Exercise: Hydrology

1. Write the name of your area of interest in the space provided (examples: Kanawha County, Elk River Watershed):

2. Utilizing the maps provided and your understanding of your area of interest, answer the following questions:

   In what watershed(s) is your area located? *(Resource: WV watersheds map)*

   In what physiographic province(s) is your area located? *(Resource: WV physio. province map)*

   What are the names of two upstream and two downstream counties? *(Resource: WV counties and rivers map)*

   How many streamflow gages are located in your area of interest? *(Resource: WV gage map)*

   What is the dominant geology in your area? *(Resource: WV geology map)*

   Does your area have any impaired waterways? *(Resource: WV impaired waterways map)*

   What is (1) the dominant land use in your area and (2) an additional land use found in your area *(Resource: WV land use/land cover map)*

Exercise: Issue Identification and Regional Cooperation

1. Fill in the sections below as they relate to your selected water resource issue.
2. Rank the concerns for each stakeholder group.
3. Identify common concerns and/or interests and indicate opportunities for cooperation.

Water Resource Issues

Sources and Stressors of Issues

Interested/Impacted Stakeholders

Potential Solutions

Exercise 4: Challenges to Implementing Planning Process

1. Review the steps to watershed planning.
2. List resources (financial, data, staff time, knowledge, etc.) that are required to complete the step and whether or not they are available.
3. Identify challenges or barriers you might face in completing the planning step or in obtaining the necessary resources.
4. Brainstorm ways to overcome these challenges (public-private partnerships, university collaboration, volunteers, etc.)

Step 1: Build Partnerships

Stakeholder meetings
Public outreach and education

Step 2: Develop Watershed Planning Goals

Related to quality, use, development, habitat,

Step 3: Characterize the Watershed

Hydrology, geology, land use, water use, quality, environmental needs, contaminants, future plans

Step 4: Assemble Plan

Critical areas, management measures, projects

Step 5: Design Implementation Program

Priorities, timeline, funding

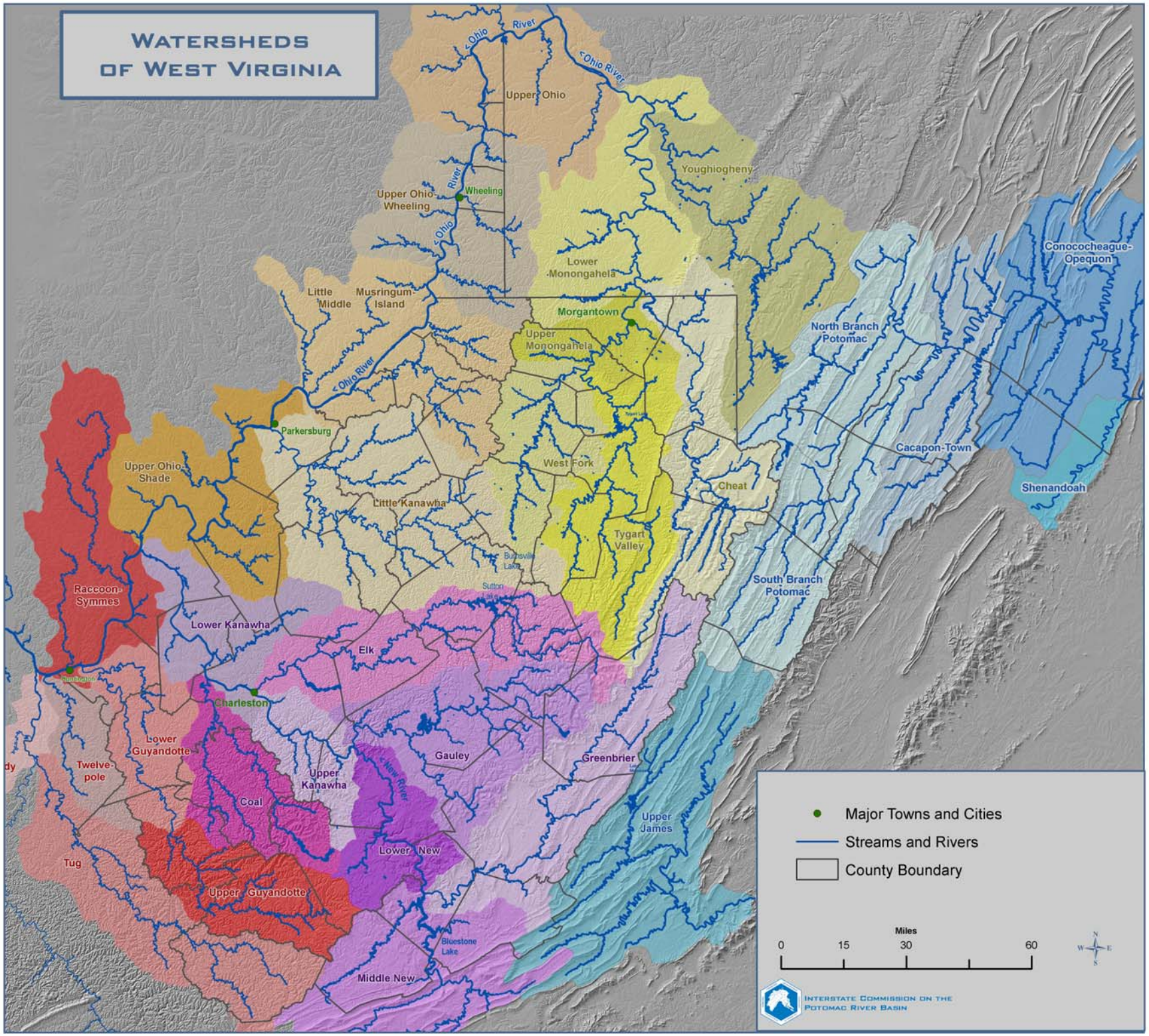
Step 6: Implement Watershed Plan

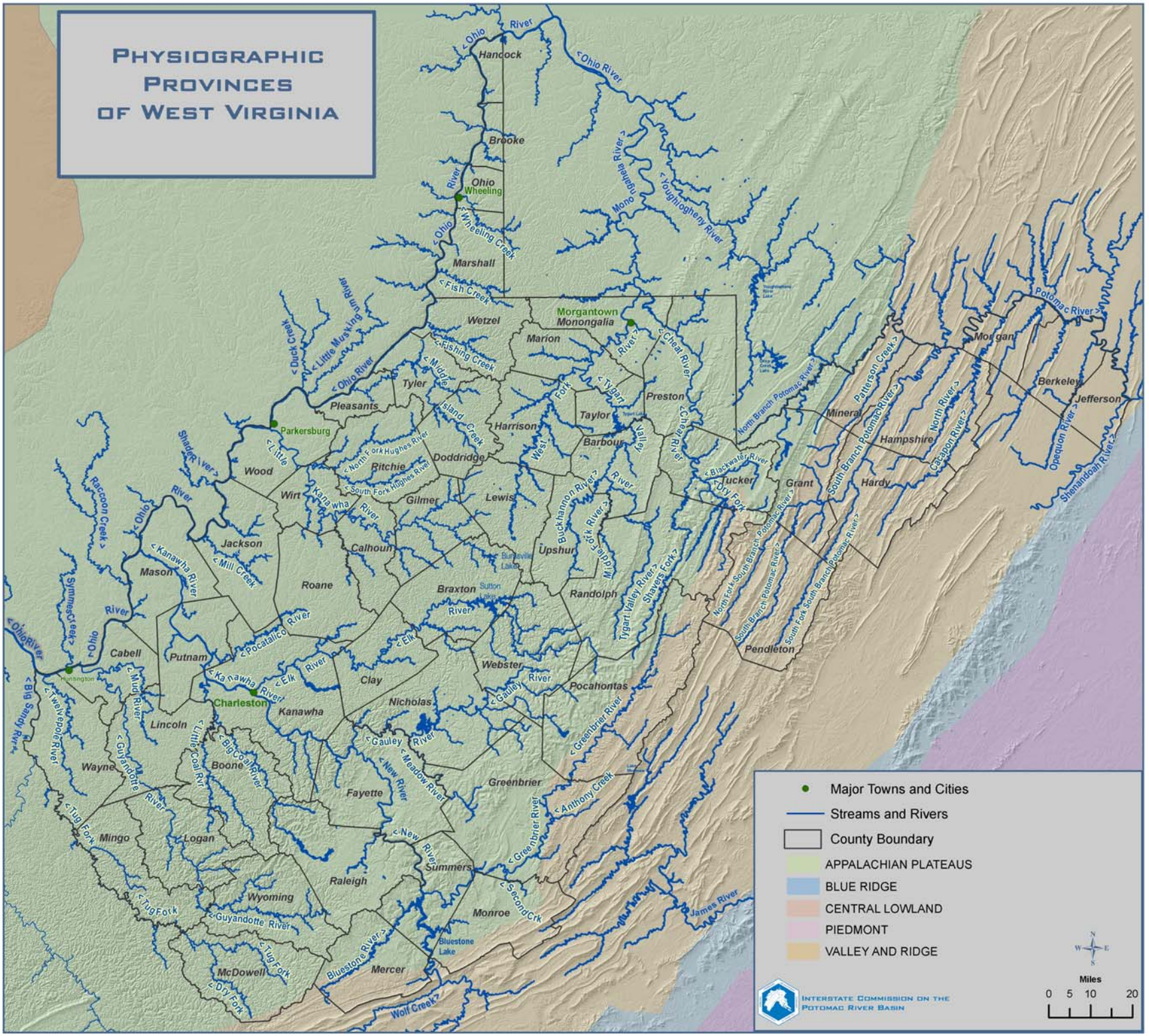
Projects, monitoring, reports

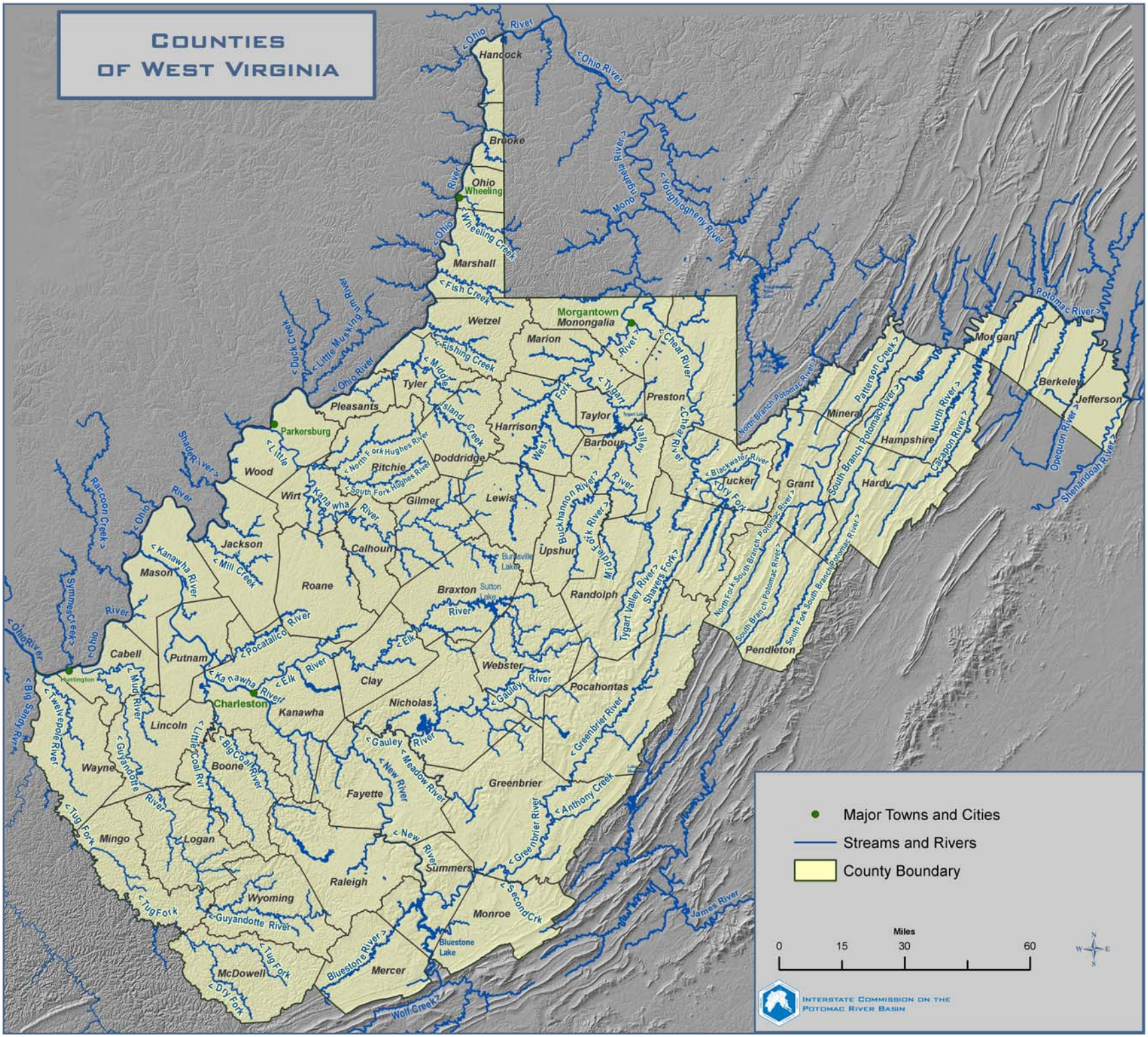
Step 7: Measure Progress and make adjustments

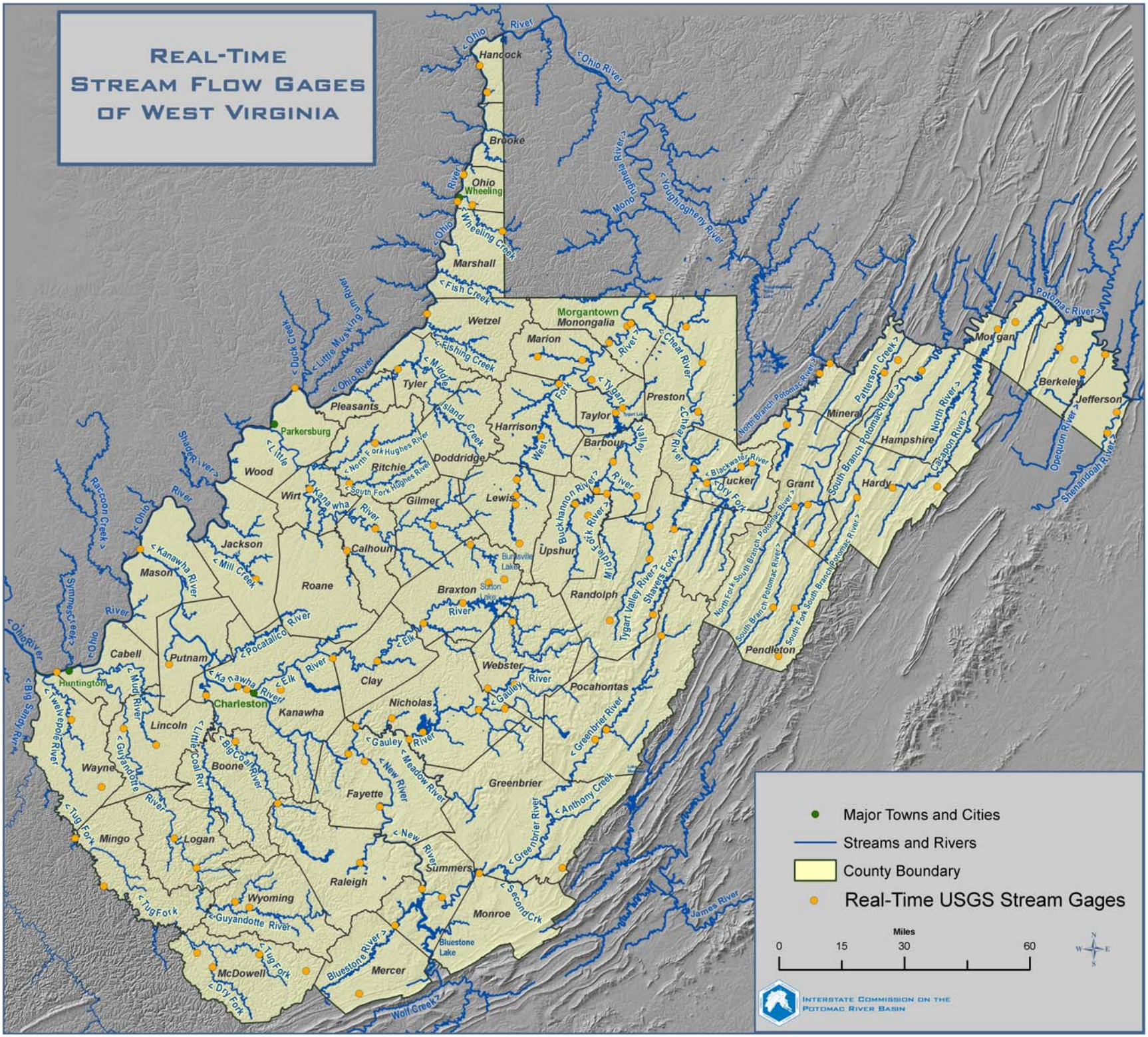
Set milestones, criteria for success, evaluate progress

	Required Resources	Challenges/Barriers	How to overcome challenges
Step 1: Build Partnerships			
Step 2: Develop Watershed Planning Goals			
Step 3: Characterize the Watershed			
Step 4: Assemble Plan			
Step 5: Design Implementation Program			
Step 6: Implement Watershed Plan			
Step 7: Measure Progress and make adjustments			


Watersheds of West Virginia
Ohio River
Upper Ohio
Youghiogheny
Upper Ohio-Wheeling
Wheeling
Lower Monongahela
Little Middle
Musringum-Island
Morgantown
Upper Monongahela
North Branch Potomac
Conococheague-Opequon
Parkersburg
Upper Ohio-Shade
West Fork
Cacapon-Town
Cheat
Shenandoah
Little Kanawha
Tygart Valley
Burnsville Lake
Sutton Lake
South Branch Potomac
Raccoon-Symmes
Lower Kanawha
Elk
Charleston
Gauley
Greenbrier
Lower Guyandotte
Twelve-pole
Upper Kanawha
New River
Coal
Upper James
Tug
Lower New
Upper Guyandotte
Bluestone Lake
Middle New
Major Towns and Cities
Streams and Rivers
County Boundary
Miles
0
15
30
60
N
W
E
S
Interstate Commission on the Potomac River Basin


Physiographic Provinces of West Virginia
Major Towns and Cities
Streams and Rivers
County Boundary
APPALACHIAN PLATEAUS
BLUE RIDGE
CENTRAL LOWLAND
PIEDMONT
VALLEY AND RIDGE
Interstate Commission on the Potomac River Basin
Miles
0 5 10 20
Hancock
Brooke
Ohio
Wheeling
Marshall
Wetzel
Morgantown
Monongalia
Marion
Tyler
Pleasants
Parkersburg
Wood
Wirt
Ritchie
Doddridge
Harrison
Taylor
Barbour
Preston
Tucker
Lewis
Gilmer
Calhoun
Upshur
Randolph
Braxton
Roane
Jackson
Mason
Putnam
Cabell
Huntington
Kanawha
Charleston
Clay
Webster
Pocahontas
Nicholas
Fayette
Greenbrier
Pendleton
Lincoln
Boone
Wayne
Logan
Mingo
Raleigh
Summers
Monroe
Wyoming
McDowell
Mercer
Grant
Hardy
Mineral
Hampshire
Morgan
Berkeley
Jefferson
Ohio River
Little Muskingum River
Duck Creek
Fishing Creek
Middle Island Creek
West Fork River
Buckhannon River
Tygart Valley River
Cheat River
Blackwater River
Dry Fork
North Branch Potomac River
South Branch Potomac River
North River
Patterson Creek
Cacapon River
Opequon River
Shenandoah River
Potomac River
Little Kanawha River
Hughes River
North Fork Hughes River
South Fork Hughes River
Kanawha River
Mill Creek
Raccoon Creek
Sandy River
Big Sandy River
Twelvepole River
Mud River
Guyandotte River
Big Coal River
Little Coal River
Tug Fork
Pocatalico River
Elk River
Gauley River
New River
Meadow River
Greenbrier River
Anthony Creek
Second Crk
Bluestone River
Bluestone Lake
Wolf Creek
James River
Burnsville Lake
Sutton Lake
Shavers Fork
North Fork South Branch Potomac River
South Fork South Branch Potomac River


Counties of West Virginia
Hancock
Brooke
Ohio
Wheeling
Marshall
Wetzel
Morgantown
Monongalia
Marion
Tyler
Pleasants
Parkersburg
Wood
Wirt
Ritchie
Doddridge
Harrison
Taylor
Barbour
Preston
Lewis
Gilmer
Upshur
Randolph
Tucker
Grant
Hardy
Mineral
Hampshire
Morgan
Berkeley
Jefferson
Jackson
Calhoun
Roane
Braxton
Clay
Webster
Pocahontas
Nicholas
Mason
Putnam
Cabell
Kanawha
Charleston
Huntington
Lincoln
Boone
Wayne
Logan
Mingo
Fayette
Greenbrier
Pendleton
Summers
Raleigh
Wyoming
McDowell
Mercer
Monroe
Major Towns and Cities
Streams and Rivers
County Boundary
Miles
0
15
30
60
Interstate Commission on the Potomac River Basin


Real-Time Stream Flow Gages of West Virginia
Major Towns and Cities
Streams and Rivers
County Boundary
Real-Time USGS Stream Gages
Miles
0
15
30
60
Interstate Commission on the Potomac River Basin
Hancock
Brooke
Ohio
Wheeling
Marshall
Wetzel
Morgantown
Monongalia
Marion
Tyler
Pleasants
Parkersburg
Wood
Wirt
Ritchie
Doddridge
Harrison
Taylor
Barbour
Preston
Lewis
Gilmer
Upshur
Randolph
Tucker
Grant
Hardy
Mineral
Hampshire
Morgan
Berkeley
Jefferson
Jackson
Calhoun
Roane
Braxton
Webster
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Nicholas
Greenbrier
Fayette
Raleigh
Summers
Monroe
Mercer
McDowell
Wyoming
Mingo
Logan
Boone
Lincoln
Kanawha
Charleston
Putnam
Cabell
Huntington
Mason
Pendleton
Ohio River
Kanawha River
Elk River
Gauley River
New River
Greenbrier River
Tug Fork
Guyandotte River
Big Coal River
Little Coal River
Mud River
Twelvepole River
Pocatalico River
Mill Creek
Sandy River
Raccoon Creek
Symmes Creek
Little Muskingum River
Duck Creek
Fishing Creek
Middle Island Creek
North Fork Hughes River
South Fork Hughes River
Kanawha River
West Fork River
Buckhannon River
Tygart Valley River
Shavers Fork
Dry Fork
Blackwater River
Cheat River
Youghiogheny River
Monongahela River
Potomac River
North Branch Potomac River
South Branch Potomac River
North Fork South Branch Potomac River
South Fork South Branch Potomac River
Patterson Creek
North River
Cacapon River
Opequon River
Shenandoah River
Anthony Creek
Second Crk
James River
Bluestone River
Bluestone Lake
Wolf Creek
Burnsville Lake
Sutton Lake
Wheeling Creek
Ohio River
Tygart Lake

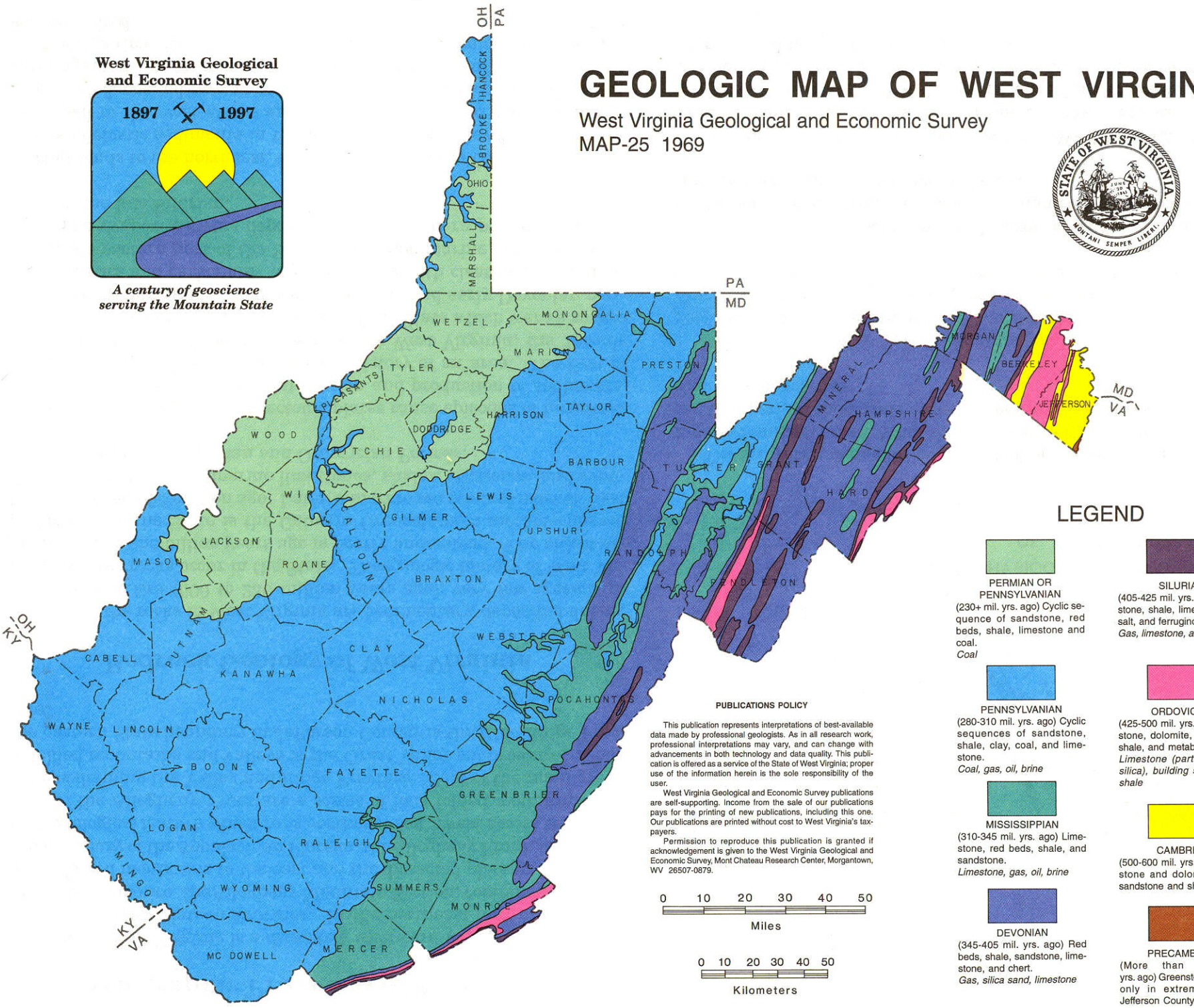
West Virginia Geological and Economic Survey

1897 1997

A century of geoscience serving the Mountain State

GEOLOGIC MAP OF WEST VIRGINIA

West Virginia Geological and Economic Survey
MAP-25 1969



LEGEND

PERMIAN OR PENNSYLVANIAN
(230+ mil. yrs. ago) Cyclic sequence of sandstone, red beds, shale, limestone and coal.
Coal

PENNSYLVANIAN
(280-310 mil. yrs. ago) Cyclic sequences of sandstone, shale, clay, coal, and limestone.
Coal, gas, oil, brine

MISSISSIPPIAN
(310-345 mil. yrs. ago) Limestone, red beds, shale, and sandstone.
Limestone, gas, oil, brine

DEVONIAN
(345-405 mil. yrs. ago) Red beds, shale, sandstone, limestone, and chert.
Gas, silica sand, limestone

SILURIAN
(405-425 mil. yrs. ago) Sandstone, shale, limestone, rock salt, and ferruginous beds.
Gas, limestone, artificial brine

ORDOVICIAN
(425-500 mil. yrs. ago) Limestone, dolomite, sandstone, shale, and metabentonite.
Limestone (particularly low silica), building stone, clay-shale

CAMBRIAN
(500-600 mil. yrs. ago) Limestone and dolomite, some sandstone and shale.

PRECAMBRIAN
(More than 600 mil. yrs. ago) Greenstone. Present only in extreme eastern Jefferson County.

0 10 20 30 40 50
Miles

0 10 20 30 40 50
Kilometers

PUBLICATIONS POLICY

This publication represents interpretations of best-available data made by professional geologists. As in all research work, professional interpretations may vary, and can change with advancements in both technology and data quality. This publication is offered as a service of the State of West Virginia; proper use of the information herein is the sole responsibility of the user.

West Virginia Geological and Economic Survey publications are self-supporting. Income from the sale of our publications pays for the printing of new publications, including this one. Our publications are printed without cost to West Virginia's taxpayers.

Physiographic Provinces of West Virginia

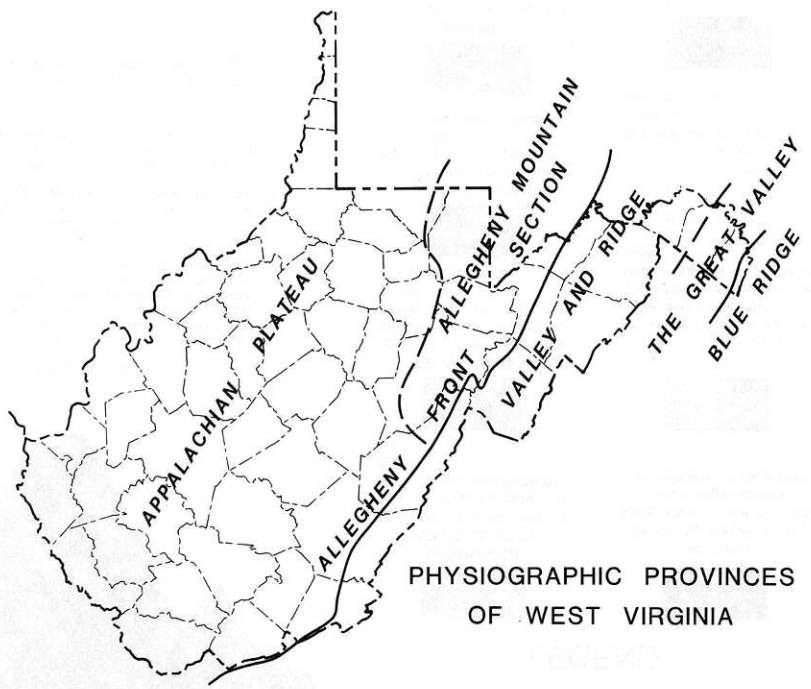
Most of West Virginia is a dissected, westward-tilting plateau called the Appalachian Plateau Province. In the northeast part of this province, a subprovince, the Allegheny Mountain Section, combines elements of the folded mountains to the east and the dissected plateau. The eastern boundary of the Appalachian Plateau, the Allegheny Front, is a prominent geological feature which runs northeast-southwest across the State. East of the Allegheny Front are a series of long folded mountains and valleys defining the Valley and Ridge Province. East of the main group of folded mountains and valleys is the Great Valley subprovince. Along the eastern State boundary in Jefferson County is the Blue Ridge Province.

Bedrock Geology of West Virginia

Most of the rocks in West Virginia are sedimentary, deposited during the Paleozoic Era (600 to 230 million years ago); very few igneous or metamorphic rocks occur in the State. The geologic history of West Virginia prior to one billion years ago is poorly understood. The oldest exposed rock in the State is the Catoctin Greenstone, a metamorphosed lava deposited 800 million ago. Later, a marine sea covered most of West Virginia and deposited marine limestones, shales, siltstones, and sandstones during the Cambrian and Ordovician Periods.

Movements of the earth's tectonic plates cause episodes of mountain building which, with subsequent erosion and production of sediments, can have major effects on the geologic history of an area. The first of these mountain-building episodes to effect West Virginia, the Taconic Orogeny, formed mountains to the east of the State which were a source of sediments during the Ordovician, Silurian, and early Devonian periods. Clastics and carbonates were deposited with clastics predominating in the eastern part of the State. Also, non-marine deposition took place and evaporites were deposited in the northern part of West Virginia in the late Silurian.

Highlands to the northeast, formed in the Acadian Orogeny, were the source of clastic sediments in the Middle and Late Devonian. The sea regressed to the west at the end of the Devonian and continental red beds were deposited over most of the State. The sea covered West Virginia again in the Middle Mississippian (about 330 million years ago). During this time, the Greenbrier Group, composed mainly of limestone, was deposited.



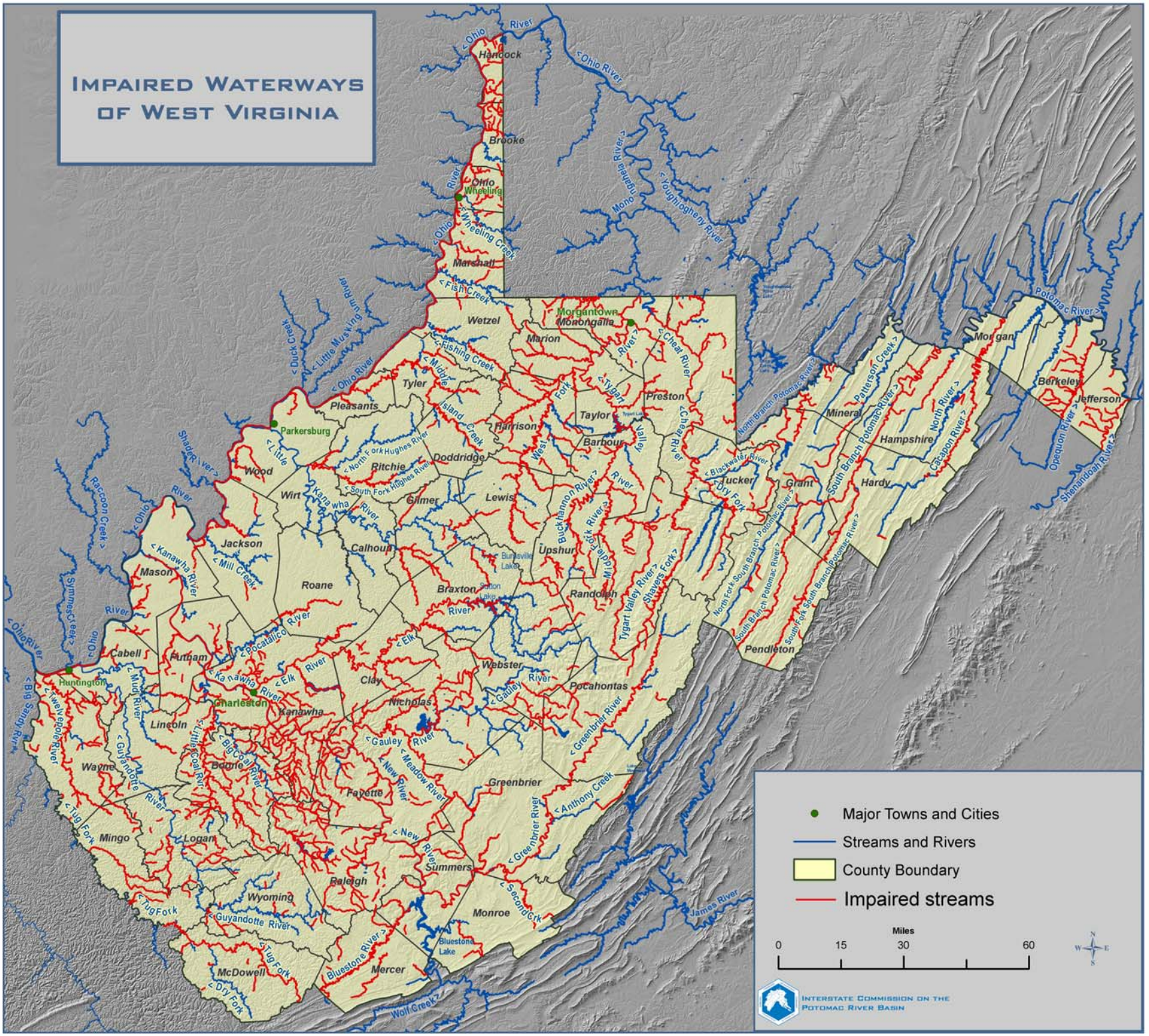
PHYSIOGRAPHIC PROVINCES OF WEST VIRGINIA

The sea retreated again near the end of the Mississippian, and during the Pennsylvanian, West Virginia was low-lying and swampy. During this period, thousands of feet of non-marine sandstone, shale, and coal were deposited.

During the Permian Period, the Appalachian Orogeny, the dominant geologic event in the formation of the Appalachian Mountains, began. Much folding and thrust-faulting occurred, especially in the eastern part of the State. Erosion became the predominant geological process.

No sedimentary rocks from the Mesozoic Era (230 to 70 million years ago) exist in West Virginia. However, hundreds of igneous dikes from this time are found in Pendleton County.

The glaciers of the ice ages never reached West Virginia. A large lake caused by an ice dam to the north resulted in lake deposits in the northern part of the State and drainage changes and alluvial deposits in the southern part. These are the only Cenozoic Era (younger than 70 million years ago) deposits in West Virginia.


Impaired Waterways of West Virginia
Major Towns and Cities
Streams and Rivers
County Boundary
Impaired streams
Miles
0
15
30
60
Interstate Commission on the Potomac River Basin
Hancock
Brooke
Ohio
Wheeling
Marshall
Wetzel
Morgantown
Monongalia
Marion
Tyler
Pleasants
Parkersburg
Wood
Wirt
Ritchie
Doddridge
Harrison
Taylor
Barbour
Preston
Lewis
Gilmer
Calhoun
Upshur
Randolph
Tucker
Grant
Hardy
Mineral
Hampshire
Morgan
Berkeley
Jefferson
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Roane
Braxton
Webster
Pocahontas
Clay
Nicholas
Greenbrier
Pendleton
Cabell
Putnam
Kanawha
Lincoln
Boone
Wayne
Logan
Mingo
Fayette
Raleigh
Summers
Monroe
Wyoming
McDowell
Mercer
Huntington
Charleston
Ohio River
Kanawha River
Elk River
Gauley River
New River
Greenbrier River
Tug Fork
Guyandotte River
Big Coal River
Little Coal River
Blue Stone River
Dry Fork
Mud River
Twelvepole River
Big Sandy River
Raccoon Creek
Duck Creek
Little Muskingum River
Fishing Creek
Middle Island Creek
North Fork Hughes River
South Fork Hughes River
Little Kanawha River
Sheder River
Mill Creek
Pocatalico River
Symmes Creek
Buckhannon River
West Fork River
Tygart Valley River
Middle Fork River
Dry Fork
Blackwater River
Cheat River
Shavers Fork
Potomac River
North Branch Potomac River
South Branch Potomac River
North Fork South Branch Potomac River
South Fork South Branch Potomac River
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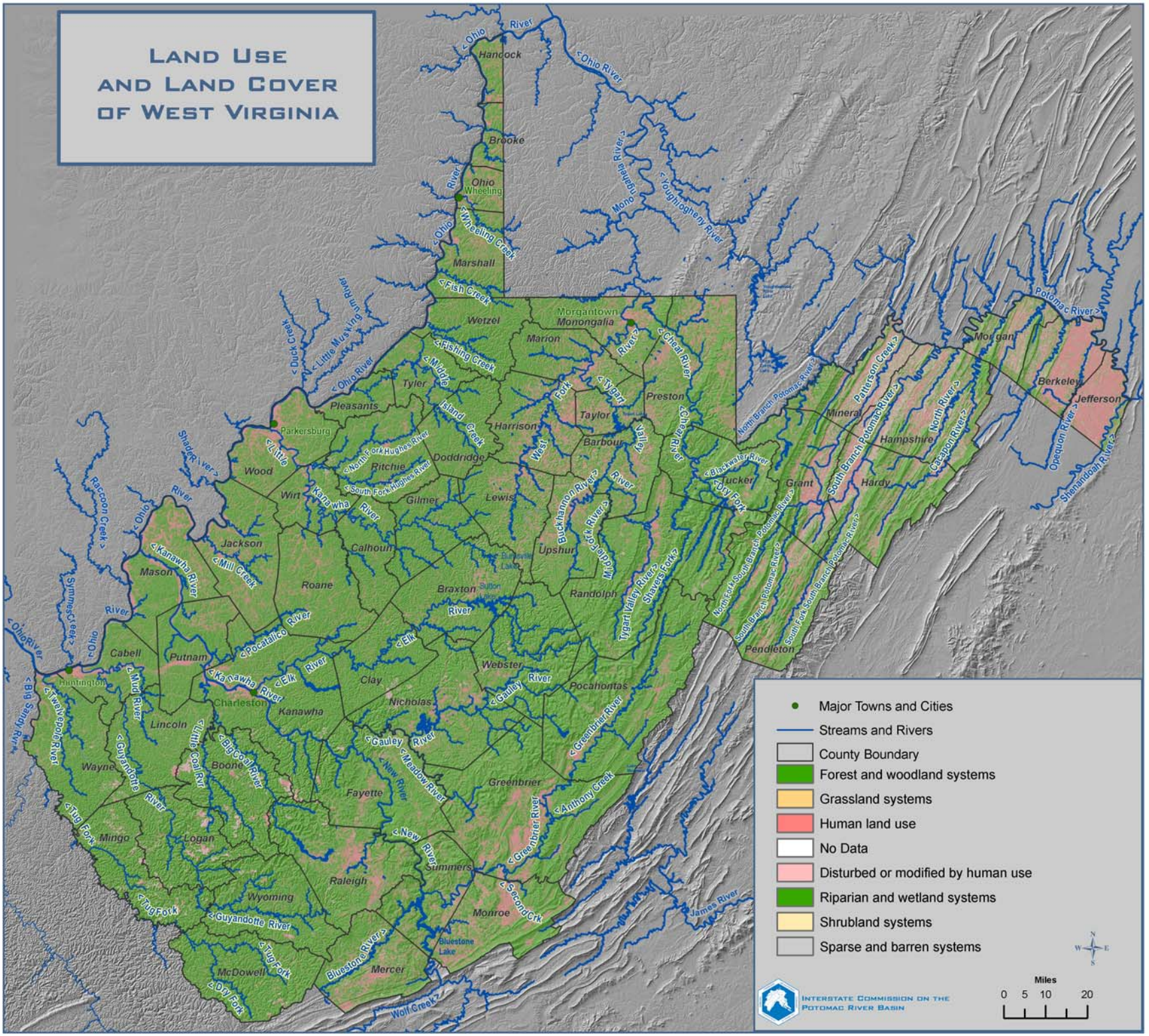
Cacapon River
Opequon River
Shenandoah River
Monongahela River
Youghiogheny River
Wheeling Creek
Ohio River
Anthony Creek
Second Crk
James River
Wolf Creek
Burnsville Lake
Sutton Lake
Bluestone Lake


Land Use and Land Cover of West Virginia
Major Towns and Cities
Streams and Rivers
County Boundary
Forest and woodland systems
Grassland systems
Human land use
No Data
Disturbed or modified by human use
Riparian and wetland systems
Shrubland systems
Sparse and barren systems
Miles
0 5 10 20
Interstate Commission on the Potomac River Basin
Hancock
Brooke
Ohio
Wheeling
Marshall
Wetzel
Morgantown
Monongalia
Marion
Tyler
Pleasants
Parkersburg
Wood
Wirt
Ritchie
Doddridge
Harrison
Taylor
Barbour
Preston
Lewis
Gilmer
Upshur
Randolph
Tucker
Grant
Hardy
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Hampshire
Morgan
Berkeley
Jefferson
Pendleton
Webster
Pocahontas
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Clay
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Roane
Calhoun
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Putnam
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Kanawha
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Fayette
Greenbrier
Summers
Monroe
Mercer
McDowell
Raleigh
Wyoming
Ohio River
Kanawha River
Elk River
Gauley River
New River
Greenbrier River
Tug Fork
Guyandotte River
Big Coal River
Little Coal River
Mud River
Twelvepole River
Big Sandy River
Potomac River
North Branch Potomac River
South Branch Potomac River
Patterson Creek
North River
Cacapon River
Opequon River
Shenandoah River
Buckhannon River
Tygart Valley River
Shavers Fork
Cheat River
Blackwater River
Dry Fork
Middle Island Creek
Fishing Creek
Fish Creek
Wheeling Creek
Little Muskingum River
Duck Creek
Raccoon Creek
Sandy River
Meadow River
Anthony Creek
Second Crk
Wolf Creek
Bluestone Lake
Sutton Lake
Burnsville Lake
James River