6-A	1.3	09-Jun-98				13.7	0.1	0.25	0.5
1488	5620	Tilhance Creek	WVP-6-A	9.4	09-Jun-98				0.9	0.01	0.1	0.25
1484	5621	UNT/Back Creek RM 5.12	WVP-6-A.2		02-Jun-98				2.4	0.04	0.15	0.32
10491	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	15-May-02	2.6	3	2.9	2.8	0.07	0.33	
36367	5622	UNT/Back Creek RM 8.07	WVP-6-A.3	0.4	22-May-07	3.2	3.4	3	3.2	0.02	0.07	0.24
1485	5623	UNT/Back Creek RM 13.11	WVP-6-A.5	0.2	03-Jun-98				2	0.05	0.15	
1489	5624	Higgins Run	WVP-6-A-1	1.6	02-Jun-98				2.1	0.02	0.11	0.28
17485	5625	Whites Run	WVP-6-A-2	0.2	03-Sep-03	5	4	3	4	0.15	0.23	0.5
20598	5626	UNT/Whites Run RM 1.63	WVP-6-A-2-C	0.8	03-Jun-04	1.2	1.1	2.2	1.5	0.05	0.1	0.26
20678	5628	UNT/Tilhance Creek RM 9.12	WVP-6-A-6	0.5	09-Jun-04	0.8	1.5	1.2	1.2	0.05	0.13	1.5
17486	5629	Elk Branch	WVP-6-B	0.7	09-Sep-03	5	7.6	4.2	5.6	0.15	0.26	0.25
16845	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	09-Jun-03	1.6	1.1	0.9	1.2	0.17	0.25	0.32
42892	5630	UNT/Elk Branch RM 4.27	WVP-6-B-8	0.27	20-May-08	2.2	2	1.3	1.8	0.1125	0.275	0.3333
51276	11153	Tub Run	WVP-6-C	1.4	02-Jun-10	3.8	2.9	1.9	2.8666	0.111	0.19	0.2125
1490	5633	UNT/Back Creek RM 27.95	WVP-6-C.8	0.6	03-Jun-98				2.5	0.05	0.15	0.2
20586	5634	UNT/Back Creek RM 27.95	WVP-6-C.8	1	03-Jun-04	1.35	1.1	2.45	1.6	0.04	0.09	0.32
1492	5635	Sawmill Run	WVP-6-D		03-Jun-98				2.8	0.1	0.15	0.6
1491	5635	Sawmill Run	WVP-6-D		03-Jun-98				2.7	0.05	0.1	0.5
1493	5637	Little Brush Creek	WVP-6-G-1	3.5	02-Jun-98				4	0.1	0.15	0.4
16949	5638	Little Brush Creek	WVP-6-G-1	6.4	02-Jul-03	2.3	2.7	2.4	2.5	0.09	0.14	0.42

Table 9. West Virginia DEP Channel Measurement Data

Back Creek Baseline Conditions, WV			
Parameter	**Baseline**	**Units**	**Reduction/improvement goal**
Acidity	1.66	mg/l	
Alkalinity	95.28	mg/l	
Biological Condition (WVSCI)	77.35		Maintain comparable to reference conditions/improve at project sites
Calcium	33.83	mg/l	
Conductivity	228.4	uS/cm	
Dissolved Oxygen	10.25	mg/l	
Iron	0.169	mg/l	
Fecal coliform	137	cfu/100ml	<10% exceedances
Habitat Conditions	70.5		Maintain comparable to reference conditions/improve at project sites
pH	7.8		
Phosphorous	0.0175	mg/l	
Sulfate	10.46		
Temperature	17.7	degrees C	
Total Nitrogen	0.65	mg/l	
Total suspended solids	11.7	mg/l	
Tilhance Creek Baseline Conditions, WV			
Parameter	**Baseline**	**Units**	**Reduction/improvement goal**
Acidity	1	mg/l	
Alkalinity	112.43	mg/l	
Biological Condition (WVSCI)	76.4		Maintain comparable to reference conditions/improve at project sites
Calcium	40	mg/l	
Conductivity	225.3	uS/cm	
Dissolved Oxygen	10.2	mg/l	
Iron	0.101	mg/l	
Fecal coliform	197	cfu/100ml	<10% exceedances
Habitat Conditions	73		Maintain comparable to reference conditions/improve at project sites
pH	7.9		
Phosphorous	0.0175	mg/l	
Sulfate	7		
Temperature	15.86	degrees C	
NO2+NO3	0.311	mg/l	

Table 10. Select Baseline Conditions and Goals, Back and Tilhance Creeks

StationID	StreamName	Location	Lat	Long	CollDate	Sample Season	RepNum	TotTaxa	EPTTax	%Ephem	%PT - Hydropsychidae	%Scrap	%Chiro	%2Dom	HBI
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/10/01	Fall 2001	1	14	8	22.69	11.8	7.56	35.29	57.14	4.71
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	03/13/03	Spring 2003	1	21	13	19.39	57.1	10.20	10.20	47.96	3.07
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/29/04	Fall 2004	1	13	8	15.25	54.2	8.47	4.24	50.85	3.09
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/30/06	Fall 2006	1	15	6	22.86	21.9	11.43	8.57	46.67	4.37
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	03/19/09	Spring 2009	1	11	5	0.97	25.2	2.91	21.36	64.08	4.98
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/05/09	Fall 2009	1	15	5	48.45	12.4	27.84	3.09	47.42	3.81
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	04/01/10	Spring 2010	1	19	12	8.47	59.3	7.63	11.86	64.41	3.26
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	09/26/11	Fall 2011	1	12	5	29.09	24.5	21.82	7.27	45.45	4.34
1AGAN000.32	Gap Run	Private bridge off Rt. 50	39.220106	-78.277074	03/13/03	Spring 2003	1	21	11	11.82	60.9	12.73	1.82	58.18	3.11
1AGAN000.32	Gap Run	Private bridge off Rt. 50	39.220106	-78.277074	10/27/03	Fall 2003	1	15	7	30.28	20.4	19.72	4.23	45.07	3.94
1AGAN000.32	Gap Run	Private bridge off Rt. 50	39.220106	-78.277074	10/27/03	Fall 2003	2	15	6	31.90	22.4	12.07	0.86	51.72	4.02
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	10/10/01	Fall 2001	1	16	8	41.59	16.8	25.66	8.85	37.17	4.36
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	10/29/04	Fall 2004	1	13	8	19.61	25.5	8.82	17.65	42.16	4.32
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	05/12/05	Spring 2005	1	15	10	24.53	32.1	5.66	30.19	44.34	4.05
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	11/03/05	Fall 2005	1	15	7	44.63	16.5	37.19	0.83	51.24	4.28
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	10/14/08	Fall 2008	1	16	7	35.45	7.3	32.73	14.55	30.91	4.40
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	04/01/10	Spring 2010	1	19	10	13.08	47.7	13.08	14.02	49.53	3.50
1AXJS001.20	X-Trib Isaacs Creel	1/4 mile upstream of pvt. ford	39.324308	-78.265697	04/07/04	Spring 2004	1	12	10	13.49	74.6	0.79	6.35	53.97	2.52

StationID	StreamName	Location	Lat	Long	CollDate	Sample Season	Richness Score	EPT Score	%Ephem Score	%PT-H Score	%Scraper Score	Chironomidae Sco	%2Dom Score	%MFBI Score	**VSCI**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/10/01	Fall 2001	63.64	72.73	37.01	33.05	14.66	64.71	61.93	77.85	**53.20**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	03/13/03	Spring 2003	95.45	100.00	31.63	100.00	19.78	89.80	75.20	100.00	**76.48**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/29/04	Fall 2004	59.09	72.73	24.88	100.00	16.42	95.76	71.03	100.00	**67.49**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/30/06	Fall 2006	68.18	54.55	37.29	61.53	22.15	91.43	77.07	82.77	**61.87**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	03/19/09	Spring 2009	50.00	45.45	1.58	70.91	5.64	78.64	51.91	73.82	**47.24**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	10/05/09	Fall 2009	68.18	45.45	79.04	34.75	53.94	96.91	75.98	90.96	**68.15**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	04/01/10	Spring 2010	86.36	100.00	13.82	100.00	14.78	88.14	51.44	99.04	**69.20**
1ABAR046.01	Back Creek	Rt. 50 bridge	39.268333	-78.314167	09/26/11	Fall 2011	54.55	45.45	47.46	68.95	42.28	92.73	78.82	83.29	**64.19**
1AGAN000.32	Gap Run	Private bridge off Rt. 50	39.220106	-78.277074	03/13/03	Spring 2003	95.45	100.00	19.28	100.00	24.67	98.18	60.43	100.00	**74.75**
1AGAN000.32	Gap Run	Private bridge off Rt. 50	39.220106	-78.277074	10/27/03	Fall 2003	68.18	63.64	49.40	57.37	38.21	95.77	79.38	89.17	**67.64**
1AGAN000.32	Gap Run	Private bridge off Rt. 50	39.220106	-78.277074	10/27/03	Fall 2003	68.18	54.55	52.03	62.96	23.39	99.14	69.76	87.98	**64.75**
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	10/10/01	Fall 2001	72.73	72.73	67.85	47.23	49.74	91.15	90.80	82.90	**71.89**
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	10/29/04	Fall 2004	59.09	72.73	31.99	71.60	17.10	82.35	83.59	83.48	**62.74**
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	05/12/05	Spring 2005	68.18	90.91	40.01	90.10	10.97	69.81	80.43	87.54	**67.25**
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	11/03/05	Fall 2005	68.18	63.64	72.80	46.43	72.07	99.17	70.46	84.10	**72.11**
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	10/14/08	Fall 2008	72.73	63.64	57.84	20.43	63.42	85.45	99.84	82.35	**68.21**
1AHOC006.23	Hogue Creek	Rt. 679	39.240278	-78.261389	04/01/10	Spring 2010	86.36	90.91	21.34	100.00	25.36	85.98	72.93	95.52	**72.30**
1AXJS001.20	X-Trib Isaacs Creel	1/4 mile upstream of pvt. ford	39.324308	-78.265697	04/07/04	Spring 2004	54.55	90.91	22.01	100.00	1.54	93.65	66.52	100.00	**66.15**

Table 11. Virginia DEQ Benthic Monitoring Data

Source	Annual Fecal Coliform Loading Under Existing Conditions	Annual Fecal Coliform Loading Under Future Conditions	Annual Fecal Coliform Loading Under TMDL Conditions	Percent Reduction (%)
Land Based				
Forest	3.79E+15	3.76E+15	3.76E+15	0
Pasture	2.24E+17	2.22E+17	6.66E+15	97
Cropland	2.95E+13	2.95E+13	8.84E+11	97
Commercial	4.44E+13	4.95E+13	1.49E+12	97
Residential	4.18E+15	7.80E+15	2.34E+14	97
Direct				
Straight Pipes	1.69E+12	1.69E+12	0.00E+00	100
Cattle DD	1.01E+13	1.01E+13	3.03E+11	97
Wildlife DD	1.12E+12	1.12E+12	1.12E+12	0
Permitted Point	1.74E+11	1.04E+12	1.04E+12	0

Table 12. Virginia Hogue Creek TMDL Fecal Coliform Load Reductions

Employee	Title	Work Group	Direct Contact #	Immediate Supervisor	Direct Contact #
Aaron Tonkery	Engineer	Dam Safety	304-368-2000 ext 3711	Delbert Shriver	304-368-2000 ext 3712
David Nesbitt	Environmental Inspector	Hazardous Waste	304-822-7266 ext 3652	Jamie Fenske	304-238-1220 ext 3514
Eric Mauzy	Environmental Inspector	Underground Storage Tank	304-822-7266 ext 3605	Denise Hight	304-926-0499 ext 1353
Mike Kanehl	Environmental Inspector	Water & Waste	304-822-7266 ext 3602	Robin Dolly	304-822-7266 ext 3606
Sarah Woody	Environmental Inspector	Water & Waste	304-822-7266 ext 3618	Robin Dolly	304-822-7266 ext 3606
Matthew Alt	Environmental Inspector – Construction Stormwater	Water & Waste	304-822-7266 ext 3603	Robin Dolly	304-822-7266 ext 3606
Anthony Willard	Environmental Inspector - CAFO	Water & Waste	304-822-7266 ext 3628	Robin Dolly	304-822-7266 ext 3606

Table 13. WV DEP Enforcement Division Contact Information for Berkeley County, WV

Program	What land is Eligible?	Length of Agreement	Rental Payment	Easement	Cost Share	Producer Obligation
Conservation Reserve Program (CRP)	Highly erodible cropland that has been planted for 4 of the 6 years preceding enactment of the 2002 law. Marginal pastureland is also eligible.	10-15 Years	$ Annual payment based on length of agreement		$ Up to 50%	Develop and follow a plan for the conversion of cropland to a less intensive use. Also, assist with the cost, establishment, and maintenance of conservation practices.
Wetlands Reserve Program (WRP)	Most private wetlands converted to agricultural use prior to 1985 are eligible. Wetland must be restored & suitable for wildlife benefits.	10 or 30 Years; Permanent		$ One-time, Up-front Payment	$ Up to 100%	Develop & follow a plan for the restoration & maintenance of the wetland. If necessary, assist with the cost of restoration.
Grassland Reserve Program (GRP)	Private grassland, shrubland and land containing forbs or land that historically contained those features is eligible.	10, 15, 20, or 30 Years; Permanent	$ Annual payment based on length of agreement	$ One-time, Up-front Payment	$ Up to 90%	Develop & comply with a plan for the easement or restoration agreement; assist with the remaining installation costs.
Wildlife Habitat Incentives Program (WHIP)	All private land is eligible, unless it is currently enrolled in CRP, WRP or a similar program.	5-15 Years			$ Up to 75%	Prepare and follow a wildlife habitat development plan; assist with the installation costs.
Conservation Security Program (CSP)	All private agricultural land & forested land that is an incidental part of an agricultural operation is eligible.	5-10 Years	$ Annual payment Based on length of agreement		$ Up to 75%	A conservation security plan is required to install and/or maintain conservation practices on working lands.
Forest Land Enhancement Program (FLEP)	All non-industrial private forestlands are eligible for financial, technical, and educational assistance.	10 Years or more			$ Up to 75%	Develop and implement a management plan; assist with the remaining installation costs.
Farm & Ranch Lands Protection Program (FRPP)	Private land that contains prime farmland or other unique resources and is subject to a pending easement from an eligible entity.	Permanent		$ One-time, Up-front Payment		Continue to use the land for agricultural purposes. Develop a conservation plan and comply with the terms of the easement.

Table 14. USDA Programs (Note: $ indicates financial incentives).

Number	Stream	Location
1	Back Creek	County Route 22 Bridge
2	Big Run	County Route 7 Bridge
3	Back Creek	County Route 7/19 Bridge
4	Tub Run	Puffinberger Ln. Bridge
5	Back Creek	County Route 18 Bridge
6	Elk Branch	Tomahawk Rd. Bridge near mouth
7	Elk Branch	Tomahawk Rd. Bridge near County Route 7/8
8	Back Creek	County Route 7/12 Bridge
9	Back Creek	County Route 6 Bridge
10	Tilhance Creek	County Route 23 Bridge
11	Whites Run	County Route 44 Bridge
12	Higgins Run	County Route 44 Bridge
13	Tilhance Creek	State Route 9 Bridge
14	Back Creek	State Route 9 Bridge
15	Back Creek	County Route 32/Allensville Rd. Bridge
16	Gough Run	County Route 32 Bridge

Table 15. Back Creek Water Quality Monitoring Locations (WV Portion).

Agricultural Erosion and Land Use	Email	Phone	Website
Eastern Panhandle Conservation District	epcd@wvca.us	304-263-4376	http://www.wvca.us/districts/?page=epcd
Natural Resource Conservation Service	Patrick.Bowen@wv.usda.gov	304-284-7540	http://www.wv.nrcs.usda.gov/
WV Conservation Agency		304-558-2204	http://www.wvca.us/
Lord Fairfax Soil and Water Conservation District		540-465-2424 x 3	http://lfswcd.org/
VA Department of Conservation and Recreation			http://www.dcr.virginia.gov/toolboxloc.shtml
Capacity Building			
Appalachian Coal Country Team	coordinator@coalcountryteam.org	304-252-4848	http://www.coalcountryteam.org/
Appalachian Energy and Environment Partnership	director@aeepartnership.org	304-294-1005	http://www.aeepartnership.org/
River Network		541-0276-1083	http://www.rivernetwork.org/
WV Stream Partners Program		800-654-5227	http://www.wvca.us/stream.cfm
WVCA Watershed Resource Center		304-558-0382	http://www.wvca.us/wvwrc/
Community Based Planning			
Natural Resource Conservation Service	Charlotte.Elliott-Friend@wv.usda.gov	304-284-7540	http://www.wv.nrcs.usda.gov/
NPS Rivers, Trails & Conservation Assistance		304-293-2941	http://www.nps.gov/rtca
WV Rivers Coalition		304-637-7201	http://www.wvrivers.org
WV Stream Partners Program		800-654-5227	http://www.wvca.us/stream.cfm
WV Bureau of Public Health (SWAP)		304-558-6746	http://www.wvdhhr.org/oehs/eed/swap/

Table 16. Back Creek Technical and Financial Assistance Providers (continued on next page)

Education and Outreach			
Cacapon Institute		304-856-1385	http://cacaponinstitute.org
Eastern Panhandle Conservation District	epcd@wvca.us	304-263-4376	http://www.wvca.us/districts/?page=epcd
Appalachian Energy and Environment Partnership	director@aeepartnership.org	304-294-1005	http://www.aeepartnership.org/
Project WET		304-296-0499 x 1036	http://www.projectwet.org
WVDEP Save Our Streams	Glenn.R.Nelson@wv.gov	304-926-0499 x 1040	http://www.dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx
The Mountain Institute		304-637-1237	www.mountain.org
WVDEP Environmental Advocate	Pamela.Nixon@wv.gov	304-926-0440 x 1328	http://www.wvdep.gov
WVCA Watershed Resource Center		304-558-0382	http://www.wvca.us/wvwrc/
WV Stream Partners Program		800-654-5227	http://www.wvca.us/stream.cfm
VA Department of Conservation and Recreation			http://www.dcr.virginia.gov/toolboxloc.shtml
WVDEP Nonpoint Source Program			http://www.dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx
Endangered Species			
WV DNR Natural Heritage Program	dnr.wildlife@wv.gov	304-822-3551	http://www.wvdnr.gov/Wildlife/RepRareSpec.shtm
VA Department of Conservation and Recreation			http://www.dcr.virginia.gov/toolboxloc.shtml
Freshwater Institute		304-876-2815	www.freshwaterinstitute.org
Fish Habitat and Recreation			
NPS Rivers, Trails & Conservation Assistance		304-293-2941	http://www.nps.gov/rtca
Trout Unlimited	gberti@tu.org	304-704-2731	www.tu.org
WV Department of Natural Resources		304-558-2204	http://www.wvdnr.gov
Floodplain Management and Erosion Control			
Eastern Panhandle Conservation District	epcd@wvca.us	304-263-4376	http://www.wvca.us/districts/?page=epcd
Natural Resource Conservation Service	Patrick.Bowen@wv.usda.gov	304-284-7540	http://www.wv.nrcs.usda.gov/
WV Conservation Agency		304-558-2204	http://www.wvca.us/
Geology and Hydrology			
WV Geological Survey		304-594-2331	www.wvgs.wvnet.edu
Hydrology Research Center		304-293-2867	www.hrc-lab.org
Monitoring and Water Quality			
Cacapon Institute		304-856-1385	http://cacaponinstitute.org
Eastern Panhandle Conservation District	epcd@wvca.us	304-263-4376	http://www.wvca.us/districts/?page=epcd
Freshwater Institute		304-876-2815	www.freshwaterinstitute.org
WVDEP Save Our Streams	Glenn.R.Nelson@wv.gov	304-926-0499 x 1040	http://www.dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx
The Mountain Institute		304-637-1237	www.mountain.org
Trout Unlimited	gberti@tu.org	304-704-2731	www.tu.org
WV Bureau of Public Health		304-558-6746	http://www.dhhr.wv.gov/bph/Pages/default.aspx
WV Conservation Agency		304-558-2204	http://www.wvca.us/
WVDEP Watershed Assessment Branch		304-926-0495	http://www.dep.wv.gov/WWE/watershed/wqmonitoring/Pages/waterquality.aspx
WV Water Research Institute		304-293-2867	http://wvwri.nrcce.wvu.edu
Open Dumps and Littering			
WVDEP Make It Shine Program		800-322-5530	http://www.dep.wv.gov/dlr/reap/wvmis/Pages/default.aspx
WVDEP Environmental Enforcement, Romney		304-822-7266	http://www.dep.wv.gov/WWE/ee/geninfo/Pages/complaints.aspx
WVDNR Law Enforcement, Romney	DNR.Law@wv.gov	304-822-3551	http://www.wvdnr.gov/LEnforce/Law.shtm
Sewage			
Eastern Panhandle Conservation District	epcd@wvca.us	304-263-4376	http://www.wvca.us/districts/?page=epcd
National Small Flows Clearinghouse	info@mail.nesc.wvu.edu	800-624-8301 x 3	http://www.nesc.wvu.edu/wastewater.cfm
WV Bureau of Public Health		304-558-6746	http://www.dhhr.wv.gov/bph/Pages/default.aspx
Stream Bank Stabilization			
Eastern Panhandle Conservation District	epcd@wvca.us	304-263-4376	http://www.wvca.us/districts/?page=epcd
Natural Resource Conservation Service	Patrick.Bowen@wv.usda.gov	304-284-7540	http://www.wv.nrcs.usda.gov/
Green Rivers	gaujot@greenrivers.net	304-704-4283	www.greenrivers.net
WV Conservation Agency		304-558-2204	http://www.wvca.us/
WVDEP Nonpoint Source Program	alana.c.hartman@wv.gov	304-822-7266 x 3623	http://www.dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx
WV DNR		304-558-2754	www.wvdnr.gov
WV Division of Forestry		304-558-2788	www.wvforestry.com
WV Water Research Institute		304-293-2867	http://wvwri.nrcce.wvu.edu
Stormwater Management			
Chesepeak Stormwater Network	watershedguy@hotmail.com	410-750-7635	http://chesapeakestormwater.net/
Region 9 Planning and Develpoment Council	mpennington@region9wv.com	304-263-1743	http://www.region9wv.com/ChesapeakeBayUpdates.aspx
WVDEP Nonpoint Source Program	sebastian.donner@wv.gov	304-822-7266 x 3608	http://www.dep.wv.gov/WWE/Programs/nonptsource/Pages/SAS.aspx
WVDEP Stormwater Program	Sherry.L.Wilkins@wv.gov	304-926-0499	http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/Pages/default.aspx

Table 16. Back Creek Technical and Financial Assistance Providers (continued)

Table 2. Comparative Runoff Reduction, TP EMC Removal and Space Required			
Practice	**Runoff Reduction (RR) (%)**	**Pollutant Removal for TP (PR) (%)**	**Shortcut Surface Area (% of Contributing Drainage Area (CDA)**
Green Roof	45 to 60	0	0
Impervious Surface Disconnection	25 to 75	0	5 to 10' wide strip or 5% of CDA
Permeable Pavement	45 to 75	25	0
Grass Channel	10 to 20	15	3 to 5
Dry (Water Quality) Swale	40 to 80	20 to 40	3 to 5
Bioretention	40 to 80	25 to 50	3 to 5
Infiltration	50 to 90	25	3 to 5
Extended Detention	0 to 15	15	2 to 4
Sheetflow to Conservation Area or Filter Strip	50 to 75	0	Combined Area > 0.5 acres
Wet Swale (coastal plain)	0	20 to 40	4 to 6
Filtering Practice	0	60 to 65	3 to 5
Constructed Wetland	0	50 to 75	3 to 6
Wet Pond	0	50 to 75	3 to 5
Range of values is For Level 1 and 2 Designs, respectively, including hydrologic soil group and whether amended soils are used for particular practices			

Table 17. Load Reductions and Space Requirements for LID and Stormwater BMPs.

WV Agricultural BMP Implementation Cost Estimates			
Practice	Number	Cost Per Unit	Cost Per Practice
Livestock Fence (feet)	130,690	$2	$261,380
Alternative Watering Source	66	$3,000	$198,000
Riparian Buffer Establishment (acres)	105	$1,000	$105,000
Armored Stream Crossing	66	$2,800	$184,800
		Total Cost	$749,180
VA Agricultural BMP Implementation Cost Estimates			
Practice	Number	Cost Per Unit	Cost Per Practice
Livestock Fence (feet)	298,416	$2	$596,832
Alternative Watering Source	150	$3,000	$450,000
Riparian Buffer Establishment (acres)	240	$1,000	$240,000
Armored Stream Crossing	150	$2,800	$420,000
		Total Cost	$1,706,832

Table 18. Agricultural BMP Implementation Cost Estimates.

PHOTOGRAPHS

Photo 1. A highly eroded stream bank along Back Creek

Photo 2. A sample of the litter found within Back Creek

Photo 3. Measuring Bank Erosion Hazard Index

Photo 4. An existing in-stream rock structure (W-weir)

Photo 5. A highly eroded stream bank along Back Creek

Photo 6. A sample of the litter found within Back Creek

Photo 7. A highly eroded stream bank along Back Creek

Photo 8. Terrace formation behind an existing NSD structure.

Photo 9. Vegetation forming on a NSD structure protecting a farm field, downstream on river right.

Photo 10. Example of a one lane bridge common in Back Creek.

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APPENDICES

WV DEP Fecal Coliform Monitoring and Decision Rationale

WVDEPs Watershed Assessment Branch uses the following protocol for fecal coliform monitoring and impairment decisions:

"Evaluation of fecal coliform numeric criteria fecal coliform assessments were based on the previously described decision criteria for numeric water quality criteria. Given the complexity of this particular criteria, most assessments are performed by comparing observations to the "maximum daily" criterion value of 400 counts/100ml. Evaluation of the monthly geometric mean fecal coliform criterion (200 counts/100ml) occurs only where five or more individual sample results are available within a calendar month. Numeric fecal coliform water quality criteria are applicable to the Water Contact Recreation and Public Water Supply designated uses. Section 8.13 of Appendix E of the West Virginia Water Quality Standards states: Maximum allowable level of fecal coliform content for Primary Contact Recreation shall not exceed 200/100ml as a monthly geometric mean based on not less than five samples per month; nor to exceed 400/100ml in more than 10 percent of all samples taken during the month. A practical difficulty exists in accurate assessment of criteria compliance due to the resource commitment that would be necessary to perform monitoring at a sufficient frequency to make determinations using the geometric mean criteria, since the monthly geometric mean criterion is conditioned upon the availability of at least five distinct sample results in a month. The "maximum daily" criterion is not conditioned by a minimum sample set requirement, but practical use of the apparent 10 percent exceedance allowance would involve at least 10 samples per month. The most frequent and regular fecal coliform water quality monitoring conducted by the Watershed Assessment Section is once per month. That monitoring frequency precludes assessment of the monthly geometric mean criterion and hampers accurate assessment of the maximum daily criterion. Due to limited resources, more frequent fecal coliform monitoring could only be accomplished by significantly reducing the number of West Virginia streams and/or stations where water quality assessments are performed. The DEP does not consider that to be a reasonable alternative. The DEP uses the following protocols when making assessments relative to fecal coliform numeric criteria:

- No assessments are based upon the monthly geometric mean criterion (200 counts/100ml) unless an available data set includes monitoring at five per month or greater frequency. When data sets are available, the listing decision criteria for numeric water quality criteria are applied, considering each monthly geometric mean as an available monitoring result.
- The listing decision criteria are applied to the maximum daily criterion (400 counts/100ml) and available individual monitoring results, but without the monthly prejudice. For example, if twice per month monitoring is conducted for a year and two results in two separate months are greater than 400, the stream would be assessed as fully supporting (2/24 – 8.3 percent rate of exceedance) rather than basing assessments on two months out of 12 in noncompliance (2/12 – 16.7 percent rate of exceedance). If five samples per month monitoring is conducted for one year and four daily results greater than 400 are measured in four different months, the stream would be assessed as fully supporting (4/60 – 6.7 percent rate of exceedance) rather than nonsupporting (4/12 – 33.3 percent rate of exceedance), provided that the monthly geometric means were below the 200 counts/100 ml criteria.

The decision criteria does not provide for 303(d) listing of waters with severely limited data sets and exceedance (i.e., one sample in a five-year period > 400 counts/100ml). Such waters would be classified as having insufficient data available for use assessment. The DEP will target these "fecal one-hit" waters for additional monitoring by incorporating them into the pre-TMDL monitoring plans at the next opportunity for TMDL development in their watershed. Where the intensified pre-TMDL monitoring (monthly sampling for one year) indicates impairment, TMDL development will be immediately initiated, even though the water may not be included in Category 5 of the current Integrated Report." (Wirts, 2012)

WV Division of Forestry GIS Approach and Rationale

The goal of the GIS analysis is to develop a map of the Back Creek watershed to prioritize forest conservation/management efforts in the watershed. The WVDOF chose a state issue-based approach supported with geo-spatial analysis to help with prioritization. A separate GIS analysis for each issue and/or sub-issue was developed. Once identified watershed issues were finalized, data gathering of GIS layers that represented threats or benefits to an issue were sought. Data layers were reclassified and combined to establish "Priority" forest landscapes in the watershed. This would assist with workforce distribution and staffing to meet both long term and short term conservation goals. Priority areas will also identify opportunities for collaboration across programs, and agencies that work in the area. Establishing priority areas will also benefit WVDOF program area management for stewardship and managed timberland. The following national priorities and objectives will also be addressed:

Conserve and Manage Working Forest Landscapes for Multiple Values and Uses:

- conserving and managing working forest landscapes for multiple values and uses
- Identify and conserve high priority forest ecosystems and landscapes
- Actively and sustainably manage forests

Protect Forests from Threats: protect forests from threats, including catastrophic

- storms, flooding, insect or disease outbreak, and invasive species
- Restore fire-adapted lands and/or reduce risk of wildfire impacts
- Identify, manage and reduce threats to forest and ecosystem health

Enhance Public Benefits from Trees and Forests: including air and water quality, soil conservation, biological diversity, carbon storage, and forest products, forestry-related jobs, production of renewable energy, and wildlife.

- Protect and enhance water quality and quantity
- Improve air quality and conserve energy
- Assist communities in planning for and reducing forest health risks
- Maintain and enhance the economic benefits and values of trees and forests
- Protect, conserve, and enhance wildlife and fish habitat
- Connect people to trees and forests, and engage them in environmental
- stewardship activities
- Manage trees and forests to mitigate and adapt to global climate change

The GIS analysis incorporated data layers from the recent "Development of Issue-Relevant State Level Analyses of Fragmentation and Urbanization" Forest Service Northeastern Area, Northern Research Station study, and coupled with several other state wide datasets. The overlay analysis incorporated 8 input layers described as follows:

Initial watershed analysis area - HUC-12 sub-watershed boundaries

Data Source: WV GIS Technical Center, "wvWbdHu12_NRCS_2009_utm83.shp" downloaded September, 2009 available at http://wvgis.wvu.edu//data/data.php

Description and GIS Process: A selection set of Back Creek HUC-12 polygon shape file records was clipped by the latest West Virginia county shape file to establish the Back Creek watershed area within WV, approximately 69,700 acres. This would serve as the study area for the individual priority input layer values, as well as summed priority scores.

Input Layer Processing and Reclassification:

Input layer 1: Development pressure (Housing Density Estimates)

Description and GIS Process:

This dataset consists of 15 common housing density classes from "Urban" to "Undeveloped Private". The two lowest density classes, "rural" (>40 acres per unit) and "undeveloped private", were used, since rural areas are most important for the forest conservation. These lowest classes were reclassified to 1. The remaining housing density classes were classified as "no data" in the original dataset, and were all reclassified as "0". The original dataset had areas of public or protected land and water polygons, which were considered undevelopable and did not have a housing density figure. These areas were also classified as 1 as they remain important to conservation.

Input layer 2: Managed Timberland / Forest Stewardship Program Participants

Description and GIS Process: A dataset of DOF Managed Timberland tax were identified using tax parcel geospatial data provided by Morgan and Berkeley Counties. Matching Managed Timberland accounts were then merged with "Current" 10 year Forest Stewardship Program participants in the newly established Back Creek Watershed analysis area. The merged and clipped data was then dissolved to

eliminate overlapping areas, as many of these landowners participate in both programs. Areas coating either Managed Timber or Stewardship were classified as “1” and the remainder as “0”.

Input layer 3: Non-coalfields areas of West Virginia

Description and GIS Process: The coal fields of West Virginia are typically areas that have non-forestry uses and have historically been areas of resource extraction. So, only areas outside of these coal fields were counted and reclassified to “1” and coal field areas as “0”.

Input layer 4: Forest patches (1,000 Acre + forest patches)

Description and GIS Process:

A 30 meter grid of forest patches of 1,000 acres and greater established in a resent USDA Forest Service study were preferred and reclassified to “1”. The remaining classes were reclassified to “0”.

Input layer 5. Interior forests (Forested areas greater than 90 meters from development)

Description and GIS Process:

Three classes represented forested areas with proximities of less than 30 meters, 30-90 meters, and greater than 90 meters distance from development, known as “developed edge”. The “developed edge” layer represents urban areas, agriculture, and barren land classifications. Interior forests are beneficial for conservation, so all forested areas further than 90 meters from development were preferred and reclassified to “1” and the rest as “0”.

Input layer 6. Forested areas within 1 mile of public and private protected lands

Description and GIS Process: A recently developed high resolution (9 meters) land use/land classification data set was developed by WVU’s Natural Resource Analysis Center (NRAC) using 2011 imagery analysis to determine forested areas state-wide. This was used to identify forested areas within 1 mile of existing public and private protected lands. Resulting forested areas were re-sampled to a 30 meter grid classified as “1” and the remainder as “0”.

Input layer 7. Forested areas within 1 mile of a river

Description and GIS Process: A recently developed high resolution (9 meters) land use/land classification data set was developed by WVU’s Natural Resource Analysis Center (NRAC) using 2011 imagery analysis to determine forested areas state-wide. This was used to indentify forested areas within 1 mile of rivers, re-sampled to a 30 meter grid and classified as “1” and the remainder as “0”.

Input layer 8. Tax parcels greater than or equal to 10 acres

Description and GIS Process: Morgan and Berkeley County tax parcels greater than or equal to 10 acres were selected, converted to 30 meter grid and classified as “1” and the remainder as “0”.

Forest Conservation Validation Overlay Result

All 8 input layers, if not already, were converted and snapped to a 30 meter UTM NAD 83 Zone 17 grid. The input layers classified 0/1were combined in a raster overlay with equal weighting and possible scores of "0-8", representing "Low" to "High" priority. The analysis shows that higher value pixels, representing the presence of most data input layers, occur in existing and approved Forest Conservation Areas.

Green Rivers GIS Approach and Rationale:

Initial Watershed Analysis:

Input Layer 1: WV Watershed Boundary Dataset (8, 10, and 12 Digits)

Description and GIS process: This dataset is a complete digital hydrologic unit boundary layer to the subwatershed (12-digit) 6th level at 1:24,000 scale. It consists of geo-referenced digital data and associated attributes created in accordance with the Federal Standard for Delineation of Hydrologic Unit Boundaries. These watershed datasets are published and approved by the NRCS as of 30 Jan 2009.
The Back Creek Watershed boundary was selected from the layer and converted into its own shapefile and used in clipping other layers to include only data within the Back Creek Watershed.

Input Layer 2: 2011 USGS National Hydrology Dataset of Back Creek downloaded from WVGIS Tech Center and developed by the USGS.

Description and GIS process: This dataset shows detailed stream segments for the Back Creek Water with their official USGS names. It was clipped to the Back Creek Watershed boundaries and used throughout the GIS analysis to show the relationship of other data to the streams in the watershed.

Land Use Analysis
Input Layer 1: Multi-Resolution Land Characteristics Consortium Land Use Land Cover 2006

Description and GIS process: The Land Use Land Cover raster was converted to a polygon and clipped into a new shapefile with the Back Creek Watershed layer to display only the land uses within Back Creek. The 20 original land cover classes were then reclassified: three types of forest cover were combined into a single forested cover layer; two types of wetland cover layers were combined into a single wetland cover layer; developed open space, developed low intensity, developed medium intensity, developed high intensity were combined into a common development layer; cultivated crops and pasture/hay cover types were combined into a common agricultural cover layer; all other land cover classes were unchanged. The Back Creek Land Use layer was then summarized into a table by land use characteristics giving a total acreage of each land use within the watershed.

Input Layer 2: Virginia and WV State Boundaries

Description and GIS process: The Back Creek Watershed wide Land Use Land Cover data, processed as described above, was clipped by the state boundary of WV and VA to create shapefiles for each state's portion of the watershed. Each state's portion was then summarized into a table by land use characteristics giving a total acreage of each land use within that portion of the watershed.

DEP TEAM Data Analysis

Input Layer 1: TEAM Data

Description and GIS process: A Microsoft Excel Data Sheet of the field collected TEAM data was provided to Green Rivers by WVDEP containing locations of stream bank erosion referenced by XY coordinate data. The spreadsheet was converted into a shapefile through ArcCatalogue using the Create Feature Class from XY Data tool. The shapefile was then converted to a feature class that included only data points that had Right or Left Streambank Erosion Severity values greater than zero. The Right and Left Streambank Erosion Severity values where than combined into a new field. The total erosion value of the data points where then displayed as color coded points according to the TEAM methodology of 1-3 = Slight, 4-6 = moderate, 7-10 = severe. A 2011 USGS National Hydrology Dataset of Back Creek was used as a baselayer to show the locations of the TEAM data along Back Creek.

Habitat Conservation Prioritization Analysis

Input Layer 1: Freshwater Institute. Wetland Corridor. Eastern Panhandle, West Virginia.
The landscape between core wetland areas is assessed for its linkage potential, and conduits and barriers to the movement of wetland-dependent species are identified. The resulting corridor thus facilitates the movement of wetland-dependent species.

Input Layer 2: Freshwater Institute Tier 2 Core Wetland (1ha). Eastern Panhandle, West Virginia.
Relatively undisturbed wetland areas and their adjacent upland buffer zone that meet a minimum size threshold based on landscape conditions. At least 2.5 acres in size but less than 25 acres. Target species: wetland-dependent plants.

Input Layer 3: Freshwater Institute Tier 1 Core Wetland (10ha). Eastern Panhandle, West Virginia.
Relatively undisturbed wetland areas and their adjacent upland buffer zone that meet a minimum size threshold based on landscape conditions. At least 25 acres in size. Target species: wetland-dependent reptiles, amphibians, birds, and butterflies.

Input Layer 4: Freshwater Institute Aquatic Core. Eastern Panhandle, West Virginia.
Stream reaches containing high quality aquatic resources (fish and mussels) and including the floodplains, wetlands, and contiguous forest within their respective drainage basin that support these resources. Umbrella species for aquatic systems include fish and mussels. Core aquatic systems are typically watersheds with minimally disturbed landscapes. WVDNR biologists classified all watersheds into four classes; Class 1 (Exceptional); Class 2 (Excellent); Class 3 (Good); Class 4 (Poor). All watersheds above Class 4 were identified as aquatic cores. Class 1 & 2 watersheds support at least one SGNC and/or support a level of diversity of SGNC within the top 25th percentile in the state and/or support a reproducing native trout population. A Class 3 watershed supports a recreational fishery and/or a moderate diversity of SGNC and/or was historically a Class 1 or 2 watershed. Other watersheds were included within a given class if they were immediately upstream of a Class 1-3 watershed or significantly contribute to a Class 1-3 watershed.

Description and GIS process: Freshwater Institute Habitat layers where clipped to the Back Creek Watershed Boundaries. The layers where then Spatially Joined to the Berkeley County Tax Map Parcels layer.

Input Layer 5, 6: Rare Threatened and Endangered Species .WVDNR Natural Heritage Program point and polygon layers of documented locations of Rare Threatened and Endangered Species.

Input Layer 7: Berkeley County 100 Year Floodplain provided by the Berkeley County Planning Commission

Description and GIS process: Layers 1-7 where clipped to the Back Creek Watershed Boundaries. The layers where then Spatially Joined to any Berkeley County Tax Map Parcels with a ¼ mile tolerance for RTES locations. The ¼ mile distance was chosen to create a habitat area that allows for species movement and to prevent disclosure of exact species locations. The resulting tax parcels are included as potential RTE Species habitat that should be included in conservation prioritization plans.

Input Layer 8: Berkeley County Tax Map Parcels provided by the Berkeley County Assessor

Description and GIS process: The Tax Map shapefile was clipped to include only the Back Creek Watershed and Spatially Joined with layers 1-7 to create layers of property parcels which contain the 100 year floodplain, potential RTE Species habitat, core wetlands, wetland corridors and aquatic habitat. The joined tax map layers where then merged to create a tax map which scored parcels on their Habitat Conservation Value. Highest Priority parcels contain the 100 Year Floodplain and or Core Wetlands. High Priority Parcels contain RTES, Wetland Corridor, and Core Aquatic Habitat, Medium Priority Parcels contain two of RTES, Wetland Corridor, and Core Aquatic Habitat, and Lower Priority Parcels contain one of RTES, Wetland Corridor, and Core Aquatic Habitat.

Impervious Surface Analysis

Input Layer 1: MLCD 2006 Percent Developed Imperviousness for WV downloaded from WVGIS Tech Center and developed by the Multi-Resolution Land Characteristics Consortium.

Description and GIS process: This raster dataset shows each cell by a value from 1-99 representing its percent developed imperviousness from 0 to 99% impervious. The raster was first clipped to the Back Creek Watershed boundary and then a new raster attribute table was calculated. The 900 sq. meter cell size was then multiplied by 0.222395 and the cell count for each impervious category to create a new area attribute field in acres. The area of each impervious category was then multiplied by the cell count for that value and 0.01 to create a new field showing the acreage of actual developed imperviousness represented. The acreage of impervious was then summarized for the entire watershed and for the respective WV and VA portions of the watershed.

Streams Bordering Agriculture Analysis

Input Layer 1: 2001 UMD RESAC Land Use Data

Description and GIS process: The agricultural lands identified in the 2001 RESAC land use data for Berkeley and Frederick Counties as described under the Land Use Analysis GIS Rational in this report where selected and a new layer was created of only the agricultural lands. The hydrology dataset of Back Creek was clipped with the agricultural lands shapefile with a tolerance of 10 feet to create a shapefile of streams within or bordering agricultural lands to display the lengths and locations of these streams within the watershed.

Stakeholder Meeting Attendees and Notes

8/8/12 Stakeholder Meeting Notes

Attendees:
Sherry Evasic
Kat and Mike CiMaglio
Charles Ashton
Kevin Ashton
Suzy Lucas
Larry Hines
Allan and Deborah Knotts
Floyd and Mike Kursey
Emily Warner
Elaine C Mauck
DNR Law Enforcement Officer from District II
Kieran O'Malley
Brent Walls
Kelly Cochran
Athey Lutz
Rob Stull

Discussion Notes and Comments:
Conservation Easements – importance of landowners talking to other landowners about benefits of easements. Ways to ease burden on landowners. Ways to prevent cropland loss while still implementing buffers – low growing vegetation, buffer on lower level created by NSD project.
Temporary road construction – use removable "swamp mats" instead of gravel and dirt roads.

Stakeholder 1:
Important Tributaries – Tilhance Creek, Elk Run, Kates Run.
Sedimentation – coming out of first order tribs above Ganotown near state line.
Strange sediment with "slimy feeling" suspended in water column at confluence of Kates Run and Back Creek.
Would like to see more sampling and concrete action rather than just another plan. Worried plan will end up stuck in a drawer and not useful.

Stakeholder 2:
Do GIS land use change analysis.
Use of zoning and ordinances as protection method.
Assessment of nutrient management plans on farms.
Find examples of ordinances, BMPs ect.. that have been successful in similar circumstances or from other protection plans.
Compare historical and present day land use.
Impervious surface increase.
Dirt road, ditch pulling by state road as a sediment contributor. Group in PA has system for estimating sediment load from these sources.
Try and identify hot spots of ATV and 4WD activity in stream and on banks.

Stakeholder 3:
Trash and illegal dumping is an issue, others agree and suggest deputizing local enforcement corps as preventative and utilizing correction workers as cleanup method.
Is water clean enough to swim in? Others in group say yes.
Not as many large mussels as there where when they were growing up. Others say there are but they are only in certain parts of the stream.

Stakeholder 4:
Not many entities to create or enforce ordinances other than the County Planning Commission.
Are we looking at taking flow measurements for NSD work as method to reduce erosion? Erosion is symptom not the problem.

Stakeholder 5:
Make upstream users do their part in preventing increased runoff and erosion.
Unimin sand plant chemical spills and fish kills near Gore, VA.

Stakeholder 6:
NSD work is expensive. Floodplain analysis is expensive.
Zoning is brought up and voted down every 6 years or so. Bringing it up is a sure way to get opposition to your work.
Back Creek really gets wide after a rain. Amazing how it spreads out.
Blockages in stream due to log jams cause erosion as stream reroutes. EPCD has funds to address only if they are affecting transportation infrastructure.

Stakeholder 7: Showed photos of high, eroded stream banks from their work. Group agrees it is an issue and that once it reaches that point, buffer zones don't work because the vegetation will get undercut.
Thick layers of filamentous algae in areas, habitat varies but always shallow areas (<1.5') of the stream, often attached to bottom-rooted coon's tail plant.

9/12/2012 Stakeholder Meeting Notes

Attendees:
Allison Beck
Greg Carnill
Richard Kidwell
Nancy Kidwell
Dawn Gonano
John Gonano
Jenni Vincent
Roland Gonano
Ed Thompson
Elaine C. Mauk
M.L. Sibble
Clint Hogbin
Doug Hutzell
Herb Peddicord

Ashby Ruddle
Glenn Nelson
Allan Knotts
Debora Knotts
Kelly Cochran
Alana Hartman
Suzy Lucas
Athey Lutz
Ryan Gaujot

Discussion and Notes:

- Scenic River designation should be revisited.
- Landfill impact to Kates Run.
- Trash Dumping is prevalent at Allensville Bridge and Rt. 9 Bridge and other locations.
- Include BMPs and Financial Assistance available to landowners in the watershed.
- Get easement data from Berkeley County Farmland Protection Board and participation data in conservation programs from NRCS.
- Trickling Falls is a beautiful location in the watershed near Birch Creek subdivision.
- The impact of erosion from development and lack of BMP implementation, i.e. the bankrupt subdivision at Wilson Ridge Rd.
- Potential impacts of Acid Precipitation.
- Mapping of Shale Barren Ecosystems.
- Status of trout in Tilhance Creek and the impact of violations at Woods Resort subdivision treatment plant into Whites Run.
- The spraying of pesticides on power lines is leaving bare dirt causing erosion and sedimentation.
- Erosion from dirt roads and ditching along roads is causing sedimentation.
- Include the prioritization of Core Habitat for preservation.
- Unrestricted ATV and 4WD access to stream and banks at Shanghai and other areas.
- Coordination with DOH to replace old bridges with span type bridges as the come up for replacement.
- Back Creek Watershed signage should be installed. BHEN has some older signs that need installed.
- Assess the adequacy of WWTPs for subdivisions and private residences.
- Share raw GIS data in final product where possible.
- Protection of riparian buffers from deer grazing.
- Stream bank erosion.

RESUMES

RYAN COOLEY GAUJOT
President
Green Rivers LLC
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Education
M.S. Geology, West Virginia University, 2002
B.S. Geology, University of Utah, Salt Lake City, UT, 1998

Geology, Surface Hydrology, and Fish Habitat Relationships in the upper Shavers Fork Drainage Basin, West Virginia, 2002, Master's Thesis, West Virginia University, Morgantown, WV.

Mr. Gaujot is president and principal geologist with Green Rivers LLC. Green Rivers provides ecological restoration to communities, associations, agencies, and businesses. Ecological restoration initiatives include turn-key stream and wetland restoration projects, mitigation banking, site identification, watershed assessment, watershed planning, riparian corridor design and construction, stream-bank stabilization, culvert & small bridge design, retrofit, and installation, acid mine drainage AMD abatement design, delineation and monitoring services.

Previous clients include Elk Headwaters Association, Friends of the Cheat, Cheat River TMDL Stakeholder Group, Shavers Fork Coalition, Briscoe Run Watershed Association, the South Branch Watershed Association of Hampshire County, Opequon Creek Project Team, Sleepy Creek Watershed Association, Tuscarora Creek Landowners, the Youghiogheny River Watershed Association, Morris Creek Watershed Association, Kelly's Creek Watershed Association, Hughes Creek Watershed Association, Davis Creek Watershed Association, Gilmer Watershed Coalition, Canaan Valley Institute, WV Rivers Coalition, WV Council of Trout Unlimited, The Nature Conservancy, Wildland Hydrology, Earth Mark Mitigation, Appalachian Stream Restoration, Appalachian Forest Products, Patriot Coal, Petroleum Development Corp., Chesapeake Energy, North State Environmental, Stantec Consulting , Summit Engineering, Highland Engineering & Surveying, GAI Consultants, Thrasher Engineering, Downstream Strategies, West Virginia University, West Virginia Water Research Institute, United States Environmental Protection Agency, United State Army Corps of Engineers, United State Fish and Wildlife Service, Federal Emergency Management Agency FEMA, United States Forest Service, WV Department of Environmental Protection, and the WV Division of Natural Resources.

Previous Employment

- Canaan Valley Institute, Thomas, WV (2002-2010); Geologist, Aquatic Restoration Team
- West Virginia Division of Natural Resources, Elkins, WV (2001-2002); Forestry Technician Internship, Wildlife Resources Division
- West Virginia University, Morgantown, WV (1999-2001); Teaching Assistant, Department of Geology and Geography, (*Teaching Assistant of the Year 2000*)
- Marshall Miller & Associates, Bluefield, VA (1998-1999); Geologist, Special Services Unit

Professional Experience
Highlights

- Stream and wetland restoration assessment, design, and construction management
- Environmental mitigation, mitigation banking, and post construction monitoring
- Stream and wetland delineation and avoidance
- Permit applications for federal, state, and local requirements
- EPA 319 watershed based plans and watershed master plans
- OSM WCAP grant submission and acid mine drainage abatement project design
- FEMA Flood Map redelineation for Gilmer and Preston Counties, West Virginia
- Watershed Assessment for River Stability and Sediment Supply (WARSSS)
- Stream gauge installation and calibrations referencing bankfull discharge
- Floodplain management strategies and floodplain delineation using LiDAR
- Geologic and hydrogeologic assessments
- Trainer in over 1000 hours of hydrologic classes and programs
- Published in the *Encyclopedia of Appalachia*, 2006, University of Tennessee Press
- Central to collaborations with technical agencies and private citizens
- Legislative testimony on water quality and flooding issues for West Virginia

Ecological Restoration Experience (1998-2012)

- Participated in all aspects of approximately **10 miles of 'on-the-ground' stream restoration projects** in the Eastern US, including design, permitting, installation, and monitoring
- **Rosgen certified levels 1-4** with Wildland Hydrology; field and **technical instructor** with Dave L. Rosgen, PhD in over 600 hours of Natural Stream Design (NSD) training courses from Levels 1-3 including the Level 1 Engineers Course
- **Stream and wetland delineation and avoidance** and 404 permit compliance for over 20 miles of natural gas pipelines and drilling locations in West Virginia
- Grant application development, design, and funding acquisition for **EPA 319 Watershed Base Plans** for the Morris Creek Watershed Association, Mountwood Park, Elk Headwaters, and Mill Creek of the Opequon River
- **Watershed Cooperative Agreement Proposals** (WCAP) to the US Office of Subsurface Mining for the Morris Creek Watershed acid mine drainage and sediment abatement projects, Montgomery, West Virginia (total projects cost $1.2 million)
- **Geomorphologic and hydrologic assessments**, bedload and suspended sediment measurement and monitoring, stream stability and sediment supply analysis, geophysical exploration, assessment of property, proposal of exploration, core drilling supervision, geophysical logging of drill holes, evaluation and closure of solid waste facilities
- **Groundwater monitoring** activities include assessment of contaminants including causes, impact, and remedial alternatives, deep and shallow well installations and development, permeability testing, sampling and reporting, water supply inventory, contaminated site risk assessment, diesel product recovery, potentiometric flow maps, and stream gauging
- **Bedload and suspended sediment sampling** for transport rates , annual sediment yield, and **TMDL reductions** for two stream monitoring stations in the Cheat Basin
- **LiDAR** data acquisition, ground control, and analyses for **FEMA flood mapping** and stream restoration projects in the Mid Atlantic Highlands, Gilmer County digital flood insurance rate map DFIRM production and community implementation
- **Geologic Assessment** for a construction project on 3,208 acre parcel adjacent to USF&WS Wildlife Refuge, the Davis municipal water supply system, WV state highways 93, a WVDEP acid mine drainage treatment system, and the Blackwater River

- Provided over **1000 hours of tailored hydrologic training** to federal, state, and local agencies and various watershed organizations in WV, MD, VA, and PA

Certifications and Training

- Rosgen Trained Level 1-4 in Applied Fluvial Geomorphology, River Assessment, Monitoring, Restoration, and Natural Stream Channel Design
- Professional Hydrologist (#09-HIT-055); American Institute of Hydrology
- Certified Floodplain Manager (CFM) #US-05-01608; Association of State Floodplain Managers

EVAN MICHAEL SUPAK
Biologist
Green Rivers LLC
supak@greenrivers.net

Education
B.S. Wildlife and Fisheries Resource Management focusing on Fisheries Management and Conservation Ecology, West Virginia University, 2008

Mr. Supak is the primary biologist for Green Rivers LLC. Green Rivers provides ecological restoration to communities, associations, agencies, and businesses. Ecological restoration initiatives include turn-key stream and wetland restoration projects, mitigation banking, site identification, watershed assessment, watershed planning, riparian corridor design and construction, stream-bank stabilization, culvert & small bridge design, retrofit, and installation, acid mine drainage AMD abatement design, delineation and monitoring services.

Previous Employment

- North Fork Watershed Project, Davis, WV (2010-2011); Project Manager. Stream restoration study and Google Earth project design
- AmeriCorps, North Fork Watershed Project, Davis, WV (2010); Summer Associate. Brook trout habitat study
- West Virginia University, Morgantown, WV (2008); Macroinvertebrate Lab Intern

Professional Experience
Highlights

- Stream and wetland delineation and avoidance
- Stream Surveying
- Construction oversight
- Permit applications for Federal, State, and Local requirements
- Landowner research and contact
- Spatial data acquisition using hand-held Garmin and Trimble GPS units
- Spatial data management with ArcGIS and Google Earth Pro
- Google Earth Pro project design
- Google Earth Pro presentations to environmental teaching professionals
- Benthic macroinvertebrate sampling and identification
- Brook trout habitat study design, logistical management, and execution
- Stream restoration feasibility study design and management
- Water quality monitoring with multi-parameter testing units

Ecological Experience (2008-2012)

- **Water resource investigations**: Stream and wetland delineations for pre- and post-impact water resource inventory and avoidance reports in accordance with U.S. Army Corps of Engineers delineation methodology
- **Stream Assessment and Surveys:** Methods include the use of survey grade equipment (RTK GPS, Total Station, and Laser Levels) to acquire morphological stream data such as cross sectional and longitudinal profiles; stream classification using the Rosgen Stream Classification System; identification of bankfull elevations; conducting pebble counts and bar samples to document stream substrate and estimate discharge; measurement of stream pattern characteristics such

as belt width, meander wavelength, radius of curvature, and sinuosity; acquisition and calculation of Bank Erosion Hazard Index, Near Bank Stress, and Pfankuch data to estimate annual bank erosion and sediment supply; use of regional curves and USGS stream gauges to validate data collected in the field; use of RIVERMorph software to compile, interpret, manage, calculate, and display stream survey data

- **Construction oversight** on stream and floodplain restoration projects
- **Permit applications related to stream restoration projects**, including US Army Corps of Engineers, West Virginia Department of Environmental Protection, West Virginia Division of Natural Resources, and local Floodplain Construction permits
- **Landowner research and contact** related to stream restoration activities in West Virginia
- **Spatial data acquisition** and in-field shapefile creation using a hand-held Trimble GeoXT GPS unit
- **Spatial data management** and map creation using GPS Pathfinder Office, ArcGIS, and Google Earth Pro for various habitat studies and technical reports
- **Google Earth Pro project design** including detailed watershed and impact location mapping for the Blackwater River, North Branch Potomac, and North Fork South Branch Potomac watersheds
- **Google Earth Pro Presentations**: *Using Google Earth in Environmental Education.* Presented to environmental educators at the 2011 West Virginia Environmental Education Association Conference
- **Benthic Macroinvertebrate and fish population sampling** with kick-net and electroshock techniques with field/lab identification on 26 streams throughout West Virginia
- **Brook trout habitat study** using WVDEP Save our Streams protocols conducted in 2010 involving 10 streams throughout the Potomac Highlands region of West Virginia
- **Stream Restoration Feasibility Study** on 8 streams located in the Blackwater River watershed, with the goal of identifying a stream suitable for brook trout reintroduction
- **Water quality monitoring** on the North Fork Blackwater River for an ongoing project monitoring acid mine drainage levels within the North Fork watershed

Certifications and Training

- **Rosgen Level I:** Applied Fluvial Geomorphology, Wildland Hydrology, 2012.
- **Rosgen Level II:** River Morphology and Applications, Wildland Hydrology, 2012.
- **The Swamp School:** U.S. Army Corps of Engineers Wetland Delineation and Regional Supplement Updates training. North American Association of Consulting Wetland Scientist Accredited 2011.

ROBERT TROY STULL
Project Manager
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Education
B.S. Environmental Studies with a concentration in Resource Management and Environmental Education, Shepherd College, 2000
Associate of Science in Park Management, Frederick Community College, 1996

Mr. Stull is the Project Manager for Green Rivers LLC. Green Rivers provides ecological restoration to communities, associations, agencies, and businesses. Ecological restoration initiatives include turn-key stream and wetland restoration projects, mitigation banking, site identification, watershed assessment, watershed planning, riparian corridor design and construction, stream-bank stabilization, culvert & small bridge design, retrofit, and installation, acid mine drainage AMD abatement design, delineation and monitoring services.

Previous Employment

- Green Rivers LLC, Thomas, WV (2011-present); Project Manager. Stream Restoration and Wetland Delineation.
- FLOC Outdoor Education Center, Harpers Ferry, WV (2006-2011); Program and Outreach Coordinator. Environmental Education programs.
- Canaan Valley Institute, Thomas, WV (2003-2006); Watershed Circuit Rider. Stream Restoration and Wastewater issues in the Mid-Atlantic Highlands
- Notre Dame Academy, Middleburg, VA (2000-2003); Faculty/Coach. Environmental Science, Health and Outdoor Recreation.
- River and Trail Outfitters, Knoxville, MD (1995-2003); Canoe and Kayak Instructor
- WV Division of Natural Resources, Inwood, WV (April- July 1999); Environmental Education Coordinator. Educational programs in the Chesapeake Bay Watershed

Professional Experience
Highlights

- Stream and wetland delineation and avoidance
- Stream Surveying
- Field Data collection
- Landowner research and contact
- Spatial data acquisition using hand-held Garmin and Trimble GPS units
- Water quality monitoring with multi-parameter testing units
- Stream restoration feasibility study design and management
- Benthic macroinvertebrate sampling and identification
- Watershed Project Management
- Assessing Wastewater Options for Small Communities
- Grassroots Fundraising

Ecological Experience (1999-2012)

- **Stream Surveying**, including the acquisition of cross sectional profiles, longitudinal profiles, and establishing control with high resolution RTK GPS, total station, and laser level equipment
- **Field data collection** for various projects including the acquisition and calculation of Bank Erosion Hazard Index, Near Bank Stress, and Pfankuch data. The use of flow meters to measure discharge, conducting pebble counts and bar samples to document stream substrates, conducting visual habitat assessments, field water chemistry tests, and sampling aquatic fish species with electroshock techniques
- **Construction oversight** on stream and floodplain restoration projects
- **Permit applications related to stream restoration projects**, including US Army Corps of Engineers, West Virginia Department of Environmental Protection, West Virginia Division of Natural Resources, and local Floodplain Construction permits
- **Landowner research and contact** related to stream restoration activities in West Virginia
- **Benthic Macroinvertebrate sampling** and field/lab identification on various streams within West Virginia
- **Stream Restoration Assessment** on Davis Creek located in Kanawha County, with the goal of identifying and prioritizing restoration efforts targeting fish habitat and sediment transport.
- **Water quality monitoring** on various streams throughout West Virginia using the WV Save Our Streams protocol.

Certifications and Training

- **Rosgen Trained Level 1-2** in Applied Fluvial Geomorphology and River Assessment
- **The Swamp School:** U.S. Army Corps of Engineers Wetland Delineation and Regional Supplement Updates training. NAACWS Accredited 2012
- **Project WET**: Certified Instructor 1/98
- **Rescue 3 International**: Swiftwater Rescue Technician 3/01
- **American Red Cross**: Certified First Aid & CPR Instructor 5/11
- **Save Our Streams**: Certified Facilitator 9/05

ATHEY EDWARD LUTZ
Environmental Geologist
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Education
B.S. Environmental Geology, The University of Dayton, 2007
Professional's Certificate: River Restoration. Portland State University, 2009

Mr. Lutz is a field geologist for Green Rivers LLC. Green Rivers provides ecological restoration to communities, associations, agencies, and businesses. Ecological restoration initiatives include turn-key stream and wetland restoration projects, mitigation banking, site identification, watershed assessment, watershed planning, riparian corridor design and construction, stream-bank stabilization, culvert & small bridge design, retrofit, and installation, acid mine drainage AMD abatement design, delineation and monitoring services.

Previous Employment

- North Fork Watershed Project, Davis, WV (2009-present); Project Director. AMD monitoring, stream restoration studies, grant procurement and management, ArcGIS and Google Earth mapping, volunteer management, environmental education, sustainable trail building.
- National Oceanic Atmospheric Administration, Davis, WV (2010-present); Contractor. Field technician for AIRMON precipitation monitoring station WV99.
- ARCADIS Gerharty and Miller, Cleveland, OH (2008-2009); Field Geologist. Field activities in support of hazardous waste site remediation and investigation.

Professional Experience
Highlights

- Brook trout habitat study design, personnel, and execution
- Stream restoration feasibility study design and management
- Soil, air, surface and groundwater monitoring and sampling
- Field Data collection
- Construction oversight at Superfund and other remediation sites
- Implementation of health and safety plans at remediation sites
- Groundwater monitoring well installations and soil logging
- Permit applications for Federal, State, and Local requirements
- Landowner research and contact
- Spatial data acquisition using hand-held Garmin and Trimble GPS units
- Spatial data management with ArcGIS and Google Earth Pro
- Google Earth Pro project design
- Google Earth Pro presentations to environmental teaching professionals
- Benthic macroinvertebrate sampling and identification
- Environmental education presentations and field trips for youth

Geological Experience (2008-2012)

- **Environmental monitoring and sampling** of various mediums to demonstrate compliance with a variety of state and federal statutes and rulings covering the investigation and remediation of contamination from hazardous materials.
- **Stream Restoration Project Design** of liming program for four acid precipitation impacted tributaries to the Blackwater River with the goal of brook trout reintroduction.
- **AMD monitoring program management** for ongoing monitoring of acid mine drainage impacts from the Coketone Mine Pool complex in the North Fork of the Blackwater River watershed including volunteer training, stream flow measurements, coordination of laboratory samples and database management.
- **Stream Surveying**, including the acquisition of cross sectional profiles, longitudinal profiles, and establishing control with high resolution RTK GPS, total station, and laser level equipment
- **Field data collection** for various projects including the acquisition and calculation of Bank Erosion Hazard Index, Near Bank Stress, and Pfankuch data. the use of flow meters to measure discharge, conducting pebble counts and bar samples to document stream substrates, conducting visual habitat assessments, field water chemistry tests for total acidity and total alkalinity, and sampling aquatic fish species with electroshock techniques
- **Construction/contractor oversight** on remediation projects including Superfund sites and emergency responses to chemical spills.
- **Health and Safety Plan implementation** at a variety of construction/remediation sites to ensure worker, environmental and public safety.
- **Permit applications related to stream restoration projects**, including US Army Corps of Engineers, West Virginia Department of Environmental Protection, West Virginia Division of Natural Resources, and local Floodplain Construction permits
- **Landowner research and contact** related to stream restoration activities in West Virginia
- **Spatial data acquisition**, wetland and stream boundary delineation, and in-field shapefile creation using hand-held Trimble GPS unit
- **Spatial data management** and map creation using ArcGIS and Google Earth Pro for various habitat studies and technical reports
- **Brook trout habitat study** using WVDEP Save our Streams protocols conducted in 2010 involving 10 streams throughout the Potomac Highlands region of West Virginia
- **Stream Restoration Feasibility Study** on 8 streams located in the Blackwater River watershed, with the goal of identifying streams suitable for brook trout reintroduction
- **Google Earth Pro education project design** including detailed watershed and impact location mapping for the Blackwater River, North Branch Potomac, and North Fork South Branch Potomac watersheds
- **Google Earth Pro Presentations**: *Using Google Earth in Environmental Education.* Presented to environmental educators at the 2011 West Virginia Environmental Education Association Conference
- **Benthic Macroinvertebrate sampling** and field/lab identification

Certifications and Training

- **WVDEP Save Our Streams**: 2011
- **The Swamp School:** U.S. Army Corps of Engineers Wetland Delineation and Regional Supplement Updates training. NAACWS Accredited 2012.