

GREEN INFRASTRUCTURE ASSESSMENT

JEFFERSON COUNTY, WEST VIRGINIA

FRESHWATER INSTITUTE
THE CONSERVATION FUND

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2006

JEFFERSON COUNTY

GREEN INFRASTRUCTURE ASSESSMENT

CHALLENGE

Jefferson County, one of the hundred fastest growing counties in the nation, faces the loss of its valuable open space, farming heritage, and environmental quality if work is not begun to proactively identify those lands and attributes that are important to the citizens of Jefferson County.

VISION

With support from the County Commission and local stakeholders create a countywide green infrastructure framework that:

- Identifies and integrate opportunities for conservation, enhancement, and restoration of natural resources
- Informs land use decisions
- Allows Jefferson County to grow while maintaining its sense of place and unique character

APPROACH

- § Identify the natural resource areas required for environmental, social and economic sustainability
- § Conserve and connect important resource features
- § Foster community involvement and consensus
- § Identify opportunities to integrate green infrastructure into the land use planning process

ACHIEVEMENTS

- § Used the mapping and analytical capabilities of geographic information systems (GIS) to identify those natural and cultural resource areas of greatest importance and value for sustaining both a healthy ecosystem and a healthy community
- § Provided opportunities to educate and engage land planning professionals and the general public on the natural, economic, and social features of Jefferson County's natural resources
- § Developed geospatial datasets to support and prioritize land use planning and resource conservation decisions
- § Developed recommendations to support sustainable land use and Jefferson County's current reconsideration of its subdivision and zoning ordinance structure
- § During the project the Historic Landmarks Commissions identified hundreds of new historic sites and identified potential new historic districts
- § The Jefferson County Ag Task Force is using project data to identify potential new zoning districts

§ Collaborated with the Virginia Division of Natural Heritage to develop a model to predict occurrences of the federally listed Madison Cave Isopod

§ Collaborated with the West Virginia Division of Natural Resources to develop conservation priority models using the Jefferson County Green Infrastructure Assessment as a template.

Project Summary

Contact

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For more information about green infrastructure please visit: www.greeninfrastructure.net

ELEMENTS OF GREEN INFRASTRUCTURE IN JEFFERSON COUNTY

Green infrastructure in Jefferson County is comprised of the natural resource based environmental, social, and economic elements of sustainability that can be spatially characterized. These elements will be incorporated in a green infrastructure framework that encompasses those areas of greatest importance for sustaining both a healthy ecosystem and a healthy community.

Environmental Elements

Ecological Quality (Habitat)

Watershed Health

Drinking Water Quality

Drinking Water Quantity

Sensitive Karst Features

Septic System Suitability

Air Quality

Social Elements

Parks and Recreational Areas

Trails - Hiking/Biking/Walking

Agricultural Landscapes

Historic and Cultural Resources

Archaeological Resources

Viewsheds

Economic Elements

Natural Capital

Working Landscapes

Cultural Tourism

Ecotourism

Explanations of the elements of Jefferson County's green infrastructure can be found here: [Elements of Green Infrastructure - Glossary](#)

MAPS OF GREEN INFRASTRUCTURE ELEMENTS

The maps on this website are preliminary in nature and will be updated as data is supplemented by ongoing efforts. The maps provided are graphical representations intended for general reference only and may not reflect the most current information, and are not intended to provide either site-specific detail or survey-caliber accuracy.

Data Layers and Sources

Ecological

Environmental

Aquifer Vulnerability

Potential Runoff Accumulation

Social

Economic

Farmland Protection

Historical Landscape

FINAL GREEN INFRASTRUCTURE MAPS

[Green Infrastructure Network with Groundwater Suitability](#)

[Green Infrastructure Network with Social and Economic Suitability](#)

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23 January 2007

Ms. Frances Morgan
President
Jefferson County Commission
P.O. Box 250
Charles Town, WV 25414

Commissioner Morgan,

Please find attached a brief summary of our green infrastructure assessment for Jefferson County. We are also providing all the digital data elements that are the primary deliverable of our efforts. The mapping and resource data provides a solid base upon which to build geospatial resource assessment, planning and monitoring capability and represents nearly a year of technical analyst effort.

There were several highlights from this project, in particular was the tremendous engagement of the Jefferson County community and elected officials in providing input data and opinions. We found that the visible patterns remaining from the early history of Jefferson County illustrate the story of a community that recognized and stayed in balance with the natural resources at hand. Consequently, we found that the areas of concentrated cultural value in the rural landscape are also some of the areas of highest resource and conservation value both agriculturally and ecologically.

The suitability rankings and the prioritization of aquifer protection and aquatic corridor restoration issues were also clearly communicated. We also found that there are significant aligned drivers for the protection of these resources in the regulatory, public health and security, and wildlife conservation areas that will support protective actions by Jefferson County.

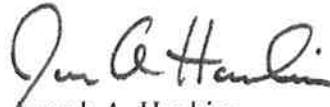
There are a number of complementary activities emerging regionally that connect with a county level green infrastructure assessment. Interstate compacts for water quality (Chesapeake Bay Restoration and MS4 Storm Water) and air quality (Ambient Air Quality Non-attainment), national and state wildlife habitat conservation efforts (West Virginia DNR Wildlife Habitat Conservation Plan, various USDA and USFWS programs), quality of life assessments (WV Vision Shared and various economic development scorecards), cultural legacy and natural resource based tourism (Gateway Communities and National Heritage Area initiatives), multi-modal and alternative transportation (WVDOH and Region 9 Transportation Planning) and even a rapidly evolving multi-state Eastern Brook Trout Restoration Joint Venture ... just a few examples of the linkages that can be made if Jefferson County has a clearly assessed inventory of green infrastructure.

The challenge going forward is to sustain the momentum and commitment. The community has now taken actions to identify and assess ecological functions and natural resource assets that are part of the commons we all share. The next steps will require developing a process so that these assets can be planned for and conserved, protected and monitored, restored and enhanced.

Moving into the next steps will require substantial engagement from both the community and the professional county planning staff to find ways to implement and provide incentives to assure the vision and outcomes identified in the phase occur and persist. How that happens is largely up to the local community but we stand by ready to provide examples and contacts with peers around the country.

It has been a pleasure working here in Jefferson County. I take both personal and professional pride in having the opportunity for some of my talented colleagues at The Conservation Fund to get to work with my friends and neighbors here at home.

Respectfully,



Joseph A. Hankins

Vice President

The Conservation Fund

enc: Jefferson County Green Infrastructure assessment data

cc: Mr. Erik Meyers, Vice President for Sustainable Programs, The Conservation Fund
Mr. Will Allen, Director for Strategic Conservation, The Conservation Fund
Mr. Michael Schwartz, GI Project Manager, The Conservation Fund's Freshwater Institute

Assessment of Green Infrastructure in Jefferson County, West Virginia

Vision for a Green Infrastructure Framework in Jefferson County

Outcomes of a Green Infrastructure Framework

- Sustained Quantity and Quality of Ground and Surface Waters
- Vital Agricultural Community and Working Landscapes
- Preserved Cultural Legacy
- Protected Habitat

Goals of a Green Infrastructure Framework

- Maintain integrity of the processes that sustain the quantity and quality of all waters of Jefferson County (such that the outcomes of land use patterns are tied to the condition of these critical resources)
- Maintain integrity of the Working Landscapes and Cultural Legacy of Jefferson County (to sustain traditional social and economic networks and preserve the unique visual and cultural character of Jefferson County)
- Employ both conservation and strategic restoration of Forests and Stream Corridors (to serve as a framework for protection of groundwater, surface water, habitat, and landscape connectivity)

Measuring Success

- Identify, inventory, and monitor key indicators of performance
- Base successful protection on outcomes measured through these indicators
- Use monitoring to determine the response to implementation and whether actions taken have been successful

Project Summary

The purpose of the Jefferson County Green Infrastructure Assessment was to define the areas of the county most valuable in terms of maintaining natural resource based environmental, social, and economic sustainability. The outcome of this assessment serves as a blueprint to minimize the impacts of growth while maximizing resource protection and community benefits. The insertion of a green infrastructure framework into the County planning process will provide predictability and certainty by identifying those resources most vital to community sustainability thus, allowing Jefferson County to grow while maintaining its sense of place and unique character.

The assessment process involved creating an inventory of green infrastructure elements in the County, the design of an ecological network, and the identification of environmental, social, and economic suitability for green

infrastructure. The inventory process involved the identification of the elements of green infrastructure in the county, identification of data sources, acquiring this data and assessing its quality and accuracy, and processing this data for input into the succeeding processes. The ecological network was designed by first identifying core forests of highest ecological value that also contained auxiliary high values; delineating hub areas surrounding these core areas that serve to create larger conglomerations of core forest areas; delineating core aquatic areas which included riparian corridors, riparian wetlands, and floodplains; and then connecting all of these elements with corridors to form a coherent network.

Green infrastructure suitability maps were created using the environmental, social, and economic elements of green infrastructure that were ranked in regards to relative importance at a meeting of invited stakeholders. These maps were then used to identify priority areas of highest composite value that should serve as focus areas for sustaining groundwater resources, working landscapes, cultural legacy, forest habitat, and stream corridors.

Throughout the project, opportunities were provided for community education and engagement in recognizing the natural, economic, and social features of Jefferson County's natural resources. Stakeholders were invited to comment on the elements of green infrastructure, assist in the prioritization of these elements, comment on the design of the ecological network and suitability maps, and finally to provide input on recommendations for the implementation of a green infrastructure framework in Jefferson County. In particular, community input resulted in the inclusion of all streams in Jefferson County as components of the ecological network, rather than those streams selected initially as core aquatic areas. Cooperative efforts with the Jefferson County Historic Landmarks Commission were instrumental in the delineation of historic districts as well.

There were numerous outcomes to the project, both expected and unexpected. The concurrent efforts of the green infrastructure assessment and the County ordinance rewrite helped to elevate land use planning issues in community discussions, served as a timely platform to incorporate green infrastructure principles into the new ordinances, and raise awareness of the land use planning and resource protection issues facing the County.

During the project the Jefferson County Historic Landmarks Commission identified hundreds of new historic sites as well as identified potential new historic districts while the Jefferson County Agricultural Task Force used project data to delineate potential new zoning districts.

New collaborative efforts also arose out of the project as staff from The Conservation Fund collaborated with the Virginia Division of Natural Heritage to develop a model to predict occurrences of the federally listed Madison Cave Isopod that may be used in Jefferson County in partnership with federal agencies, and will be cooperating with the West Virginia Division of Natural

Resources to develop conservation priority models using the Jefferson County Green Infrastructure Assessment as a template.

Project Deliverables

The primary deliverable of this project is a geographic information system containing data layers representing:

- Components of the Green Infrastructure Network
 - Forest Cores
 - Forest Hubs
 - Terrestrial Corridors
 - Aquatic Cores
 - Aquatic Corridors
- Green Infrastructure Suitability Surfaces
 - Environmental Suitability
 - Social Suitability
 - Economic Suitability
 - Combined Suitability
 - Component Data Layers
- Base layers such as roads and waterways along with other data used in the assessment of the County's green infrastructure
- Green Infrastructure Maps

A complete list of data provided is listed in the appendix.

Overview of Green Infrastructure Framework

Creating a Green Infrastructure Framework for Jefferson County will require the identification and integration of opportunities for resource management and land use planning at multiple scales. The areas of highest resource value recognized by the green infrastructure assessment are: Groundwater Resources; Working Landscapes; Cultural Legacy; Forest Habitat; and Stream Corridors. It is important to recognize that these resources often overlap spatially, representing areas of particularly high value.

Groundwater Resources

Both groundwater quantity and quality need to be managed to protect groundwater resources. This will require protection and management of significant recharge areas as well as those areas of high vulnerability. Groundwater recharge is maximized where runoff is minimized i.e. where the soil is most permeable and in areas far from surface water. Groundwater in Jefferson County is most vulnerable in areas far from streams, in areas of high septic system density, and within source water protection areas. Our groundwater resources can best be served by managing stormwater comprehensively using performance-based standards; maintaining natural land cover; managing septic systems and minimizing their density; and minimizing land disturbance.

Working Landscapes

The working landscapes of Jefferson County – agriculture, forests, and rivers, require management if they are to remain a vital part of the community. Agriculture is a community affair and farmers need farmers in their community thus, it is important to maintain the integrity of these social networks and preserve contiguous farmland. Along with historic landscapes, agricultural landscapes help create the unique visual and cultural character of Jefferson County.

Cultural Legacy

The cultural legacy of Jefferson County is entwined with the unique character of its landscape. As a consequence of the early history of Jefferson County being the story of living in balance with the resources at hand, we see that the areas of concentrated cultural value in the rural landscape are also some of the areas of highest value both agriculturally and ecologically. The historic districts identified by the Jefferson County Historic Landmarks Commission were designed to recognize these early settlement patterns.

Forest Habitat

Because it provides so many services, forest forms the core of green infrastructure. The greatest threat to our forests is fragmentation, as large patches of intact forest are essential for their unique ecology. These core forests should be preserved at all costs and bolstered where possible through reforestation. Groundwater and stream management goals should also be taken under consideration when planning for reforestation or forest mitigation. Trees in the landscape are so important no matter how big the patch is, that the county should strive to maintain at least 45% forest cover on a watershed basis at minimum, and 51% in watersheds of exceptional value.

Stream Corridors

Jefferson County's streams deserve special attention because surface water features are so scarce in karst topography. Consequently, special consideration needs to be given to the interrelationship between ground and surface waters and how actions on the surface affect our springs and streams. Maintaining a cap on impervious surfaces, preserving forested riparian buffers, and managing nutrients are all essential for keeping our streams healthy and clean. Caps on impervious surfaces should be implemented on a watershed basis. Watersheds with more than 10% impervious cover should be managed intensively to prevent further degradation, and watersheds with trout streams should be maintained at less than 4% impervious cover. The majority of the riparian corridors in Jefferson County are currently in poor condition and it is recommended that this condition be improved. A good target would be to create riparian corridors that are at least 71% forested with trout streams being forested at 77%. Nutrients can be managed effectively and economically by placing a cap on all water pollution in the county and encouraging nutrient trading and other performance-based management practices.

Recommendations for Implementation

Adequate protection of the resources that comprise green infrastructure can be ensured through integrating the green infrastructure framework into ordinances, comprehensive planning and land use management, and recognizing the impact of regional issues. Performance indicators should be identified and used to monitor the success of these efforts.

Ensure Compatibility of New Ordinances

Incorporate green infrastructure into the zoning process at both the site and county level. A countywide context will ensure that individual development projects incrementally advance the land use planning goals of the county.

Site Level

- Resource Protection Standards
- Residential Site Capacity Calculations

County Level

- Overlay Zones
 - Groundwater Resources Overlay Zone
 - Agricultural District Overlay Zone
 - Historic District Overlay Zone
 - Green Infrastructure Network Overlay Zone
- Open Space Regulations

Integration of Green Infrastructure Principles

- Incorporate green infrastructure principles into the next revision of Jefferson County Comprehensive Plan.
- Develop a plan for regular updates and revisions to components of the green infrastructure network.
- Use green infrastructure framework to identify opportunities for conservation, restoration, and environmental management.
- Ensure consistency of green infrastructure goals with the goals of other county activities.

Regional Context

Considering the regional context there are a number of national, regional, and statewide efforts that may impact Jefferson County, offering both opportunities and challenges:

- WV Watershed Management Framework
- Chesapeake Bay Restoration
- National and State Conservation Efforts
- Tourism
- Air Quality
- Quality of Life
- Climate Change
- Transportation Planning
- Regional Utility Planning

Performance Indicators

Set targets and measure progress for critical indicators of community sustainability. Measuring progress is a vital component of any land management process, providing both transparency and opportunities for evaluation and improvement of strategies. This will also enable the County to obtain a more refined picture of the state of land use in the county, protect critical resources, and monitor progress of both the green infrastructure framework and zoning. Monitoring may require acquisition of more current and accurate geospatial data in addition to regular updates of existing geospatial data. We recommend that the following resources be monitored and evaluated for progress in implementing the goals of green infrastructure:

- Groundwater
- Forest Cover
- Land Use
- Impervious Surface Areas
- Stormwater Management
- Floodplains
- Riparian Corridor Condition
- Streams
- Wetlands
- Wildlife Populations and Habitat
- Air Quality

Appendix

Green Infrastructure Assessment Data Layers- Geographic Information System

Green Infrastructure Network

- Forest Cores
- Forest Hubs
- Terrestrial Corridors
- Aquatic Cores
- Aquatic Corridors

Green Infrastructure Suitability

Environmental Suitability

- Groundwater Recharge
- Groundwater Vulnerability
- Watershed Health
- Air Quality
- Septic System Suitability
- Sensitive Karst Features
- Ecological Quality

Social Suitability

- Working Landscapes
- Natural Capital
- Ecotourism
- Cultural Tourism

Economic Suitability

- Historic and Cultural Resources
- Agricultural Landscapes
- Viewsheds
- Archaeological Resources
- Trails
- Parks and Recreational Areas

Combined Suitability

Land Use - Land Cover

- Imperviousness
- Topographic Map Mosaic
- Aerial Photo Mosaic

Streams

- Rivers
- Watersheds
- Bedrock Geology
- Faults
- Folds
- Fracture Traces
- Hobba Groundwater Hydrology Map
- S. Howell Brown 1852 County Map
- Springs
- Wetlands
- Floodplains
- Sinkholes
- Wastewater Service Areas
- Septic Systems

Conservation Easements

- Institutional Open Space
- Educational Facilities
- Parks
- Parks-National
- Federal Lands - Appalachian Trail
- Trails
- Washington Heritage Trail Byway
- Wildlife Management Areas
- Public River Access Sites
- Forest Stewardship Lands
- Agricultural Lands

Towns

- County Boundary
- Roads
- Railroads
- Transmission Powerlines
- Identified Historic Districts
- National Historic Register
- Cemeteries
- Census Block Centroids_1990
- Census Block Centroids_2000

Glossary

Elements of Green Infrastructure

Overview

The green infrastructure of Jefferson County is comprised of the natural resource based environmental, social, and economic elements of sustainability that can be spatially characterized. These elements will be used to identify those areas of greatest importance for sustaining both a healthy ecosystem and a healthy community.

Environmental Elements

The environmental elements of green infrastructure include ecological, environmental, and hydrologic sub-elements.

- **Ecological Quality** is related to the characteristics of terrestrial habitat required to meet the needs of native species e.g. forest, riparian (river) corridors, springs/seeps, and wetlands.
- **Watershed Health** is the term used to characterize a watershed in regards to condition, value, and vulnerability. It is determined by pollution potential, impairment (as defined by WVDEP), status of aquatic habitat, status of impervious surfaces and stormwater management. Resource value is also considered as some waterways are valued more than others either in terms of drinking water, trout fishing, etc.
- **Drinking Water Quality** is influenced by geology and land use. Geology affects how rapidly water is transmitted underground, often bypassing natural filtration, while land use affects the quality of water being transmitted underground.
- **Drinking Water Quantity** refers to groundwater recharge, which in Jefferson County is primarily controlled by topography and geology. Both topography and geology control how much rainfall either becomes surface water or groundwater. Karst areas in Jefferson County have relatively little surface water, consequently, much of the runoff that would normally flow into streams goes into the groundwater. Thus, relatively large level areas of the county located far from surface water have the potential to be significant areas of groundwater recharge.
- **Sensitive Karst Features** are caves, springs, and sinkholes. These features are sensitive in terms of maintaining the healthy functioning of a karst system.
- **Septic System Suitability** represents the characteristics necessary to maintain a functional septic system. Septic system suitability is determined by health department standards and is primarily related to the soil characteristics necessary to adequately filter wastewater leaving the septic system drainfield.
- **Air Quality** elements are those that will help communities meet federal air quality standards, namely trees.

Social Elements

- **Parks and Recreational Areas** are county, municipal, state, and federal lands used for outdoor activities such as athletics, hunting, and fishing.
- **Trails** are on- and off-road trails and paths used for hiking, biking, and walking.
- **Agricultural Landscapes** are agricultural lands appreciated for their aesthetic value at the landscape scale.
- **Historic and Cultural Resources** are those sites and districts registered with the National Park Service, as well as historic resources identified by the Jefferson County Historic Landmarks Commission such as districts, villages, civil war sites, and African-American heritage districts.
- **Archaeological Resources** are those areas and sites of identified and probable archaeological significance.
- **Viewsheds** are landscapes appreciated for their aesthetic value.

Economic Elements

- **Natural Capital** is the land, natural resources, and ecosystems that yield direct and indirect economic benefits for the human population. Natural capital provides indirect economic value in the form of hydrologic services, ecosystem services, atmospheric regulation, pollution control, recreation, and culture.
- **Working Landscapes** are those that provide direct sustainable income to landowners e.g. farmland and forests.
- **Cultural Tourism** is tourism where historic and cultural resources are the primary attraction.
- **Ecotourism** is tourism where natural features are the primary attraction and includes such activities as hiking, photography, and river recreation.

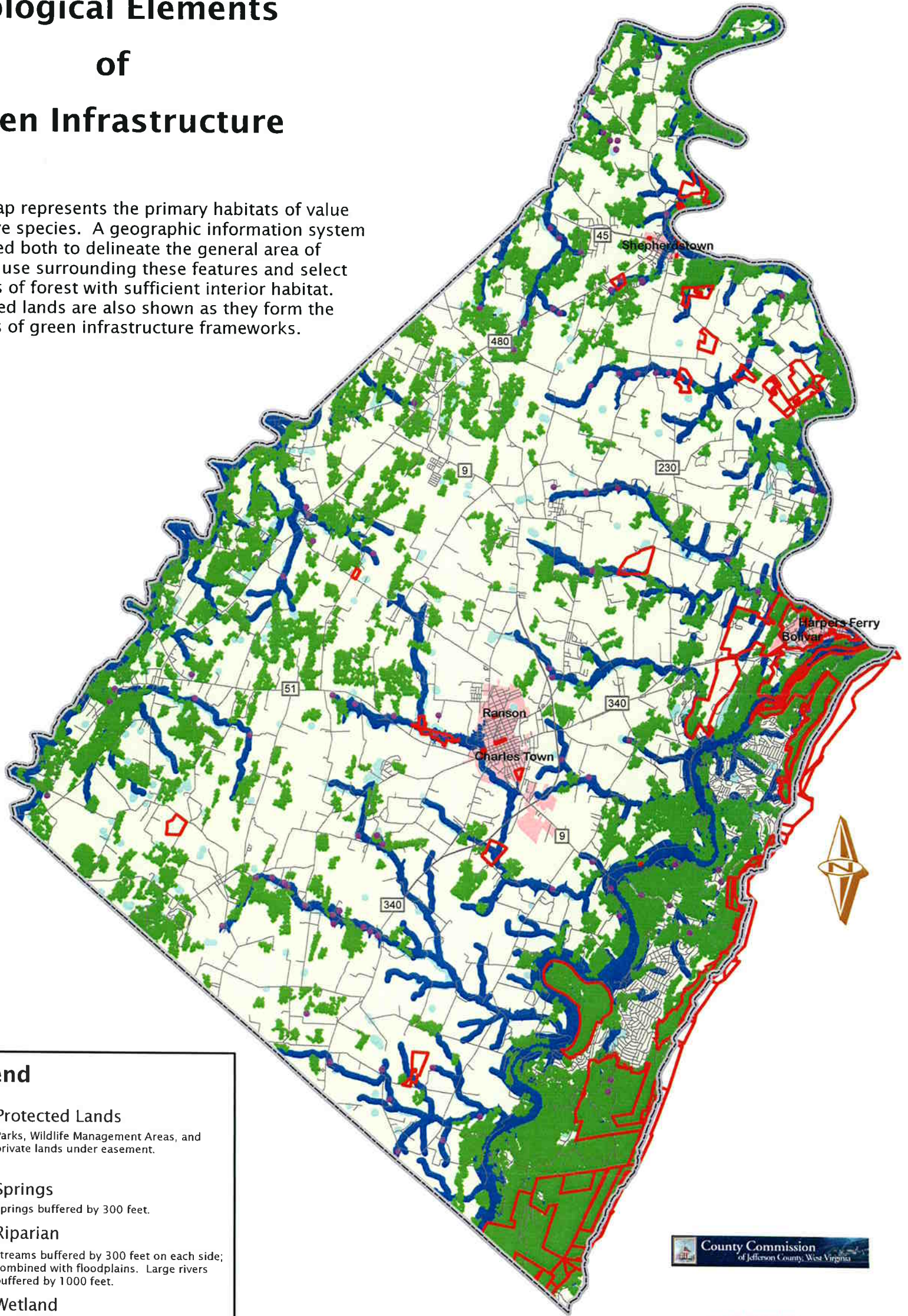
Jefferson County Green Infrastructure Assessment

Data Layers as of 20 July 2006

Dataset	Source
Aerial Photography	WV State Addressing and Mapping Board
Archaeologically Significant Areas	Shepherd University
Buildings	Jefferson County Addressing Office
Caves	WV Division of Natural Resources-Natural Heritage Program
Cemeteries	U.S. Geological Survey, Shepherd University
Designated Uses of Surface Water	WV Department of Environmental Protection
Digital Elevation Model (topography)	U.S. Geological Survey National Elevation Dataset
Distance to Nearest Stream	Derived from US Geological Survey National Elevation Dataset
Floodplains	Federal Emergency Management Agency
Geology	WV Geological and Economic Survey
Geology, Characteristics	U.S. Geological Survey
High Quality Streams	WV Division of Natural Resources
Historic Sites and Districts	WV State Historic Preservation Office
Hydrography (waterbodies)	U.S. Geological Survey - National Hydrography Dataset (High Resolution)
Identified Historic Sites and Districts	Jefferson County Historic Landmarks Commission
Impaired Waters	WV Department of Environmental Protection
Imperviousness	U. of Maryland - Regional Earth Science Applications Center
Land Use - Land Cover	U. of Maryland - Regional Earth Science Applications Center
Land Use - Land Cover (circa 1950)	WV Division of Natural Resources
LANDSAT Satellite Imagery	U.S. Geological Survey
Municipal Boundaries	U.S. Census Bureau TIGER/Line 2000
National Park Boundaries	National Park Service
Parks	U.S. Census Bureau TIGER/Line 2000
Powerlines	Jefferson County Addressing Office
Private Conservation Easements	Appalachian Trail Conservancy, Jefferson County Farmland Protection Board, Land Trust of the Eastern Panhandle, Potomac Conservancy, The Nature Conservancy
Projected Growth	Chesapeake Bay Program
Protected Lands	Appalachian Trail Conservancy
Public River Access Sites	WV Division of Natural Resources
Railroads	Jefferson County Addressing Office, U.S. Geological Survey
Rare and Threatened Species	WV Division of Natural Resources-Natural Heritage Program
Roads	Jefferson County Addressing Office, U.S. Geological Survey, WV Division of Highways
Runoff Accumulation	Derived from US Geological Survey National Elevation Dataset
Schools	U.S. Census Bureau TIGER/Line 2000
Source Water Protection Areas	WV Department of Health and Human Resources
SPOT Satellite Imagery	SPOT Image Corporation
Springs	WV Geological and Economic Survey Publications
Stormwater Ponds	WV Department of Environmental Protection
Trails (Existing & Proposed)	Appalachian Trail Conservancy, Hagerstown-Eastern Panhandle Metropolitan Planning Organization, National Park Service, WV Statewide Trail Plan
Trout Streams	WV Division of Natural Resources
Urban Growth Boundaries	City of Charles Town, City of Ranson
Watersheds	Derived from US Geological Survey National Elevation Dataset
Wetlands	National Wetlands Inventory

Ecological Elements of Green Infrastructure

This map represents the primary habitats of value to native species. A geographic information system was used both to delineate the general area of habitat use surrounding these features and select patches of forest with sufficient interior habitat. Protected lands are also shown as they form the nucleus of green infrastructure frameworks.

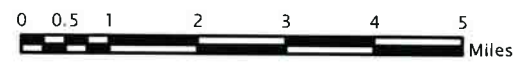


Legend

- Protected Lands**
Parks, Wildlife Management Areas, and private lands under easement.
- **Springs**
Springs buffered by 300 feet.
- **Riparian**
Streams buffered by 300 feet on each side; combined with floodplains. Large rivers buffered by 1000 feet.
- **Wetland**
Wetlands buffered by 300 feet.
- **Forest**
Forest patches with interior forest (greater than 100 feet from edge) areas larger than 10 acres.

County Commission
of Jefferson County, West Virginia

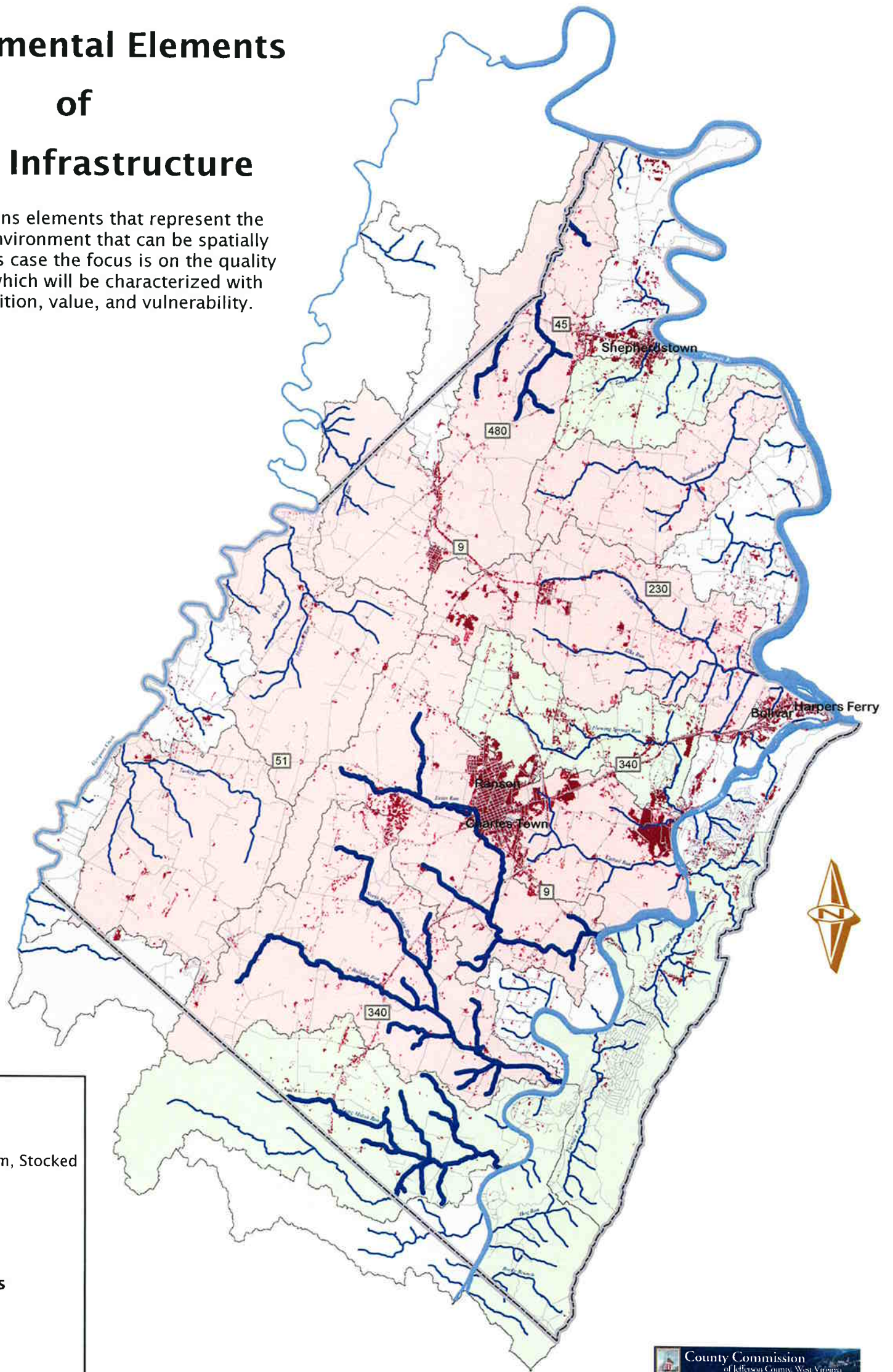
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Environmental Elements of Green Infrastructure

This map contains elements that represent the quality of the environment that can be spatially assessed; in this case the focus is on the quality of watersheds which will be characterized with regards to condition, value, and vulnerability.



Legend

Waterways

- Trout Stream, Stocked
- Streams
- Rivers
- Roads

Imperviousness Value

- High : 100%
- Low : 0%

**Watershed Status
WVDEP 303d List**

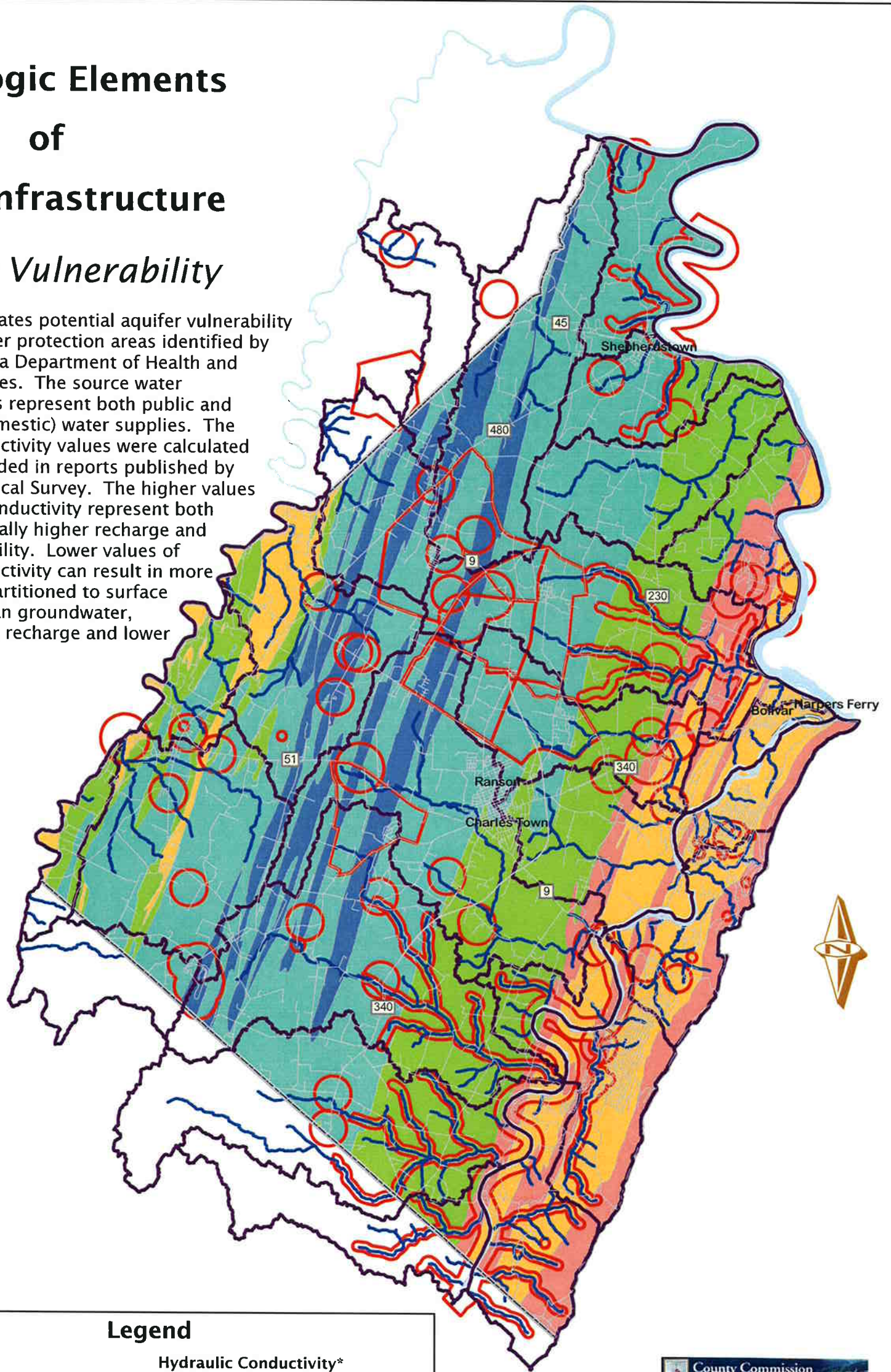
- Not Impaired
- Impaired
- Insufficient Data



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Hydrologic Elements of Green Infrastructure *Aquifer Vulnerability*

This map illustrates potential aquifer vulnerability and source water protection areas identified by the West Virginia Department of Health and Human Resources. The source water protection areas represent both public and private (non-domestic) water supplies. The hydraulic conductivity values were calculated from data provided in reports published by the U.S. Geological Survey. The higher values for hydraulic conductivity represent both areas of potentially higher recharge and higher vulnerability. Lower values of hydraulic conductivity can result in more rainfall being partitioned to surface water rather than groundwater, resulting in less recharge and lower vulnerability.



Legend	
Watersheds	Hydraulic Conductivity* (feet/day)
Rivers	0 - 0.36
Streams	0.37 - 1.47
Source Water Protection Area	1.48 - 18.13
Roads	18.14 - 42.28
	42.29 - 87.30

*Dividing transmissivity by saturated thickness using well data for a specific formation provides an estimate of hydraulic conductivity.

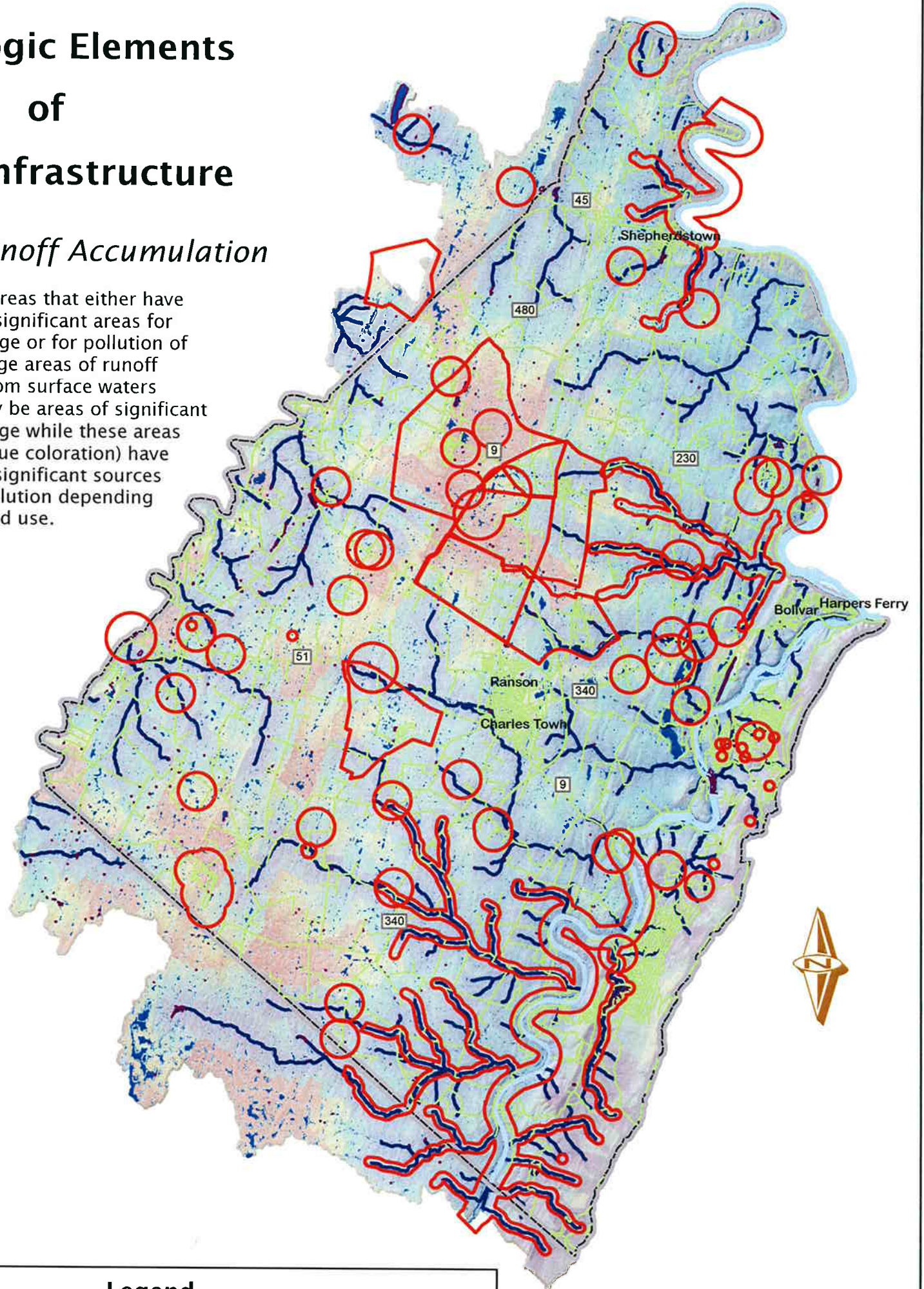


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Hydrologic Elements of Green Infrastructure

Potential Runoff Accumulation

This map displays areas that either have the potential to be significant areas for groundwater recharge or for pollution of surface waters. Large areas of runoff accumulation far from surface waters (red coloration) may be areas of significant groundwater recharge while these areas close to streams (blue coloration) have the potential to be significant sources of surface water pollution depending on the overlying land use.



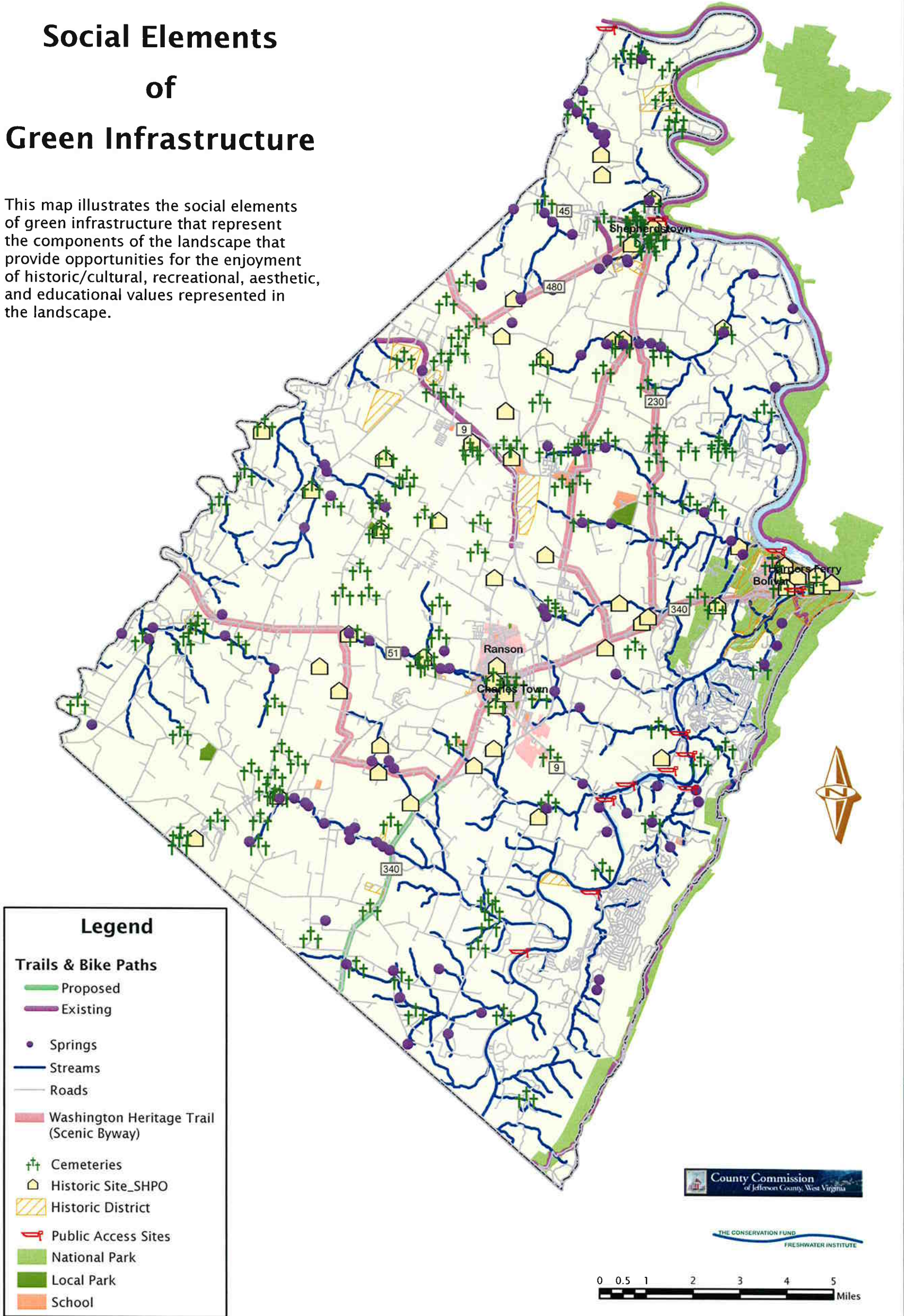
Legend	
<ul style="list-style-type: none"> River Streams Waterbody (Pond, Lake, etc.) Roads Source Water Protection Area 	<p>Runoff Accumulation</p> <ul style="list-style-type: none"> High Medium <p>Distance to Nearest Stream (meters) Value</p> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; background: linear-gradient(to top, red, orange, yellow, green, blue); border: 1px solid black; margin-right: 5px;"></div> <div style="font-size: 8px;"> High : 9527 Low : 0 </div> </div>



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Social Elements of Green Infrastructure

This map illustrates the social elements of green infrastructure that represent the components of the landscape that provide opportunities for the enjoyment of historic/cultural, recreational, aesthetic, and educational values represented in the landscape.



Legend

Trails & Bike Paths

- Proposed
- Existing

- Springs
- Streams
- Roads
- Washington Heritage Trail (Scenic Byway)
- Cemeteries
- Historic Site_SHPO
- Historic District
- Public Access Sites
- National Park
- Local Park
- School

County Commission of Jefferson County, West Virginia

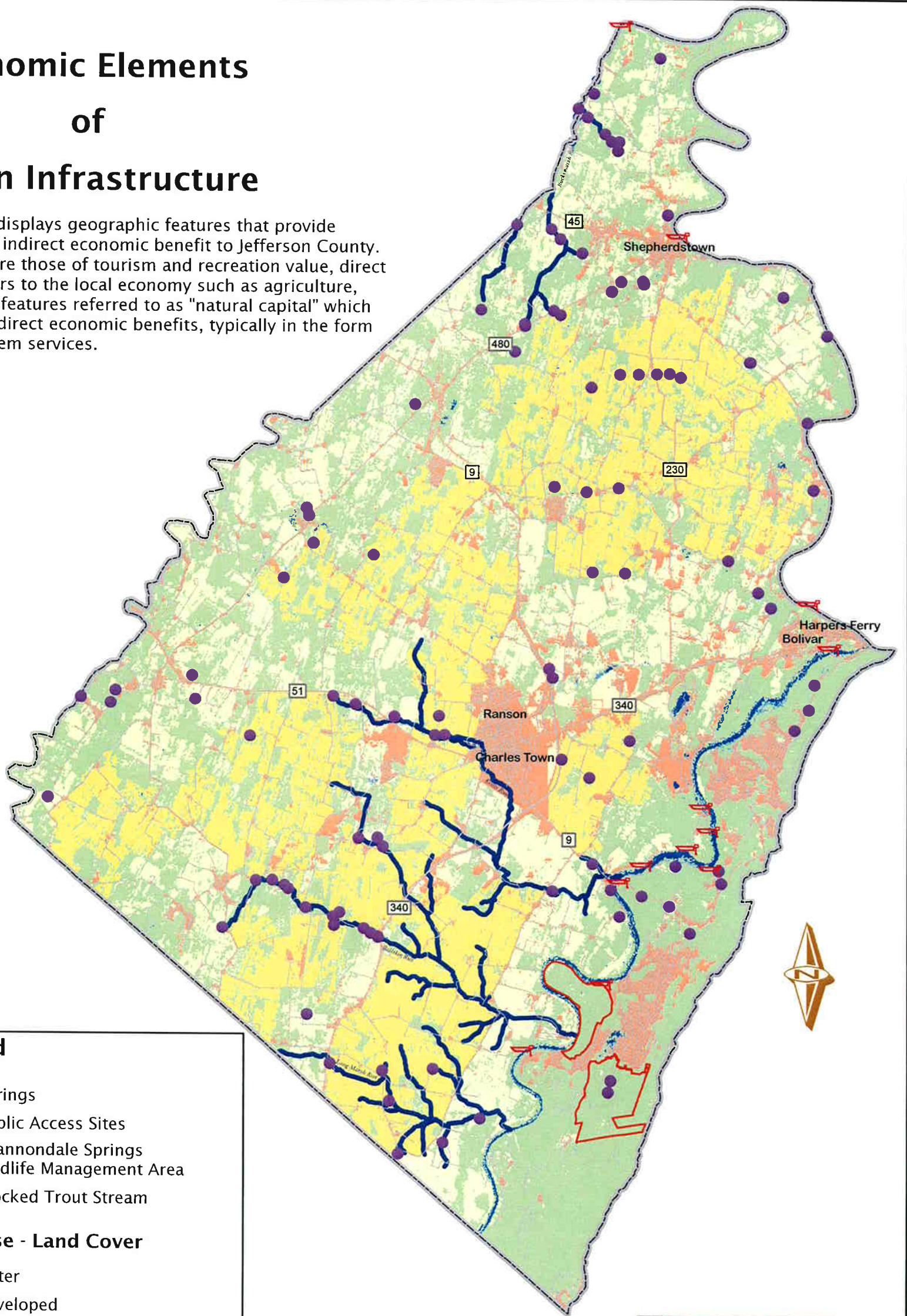
THE CONSERVATION FUND FRESHWATER INSTITUTE

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Economic Elements of Green Infrastructure

This map displays geographic features that provide direct and indirect economic benefit to Jefferson County. Included are those of tourism and recreation value, direct contributors to the local economy such as agriculture, and those features referred to as "natural capital" which provide indirect economic benefits, typically in the form of ecosystem services.



Legend

- Springs
- ✈ Public Access Sites
- ▭ Shannondale Springs Wildlife Management Area
- Stocked Trout Stream

Land Use - Land Cover

- Water
- Developed
- Forest
- Agriculture
- Grassland
- Wetland
- Area of Contiguous Agriculture

County Commission of Jefferson County, West Virginia

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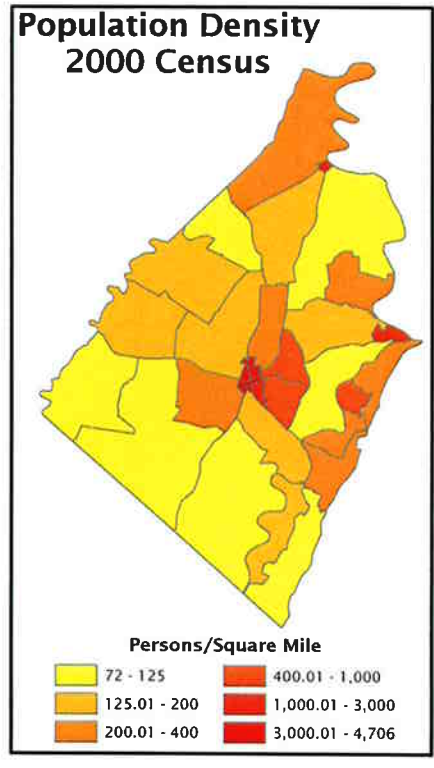
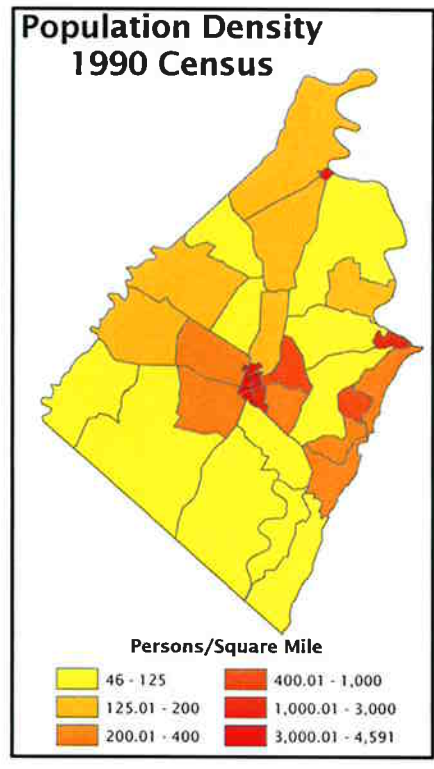
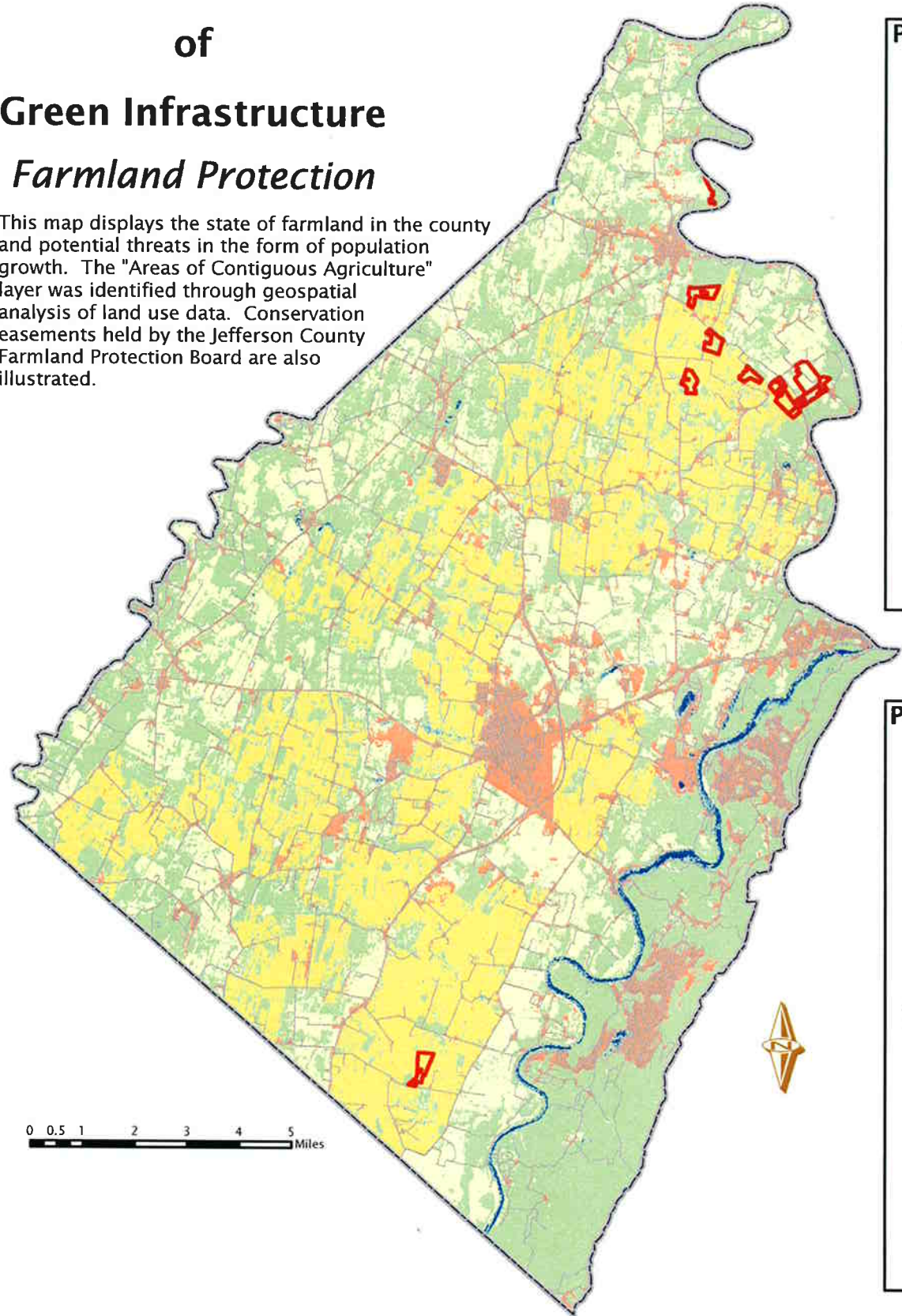


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JEFFERSON COUNTY 2006 Green Infrastructure Assessment

Elements of Green Infrastructure Farmland Protection

This map displays the state of farmland in the county and potential threats in the form of population growth. The "Areas of Contiguous Agriculture" layer was identified through geospatial analysis of land use data. Conservation easements held by the Jefferson County Farmland Protection Board are also illustrated.



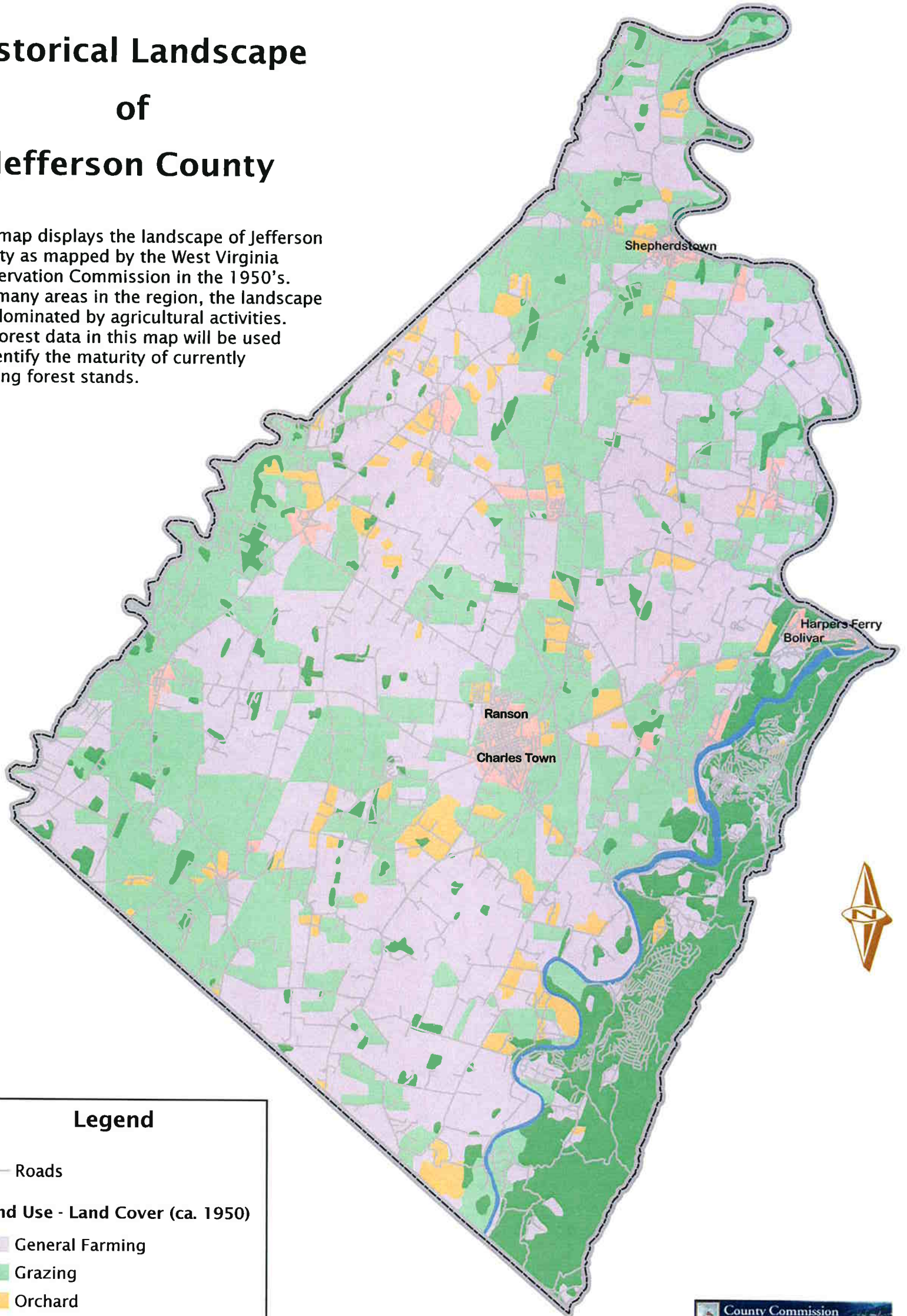
Legend		
Farmland Protection Board Easement	Water	Agriculture
Area of Contiguous Agriculture	Developed	Grassland
	Forest	Wetland



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Historical Landscape of Jefferson County

This map displays the landscape of Jefferson County as mapped by the West Virginia Conservation Commission in the 1950's. Like many areas in the region, the landscape was dominated by agricultural activities. The forest data in this map will be used to identify the maturity of currently existing forest stands.



Legend

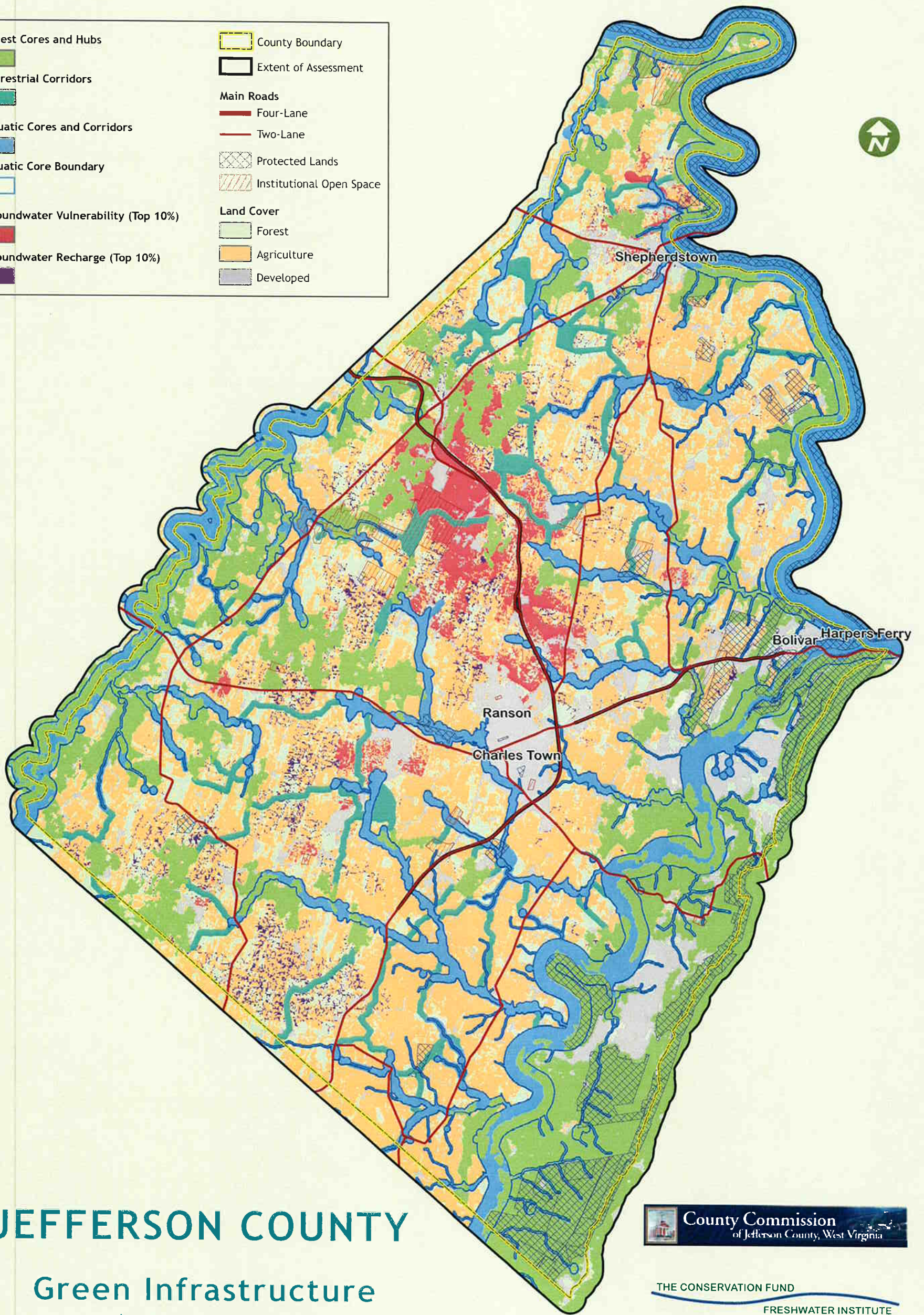
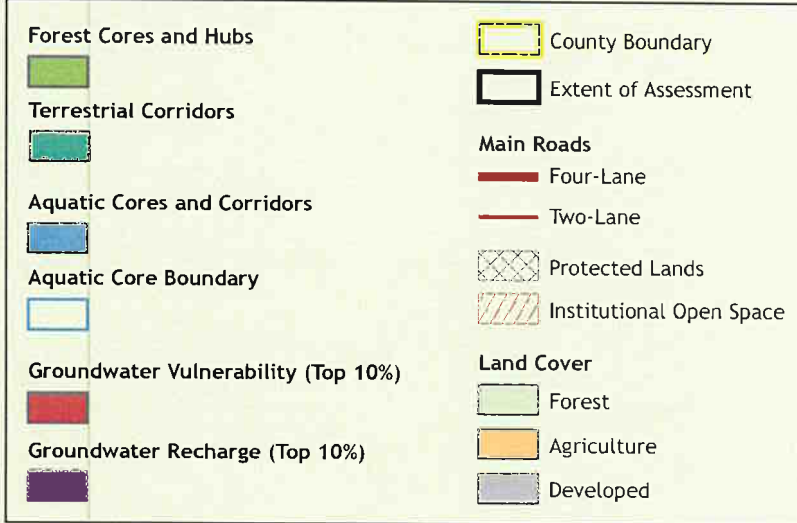
- Roads
- Land Use - Land Cover (ca. 1950)**
- General Farming
- Grazing
- Orchard
- Non-Forest
- Water
- Forest



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GREEN INFRASTRUCTURE NETWORK

GROUNDWATER

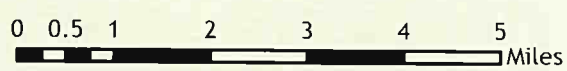


JEFFERSON COUNTY

Green Infrastructure Assessment



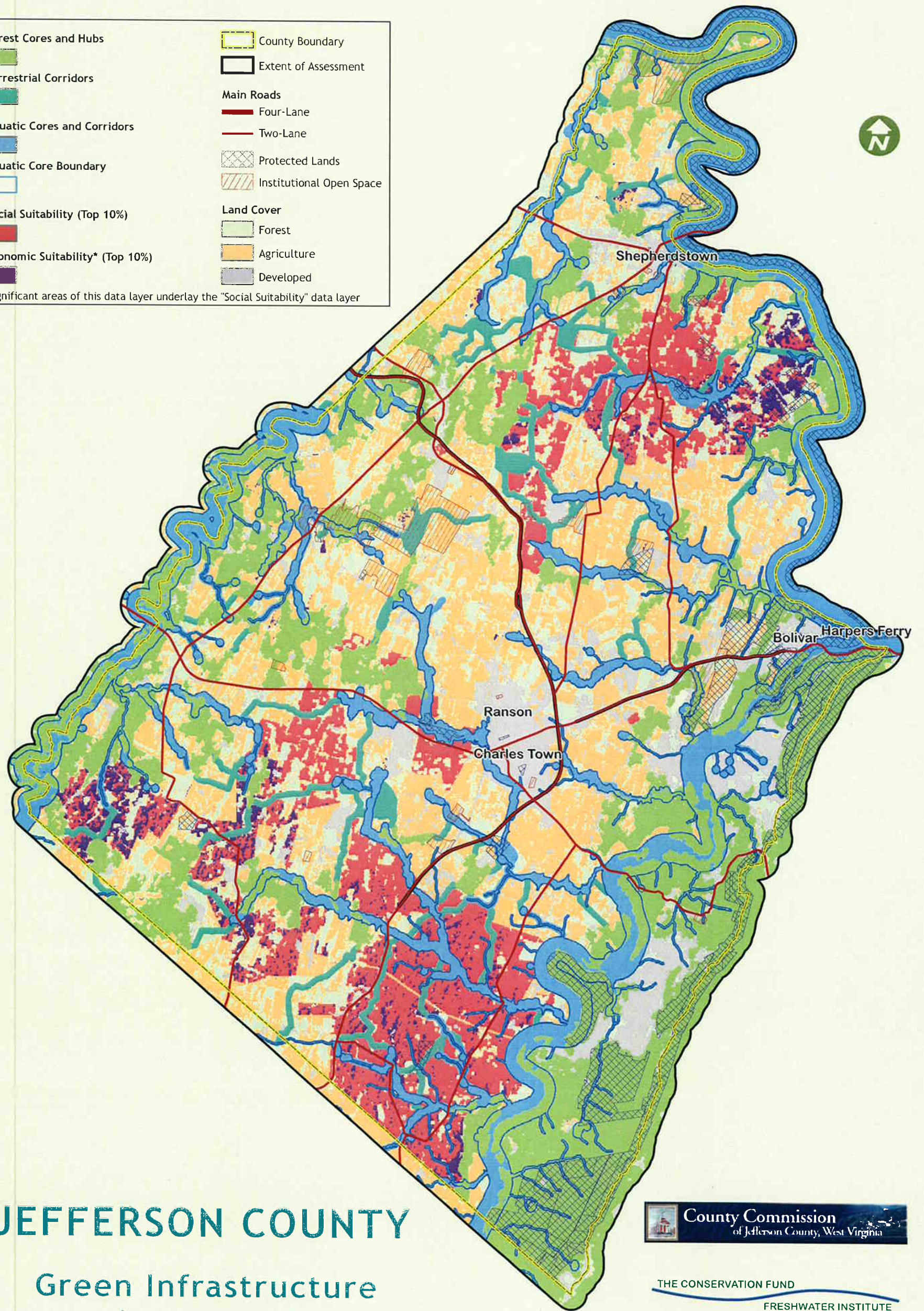
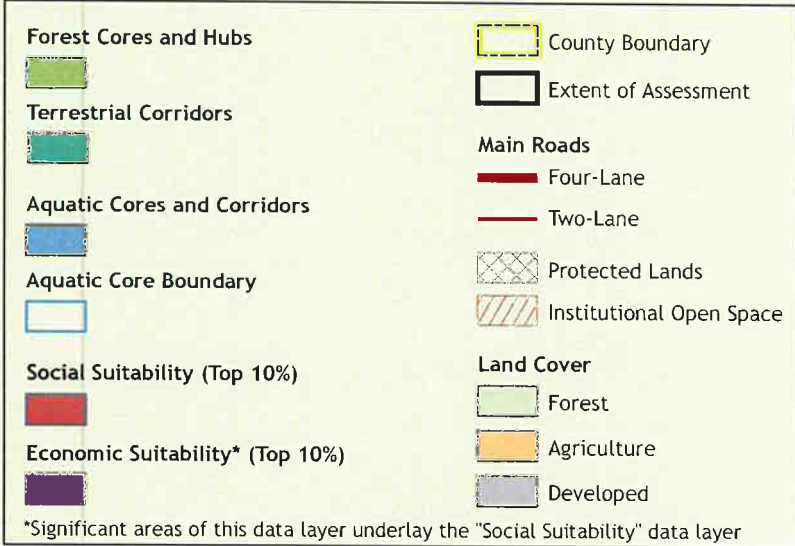
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GREEN INFRASTRUCTURE NETWORK

SOCIAL & ECONOMIC SUITABILITY

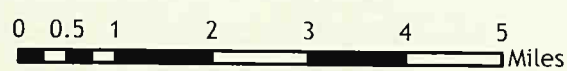


JEFFERSON COUNTY

Green Infrastructure Assessment



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JEFFERSON COUNTY GREEN INFRASTRUCTURE ASSESSMENT

"The Conservation Fund applauds the work of its partners across America for their efforts to advance smart conservation, creating livable communities and networks of natural areas, working landscapes and open space. This balanced and strategic approach to conservation serves as a model for the nation."

-Mark Benedict, co-author,
Green Infrastructure: Linking
Landscapes and Communities

CHALLENGE

Jefferson County, one of the hundred fastest growing counties in the nation, faces the loss of its valuable open space, farming heritage, and environmental quality if work is not begun to proactively identify those lands and attributes that are important to the citizens of Jefferson County.

VISION

With support from the County Commission and local stakeholders, create a countywide green infrastructure framework that:

- Identifies and integrate opportunities for conservation, enhancement, and restoration of natural resources
- Informs land use decisions
- Allows Jefferson County to grow while maintaining its sense of place and unique character

APPROACH

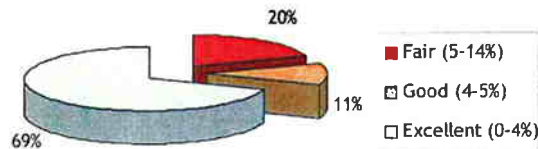
- Identify the natural resource areas required for environmental, social, and economic sustainability
- Conserve and connect important resource features
- Foster community involvement and consensus
- Identify opportunities to integrate green infrastructure into the land use planning process

ACHIEVEMENTS

- Used the mapping and analytical capabilities of geographic information systems (GIS) to identify those natural and cultural resource areas of greatest importance and value for sustaining both a healthy ecosystem and a healthy community
- Provided opportunities to educate and engage land planning professionals and the general public on the natural, economic, and social features of Jefferson County's natural resources
- Developed geospatial datasets to support and prioritize land use planning and resource conservation decisions
- Developed recommendations to support sustainable land use and Jefferson County's current reconsideration of its subdivision and zoning ordinance structure
- During the project, the Historic Landmarks Commissions identified hundreds of new historic sites and identified potential new historic districts
- The Jefferson County Ag Task Force is using project data to identify potential new zoning districts
- Collaborated with the Virginia Division of Natural Heritage to develop a model to predict occurrences of the federally listed Madison Cave Isopod
- Collaborated with the West Virginia Division of Natural Resources to develop conservation priority models using the Jefferson County Green Infrastructure Assessment as a template

WATERSHED HEALTH

In the recently published "State of the Chesapeake Forests", watersheds are given grades according to the amount of impervious surfaces in the watershed. Even slight increases in impervious surfaces such as roads and rooftops can have dramatic negative effects on stream habitat and water quality. Impervious surfaces can also reduce the amount of rainfall available to recharge our aquifers. The graph below shows the scores for watersheds in Jefferson County as a percent of total area in the County. Significant negative impacts can begin when imperviousness reaches just 4% of watershed area.



WATERSHED IMPERVIOUSNESS

Contact:

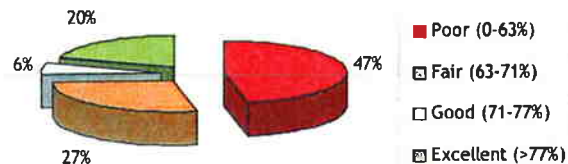
Michael Schwartz
The Conservation Fund,
Freshwater Institute
Phone: 304.876.2815
m.schwartz@freshwaterinstitute.org

THE STATE OF OUR FORESTS

In 1950 there were just under 20,000 acres of forest in the County and in 2000 there were just over 57,000 acres. Although there are now more acres of forest per person than there were in 1950 this number is only average across the Chesapeake Bay region.

Trees are important for many reasons - habitat, groundwater recharge, water quality, and economic value among others. To protect stream quality it is important that riparian corridors are forested. The Chesapeake Bay Program recommends that 70% of riparian corridors be buffered with trees for maximum water quality benefit. Currently, nearly 60% of the riparian corridors in the Chesapeake region are covered by trees. In Jefferson County, only about a quarter of our riparian corridors are adequately buffered.

RIPARIAN FOREST COVER



NEWS RELEASE:

**Presentation of a ~~Green Infrastructure Network Design~~
For Jefferson County and discussion of Implementation Strategies
Contact: Michael Schwartz 304.876.2815 x237
Shepherdstown, WV (10 November 06)**

On Wednesday evening, November 15, 2006, from 7:00 – 9:00 pm at the Clarion Hotel in Shepherdstown, WV, The Conservation Fund will present the results of its proposed Green Infrastructure Network Design for Jefferson County and facilitate a discussion on possible implementation strategies that can be included in a report to the Jefferson County Commission. Earlier this year, the County Commission of Jefferson County commissioned The Conservation Fund to conduct a Green Infrastructure Assessment.

As part of the Green Infrastructure Assessment, data layers depicting open spaces, cultural areas, working lands, and ecologically sensitive areas are compiled into a network design that can be used to inform county decision-making processes.

“~~For~~ compiling numerous data layers and meeting with representatives from constituencies across the county, we are very excited to present to the public our proposal for a Green Infrastructure Network Design for Jefferson County and to hear their recommendations on possible implementation strategies”, said Joe Hankins, Vice President and Director of the Freshwater Institute. Hankins went on to say that the Design presented during the November 15th Forum along with the discussion on implementation strategies will be included in a report The Conservation Fund presents to the Jefferson County Commission. “It is very important to us that the public understands our proposal for a network design and understands the various options for potential implementation strategies”.

This will be the third and final forum organized by the Conservation Fund on this Assessment process. The Forum is free and open to the public and will be located in Salon A of the Clarion Hotel. No tickets or reservations are required. For additional information contact Michael Schwartz at 304-876-2815 or m.schwartz@freshwaterinstitute.org

Green Infrastructure Stakeholder Input Meeting

Please join us on Thursday July 20 from 2-4:30 pm in Salon A at the Clarion Hotel & Conference Center in Shepherdstown to participate in a workshop for ranking the relative importance of the natural resource based environmental, social, and economic elements of the green infrastructure framework that is being developed for Jefferson County.

The Green Infrastructure Assessment, funded by the Jefferson County Commission, will create a countywide green infrastructure framework that supports strategic natural and cultural resource conservation and land use planning. This framework will allow Jefferson County to grow while maintaining its sense of place and unique character. A project factsheet is attached that contains additional details.

This meeting is for professional stakeholders active in Jefferson County.

An open house for the general public will be held from 7-9 pm at the same location. If you are unable to attend the afternoon meeting please feel free to join us in the evening.

Date: Thursday July 20, 2006

Time: 2:00 - 4:30 pm

Location: Clarion Hotel & Conference Center
233 Lowe Drive
Shepherdstown, WV

Meeting Agenda

2:00 pm - 2:15 pm

Welcome and Participant Introductions
Michael Schwartz, The Conservation Fund

2:15 pm - 2:35 pm

Role of Ranking Exercise in the Assessment of Jefferson County Green Infrastructure
Will Allen, Director of Strategic Conservation Programs, The Conservation Fund

2:35 pm - 2:55 pm

Review Maps of Jefferson County Green Infrastructure Elements
Will Allen and Michael Schwartz, The Conservation Fund

2:55 pm - 3:10 pm

Break

3:10 pm - 4:10 pm

Ranking Exercise for Land Evaluation Factors
Will Allen and Michael Schwartz, The Conservation Fund

4:10 pm - 4:30 pm

Next Steps and Wrap Up
Michael Schwartz, The Conservation Fund

Please feel free to contact me if you have any questions or if know of any other professional stakeholders who might be interested in providing their input. If you cannot attend feel free to invite someone else from your office to attend in your place.

I look forward to seeing you next Thursday,

Michael Schwartz

Press Release

On Thursday, June 8, 2006 at 7:00 pm local author Mark Benedict will present "Green Infrastructure: Linking Landscapes and Communities" in the Byrd Auditorium at the National Conservation Training Center in Shepherdstown, WV. Dr. Benedict is The Conservation Fund's Senior Associate for Strategic Conservation. The presentation will be based on his newly released book co-authored with Ed McMahon of the Urban Land Institute. Following the presentation, Joe Hankins, Director of The Conservation Fund's Freshwater Institute, will provide an overview of the Jefferson County Green Infrastructure Assessment.

Communities all across America are facing the same challenge – how to grow without sacrificing the natural, historic and cultural features that improve quality of life for residents, attract visitors and new business and bolster the economy. With land consumption and fragmentation accelerating, communities need a better way to proactively decide what lands to develop and what lands to conserve. Green infrastructure helps communities make this vital choice by bringing diverse people and organizations together to create a blueprint for future growth while ensuring that important natural resources and community assets will be preserved for future generations.

Providing both the historic framework for the importance of greenways and green space networks, and practical advice on how to design and implement them, Mark Benedict and Ed McMahon's new book, *Green Infrastructure: Linking Landscapes and Communities*, is a valuable resource for anyone who wants to understand innovative approaches to conservation-minded land use. From the individual parcel to the multi-state region, *Green Infrastructure* looks at the landscape in relation to the many uses it could serve, for nature and people, and determine which use achieves the most benefit for both.

The Jefferson County Green Infrastructure Assessment will support strategic natural resource conservation and land use planning while reflecting county-wide needs and the county's regional ecological and cultural context. This project provides an excellent opportunity to apply green infrastructure concepts and practices locally.

Both presenters reside in the Eastern Panhandle and are involved in local land and water conservation activities: Benedict as a board member of the Land Trust of the Eastern Panhandle and Hankins as a member of the Jefferson County Water Advisory Committee.

The presentation is free and open to the public. No tickets or reservations are required. It is part of a monthly series of "Conservation & Community" public lectures held at the National Conservation Training Center. The series is co-sponsored by the Friends of NCTC. For more information on the series please visit the web site: <http://training.fws.gov/history/publiclectures.html> or contact Mark Madison (Mark_Madison@fws.gov; 304 876-7276).

The Journal

June 4, 2006

Green thumbs go up for idea

By LAUREN HOUGH
lthough@journal-news.net

SHEPHERDSTOWN - Green space may be natural, but planning to preserve it takes a fair amount of science.

On Thursday, local author Mark Benedict, Ph.D., will discuss ways for local communities to harness the benefits of implementing green infrastructure - such as wetlands, grasslands, mountain ridges and trails - during his lecture at the National Conservation Training Center.

"Communities all across America are facing the same challenge - how to grow without sacrificing the natural, historic and cultural features that improve quality of life for residents, attract visitors and new business and bolster the economy," Benedict said.

He defines green infrastructure as an interconnected, strategically planned network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water and provides a wide array of benefits to people and wildlife in the recently published "Green Infrastructure: Linking Landscapes and Communities," which he co-authored with colleague Ed McMahon.

The text further explains ways to meet those challenges - namely, with adequate, community-centered planning.

"It's as important to plan and protect green infrastructure as it is to plan, design, construct and maintain built infrastructure," such as roads, hospitals and waterways, Benedict said.



MARTIN B. CHERRY

Mark Benedict Ph.D., left, and Michael Schwartz of the Conservation Fund chat near a spring at the Freshwater Institute near Shepherdstown. Benedict co-authored *Green Infrastructure* which discusses linking city planning with environmental awareness. A lecture on the book will be held Thursday at the National Conservation Training Center.

One of the issues the Eastern Panhandle has been faced with is how to provide adequate roadways to residents, said Benedict, a Berkeley County resident. Recently, however, conflicts have arisen over how to use resources such as farmland and land with historical value - conflicts that have widely divided communities.

Unifying all those with an interest in the land around a nature-centered framework to prevent such divisions and land battles has been the focus of the Jefferson County Green Infrastructure Assessment, a new project combining urban and regional planning with conservation biology and landscape ecology to meet countywide needs.

Planning professionals and the general public are slated to meet for educational seminars and discussions regarding data taken throughout the county, designed to help identify areas that are important to the community - those in need of preservation, restoration or those available for development.

"You can't wait until the bulldozer is there to clear the land," Benedict said. "That's not the time to try to plan."

People are moving to the Eastern Panhandle because they like the green landscape, Benedict said, yet the increased development helps to provide the tax base that funds services to improve the quality of life for residents. With proper planning, each natural habitat, park location and future subdivision can be identified before that section of land ever comes into question.

"What we believe, is that doing this kind of approach - coming up with a logical way to identify the most important farmlands, historical sites - (will) provide framework to help us do a better job with these decisions," Benedict said. "You'll never eliminate all the battles, but this will help it."

As a part of the Jefferson County assessment, the public will be afforded a chance to provide planners with their input on what sites exemplify their own environmental, social and economic values, said project leader Michael Schwartz, research associate for The Conservation Fund's Freshwater Institute.

Thursday's presentation on green infrastructure will be followed by an overview of the Jefferson County assessment project by Joe Hankins,

director of The Conservation Fund's Freshwater Institute.

The overview, Benedict said, is an initial way to let local people know about the concept of green infrastructure and begin a dialogue that can be used to better identify important land features.

Everyone with an interest in the land - from developers to historians, trail lovers to sportsmen - can maintain their separate interests while finding a way to bring them together.

"This is the starting point, not the ending point," he said.

Despite all the growth that has already occurred throughout the Eastern Panhandle, Benedict and Schwartz say it's not too late to develop a land-use framework to implement. Cities like Chicago are only now doing major work toward going "green."

"It's a balance," Schwartz said. "People need a place to live, but they have to do it in a way that's sustainable. You have to make people aware that what you do on your land can effect nature."

Now is a good time to begin work toward assessing the county, he said, since plans to rewrite subdivision ordinances are already in the works.

Thursday's presentations, which are free and open to the public, will be held at 7 p.m. in the Byrd Auditorium of the National Conservation Training Center in Shepherdstown as part of a monthly series of Conservation and Community public lectures.

THE CONSERVATION FUND

America's Partner in Conservation

GREAT GREEN OPPORTUNITIES

Jefferson County, West Virginia

The Conservation Fund applauds the work of its partners across America for their efforts to advance smart conservation, creating livable communities and networks of natural areas, working landscapes and open space. This balanced and strategic approach to conservation serves as a model for the nation.

With the help of *Conserving Green Infrastructure: Linking Landscapes and Communities*

CONTACTS:

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Project Leader
The Conservation Fund,
Freshwater Institute
Phone: 304.876.2615
mschwartz@freshwaterinstitute.org

Leslie D. Smith
County Administrator,
Jefferson County
Phone: 304.728.3288

CHALLENGES

The open space, farming heritage and environmental quality of Jefferson County, one of the hundred fastest-growing counties in the nation, are imperiled by suburban growth and habitat fragmentation.

APPROACH

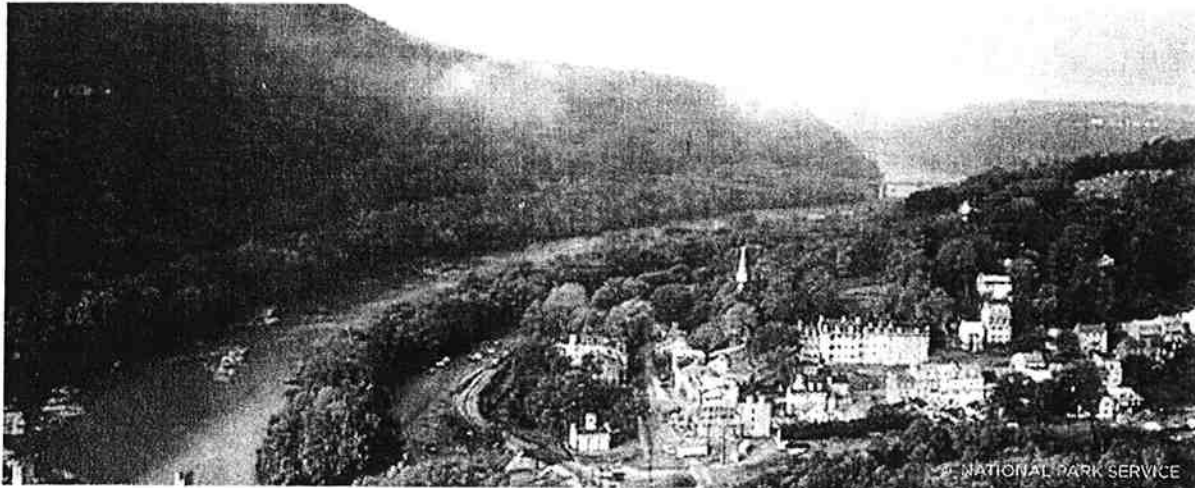
The County Commission of Jefferson County, West Virginia, is working with The Conservation Fund's Freshwater Institute and local stakeholders to create a countywide green infrastructure framework that supports strategic natural resource conservation and land use planning.

The green infrastructure assessment will use the mapping and analytical capabilities of geographic information systems to:

- Identify the natural resource areas required for environmental, social and economic sustainability
- Conserve and connect important resource features
- Educate and engage land planning professionals and the general public
- Foster community involvement and consensus
- Leverage public and private investments
- Identify opportunities to fund environmental mitigation
- Provide recommendations and data to support Jefferson County's reconsideration of its comprehensive planning and ordinance structure
- Identify opportunities to integrate green infrastructure into the land use planning process



© CHINA S. MIDDLETON



NATURAL RESOURCES FOCUS

- Ground and surface water
- Agricultural and working rural landscapes
- Natural areas designated for sustainable tourism
- Parks, trails, greenways and scenic byways
- Wildlife habitat
- Cultural legacy and heritage
- Open space

REGIONAL ACCOMPLISHMENTS

- Interstate compacts for water quality (Chesapeake Bay Restoration and MS4 Storm Water) and air quality (Ambient Air Quality Non-attainment)
- National and state wildlife habitat conservation efforts (West Virginia Department of Natural Resources Wildlife Habitat Conservation Action Plan and USDA and US Fish and Wildlife Services programs)
- Quality of life assessments (West Virginia Vision Shared and economic development scorecards)
- Cultural legacy and natural resource-based tourism (Gateway Communities and National Heritage Area initiatives)
- Multi-modal and alternative transportation (West Virginia Department of Highways and Region 9 Transportation Planning)
- Multi-state Eastern Brook Trout Restoration Joint Venture

PARTNERS

Funded by the County Commission of Jefferson County, West Virginia

THE CONSERVATION FUND

JOSEPH A. HANKINS
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1098 TURNER ROAD
SHEPHERDSTOWN, WEST VIRGINIA 25443
VOICE: 304-876-2815
FAX::304-870-2205
j.hankins@freshwaterinstitute.org

4 March 2005

RECEIVED

MAR 28 2005

Mr. A.M.S. "Rusty" Morgan III
President
Jefferson County Commission
P.O. Box 250
Charles Town, WV 25414

JEFFERSON COUNTY
PLANNING, ZONING AND ENGINEERING

Commissioner Morgan,

Please find attached a proposal for a green infrastructure assessment for Jefferson County. My submission of a proposal somewhat late in the county budget process was stimulated by public comments and discussion over the last week about land use planning, changes in the zoning process and the possible decision to increase the investment of public county funds in land protection ... a concept that I fully support and will work to make possible.

As a local citizen and land conservation professional, I believe it is critical that these discussions and planned actions are taken in context with a resource plan and I do not believe that this now exists for Jefferson County. Without a full assessment of the resources and the needs for habitat conservation, open space, recreation areas, and critical ecological function uses such as source water protection and recharge, these decisions will be made *ad hoc* as parcel opportunities are presented and not with a larger or longer view. We believe that a green infrastructure assessment and plan can be the basis for both private and publicly funded land use and conservation investment decisions. Such an assessment can be an integral information resource in supporting the existing and any future Comprehensive Plan and can provide a reasonable, documented basis for considerations of zoning and changes in land use consistent with new land use planning legislation at the state level. A green infrastructure assessment and plan will also be a critical and wholly complementary base for any parallel development of a county wide technology investment in a geospatial information system.

I have attached as a background document a summary of work the Conservation Fund performed for Talbot County, Maryland in 2004 that might be similar in scale to the effort proposed locally. The Conservation Fund has worked nationally with communities of all sizes to assemble green infrastructure plans. We are just under way on a project for Baltimore County, are in-progress for the city of Houston, Texas and have completed an assessment for Metro Atlanta, Georgia inside the I-285 loop. We have also worked in more rural locations like the Catocin Mountain view shed in Frederick County, Maryland; with three counties in the New River watershed in North Carolina; and in multiple counties in the Delaware Bay.

As you know, The Conservation Fund has a unique presence in the county with our largest field office at the Freshwater Institute and senior level staff collaborating in leadership and

training in cooperation with the National Conservation Training Center. Our national staff expert in green infrastructure planning, Dr. Mark Benedict, works out of NCTC and lives right here in the Eastern Panhandle. The County Commission has my personal commitment that you would receive the benefit of the very best folks we have in the Conservation Fund to work on this effort.

Working with our team here we have estimated a \$37,800 cost for this effort. As I have some insight into these matters I can say that that is an exceptional value. As this plan would benefit the county communities generally there may be some opportunity to gain some shared support from the municipalities as well, I have not explored that possibility.

I also understand that there may be some potential conflict found in my private participation on county boards or local advisory committees and the presentation of this proposal. I would look to your guidance and counsel to determine if such relationships do present an unworkable conflict for the possible involvement of The Conservation Fund. It is certainly not my intention to create a violation of the ethics rules and I am far from expert in those matters.

I realize that the county planning process for the next fiscal year is in full swing and that you receive many worthy and justified requests for support that cannot all be met. If you feel that it is appropriate and there is sufficient interest, I'd look forward to an opportunity to discuss this proposal further with you.

Thank you for your time.

Sincerely,



Joseph A. Hankins
Vice President
The Conservation Fund

enc: Jefferson County proposal
Talbot County Green Infrastructure Plan

cc: Mr. Erik Meyers, Vice President for Sustainable Programs, The Conservation Fund
Mr. Will Allen, Director for Strategic Conservation, The Conservation Fund
Dr. Mark Benedict, Senior Associate, Strategic Conservation, The Conservation Fund

Green Infrastructure Assessment

Jefferson County, West Virginia

Introduction

The unique character of Jefferson County is imperiled by fragmented patterns of growth that disrupt normal ecosystem functions, community vitality, and limit future opportunities. The continued protection of the County's diverse natural and rural landscapes, and economic vitality rely on the conservation of its unique ecological and cultural geography.

Green infrastructure is defined as an interconnected network of green space that conserves natural ecosystem values and functions, and provides associated benefits to human populations. Green infrastructure is the ecological framework needed for environmental, social, and economic sustainability – our county's natural life support system. Incorporating green infrastructure into planning differs from conventional open space planning because it assesses conservation values in concert with land development, growth management, and built infrastructure planning. Green infrastructure employs planning, design and implementation approaches similar to those used for roads, water and wastewater management systems, and other community support facilities.

Development of a plan to conserve the green infrastructure of Jefferson County represents an opportunity to guide the pattern of future growth and development by incorporating green infrastructure into land use planning to provide a framework for sustainable development. A green infrastructure framework can provide a diversity of economic, social, and ecological benefits by identifying ecologically, culturally, and recreationally significant lands. A well thought out green infrastructure plan can increase property values and community well-being, while decreasing the costs of public services and infrastructure, including the costs for water treatment, and wastewater and stormwater management.

Current land conservation efforts in the United States are largely reactive, site specific, narrowly focused, and poorly integrated with land use planning and growth management efforts. Growing rapidly in popularity and application, green infrastructure provides a strategic approach to land and water conservation that identifies conservation priorities and provides a planning framework for conservation and development. Emphasizing the importance of protecting large blocks of contiguous land and establishing connectivity, it aims to establish a matrix of natural areas, conservation lands, and working landscapes. A Green Infrastructure Plan provides a blueprint for accommodating appropriate growth and development while preserving valuable natural resources, native species, cultural assets, and the agricultural economy.

The unique karst terrain of Jefferson County is a landscape defined by the subtle interplay of water and limestone and requires a special focus to preserve the integrity of the karst system and its attendant water resources. Managing land use in karst necessitates a specific focus on: stormwater management; preserving natural hydrology; maintaining integrity of karst functions and processes; source water protection zones; and wastewater management.

A green infrastructure assessment and planning process will facilitate implementation of the *Jefferson County Comprehensive Plan* by providing crucial information needed to minimize the environmental impacts of growth while maximizing preservation of resources that are important to maintaining the quality of life for the community. Development of a green infrastructure plan will also help the

county, municipalities, and other organizations develop grant proposals and obtain funding for land conservation; assist in meeting the commitments of West Virginia's Potomac Tributary Strategies; and provide geospatial data for use by county staff.

Project Overview

The Conservation Fund's Freshwater Institute proposes to conduct a green infrastructure assessment and submit recommendations for its conservation. The assessment and associated recommendations will have a solid focus on water resources. This will entail the identification of salient conservation goals and their value to the community; conducting an inventory of information and data needed to develop a plan to meet these goals; the green infrastructure assessment; and finally the development of recommendations for implementing goals for the conservation of green infrastructure. Outside the scope of this proposal but essential to conservation would be a second phase consisting of a detailed parcel-based assessment involving detailed ground-truthing, and scoring of individual parcels. The outcomes from this process will provide decision-making tools to facilitate conservation planning that maximizes benefits to the community while minimizing potential negative impacts of growth.

Green Infrastructure Assessment

The assessment of green infrastructure, based on the principles of urban and regional planning, conservation biology, and landscape ecology, provides a consistent approach for landscape evaluation. Incorporated into a green infrastructure assessment are important landscape features, and natural and cultural resources and how they relate to the landscape. This assessment will use geospatial characteristics deemed specifically important to a green infrastructure network in Jefferson County – land use, hydrology, wetlands, soils, septic system suitability, slope, floodplains, waterways, springs, sinkholes and other karst features, protected and managed lands, parks and trails, roads and scenic byways, watershed boundaries, wildlife habitat, growth projections, viewsheds, and zoning. Each of these characteristics will be assigned value and weight according to their relative importance.

An important aspect of this assessment will be the preservation of hydrological services for the County. Healthy watersheds provide hydrological services in the form of water purification, groundwater recharge, erosion control, and reduced vulnerability to flooding. Land areas will be scored for hydrological services based on current conditions and vulnerability to development.

The proposed green infrastructure assessment will utilize a Geographical Information System to develop a county-wide grid of ¼ acre cells containing multiple layers of information georeferenced to a particular cell. The map that results from this assessment will display the value of individual grid cells based on the relative importance of the underlying data layers scaled by conservation priority. A green infrastructure network design will then be developed using a process called least-cost path analysis. The resulting network will be composed of hubs linked together by corridors, where hubs are relatively large areas of high conservation value and corridors are smaller areas of ecologically and socially valuable lands (such as riparian areas and ridges) linked together to form a contiguous network of green infrastructure. Buffering these smaller areas to form linkages forms corridors. Hubs and corridors can contain areas such as farmland, cleared lands, or utility corridors that could be targeted for restoration.

Hubs and corridors are then scored according to their value within the network, vulnerability to development, current level of protection, and management status. The results of this analysis then allow for the development of conservation/management priorities. Multiple analyses can be conducted based on specific priorities such as recreation, heritage, environmental, or ecological value.

Green Infrastructure Recommendations

A set of green infrastructure recommendations will be developed utilizing the results of the green infrastructure assessment. Developed recommendations will include the identification of critical areas for conservation, the establishment of priorities for protection, and suggestions regarding tactics for implementation and funding. The recommendations will center on preserving hydrological services of watersheds in order to protect quantity and quality of water resources and mitigate stormwater impacts. The recommendations will also focus on ecologically important resource areas and prime areas for parkland and nature-based recreation (e.g. hiking, horseback-riding). The plan will also be mindful of the *Jefferson County Comprehensive Plan* in order to reflect the community values, future vision, and local interests set forth by Jefferson County and its residents.

The green infrastructure recommendations will emphasize strategic conservation that focuses on the protection of an interrelated system of conservation lands rather than piecemeal protection of individual parcels, recommends protection based on criteria for multiple functions and purposes, rather than on individual criteria, thus ensuring that the whole is greater than the sum of its parts.

A green infrastructure assessment and future plan can provide numerous benefits to Jefferson County:

- ◆ Prevent “haphazard conservation” by identifying the most valuable and vulnerable lands for protection and leveraging public and private investments in land conservation
- ◆ Conserve quality and quantity of water resources
- ◆ Increase the overall effectiveness of existing conservation programs by providing a focal point for their coordination
- ◆ Conserve and connect areas with multiple important resource features
- ◆ Enhance tourism potential
- ◆ Improve property values
- ◆ Produce a tangible improvement in quality of life
- ◆ Sustain working farms
- ◆ Reduce opposition to development
- ◆ Provide predictability and certainty
- ◆ Reduce costs for built infrastructure
- ◆ Identify and protect lands that:
 - Illustrate our heritage
 - Serve as outdoor classrooms for environmental education
 - Offer recreational opportunities
 - Provide ecosystem services such as flood mitigation, pollution filtration, wildlife habitat, aesthetics, soil conservation, and climate regulation

Estimated Budget

Green Infrastructure Assessment

Planning and Data Collection = \$10,200

Geospatial Analysis = \$18,400

Green Infrastructure Assessment Report and Recommendations

Summarize Analysis = \$5,400

Develop Recommendations = \$3,800

Total = \$37,800

Green Infrastructure:

Smart Conservation for the 21st Century



"Infrastructure – the substructure or underlying foundation...on which the continuance and growth of a community or state depends"

– WEBSTER'S NEW WORLD DICTIONARY

Mark A. Benedict, Ph.D.

Edward T. McMahon, J.D.

The Conservation Fund

SPRAWL WATCH CLEARINGHOUSE MONOGRAPH SERIES

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- ✿ Mark A. Benedict, "Green Infrastructure: A Strategic Approach to Land Conservation," *American Planning Association PAS Memo*, October 2000

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About Sprawl Watch Clearinghouse

The Sprawl Watch Clearinghouse is a nonprofit organization based in Washington, DC. The Sprawl Watch Clearinghouse mission is to make the tools, techniques, and strategies developed to manage growth, accessible to citizens, grassroots organizations, environmentalists, public officials, planners, architects, the media and business leaders. At the Clearinghouse, we identify, collect, compile, and disseminate information on the best land use practices, for those listed above.

This report and many other sources of information on sprawl and smart growth are available on the World Wide Web at www.sprawlwatch.org.

About The Conservation Fund

The Conservation Fund is a national, non-profit land conservation organization headquartered in Arlington, Virginia, that forges partnerships to protect America's legacy of land and water resources. Through land acquisition, community planning, and leadership training, the Fund and its partners demonstrate sustainable conservation solutions emphasizing the integration of economic and environmental goals. Since 1985 The Fund has protected more than 3 million acres of open space, wildlife habitat and historic sites across America. To learn more about The Conservation Fund, please visit their website at www.conservationfund.org.

Front cover photo: Cooper/USFWS

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Jefferson County Green Infrastructure Assessment

Proposed by
The Conservation Fund's Freshwater Institute

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Conservation Mission

The Conservation Fund forges **partnerships** to conserve America's legacy of land and water resources. Through **land acquisition, sustainable programs, and leadership training**, the Fund and its partners demonstrate sustainable conservation solutions emphasizing the **integration of economic and environmental goals**.

The Challenges of Growing Communities

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Infrastructure - What Is It?

Definition of Infrastructure

The substructure or underlying foundation on which the continuance and growth of a community depends.

Wisconsin's New World Dictionary

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Infrastructure - What Is It?

Transportation	Utilities	Public Buildings
• Roads & Highways • Rail & Air Facilities	• Power & Communications • Water Supply & Management • Wastewater Disposal	• Schools & Libraries • Hospitals • Prisons

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Infrastructure - What Is It?

Green Infrastructure - Our Community's Life Support System!

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Green Infrastructure - What Is It?

An interconnected network of natural lands and other open spaces that conserves ecosystem values and functions and provides associated benefits to human populations.

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Green Infrastructure - What Is It?

An interconnected network composed of:

- ✓ Conserved Natural Areas & Features
- ✓ Working Lands with Conservation Value
- ✓ Greenways, Greenbelts, and Trails
- ✓ Other Protected Open Spaces

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Green Infrastructure - Nature Working for You!

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Providing Ecological Services

- Charles River Basin, Massachusetts
 - 8,534 acres of freshwater marsh & wooded swamp
 - > \$95 million in annual economic benefits including:
 - \$40 million in Flood Damage Prevention
 - \$25 million in pollution reduction

** National Studies – lands preserve for flood storage have a 8:1 dollar savings over manmade flood control structures*



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Providing Ecological Services

- Worldwide
 - 105 of world's biggest cities rely on protected forests for drinking water:
 - Rio - 1,249 mi², 80% of supply
 - Tokyo - 1,013 mi², 97% of supply
 - Malbourne - 429 mi², 90% of supply
- New York City
 - New Water Treatment Plant = 50-6 billion vs. \$1-1.5 billion over 10 years to protect Catskill, Delaware & Croton watersheds, together deliver 1.3 billion g/day



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Providing Ecological Services


- Sacramento
 - Urban forests remove > 200,000 Metric tons/yr. est. value = \$3 million/yr in pollution cleanup costs
- New York City
 - > 5 million trees cover 17% of public & private land, est. value = \$10 million/yr in pollution mitigation costs
- Delaware Valley
 - Urban forests remove 1.7 million pounds of air pollutants each year, est. value = \$3.9 million



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Maintaining Working Lands

- Working Lands
 - Major source of resource goods / jobs
 - Economic engine for rural regions & major contributor to state economies
- Example – Virginia Data (1997)
 - Forestry – 228,000 jobs, \$9.8 billion
 - Agriculture – 235,000 jobs, \$19.8 billion



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Supporting Nature-Based Tourism

- Wildlife-Related Recreation
 - One of most popular forms of recreation
 - 2001 – 82 million participants vs. 89 million for major league sports
 - Sport Fishing in 1996 - \$108.4 billion
- Example – West Virginia Data
 - Hunting – 369,000 people, 6246 jobs, \$398 million
 - Fishing – 336,000 people, 4450 jobs, \$309 million
 - Wildlife Rec. – 372,000 people, 3466 jobs, \$190 million
 - TOTAL – nearly \$600 million



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"Selling" Homes and Communities

- Key Factors Attracting New Residents & Businesses - open space amenities, access to outdoor recreation
- Natl. Assoc. of Realtors Survey – 57% more likely to purchase by green space / 50% would pay 10% more
- 1994 survey – 77% ranked "lots of natural green space" 2nd after "low traffic & quiet" (tennis 28th, golf 29th)



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Increasing Property Values

- Homes in communities with protected open space appreciate more
- Homesites in vicinity of parks and recreation areas enhanced by 15 – 20%
- Massachusetts - \$17,000 price difference for conventional homes vs. clustered homes with open space
- California – 3-mile greenbelt added \$41 million in value to surrounding properties
- Canada – 12 to 16% greater value for properties adjacent to greenways



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Enhancing Quality of Life

- Provides opportunities for nature-based recreation
- Serves as sites for outdoor education / stewardship
- Promotes better physical & mental health
- Enhances community appearance
- Maintains a connection to nature
- Excites & engages diverse people and organizations



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Protecting Natural Resource Values

- Supports native species & habitats
- Maintains ecological processes & functions
- Sustains air & water resources
- Helps protect and restore naturally functional ecosystems



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Providing a Foundation for Sustainable Communities

The Sustainability Pyramid (From Learning with Green Infrastructure, TMA, the Heritage Conservatory)

Built Capital
Only Intentional
Man-Made Materials
Roads, Sewers, Buildings, etc.

Human & Social Capital
People, Places & Connections
Family, Neighborhoods, Communities, Government, Education, Health, Religion

Natural Capital
Air, Water, Land, Energy, Raw Materials & the Beauty of Nature
(Foods, Forest, Grass, Soils, etc.)

Viable Ecosystem
Containing Healthy Plants and Animals & Properly Functioning Nature Processes
(such as the Water Cycle, Food Chain, Ecosystems, Carbon, Plant Succession)

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Providing a Foundation for Sustainable Communities

"Just as we must carefully plan for and invest in our capital infrastructure — our roads, bridges and waterlines, we must invest in our environment or green infrastructure — our forests, wetlands, streams and trees."
Former Maryland Governor Pate Glendon, January 1999

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Providing a Foundation for Sustainable Communities

Green Infrastructure and Gray Infrastructure

Require:

- **Physical and Fiscal Planning**
 - to meet community support objectives
- **Funding**
 - for implementation and maintenance
- **Management**
 - for Long Term Success

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Providing a Foundation for Sustainable Communities

Green Infrastructure and Gray Infrastructure

Ideally are:

- Planned Simultaneously
- Planned as Complementary Components of a System

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What Are the Origins of the Green Infrastructure Approach?

Two Guiding Concepts

- ❖ Protecting & linking parks and other green spaces for the benefit of people

"A connected system of parks and parkways is manifestly far more complete and useful than a series of isolated parks." Frederick Law Olmsted, Jr. 1903

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What Are the Origins of the Green Infrastructure Approach?

Two Guiding Concepts

- ❖ Protecting & linking parks and other green spaces for the benefit of people
- ❖ Preserving & linking natural areas to benefit biodiversity and counter habitat fragmentation

"At present, not one park is large enough to provide year-round sanctuary for adequate populations of all resident species..." George Wright, 1932

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What Are the Elements of a Green Infrastructure Network?

- ✓ Hubs – anchor the system
- ✓ Links – tie the system together
- ✓ Sites – smaller areas, may not be attached
- ✓ Public, private and non-profit lands

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What Are the Elements of a Green Infrastructure Network?

Green Infrastructure Network Elements

- **Connectivity with Non-point Source Runoff Treatment**
- **Restorable Supporting Natural Ecosystem Values and Functions**

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What Are the Elements of a Green Infrastructure Network?

Natural Ecosystem Values and Functions

Biodiversity & Ecological Processes

- Ecological Communities & Other Natural Features (e.g. Wetland)
- Fish & Wildlife Resources (e.g. Wildlife Refuge, Ecobelt)
- Watersheds/Water Resources (e.g. Floodplain, Aquifer Recharge Area)
- Working Landscapes with Ecological Values (e.g. Rangeland with Native Habitat)



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What Are the Elements of a Green Infrastructure Network?

Associated Benefits to Human Populations

Societal Values & Economics

- ✓ Recreation & Health (e.g., Parks, Trails & Greenways)
- ✓ Cultural Resources (e.g., Historic Sites, Educational Sites)
- ✓ Growth Pattern and Character (e.g., Greenbelts, Viewsheds, Commons)
- ✓ Working Lands with Economic Values (e.g., Farms, Managed Forests, Ranches)

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Why Do Communities Need to Identify, and Protect Their Green Infrastructure?

Accelerated Consumption & Fragmentation of Open Land!




1971 1998
St. Charles, Missouri (Outside St. Louis)

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Open Space Conversion

The rate of open space conversion far exceeds population growth!

↓ 1982-1997 = 2.3 million acres/year	↓ 47.1% change in urbanized area
↓ 1.5% rate (1982-92) (1.4 mB. ac./year)	↓ 12.02% change in population

(Source: USDA National Resources Inventory, 2000) (Source: Economic Institute, 2002)



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Social & Ecological Consequences

Social Impacts

- ✓ Loss of "Free" Services Provided by Natural Systems
- ✓ Decline of Productive Farms and Forestlands
- ✓ Loss of Connection Between People & Nature

Ecological Impacts


- ✓ Loss of Natural Areas
- ✓ Fragmentation of Habitat
- ✓ Disruption of Natural Landscape Processes
- ✓ Degradation of Water & Air Resources




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The Green Infrastructure Approach

The green infrastructure approach is based on the identification, protection and long-term management of interconnected networks of natural lands and other open spaces that cross political boundaries and span diverse landscapes and regions.



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The Green Infrastructure Approach

It makes the rational argument that the conservation and maintenance of functional natural systems not only protect ecosystems values and functions . . .




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The Green Infrastructure Approach




... but also provides diverse recreational, social, economic and health benefits to human populations.

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Green Infrastructure - Linking Lands for People & Nature!




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For More Information - www.greeninfrastructure.net



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ADDENDUM

GREEN INFRASTRUCTURE ASSESSMENT

JEFFERSON COUNTY, WEST VIRGINIA

April 10, 2008

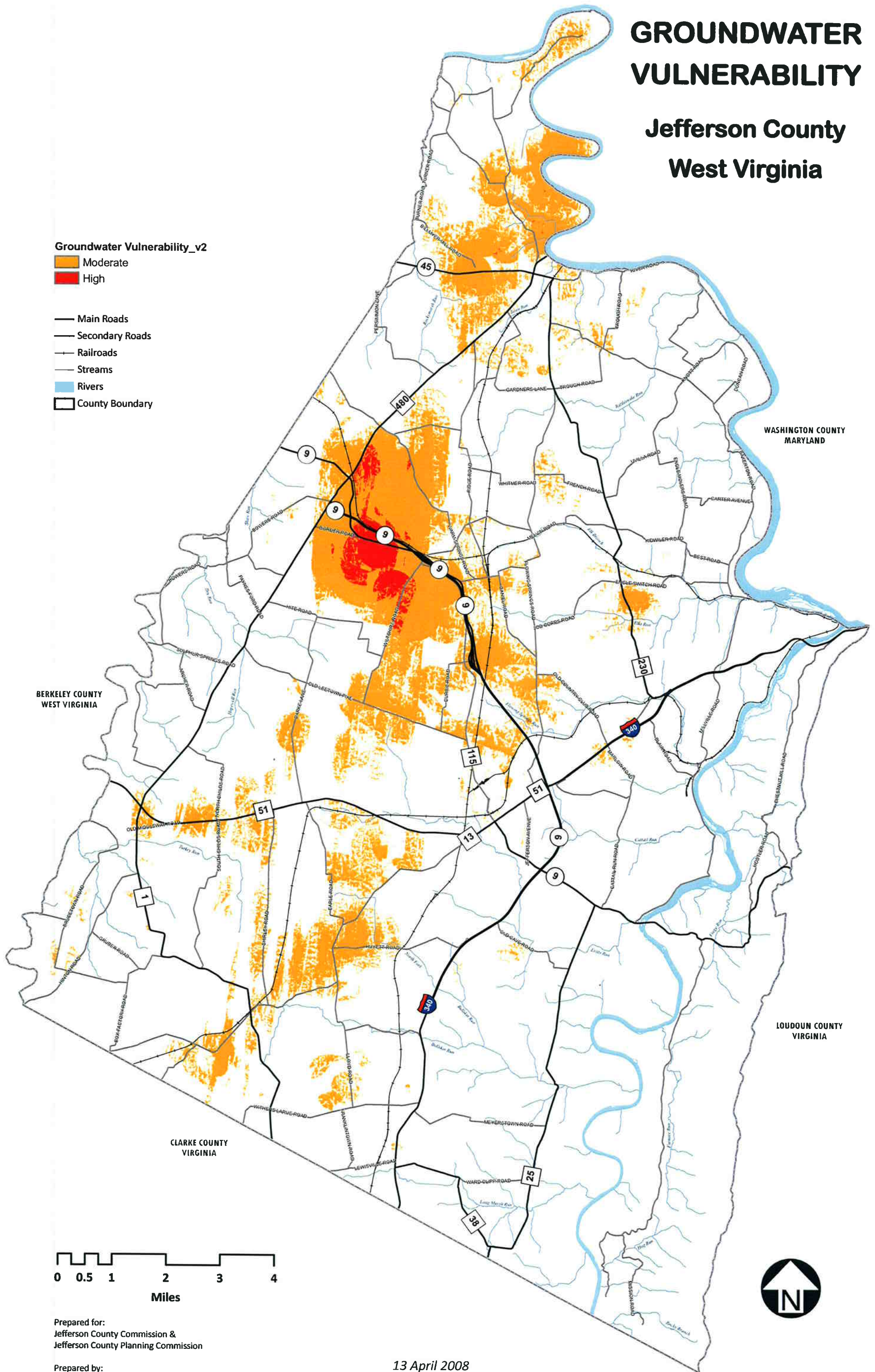
GROUNDWATER VULNERABILITY

Jefferson County West Virginia

Groundwater Vulnerability_v2

- Moderate
- High

- Main Roads
- Secondary Roads
- Railroads
- Streams
- Rivers
- County Boundary



Prepared for:
Jefferson County Commission &
Jefferson County Planning Commission

Prepared by:
Jefferson County Planning Department

13 April 2008



Groundwater Vulnerability

Summary

All groundwater is vulnerable in relative terms and karst ground waters are even more vulnerable.

“Groundwater Vulnerability” is an index of the factors that characterize the intrinsic vulnerability of karst groundwater in regards to hazards, vulnerability, and resource protection. The original purpose of this index was for use as an input for determining environmental suitability of land use practices for the 2006 Jefferson County Green Infrastructure Assessment. See “Appendix_Groundwater Vulnerability Methodology” for methods used to develop the index.

- *Hazards*: Population Density, Sensitive Karst Feature Density, Septic System Density
- *Vulnerability*: Stream Density, Sensitive Karst Feature Density, Groundwater Recharge Potential, Hydraulic Conductivity, Transmissivity
- *Resource Protection*: Source Water Protection Areas

Notes

- ◆ If maps of drinking water service areas were available, density of private wells could be incorporated into the index.
- ◆ An accurate map of sinkholes would be of use in increasing the overall accuracy of the index.
- ◆ Forthcoming geospatial data for wastewater service areas could be used to refine septic system density.
- ◆ The Source Water Protection Area dataset was obtained in 2004. A more recent version may be available from Scott Rodeheaver (WV Dept. of Health and Human Resources – Source Water Assessment and Wellhead Protection Program; Phone 304-558-6713).
- ◆ Incorporating fracture trace density into the index would aid in identifying areas of high seasonal water tables. Areas with high water tables are vulnerable to groundwater contamination as there is little to no attenuation of contaminated runoff in these areas. Conversely, a map of water table depths would be more helpful.
- ◆ All inputs were assigned equal weights. The index could be modified by weighting some inputs higher than others.

Input Data

1. Population Density [pop_den] - A measure of potential contamination from leaking sewer pipes and contamination from human-related activities e.g. used motor oil or pesticides.
2. Stream Density [stream_den] – Karst terrains are typified by a paucity of surface drainage relative to other landscapes. Thus, areas with less surface drainage (lower stream density) have a greater proportion of rainfall recharging groundwater than areas with more surface drainage. Calculated on a watershed basis. Stream density is not directly correlated to “Distance from Stream”.
3. Sensitive Karst Feature (caves and sinkholes) Density [krst_feat_den] - A measure of the likelihood of runoff entering directly into the groundwater through caves or sinkholes.
4. Groundwater Recharge Potential [gw_rchrg] - A measure of both the potential volume of water percolating into the ground and the probability that it will not enter a stream through surface runoff or shallow subsurface flow. Incorporates a topographic index and distance from streams.
 - 4.1. Topographic Index - Used to estimate the potential amount of runoff at a given point on the landscape by integrating topography and soil permeability. Can indicate areas of high seasonal water tables.
 - 4.1.1. Input:
 - 4.1.1.1. Slope – Steeper slopes accumulate more water at bottom of slope.
 - 4.1.1.2. Upstream Drainage Area – The accumulated area draining to a given point.

- 4.1.1.3. Soil Permeability - A measure of how fast water percolates into the ground.
- 4.1.2. Topographic Index = $\text{Ln}([\text{upstream drainage area}] / (\text{Tan}([\text{slope}]) * [\text{soil permeability}])))$
- 4.2. Distance from Stream - The greater the distance from a stream the greater proportion of rainfall recharges groundwater rather than entering a stream or river through surface and subsurface runoff.
- 4.3. Groundwater Recharge Potential = Distance from Stream + Topographic Index
- 5. Hydraulic Conductivity [hydl_cond] - A measure of how fast groundwater water moves vertically.
- 6. Transmissivity [trnmsvty] - A measure of how fast groundwater moves horizontally.
- 7. Source Water Protection Area [swap] – Area delineated by West Virginia Bureau for Public Health for protection of public water supplies.
 - 7.1. There are three types of source water protection areas:
 - 7.1.1. Community: Serves at least 15 service connections used by year-round residents or regularly serves 25 year-round residents.
 - 7.1.2. Non-Transient Non-Community: Serves at least the same 25 nonresidential individuals during 6 months of the year.
 - 7.1.3. Transient Non-Community: Regularly serves at least 25 nonresidential individuals (transient) during 60 or more days per year.
- 8. Septic System Density [septic_den] - A measure of potential contamination from inadequately maintained or improperly sited septic systems. Approximated through use of locations of addressable buildings. Buildings within wastewater treatment plant collection areas (estimated) were excluded.

Groundwater Vulnerability - Methodology

Notes

- ◆ Except where noted all geoprocessing was performed in ESRI ArcGIS Desktop 9.1.

Methods

1. Input Data

1.1. Population Density

1.1.1. Data Source: 2000 Census Block Centroids (U.S. Census Bureau)

1.1.2. Calculated using "Kernel Density" tool where search radius = 1800 meters and density units = square kilometers. Raw data reclassified to five classes using natural breaks algorithm.

1.2. Stream Density

1.2.1. Data Source: High-resolution National Hydrography Dataset (USGS)

1.2.2. Stream density calculated by dividing watershed area by total length of streams in watershed and converting to raster where value_field = stream density. Raw data reclassified to five classes using natural breaks algorithm.

1.3. Sensitive Karst Feature Density

1.3.1. Data Sources: Caves (WVDNR); Sinkholes (USGS)

1.3.2. Cave and sinkhole coverages merged into one shapefile. Density calculated using "Kernel Density" tool where search radius = 998.95 meters and density units = square miles. Raw data reclassified to five classes using natural breaks algorithm.

1.4. Groundwater Recharge Potential

1.4.1. Topographic Index

1.4.1.1. Slope

1.4.1.1.1. Data Source: 1/3 arc-second National Elevation Dataset (USGS)

1.4.1.1.2. Calculated using "Slope" in TauDEM 3.1 tool where units = degrees and flow direction input raster derived using D-infinity method. Slope in degrees converted to radians (required for calculation of topographic index) by multiplying slope raster by $180 \div 3.14159$. Raw data reclassified to five classes using natural breaks algorithm.

1.4.1.2. Upstream Drainage Area

1.4.1.2.1. Data Source: 1/3 arc-second National Elevation Dataset (USGS)

1.4.1.2.2. Upstream drainage area (aka "flow accumulation" or "specific catchment area") calculated using TauDEM 3.1 with D-infinity flow direction raster as input. Raw data reclassified to five classes using natural breaks algorithm.

1.4.1.3. Soil Permeability

1.4.1.3.1. Data Source: Saturated hydraulic conductivity – Jefferson County Digital Soil Survey (NRCS-SSURGO)

1.4.1.3.2. SSURGO map unit polygons converted to raster using where value_field = ksatsat_rep (representative value of saturated hydraulic conductivity). Raw data reclassified to five classes using natural breaks algorithm.

1.4.1.4. Topographic index calculated in Raster Calculator using formula: $\ln([\text{upstream drainage area}] / (\tan([\text{slope}]) * [\text{soil permeability}]])$. Raw data reclassified to five classes using natural breaks algorithm.

1.4.2. Distance from Stream

1.4.2.1. Data Source: High-resolution National Hydrography Dataset (USGS)

1.4.2.2. Calculated in TauDEM 3.1 using rasterized streams and D-8 flow direction raster (derived from 1/3 arc-second National Elevation Dataset) as inputs. This method provides the hydrologic distance to a stream as opposed to euclidean distance. Raw data reclassified to five classes using natural breaks algorithm.

- 1.4.3. "Groundwater Recharge Potential" calculated in Raster Calculator using formula: Distance from Stream + Topographic Index. Raw data reclassified to five classes using natural breaks algorithm.
- 1.5. Hydraulic Conductivity
 - 1.5.1. Data Source: Well data in USGS Open File Report 2005-1407 "Fracture Trace Map and Single-Well Aquifer Test Results in a Carbonate Aquifer in Jefferson County, West Virginia".
 - 1.5.2. Hydraulic conductivity calculated by dividing transmissivity by saturated thickness (= well depth-water level) and then calculating mean value throughout a given geologic formation (ave_K). Converted to raster where value_field = ave_K. Raw data reclassified to five classes using natural breaks algorithm.
- 1.6. Transmissivity
 - 1.6.1. Data Source: Well data in USGS Open File Report 2005-1407 "Fracture Trace Map and Single-Well Aquifer Test Results in a Carbonate Aquifer in Jefferson County, West Virginia".
 - 1.6.2. Transmissivity calculated by determining mean transmissivity throughout a given geologic formation (ave_transm). Converted to raster where value_field = ave_transm. Raw data reclassified to five classes using natural breaks algorithm.
- 1.7. Source Water Protection Area
 - 1.7.1. Data Source: Source Water Assessment Program, West Virginia Bureau for Public Health, Environmental Engineering Division (2004)
 - 1.7.2. Source water protection areas converted to separate shapefiles according to class (i.e. C, NC, or NTNC). Each class then converted to separate raster where value_field = "5" for C; "3" for NTNC; and "2" for NC. Added all three rasters together using Raster Calculator and reclassified to 5 classes using the natural breaks algorithm.
 - 1.7.3. Scores for Source Water Protection Areas were assigned subjectively based on relative risk to water consumers within their respective area.
- 1.8. Septic System Density
 - 1.8.1. Data Source: 2005 Buildings (Jefferson County Addressing Office)
 - 1.8.2. Extracted addressable buildings from buildings shapefile using "Select by Attribute" with "layer"=A3010. Addressable building polylines converted to polygons by converting polylines to DXF format and then converting DXF file to polygons. Derived polygon centroids from polygons using Visual Basic script "Polygon to Centroid 1.1". Extracted centroids not located within a wastewater service area and saved as shapefile. Calculated density of addressable building centroids using "Kernel Density" where search radius = 1609 meters and density units = square miles. Raw data reclassified to five classes using natural breaks algorithm.
2. Calculation of Groundwater Vulnerability Index
 - 2.1. Raw data for all variables were reclassified to a scale of 1-5 in relation to impact on groundwater vulnerability using the Jenks natural breaks classification method in ESRI ArcGIS Desktop. The natural breaks method is most suitable for data that does not possess a statistically normal distribution. The reclassification process allows for data to be indexed to common scale where data layers can then be added together to form a cumulative index.
 - 2.2. Groundwater Vulnerability (output grid: [grdwtr_vul08u]) = [Population Density] + [Stream Density] + [Karst Feature Density] + [Groundwater Recharge Potential] + [Hydraulic Conductivity] + [Transmissivity] + [Source Water Protection Areas] + [Septic Density]
 - 2.3. Groundwater Vulnerability output [grdwtr_vul08u] indexed to a scale of 1-10 by dividing the maximum value by the product of the maximum value times 0.1 (output grid: [grdwtr_vul08i]).
 - 2.4. Indexed output [grdwtr_vul08n] then reclassified to a value of "1" for moderately vulnerable areas and to a value of "2" for highly vulnerable areas (output grid: [grdwtr_vul08r]) using a 10 class natural breaks classification where classes 8-9 were classified as "moderately vulnerable" and class 10 as "highly vulnerable" per Planning Department staff recommendation.

JEFFERSON COUNTY DRAFT ZONING AND SUBDIVISION ORDINANCES

(ver. 11-14-2007)

Recommendations for Integration of Green Infrastructure Principles

Summary

Overall, by identifying and protecting the most valuable natural resources of Jefferson County, these ordinances afford substantial protection for the sustainability of these resources. Of particular note are the Resource Protection Standards and the overarching philosophy of Avoid – Minimize – Mitigate, which serves to promulgate the principles of Low Impact Development.

While these ordinances contain some expressions of the principles of Low Impact Development, sufficient detail is lacking to ensure sufficient implementation of these principles. Therefore, we recommend that Jefferson County create a separate stormwater ordinance that will include sufficient detail to protect and preserve the water resources of the County by requiring Low Impact Development and Environmental Site Design practices. Utilizing non-structural stormwater management practices throughout a development serves to create a multifunctional landscape that provides additional amenities to homeowners such as recreation, wildlife habitat, and increased property values. These characteristics may also serve to increase homeowner willingness to maintain such systems, a critical issue in long-term stormwater management. A separate stormwater ordinance would also serve to consolidate the disparate stormwater management requirements scattered through both the zoning and subdivision ordinances.

Recognizing the multifunctionality of vegetation for providing ecosystem services, consideration should be given to inserting provisions that encourage use of landscaping requirements and mitigation to enhance the green infrastructure network in ways that protect water resources and enhance valuable habitat. Ensuring that modulations and variances are systematic and consistent in regards to protecting natural resources of highest value and encouraging mitigation towards enhancement of the green infrastructure network should also be considered.

Care needs to be taken in regard to defining riparian areas. Defining streams by surface flow regimes in karst topography requires consideration of the subsurface and groundwater flows that typically sustain them. What might be defined as an ephemeral stream in some areas can flow for months on end or even longer during abnormally wet years and then not flow again for over a year or more. Conversely, normally “perennial” streams in karst can go dry for extended periods during extreme droughts. Although surface flow may not be present there may still be high water tables following the general topography of drainways. It is this resource that requires protection because of its vulnerability. The presence or absence of surface flow is of secondary concern in karst topography where surface and ground water are often functionally indistinguishable.

As stands, the ability of the Zoning Ordinance to meet countywide resource protection goals with certainty is not apparent. As mentioned in our previous recommendations (attached), overlay zones could be used to ensure that the planning goals of the County are implemented across planning zones. Additional overlay zones that should be considered are those that support the restoration of native brook trout and require enhanced stormwater management in watersheds where the impervious surface is greater than 10%.

Finally, ensuring consistent use of terms (e.g. detention/retention, drainage/swale) to facilitate ease of interpretation throughout the ordinances should be taken into consideration.

Zoning Ordinance

Article 4

Division 4.200 Resource Protection Standards

Table 4.200 Open Space Ratios

- ◆ Open Space Ratios for the following Resources are lower in AG and CS districts than in other districts but should be equal or higher as in previous versions of the ordinance:
 - Riparian Buffers
 - Core Woodlands Young
 - Mature Woodlands
 - Young Woodlands
 - Steep Slopes 15-25%
- ◆ “Bald Eagle Nest” should be changed to “Bald Eagle Primary Management Zone” and defined in “Definitions” according to attached document – “Bald Eagle Protection Guidelines”.
 - Consideration should also be given to developing Open Space Ratios for a Bald Eagle Secondary Management Zone and regulating uses within the primary zone or both these zones in Section 4.401.

Division 4.300 Site Capacity Calculations

Section 4.301 Site Capacity Requirement

- ◆ B.4 and 5. Look like loopholes whereby a site dominated by upland forest and other non-wetland, non-floodplain resources is entirely unprotected. If a developer defines the site boundaries to take advantage of this loophole, there may be no protection for these important resources. Any wetlands besides farm ponds should not be buildable. What exactly is the intent of this Section?

Division 4.400 Open Space Regulations

Section 4.401 Uses in Open Space

- ◆ This section and associated tables contain numerous errors and inconsistencies such as missing resources (e.g. Shallow Bedrock) and limitations that are listed in the table but not described in the text as well as limitations listed in the text not being reflected in the table as such. The recommendations below are not exhaustive and will be revisited upon completion of a consistent description and tabulation of open space uses.

- ◇ Adequate buffers are required to limit contamination of groundwater (sinkhole buffers and wellhead protection areas) from animals and other uses. While 50 feet is an adequate buffer width, a wider buffer allows for a much better margin of safety for drinking water protection.
- ◇ As structural integrity of the riparian buffer is necessary to maintain function it is important that uses that entail vegetation removal be limited as much as possible.
- ◇ Apiaries
 - Use should be limited to ensure that clearing and roads do not impair condition of riparian zone.
- ◇ Field Crops
 - Missing text on limitations for *Highly Vulnerable Areas*.
- ◇ Orchards
 - At minimum a 50-foot uncultivated buffer should be required between orchards and water bodies, sinkholes, and wellhead protection areas. A 100-foot buffer is recommended for spraying.
- ◇ Pasture
 - Limit use to greater than 50 feet from wellhead protection areas (same as text requirements for sinkhole buffers).
- ◇ Kennels and Stables
 - Limit use to greater than 50 feet from wellhead protection areas.
- ◇ Ball Fields
 - Should not be permitted in riparian buffer.
- ◇ Picnic Areas
 - Limited – no roads or other paved surfaces in riparian zone.
- ◇ Pools
 - Listed in table but not in text.
- ◇ Playing Courts
 - Should not be permitted in riparian buffer (as specified in table) and only limited use should be allowed in wellhead protection area.
- ◇ Detention Areas
 - Should not be permitted in riparian zone.
 - Low quality wetlands not defined.
 - Use of existing wetlands for stormwater management is not recommended.

Division 4.500 Additional Resource Standards

Section 4.510 Wetland Mitigation

- ◇ Current federal standards and judicial reviews are unclear as to exactly what constitutes an “isolated” wetland. In light of this and the fact that wetlands separated from waterways may be connected to the groundwater system or to ephemeral watercourses leads us to recommend that mitigation of isolated wetlands not be permitted. If mitigation of wetlands is to be allowed it should be steered towards augmenting existing large wetlands, wetland complexes, or constructing wetlands within green infrastructure corridors.

- ◆ Wetland quality (high or low) is not defined in the ordinance. Defining wetland quality is not easily accomplished and if there is a firm desire to define wetland quality, a uniform standard will need to be developed. An adequate definition of quality would also be useful to ensure protection of high quality wetlands.
- ◆ It is unclear how size thresholds for wetland mitigation were determined. Recommend reducing size thresholds to one-quarter acre in residential districts and one-half acre in nonresidential zoning districts if mitigation is to be permitted.
- ◆ Mitigation of marl wetlands should not be permitted or only if surveyed and shown not to contain any rare, threatened, or endangered plants.

Section 4.513 Mature Woodlands

- ◆ Items D, E, and F are difficult to understand as to what is allowed and not allowed and as to guidelines for mitigation. While it is true that mature core forest is more valuable than young core forest in the present tense, young core forest will eventually become mature core forest. The size of the forest rather than age is the most important characteristic in terms of preservation.
- ◆ A. Not clear as to how “area permitted to be disturbed shall be located to maximize size of the undisturbed habitat”. It should be made clear that disturbance of core forests is to be avoided.
- ◆ D. Mitigation should be steered towards increasing size of existing core forest. Cutting of young core forest should not be allowed or should require higher mitigation requirements.
- ◆ E. Mitigation of any core forest should not be allowed regardless of age as these are the most important woodlands in the County. Table 4.513 and the examples are confusing and should be revised.

Section 4.514 Sinkholes

- ◆ Need to be consistent throughout this section, Section 4.515, and other sections of ordinances to specify that stormwater CAN be allowed to enter a sinkhole as long as it meets pre-development quantity and quality. Adopt text in 4.514.D.3 “Stormwater flows to sinkholes shall mimic pre-development volumes and shall be of a quality no worse than if discharged towards the sinkhole through a wooded buffer”. The Madison Cave Isopod (Jefferson County’s only federally listed species) requires food input through sinkholes and caves. Ensure that sinkhole filling is not an option or the option of last resort – Madison Cave Isopod requires open sinkholes for survival.

Section 4.516 Vulnerable Areas

- ◆ A. Vulnerable areas need to be defined more clearly. See suggested revision in “Definitions” section.
- ◆ D. Requirements of geotechnical study should be spelled out in more detail. Recommend using geotechnical study requirements from the Maryland Stormwater Manual and Loudoun County Facilities Standards Manual as a template (attached).

- ◇ F. Open connections to groundwater should not be filled or sealed but adequately buffered with natural vegetation with inflows not to exceed pre-development quantity and quality.
- ◇ G. Drainage and stormwater system requirements would best be specified in a separate Stormwater Ordinance. These requirements should follow the principles of Low Impact Development/Environmental Site Design.
 - Suggest revising text to:
A drainage and stormwater management system shall be developed that ensures that the rate and quality of stormwater recharging the aquifer is that of the area in a natural state. The natural hydrologic functions of the landscape to absorb and treat stormwater should be maintained or re-created. This can be achieved by maintaining existing drainage patterns, disconnecting impervious surfaces, increasing Time of Concentration, minimizing site disturbance to maintain natural soil properties, and controlling stormwater as close to the source as possible through multiple small-scale controls. Site landscaping and natural area conservation should be utilized to maximize the benefits of natural water filtration that vegetation provides as well. Site layout should be designed around the stormwater management system.

Section 4.517 Steep Slopes

- ◇ Modify text to reflect slope ranges of 15-25% and greater than 25% as used in other parts of the ordinances.

Division 4.600 Stormwater Management

Section 4.602 Stormwater Standards

- ◇ B. Water quantity modeling calculations should include entire area draining to site not just onsite area.

Article 8

Division 8.300

Section 8.303 Open Space Landscaping

- ◇ This section represents an opportunity to enhance ecological value of existing woodlands by adding plants to perimeter.
- ◇ C. Wetlands
 - Enhancement of wetlands is to be commended. However, this section seems to contradict earlier wetland mitigation guidance.

Division 8.500

Section 8.502 Plant Species

- ◇ A. Change from “native to West Virginia” to “native to Ridge and Valley Province within 15 miles of county border”. Ecologically speaking, Jefferson County has more in common with Clarke County, VA and Washington County, MD than it does with the remainder of West Virginia. It also occupies a unique transitional niche between northern and southern ecoregions.
- ◇ B. Required number of species should be increased to sustain biodiversity.

Section 8.503 Soil Preparation

- ◆ Strike “D” – Initial fertilization is important for tree establishment and as long as applied conservatively should not have deleterious effects. Consider recommending fertilization at appropriate rates for the initial establishment of trees and shrubs.

Definitions

- ◆ Highly Vulnerable Area
 - Revise to – “An area where the combination of soils, subsurface conditions, geologic features, hydrology, population density, and Source Water Protection Areas makes the groundwater highly vulnerable to contamination.”
 - “Moderately Vulnerable Area” needs to be defined in consultation with Planning Department staff. This is basically an area that contains a lower intensity of the conditions that make an area highly vulnerable.
- ◆ Intermittent Stream
 - Suggest revising to – “A well-defined channel within which water flows for only part of the year during normal hydrologic conditions.”
 - Does not appear to be used in ordinance.
- ◆ Low Quality Woodland
 - Suggest revising to “A small (less than 20 acres) or edge-dominated (less than 200 feet wide) woodland that is dominated by invasive or exotic species or contains a majority of diseased or dead trees.”
- ◆ Perennial Stream
 - Suggest revising to – “A channel with banks and a bed within which water flows year-round but may stop flowing during prolonged drought.”
 - Suggest reviewing “Fairfax County Perennial Stream Identification Protocol” for further guidelines to differentiate between ephemeral, intermittent, and perennial streams (attached).
- ◆ Rare Species
 - Incorrect. Revise to – “A species which exists in low numbers or in isolated areas and may be threatened or endangered.”
- ◆ Riparian Buffer
 - Ephemeral streams are not defined. We recommend using a drainage area threshold to define them such as outlined in the current definition of “Swale”.
 - Because of the primarily subsurface nature of karst hydrology we recommend that consideration be given to the development of buffer requirements for ephemeral waterways without channels using a drainage area threshold to define them such as outlined in the current definition of “Swale”. A buffer width of 30 feet is suggested.
 - Create new category for intermittent streams and require 75 foot buffer.
 - Potomac River – increase to 300 feet and include Shenandoah River in this category.
 - Create new category for Opequon Creek and require 200 foot buffer.

- Create new category for springs and require 100 foot buffer.
- Wetlands, Marl – not defined.
- Wetlands, Farmed – unclear as to what purpose buffers for farmed wetlands would serve.
- ◇ Shallow Bedrock
 - Consider changing “Any area where limestone appears...” to “Any area where rock outcrops appear...”
- ◇ Sinkhole
 - Add definition for “Historic Sinkhole” using definition in Section 4.514 D.1. of Zoning Ordinance.
- ◇ Steep Slopes
 - Definition unclear – drop of 10 feet over what horizontal distance?
 - Classes should be 15-25% and >25% as specified in Resource Protection Standards.
- ◇ Surface Water
 - Definition unclear. Is this intended to define a pond? Areal threshold should be lower – one-eighth or one-quarter acre.
 - Recommend use of the Local Resolution National Hydrography Dataset as mapping standard for ALL water bodies. USGS topographic maps utilize mapping standards for hydrographic features that are often inconsistent with ground conditions. The Local Resolution National Hydrography Dataset was developed using 2003 aerial photography.
- ◇ Swale
 - Is this intended to define ephemeral waterways/watercourses? If so, should be defined as such.
 - How were the area thresholds derived?
- ◇ Watercourse
 - Utilize Local Resolution National Hydrography Dataset as “mapped” reference.
- ◇ Watershed
 - Change “stormwater” to “surface”.
- ◇ Wetland
 - Marl wetland not defined. These are wetlands that contain the soil series Fairplay or Lappans.
- ◇ Woodland
 - The definition of “Core Young Woodland” eliminates any large wooded area comprised of small trees. All young woodlands become mature at some point in time.
 - The DBH requirements for mature and young core woodlands should be phrased as “averaging” as are the definitions for other woodland types.

Subdivision and Land Development Ordinance

Article 20

Division 20.300

Section 20.302 Subdivision General Review Standards

- ◆ A.2.b. Where are resources ranked for value/quality? Options for adjustment of location should be expanded to include protection of recharge areas and core forests. This section seems to contradict Section 4.s01.B.4-5 of the Zoning Ordinance.

Section 20.303 Land Development General Review Standards

- ◆ A.2.b. See comments for Section 20.302.A.2.b.

Article 22

Division 22.200

Section 22.208 Curbs

- ◆ Refers to tables that are not in text. Curb requirements should be consistent with requirements to minimize stormwater runoff.

Division 22.400

Section 22.405 Design Standards for Drainage and Detention/Retention

- ◆ Both parts named "Quantity Control".
- ◆ Ensure that pre-development runoff is calculated for entire watershed above site not just onsite.

Section 22.406 Retention or Detention

- ◆ B. How will practicality be determined?
- ◆ E.4. Refers to regional storm water facility. Where are these provided for?

Section 22.410 Other Systems for Retention or Detention

- ◆ D. How will practicality be determined?

Section 22.411 Maintenance

- ◆ Long-term maintenance of stormwater management structures is critical.

ATTACHMENTS

- A. Bald Eagle Protection Guidelines.pdf
- B. Fairfax Cty_Perennial Stream Identification Protocol.pdf
- C. Maryland Stormwater Manual_Apndx_D2_Geotechnical Methods for Karst.pdf
- D. Loudoun Cty_FSM_Chapter 6_Soil_Geotech_Hydrogeo Reviews.pdf

Comments on previous ordinance drafts (provided as reference):

- E. JCGIA_Implementation Recommendations_112806.pdf