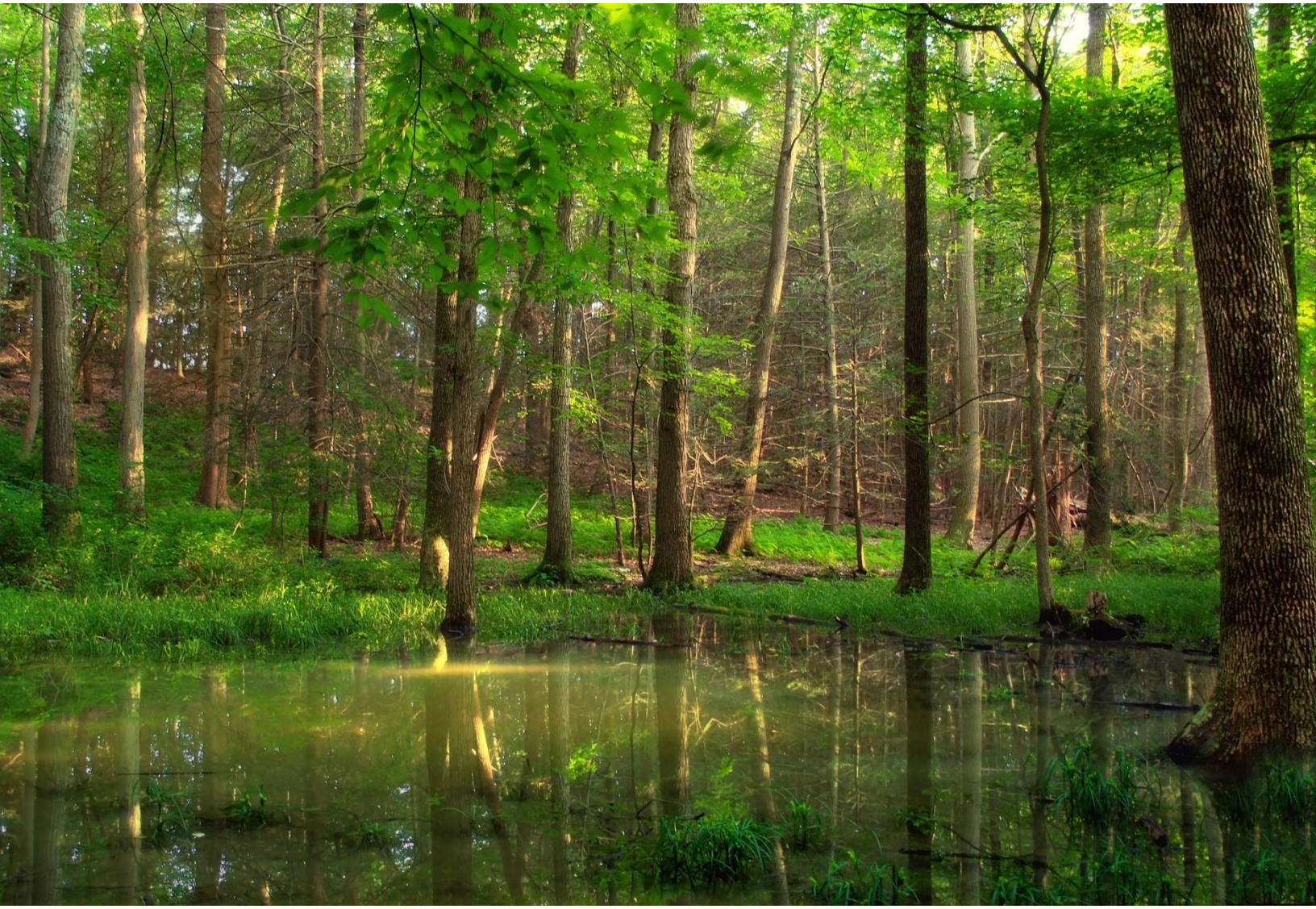
FINAL REPORT



Land Use Controls for Forest Buffers in the Delaware River Basin

An Evaluation of Existing Municipal Policies and their Role in Protecting Forested Riparian Buffers

Authors

Dr. Jean Marie Hartman
Karen Cappiella
Julie Schneider
Will Price

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RUTGERS
School of Environmental and Biological Sciences
Department of Landscape Architecture
93 Lipman Drive
New Brunswick, NJ 08901-8524

CENTER FOR WATERSHED PROTECTION
Center for Watershed Protection
3290 North Ridge Road, Suite 290
Ellicott City, MD 21043

PINCHOT INSTITUTE FOR CONSERVATION
1400 16th Street NW
Washington, DC 20036

Table of Contents

i. Executive Summary

The Delaware River Basin (DRB) watershed spans four states, and includes 42 counties and 838 municipalities. Residents of most these towns depend on surface waters for drinking water supplies. For this reason they are also dependent on the protection of waterways that flow through their municipality. Well-developed natural cover and especially forests are well-proven to be the best landcover for riparian protection and water quality. In the DRB there is wide variation between towns in how they regulate land use and the extent to which they protect riparian buffers. The way in which this variation explicitly affects water quality in the DRB is of wide concern, but is not completely understood nor sufficiently prioritized.

With the support from the Academy of Natural Science of Drexel University's *Delaware River Watershed Research Fund*, Rutgers University, the Center for Watershed Protection (CWP), and the Pinchot Institute conducted an analysis of the role of municipal land use controls in protecting natural riparian buffers in the DRB. A particular focus is the role of forests, and how their conservation is supported through the combination of plans and regulations adopted and implemented by municipalities. It is a scientific study not intended to characterize land use controls throughout the entire basin, nor the basinwide condition of riparian areas, landcover, and water quality. Rather, the intent is to better understand the inter-relationship between these variables.

The study was conducted in consultation with an advisory committee, which primarily assisted in the design phases. Members of this committee helped devise a study plan that could best tackle questions on the role and effect of land use controls in a geography as complex as the DRB. This first phase consisted of extensive spatial analyses led by Rutgers University. The analysis looked at potential study areas in every physiographic region of the basin, considering landcover types, water quality, characteristics of different kinds of municipalities, and where previous reviews of local development regulations had been conducted. This work lead to deciding on a study area "in the middle" of the DRB, which included portions of the Ridge and Valley and Highlands physiographic provinces. Within this area the study team selected 60 municipalities to study in depth, and two municipalities to conduct case studies on buildout within different planning scenarios. Spatial analysis work continued throughout the three phases to support analyses on land use controls and relationships to landcover, but also to produce information for all 60 municipalities.

CWP led an analysis of municipal codes and ordinances related to site development. They were evaluated using CWP's **Forest-Friendly Code and Ordinances Worksheet (COW).** Fifty-three (53) of the 60 municipalities were suitable for evaluation, based on availability of information or location. Categories of analysis included: Zoning (2 questions), Buffers (9 questions), Clearing and Grading (4 questions), Forest Conservation (4 questions), Floodplain and Wetland Protection (2 questions), Open Space Design and Management (15 questions).

Scoring for these categories referenced subdivision and land development ordinances; zoning ordinances; stormwater management, rainwater or drainage ordinances; buffer or floodplain regulations; tree protection or landscaping ordinances; and, erosion and sediment control ordinances. Documents were obtained online and directly from municipalities addressing each of the categories of analysis and were scored based on a weighting system. CWP found a wide range of variation in the presence/absence/coverage of different measures. Of the 53 municipalities reviewed, the average total score was 25.5%, with a range of 0% to 71%. *Floodplain*, *Wetlands*, and *Zoning* scored the highest for most municipalities, while specific *Forest Conservation* measures and *Buffers* typically scored the lowest. However, there was great variability among municipalities within the study area, including between towns in the same counties and states. Comprehensive state policies (e.g. NJ Highlands Planning Act) to which some municipalities were subject to tended to increase scores.

The study team also evaluated landcover in each of the municipalities, particularly focused on the extent of protected natural landcover within 50-foot, 100-foot, and 300-foot riparian buffer areas. This spatial information was useful to understand the extent to which the COW scores on land use controls may or may not be related to regulation and protection of lands important for water quality. The analyses were performed at the municipal, county, and state levels. The high level of variation in COW scores between towns, combined with the challenges of measuring against historical development vs. outcomes from new regulations/plans is a well-known problem inherent to these kinds of analyses, and was encountered here. However, certain patterns were notable and can inform future priorities.

One of the analyses looked at "apportionment" of development within municipal boundaries, and showed by aggregating data at the county and state level for the studied municipalities that New Jersey municipalities have a lower portion of their development in streamside zones (@ 50' NJ=2.2%, PA=4.3%). The analysis also showed that COW scores for NJ municipalities correlated more strongly with riparian buffer protection than PA municipalities (R=-0.60), and that COW scores are most strongly correlated with open space protection in NJ (R=77). COW scores in PA municipalities were only weakly related to the presence of protected land across the municipal land area, suggesting that towns with more robust land use controls in Pennsylvania prioritize other conservation measures. The strongest relationship for Pennsylvania municipalities was between stream buffer ordinances and buffer protection within 50'. In general PADUS data shows that NJ municipalities may have more protected forests lands within their boundaries, but not more forests than PA towns.

Two case studies were selected from among the 53 evaluated in the study area. These included Mt. Olive, NJ and Greenwich, PA. CWP conducted a buildout analysis in these two municipalities to determine how water quality impairment might result from two scenarios—"status quo" and "conservation." The conservation scenario models outcomes if new, but modest, protection requirements (which differed based on the two settings) are implemented. In both scenarios the townships would lose forests and open space. However, for both towns the conservation scenarios significantly reduced pollutant loadings that would have resulted from status quo buildout scenarios.

Another long-term value of the analyses carried out for this study is the information now available for municipalities and institutions seeking to prioritize and support the conservation of riparian buffers within municipal lands. Among these resources are the scores developed through the COW analysis, which pinpoint the strengths and weaknesses of land use controls for different resource concerns. A recommendation is that this information can be used in consultation with local planners as well as public and private institutions seeking to assist and support their efforts.

The project also led to the development of comprehensive stormwater reports specific to the 60 municipalities within the study area. The reports are available online and include maps and aerial imagery for each municipality (e.g. landcover within protected areas; landcover within 50'/100'/300' riparian buffers; hydrology; and pollutant loads and sources). This information will be helpful to anyone working within or with municipalities in the study area, and could be expanded to other portions of the Basin.

That land use controls used by the 53 municipalities in the study area vary widely in scope and impact was the expectation and purpose of the project. This study better characterizes this dynamic to make recommendations on where and how to engage based on deficiencies in land use controls and their variable effect in different settings. These insights can hopefully inform the priorities and efforts of planners well beyond the study area into other regions of the Basin.

ii. Introduction

The effect of forest cover loss on water yield and quality is an ongoing concern that plays out differently in every watershed, specific to the amount and type of precipitation, topography, and landcover, among other factors (Andreassian 2004). Some of the earliest scientific attempts to measure this relationship occurred in watersheds in Europe and intensified in the U.S. when at the turn of the last century widespread deforestation across the U.S. caused catastrophic floods and sedimentation (Hornbeck and Kochenderfer, 2004). Over a century ago the U.S. began to undertake conservation measures to reduce flooding and soil loss, but also to preserve and improve water supplies for cities. Floods in the Mid-Atlantic region, including the Delaware River Basin had caused millions of dollars in damage (Forest History Society, 2013). Eventually this brought about the passage of the Weeks Act in 1911, the National Waterways Commission, and support for federal science and agency action (Hornbeck and Kochendorfer, 2004).

Forest conservation for the protection of water resources had begun, but the research behind it had yet to really develop. Appended to the 1912 Proceedings of the National Waterways was a report concluding that, among their influences, forests cannot in themselves protect against major floods, but that forests can reduce their destructiveness. As summarized by Alden Hibbert, who by looking at 39 forest treatment studies concluded that: "Reduction of forest cover increases water yield; establishment of forest cover on sparsely vegetated land decreases water yield; and, response to treatment is highly variable and, for the most part unpredictable (Hibbert 1965)."

Managing Watersheds

Forests are irrefutably better at reducing and attenuating runoff than impervious surfaces throughout a watershed, especially the developed land within the floodplain. Much of the forests and open space being lost to development, at a national rate of 6,000 acres a day, are irrecoverably urbanized or dissected and diminished by roads. In the Eastern US, this is amplified by a development pattern that typically spreads like a spider web from little towns at the confluence of waterways. So the principal scientific challenge not only requires understanding how loss of forests affects streamflow and inputs, but what happens when they are replaced by impervious areas in the floodplain.

Flow and water quality management in urbanizing watersheds is now informed by four decades of research focused on impervious cover and its relationship to urbanization (Brabec. et. al., 2002). The myriad of studies has increased with the sophistication of geographic information systems (GIS) to consider: placement of impervious surface; connectivity to waterways; the limits of riparian forests in denuded watersheds; the role of other types of pervious cover; and engineered retention that simulates more natural durations of storage and release. They suggest there is no magic threshold for a watershed—of say 10% impervious, or 75% forested (Brabec et. al. 2002; Booth et. al. 2003). Rather, it appears that for each watershed there is a condition somewhere along a continuum of cumulative forest loss, poor stormwater management, and degraded floodplains at which hydrological and ecological changes depart from tolerable limits. Losing this natural green infrastructure to other uses makes rivers and streams less drinkable, swimmable, and fishable.

A century of legislation and case law has set and reset policies and measures, beginning with the River and Harbor Acts of 1899, and punctuated by Water Quality Act (1965), Federal Water Pollution Control Act Amendments (1972, "Clean Water Act"), Safe Drinking Water Act (1974), and the Nonpoint Source (NPS) Initiative of 1991. Some of the challenge in meeting water quality targets has been institutional, requiring coordination among state, federal, and local agencies that intersect throughout a watershed. In

some cases shared problems have been vested in institutions like The Delaware River Basin Commission. At times these policies demanded science and analysis tools that were yet undeveloped. For example, the wasteload allocation process implicit in the Water Quality Act of 1965 simply could not be implemented in a manner to protect water bodies (Shanahan 1996).

Protecting Forested Buffers

Trying to win back the green infrastructure that is lost—to recover a now developed floodplain, re-route and retain stormflows, or simply bring forests back to the land—can be far more expensive than protecting it in the first place. Similarly, treating the watery aftermath of floods or pollution is expensive. Some studies have documented this difference as the cost-benefit of land protection vs. water treatment, with one report by the Trust for Public Land showing two dollars in treatment costs saved for every dollar spent in forest protection (Freeman 2008). Another recent study predicted the net benefits, mostly through avoided costs of flood damage, if riparian areas were kept as green space and not developed (Kousky 2011).

The Delaware River Basin includes four states, 42 counties, and hundreds of municipalities. The river serves 16.2 million people for drinking water alone (5% of the US population) and contributes an estimated $25 billion each year to the region's economy (Kauffman 2011). Waters flowing from reservoirs and the remainder of the watershed provide electricity (via cooling water for natural gas, coal, and nuclear facilities) and drinking water (delivered by more than 100 purveyors) for 8 million people living within the basin and 8 million in New York City.

There is a critical difference in the approach that has characterized the protection of forests in rural areas (e.g. maintaining forested buffers or strips of natural vegetation on farms), versus approaches used in urban and suburban areas. In many parts of the country "rules" for privately owned farms and forestlands have usually taken the form of federally-funded technical and financial assistance delivered by counties and states, in support of federal water quality goals. For example the USDA Farm Bill invests approximately $8.6 billion to help more landowners better protect or install natural cover on their lands. These programs are an extension of the efforts of Soil and Water Conservation Districts beginning in the 1930s, as well as extension programs designed to increase commodity production. Virtually none of this support is directed to municipalities.

Protecting forests in urban and suburban areas from non-point source pollution, especially in the East, has principally been the domain of municipalities, encouraged and mandated when possible by states to achieve compliance with federal pollution control laws (Richardson 2003). The science and policy supporting these efforts also came about later than their rural analogs. In many locales, recognition of the need for municipal-level regulation began well after farms began to give way to urbanization in the middle of the 20th century. (The roll-out still continues, which is the subject of this study). Another critical difference is that the options perceived to be available to municipalities are more restrictive in nature than those measures promoted in rural areas—taking the form of zoning codes and ordinances that limit land use, vs. best management practices and cost-share investments to change landcover on bare soils. In many towns there is pushback and, in some, litigation on regulatory takings from private landowners and developers (Flenner 1996, Casey 2008).

The growing body of science of how to best protect water quality through policies that promote waters by retaining forests in urban and suburban environments now spans several decades (Braberg 2003, Wenger et. al. 2009). Conclusions to date are unequivocal and deceptively simple: "Land use changes driven by urban development impose immediate threats to watershed health and sustainability of water resources." (Qiu et. al. 2013). Studies on the subject continue to show that the different kinds of land use controls differ in viability and effectiveness depending on the sociopolitical and hydrological character of a

landscape (Qiu et. al. 2013). For example, the science on forest buffers can disagree on where they should be used (e.g. strictly riparian areas), (Qiu and Dosskey 2012).

While many studies look at the effectiveness (including cost and performance) of different kinds of forest buffers, some have included the other kinds of benefits of protecting riparian forests—e.g. from the perspective of avoiding damages to infrastructure that would have been constructed in these areas if the buffer requirement did not exist. Sabegh et. al. (2001) showed that ". . . under the normal patterns of development in a study area, urbanization can increase average annual damage (AAD) by more than 800 times." In other words, buffering waterways with forests and other natural landcover can not only protect water quality, but help municipalities avoid damages to hard infrastructure when the flood inevitably comes.

Work by Williams et. al. (2006) showed that different watersheds will require multiple measures for hydrologic management in urbanizing watersheds. Buffer retention and other forms of low impact development will need to be complemented by (and weighed against) other measures like more widescale land preservation and retention ponds to achieve desired conditions. And these different strategies will differentially mitigate water quality problems (e.g. thermal pollution, TSS, phosphorus, DO, etc.) at various scales (from the watershed to one local stream)—making it hard to standardize prescriptions in a watershed (Singh et. al. 2014; Ekness and Randhir 2007).

Most municipal officials recognize that implementing an effective and viable set of land use controls in their cities and towns can generate controversies that disrupt other goals, and strain municipal budgets and staffing. Some have been dissuaded, and others have developed an impressive set of zoning codes and ordinances that work for their communities to protect forests. This is also a challenge for scientists and the institutions that can work with communities not only through the processes of scientific and economic evaluation, but also to develop means to best communicate the need of land use controls, forests, and the benefits they will provide the community (Norton 2008).

iii. Purpose of Study

This study provides a better understanding of the extent to which municipalities in the DRB have employed land use controls to protect forests near waterways, and the effect this may be having on water quality. Through a grant from the Delaware Watershed Research Fund (DWRF), a partnership was formed with Rutgers University ("Rutgers"), the Center for Watershed Protection ("CWP"), and the Pinchot Institute for Conservation ("PIC") on a three-year research project to prioritize areas of the DRB (also "the Basin") that are in need of improved regulatory protection for important forest lands such as riparian buffers.

The work proceeded in three phases involving the guidance of an advisory committee *(Appendix 1*) and consultations with scientific experts working in the Basin, institutions experienced with work on land use controls in the region, regulators, and municipalities involved in the study. The phases included:

1. Gap analysis to identify geographic areas in the Delaware River Basin with the greatest need for a comprehensive review of forest protection regulations and the appropriate scope for such a review;
2. Comprehensive inventory of forest protection policies and regulations in the priority region identified (53 municipalities); and,
3. An evaluation of the linkages between forest protection policies and the amount of forest measured through high-resolution mapping.

Two additional analyses were added through the course of the project, to build on the information generated and create resources that could be further developed and used by organizations working on the role of land use controls in the DRB, especially as they relate to forests. These include:

4. Two case studies that look more closely at how forest retention/loss would affect waterways (i.e. in Mt. Olive, NJ and Greenwich, PA)
5. Municipal Stormwater Reports

This project began by establishing an advisory group to recommend where to focus the study within the basin. The advisory group was made up of partners working on forest and riparian buffer policies and projects in the basin. This process resulted in the random selection of 60 municipalities in the basin from the Highlands and Ridge and Valley physiographic regions that are representative of the different municipality types (e.g., cities, boroughs, townships) and level of development in these regions. Included in the advisory group are three of the Delaware River Watershed Initiative clusters whose boundaries overlap with the project focus area: 1) New Jersey Highlands, 2) Middle Schuylkill, and 3) Upper Lehigh.

CWP conducted a review of municipal codes and ordinances related to riparian (streamside) buffer and forest protection for 53 of the selected 60 municipalities located in Pennsylvania and New Jersey. The purpose of the review was to answer the research question: How do forest protection regulations in the study area compare to established benchmarks and how do they vary across municipalities? The results of the evaluation of municipal codes and ordinances were analyzed using information on landcover, land protection and water quality developed by Rutgers to better understand the current role and future potential of municipal land use controls in the protection of DRB riparian buffer forests. The results will be used to guide where and how future ordinance work occurs in the basin and improve our understanding of what makes forest protection regulations effective. The results of the review will be shared with the advisory group, associated cluster groups and others who work directly with basin municipalities to help guide future assistance to municipalities and recommendations related to improving buffer and forest protection in the study area.

A. Selecting Study Areas within the DRB

The DRB intersects four states (New York, New Jersey, Pennsylvania and Delaware) and 42 counties. The Watershed has been the focus of numerous regional studies, beginning with the formation of the Delaware River Basin Commission (DRBC) in 1961 (https://www.nj.gov/drbc/about/). The DRBC's chief canon is: "that the waters and related resources of the Delaware River Basin are regional assets vested with local, state, and national interests for which there is a joint responsibility."

More recently, the Delaware River Watershed Initiative has directed attention to the role and impacts of land use on water quantity and quality. While their goals continue to include "Clean Water for Millions", they also include "Green and Livable Communities", and "River friendly Farms." With these goals in mind, eight study areas or "Clusters" have been selected for multidisciplinary protection and restoration projects. These clusters range in size from 132 square miles to 2,119 square miles and encompass pristine headwaters as well as urban centers.

The 2016 National Land Cover Database (https://www.mrlc.gov/data/nlcd-2016-land-cover-conus) has been used throughout this report to categorize land use and landcover. This project focuses on the status and vulnerability of natural lands within the watershed. The term "natural lands" is used in this study to include upland and wetland forests as well as emergent wetlands and early successional communities such as shrub scrub and herbaceous meadows. This broad category is used because of the way digital land cover data is classified and because watershed and stormwater models usually combine all these into a single category. The term excludes developed lands, including active recreation, development, barren land, and agricultural land. The scale at which landcover and other data were assembled to guide the selection of study areas was the physiographic region. The following section summarizes the major physiographic regions of the DRB and results of this analysis.

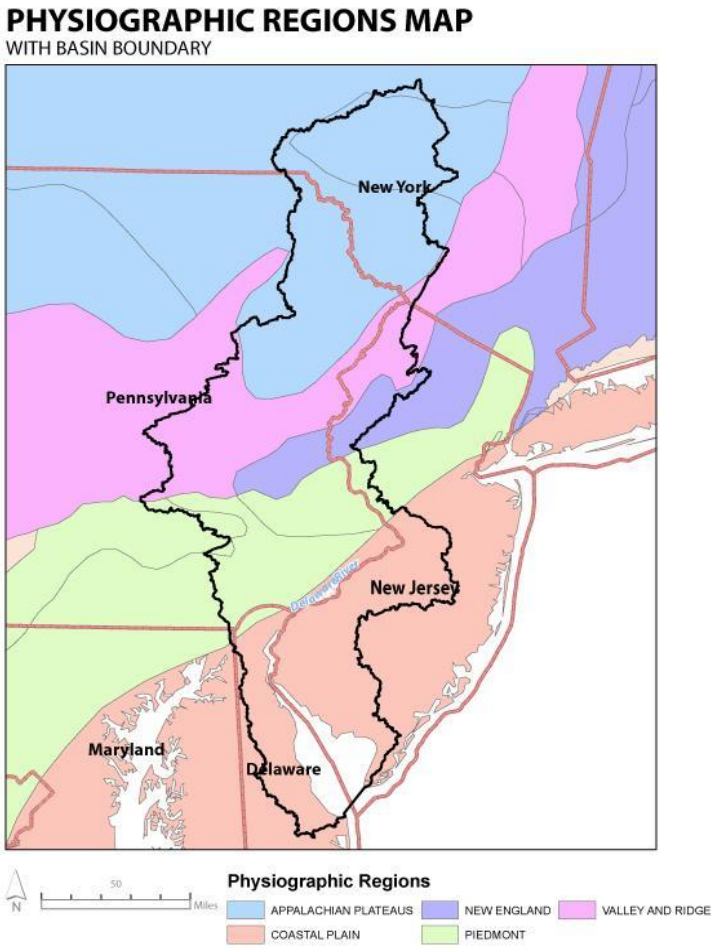
Physiographic Regions of the Delaware Basin

The DRB watershed intersects five physiographic regions Table 1 presents the area in the provinces as well as the natural land and forest cover. "Natural Land Cover" includes forests, shrublands, meadows, and wetlands. In four of the provinces the majority of natural lands are forests. In the Coastal Plain, forests account for less than 40% of the natural lands.

Table 1. *Physiographic Provinces in Delaware Watershed.*

Physiographic Province	Province Total (Square Miles)	Natural Land Total (Square Miles)	Natural Land Cover in Province (%)	Forest Total (Square Miles)	Forest in Province (%)	Protected Natural Land (Square Miles)	Protected Natural Land (%)
Appalachian Plateaus	4,282	3,552	83.0	3,292	76.9	909	21.2
Valley and Ridge	2,247	1,332	59.3	1,243	55.3	370	16.5
New England/Highlands	765	353	46.1	309	40.4	149	19.5
Piedmont	2,322	875	37.7	792	34.1	170	7.3
Coastal Plain	3,276	1,330	40.6	501	15.3	532	16.3
BASIN TOTAL	**13,600**	**7,445**	**54.7**	**6,137**	**45.1**	**2,132**	**15.7**

Figure 1. *Physiographic Provinces in Delaware Watershed.*



The Appalachian Plateaus Province is characterized by rugged, dissected plateaus on the western side of the Appalachian Mountains. It has the most area of Natural Land Cover; and also has the highest level of protection (21.2% in Table 1). The rugged geology and their northern extent have helped dissuade development. The New England (Highlands*) Province is a mountainous area with sharp topographic patterns, exposing metamorphic rocks. It constitutes the smallest area in the basin and is second in level of protection (19.5%). The Valley and Ridge Province is characterized by elongated, parallel ridges and valleys. The Valley and Ridge Province has parallel ridges surrounding valleys and areas of steep topography along the ridges. The Piedmont is the foothills to the more mountainous province and represents a transition to the Coastal Plain. The relatively flat coastal plain was covered by the Atlantic over geologic time. Figure 1 shows the relative area of the provinces and their natural land and forest cover.

* The New England Province is also referred to as the Highlands Province in this region. Because of the familiarity of the term Highlands in this region, we will refer to the Highlands rather than the New England Province throughout this document.

Appalachian Plateaus Province

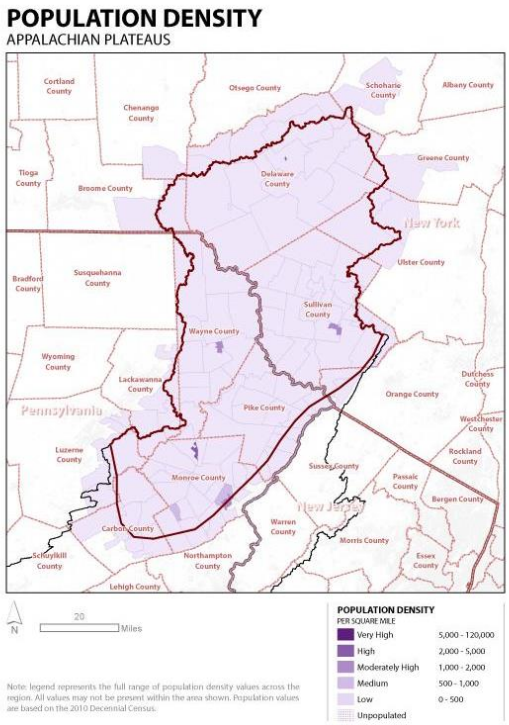
The Appalachian Plateaus Province includes the northern-most 4,282 square miles in the DRB (Table 2). Figure 2 includes four distinct assessments of the province. The population density map shows the limited area of moderate density. The land cover map shows limited areas of development and agriculture within the majority cover of 3,879 square miles (90%) in natural lands. Less than 25% of the natural lands in this province has protected status by federal, state, or private ownership.

Table 2. *Land Use in the Appalachian Plateaus Province*

NLCD Category	Area	%	Protected Natural Land	Area	%
Open Water	93	2.2			
Developed, Open Space	251	5.9			
Developed, Low Intensity	36	0.8			
Developed, Medium Intensity	11	0.3			
Developed, High Intensity	4	0.1			
Barren Land	9	0.2			
Deciduous Forest	2,372	55.4	Deciduous Forest	606.1	66.7
Evergreen Forest	160	3.7	Evergreen Forest	35.3	3.9
Mixed Forest	760	17.7	Mixed Forest	182.6	20.1
Shrub/Scrub	31	0.7	Shrub/Scrub	10.6	1.2
Herbaceous	29	0.7	Herbaceous	4.5	0.5
Hay/Pasture	317	7.4			
Cultivated Crops	10	0.2			
Woody Wetlands	186	4.4	Woody Wetlands	65.6	7.2
Emergent Herbaceous Wetlands	14	0.3	Emergent Herbaceous Wetlands	4.0	0.4
TOTAL	**4,282**	**100.0**		**909**	**100.0**

Figure 2. *Appalachian Plateaus Population Density (a), Land Cover (b), Natural Land Cover (c) and Protected Natural Lands (d)*

a.



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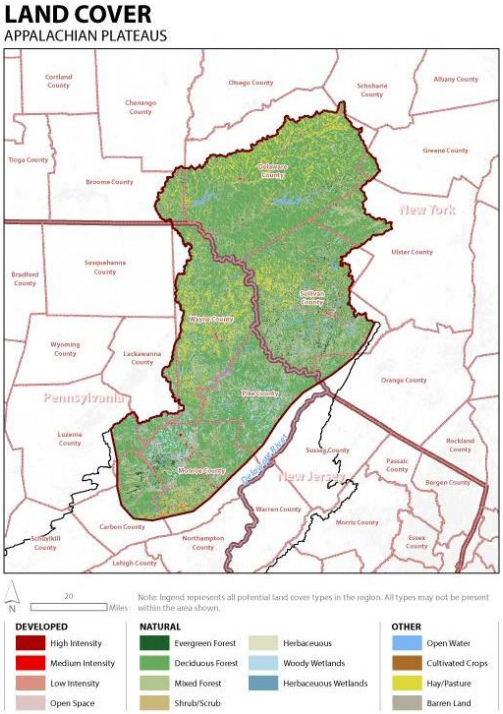

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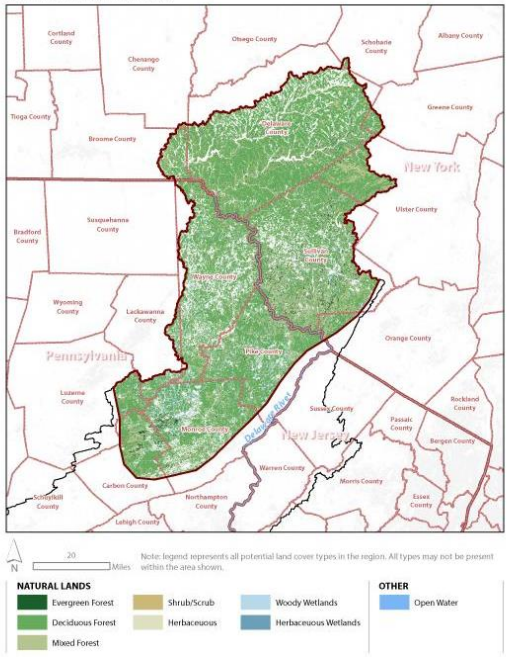

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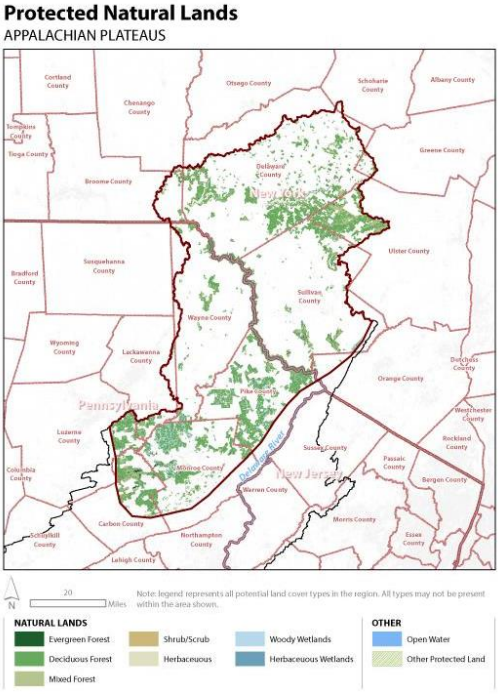


The Valley and Ridge Province

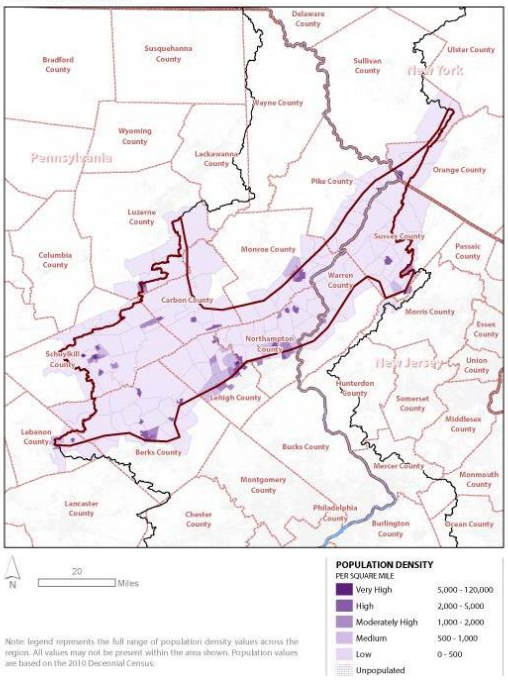
The Valley and Ridge Province includes 2,247.2 square miles in the DRB (Table 3). Figure 3 includes four distinct assessments of the province. The population density map (a) shows scattered areas of moderately high to high population density. The land cover map (b) shows limited areas of development and scattered agriculture, especially in the southern half. Approximately 16% of the natural lands in this province has protected status by federal, state, or private ownership.

Table 3. *Land Use in the Valley and Ridge Province of the Delaware River Basin. NLCD refers to the 2016 National Landcover Database categories. Protected Natural Land areas are derived from the Protected Areas Database of the US (PAD-US) and includes natural lands but not historic or agriculture protected areas. Area is measured in square miles.*

NLCD Category	Area	%	Protected Natural Land	Area	%
Open Water	34.0	1.51		0.00	0.00
Developed, Open Space	179.1	7.97		0.00	0.00
Developed, Low Intensity	84.5	3.76		0.00	0.00
Developed, Medium Intensity	34.2	1.52		0.00	0.00
Developed, High Intensity	12.8	0.57		0.00	0.00
Barren Land	18.3	0.82		0.00	0.00
Deciduous Forest	1,034.7	46.04	Deciduous Forest	289.72	78.33
Evergreen Forest	26.9	1.20	Evergreen Forest	6.83	1.85
Mixed Forest	181.7	8.09	Mixed Forest	43.39	11.73
Shrub/Scrub	12.8	0.57	Shrub/Scrub	3.78	1.02
Herbaceous	8.6	0.38	Herbaceous	2.02	0.54
Hay/Pasture	227.4	10.12		0.00	0.00
Cultivated Crops	325.1	14.47		0.00	0.00
Woody Wetlands	63.1	2.81	Woody Wetlands	22.79	6.16
Emergent Herbaceous Wetlands	3.9	0.17	Emergent Herbaceous Wetlands	1.34	0.36
TOTAL	**2,247.2**	**100.00**		**369.87**	**100.00**

Figure 4. *Valley and Ridge Province Population Density (a), Land Cover (b), Natural Land Cover (c) and Protected Natural Lands (d)*

a.



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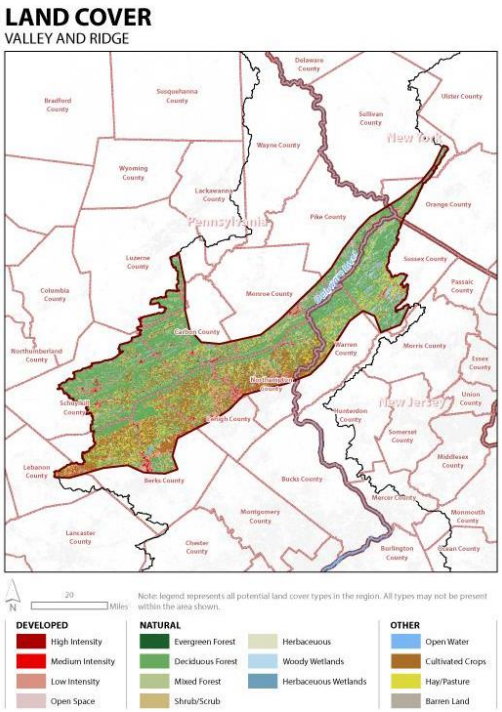

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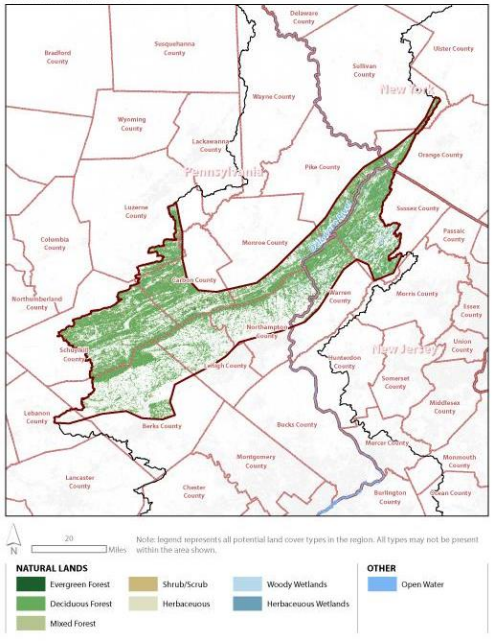

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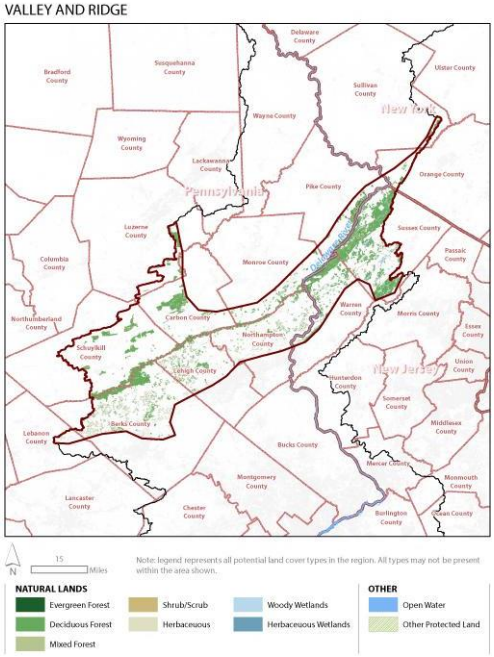


Highlands/New England Province

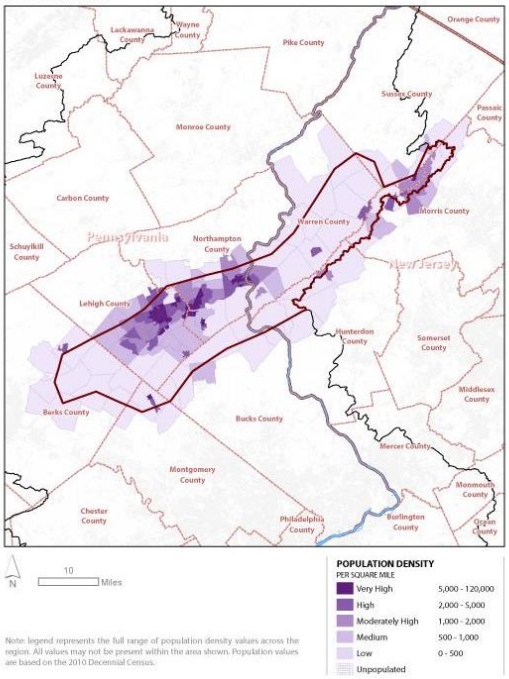
The Highlands province (also referred to as New England Province in some data sources) makes up less than 6% of the DRB. More than 36% of the area is deciduous forest and approximately 20% of the area is protected from development through federal, state, local or private ownership (Table 4). The developed area is greater than 25% of the area. Most of the developed area is in Pennsylvania, along the north side. In New Jersey, the Highlands Water Protection and Planning Act (2004) sets regulations for development. This accounts for the much higher proportion of protected natural land (c versus d) being found in New Jersey.

Table 4. *Land cover in the Highlands Province of the Delaware River Basin. NLCD refers to the 2016 National Landcover Database categories. Protected Natural Land areas are derived from the Protected Areas Database of the US (PAD-US) and includes natural lands but not historic or agriculture protected areas. Area is measured in square miles.*

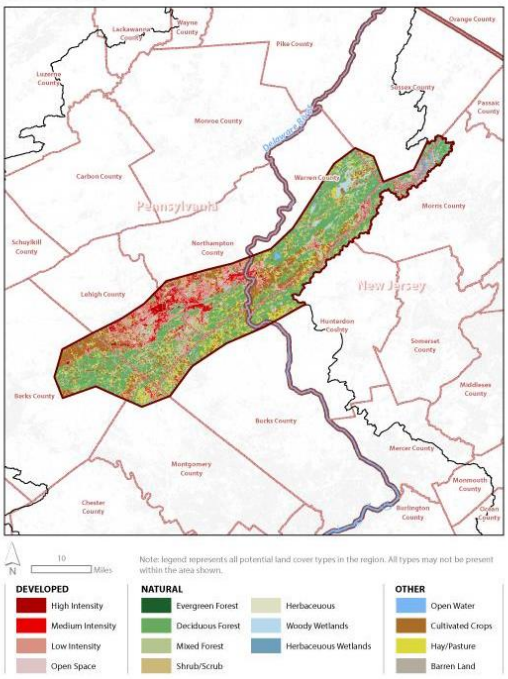
NLCD Category	Area	%	Protected Natural Land	Area	%
Open Water	10.3	1.35		0.0	0.00
Developed, Open Space	99.2	12.96		0.0	0.00
Developed, Low Intensity	64.7	8.46		0.0	0.00
Developed, Medium Intensity	33.0	4.31		0.0	0.00
Developed, High Intensity	13.2	1.72		0.0	0.00
Barren Land	1.8	0.23		0.0	0.00
Deciduous Forest	281.1	36.74	Deciduous Forest	124.1	36.74
Evergreen Forest	0.5	0.07	Evergreen Forest	0.1	0.07
Mixed Forest	27.6	3.60	Mixed Forest	5.4	3.60
Shrub/Scrub	7.6	1.00	Shrub/Scrub	1.3	1.00
Herbaceous	2.8	0.37	Herbaceous	1.0	0.37
Hay/Pasture	88.8	11.60		0.0	0.00
Cultivated Crops	101.5	13.27		0.0	0.00
Woody Wetlands	32.2	4.21	Woody Wetlands	17.2	4.21
Emergent Herbaceous Wetlands	0.8	0.10	Emergent Herbaceous Wetlands	0.4	0.10
TOTAL	**765.0**	**100.0**		**149.4**	**46.1**

Figure 5. *Highlands Province Population Density (a), Land Cover (b), Natural Land Cover (c) and Protected Natural Lands (d)*

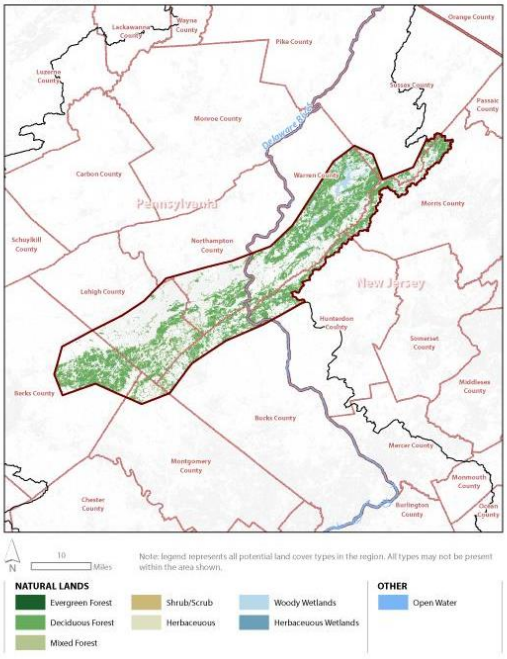
a.



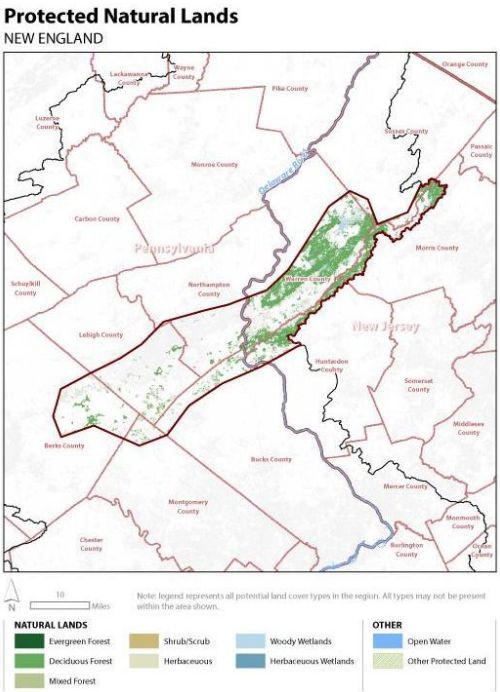
b.



c.



d.



Piedmont Province

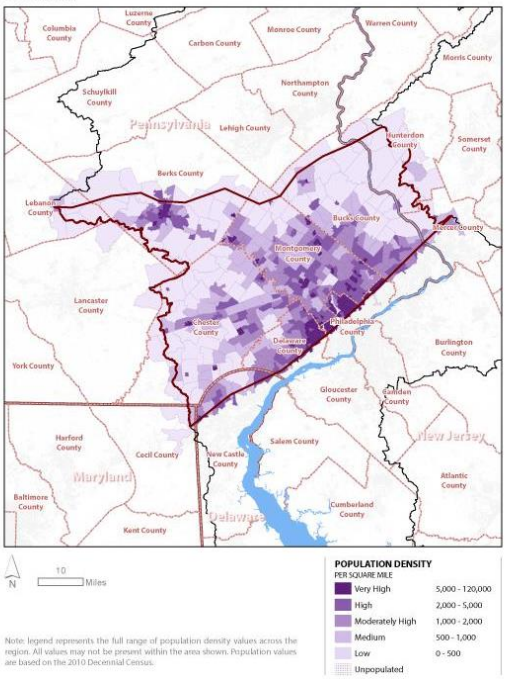
The Piedmont Province includes the center of the DRB. Figure 6 includes four distinct assessments of the province. The population density map (a) and land cover map (b) show the relatively high level of development in this province. The natural land cover map (c) and protected land cover (d) show the widespread deciduous forest cover and the limited level of protection. Less than 25% of the natural lands in this province has protected status by federal, state, or private ownership.

Table 5. *Land cover in the Piedmont Province of the Delaware River Basin. NLCD refers to the 2016 National Landcover Database categories. Protected Natural Land areas are derived from the Protected Areas Database of the US (PAD-US) and includes natural lands but not historic or agriculture protected areas. Area is measured in square miles.*

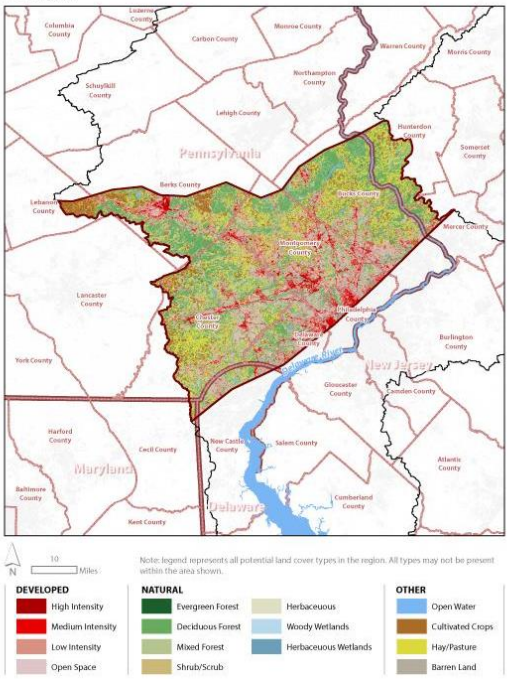
NLCD Category	Area	%	Protected Natural Land	Area	%
Open Water	20.7	0.89			
Developed, Open Space	459.5	19.79			
Developed, Low Intensity	231.2	9.96			
Developed, Medium Intensity	112.8	4.86			
Developed, High Intensity	39.8	1.72			
Barren Land	5.8	0.25			
Deciduous Forest	598.2	25.76	Deciduous Forest	128.34	75.45
Evergreen Forest	7.6	0.33	Evergreen Forest	1.64	0.96
Mixed Forest	186.5	8.03	Mixed Forest	24.43	14.36
Shrub/Scrub	22.5	0.97	Shrub/Scrub	2.21	1.30
Herbaceous	7.8	0.34	Herbaceous	0.98	0.58
Hay/Pasture	404.4	17.42			
Cultivated Crops	173.2	7.46			
Woody Wetlands	50.4	2.17	Woody Wetlands	12.03	7.07
Emergent Herbaceous Wetlands	1.8	0.08	Emergent Herbaceous Wetlands	0.47	0.27
TOTAL	**2,322.0**	**100.00**		**170.10**	**100.00**

Figure 6. *Piedmont Province Population Density (a), Land Cover (b), Natural Land Cover (c) and Protected Natural Lands (d)*

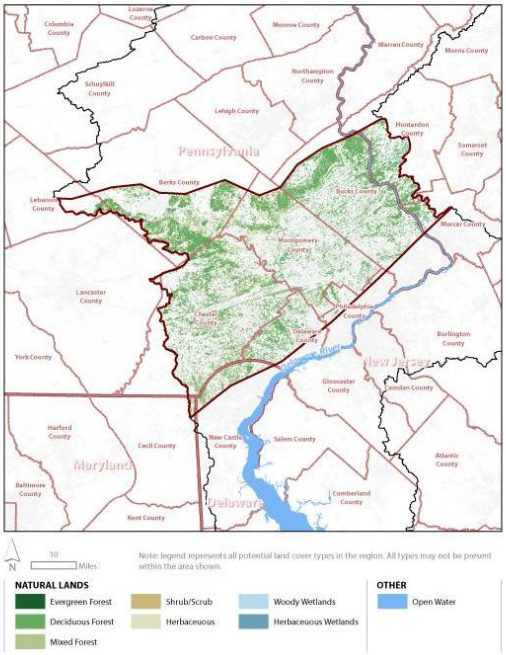
a.



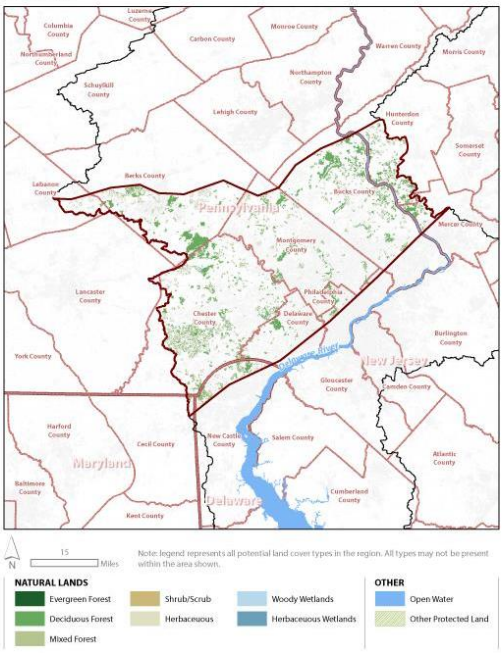
b.



c.



d.



Final Selection of the Study Area

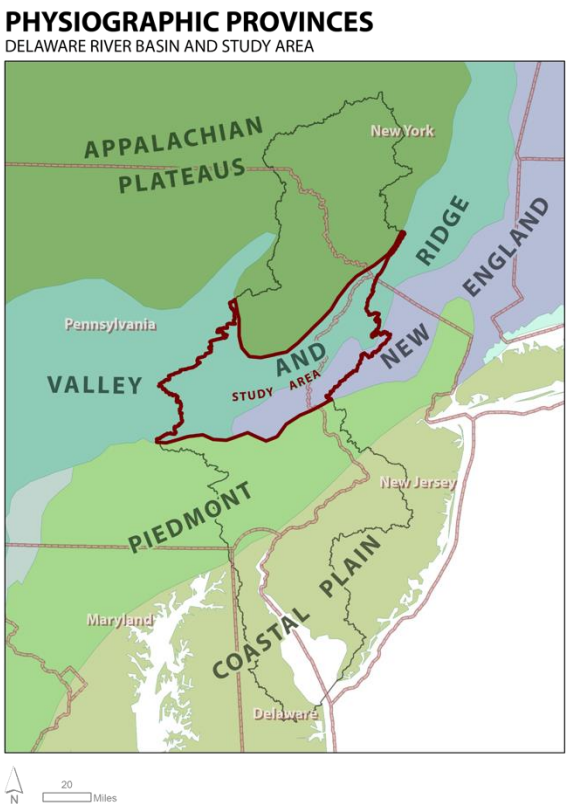
The selection of the study area was accomplished through iterative consultations with the advisory committee, beginning with meetings focused on how to best select towns and geographies that will facilitate understanding the relationship between land use regulations, landcover, and forest conservation of DRB stream buffers. The group considered each physiographic region, eliminating the Coastal Plain early on since its physiographic character is especially distinct from all other regions in the DRB which on their own not only influence the character of forests and streams, but also the historic and future growth of the many townships potentially involved. Also considered was the extent to which municipal code reviews had been previously conducted within the Basin, with the goal of focusing this study on geographic areas having gaps in this knowledge base.

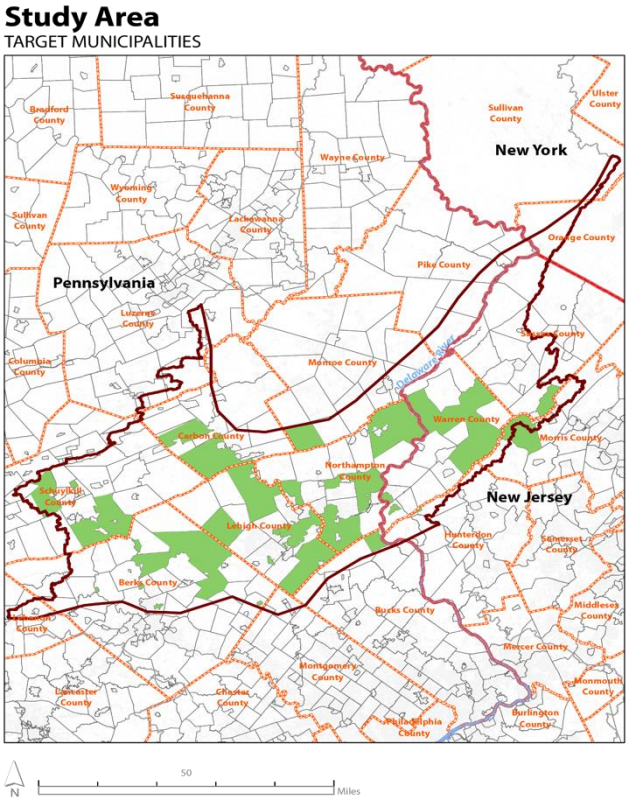
The advisory committee contemplated several scenarios, ranging from focusing on a singular and well-constrained geographic region, to selecting like-sized municipalities throughout the Basin. As deliberations proceeded Rutgers provided new maps and analyses to answer the questions of the group and the project team.

A key consideration was to make sure that municipalities represent a resolvable range of differences, but are not so different that relationships between forests, buffers, and land use controls cannot be understood. Among the physiographic regions it was determined that an area spanning the central portion of the Basin would contain enough townships from among which to choose, yet not be so wildly different in demographics and topography (and water quality) to confuse matters. Additionally, it became important to be able to consider differences in land use controls that may also be driven by state policies and institutions.

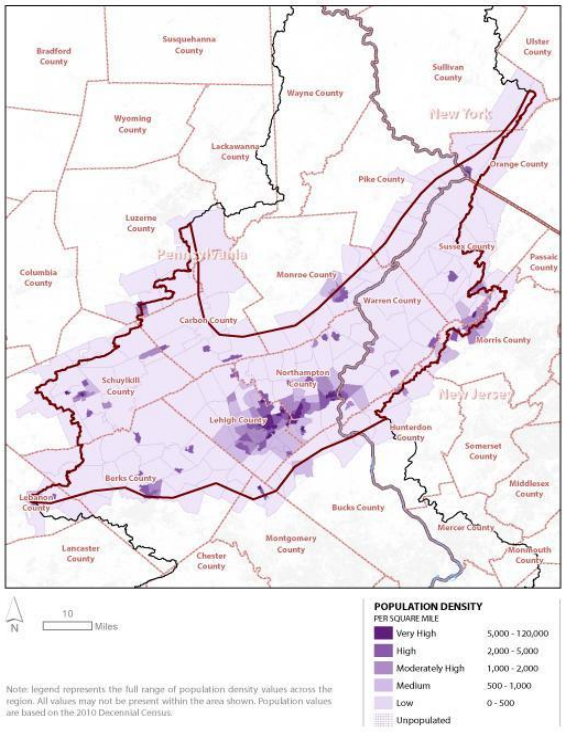
Ultimately the advisory committee selected the Highlands and Ridge and Valley physiographic regions as the focus of the study. Analyses by Rutgers were used to randomly select 60 municipalities within this chosen area that represent a mix of municipality types (e.g., city, township, borough) and level of urbanization. Figure 7 illustrates the selected study area and municipalities.

Figure 7a. *The (a) Physiographic provinces, (b) municipalities targeted for code view and analysis, (b) (c) population density, (d) landcover, (e) natural landcover, and (f) natural landcover within protected lands.*





POPULATION DENSITY
STUDY AREA

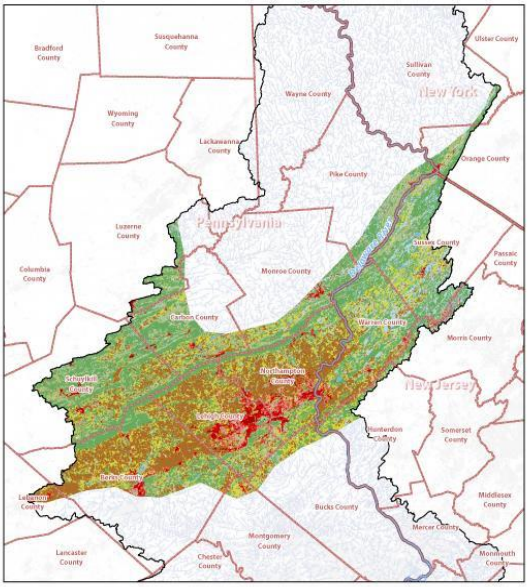


Note: legend represents the full range of population density values across the region. All values may not be present within the area shown. Population values are based on the 2010 Decennial Census.

POPULATION DENSITY
PER SQUARE MILE

Very High	5,000 - 120,000
High	2,000 - 5,000
Moderately High	1,000 - 2,000
Medium	500 - 1,000
Low	0 - 500
Unpopulated	

LAND COVER
STUDY AREA

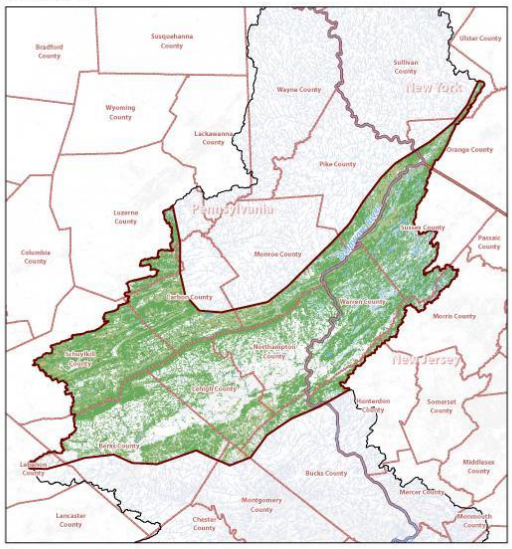


DEVELOPED
- High Intensity
- Medium Intensity
- Low Intensity
- Open Space

NATURAL
- Evergreen Forest
- Deciduous Forest
- Mixed Forest
- Shrub/Scrub
- Herbaceuous
- Woody Wetlands
- Herbaceuous Wetlands

OTHER
- Open Water
- Cultivated Crops
- Hay/Pasture
- Barren Land

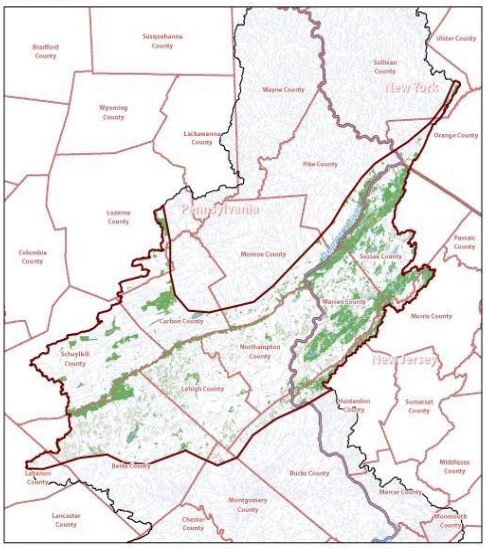
NATURAL LAND COVER
STUDY AREA



NATURAL LANDS
- Evergreen Forest
- Deciduous Forest
- Mixed Forest
- Shrub/Scrub
- Herbaceuous
- Woody Wetlands
- Herbaceuous Wetlands

OTHER
- Open Water

NATURAL LAND COVER WITHIN PROTECTED LANDS
STUDY AREA



NATURAL LANDS
- Evergreen Forest
- Deciduous Forest
- Mixed Forest
- Shrub/Scrub
- Herbaceuous
- Woody Wetlands
- Herbaceuous Wetlands

OTHER
- Open Water
- Other Protected Land

B. Review of Municipal Codes and Ordinances

CWP conducted a review of municipal codes and ordinances related to riparian (streamside) buffers and forest protection for 53 of the 60 randomly selected municipalities in the Highlands and Ridge and Valley physiographic regions of the basin. The Center's 2018 Forest-Friendly Code and Ordinances Worksheet (COW) was used for the review (Appendix 2). The Forest-Friendly COW allows an in-depth review of a community's codes and ordinances in terms of their ability to protect forests from clearing and other impacts during development.

Methods

The questions used for the code review were compiled from the Center for Watershed Protection's recently revised Code and Ordinances Worksheet (COW), a tool developed in 1998 to help communities evaluate and improve their local development regulations so they reduce impervious cover, conserve natural areas and reduce stormwater pollution. The COW provides a standardized scoring system for communities to evaluate their own regulations against nationally established benchmarks. The Center has applied the COW in more than 75 communities across the country.

COW questions that relate to forest protection were selected for inclusion in the checklist. This includes regulations that directly protect forests, such as forest conservation or stream buffer requirements, as well as regulations that indirectly protect forests, by limiting development on steep slopes or promoting open space design. Two additional questions were added to the checklist from the Center for Watershed Protection's *Making your Community Forest Friendly: A Checklist for Municipal Program/Code Review*. Some changes to the questions were made to address suggestions from the project advisory committee.

The checklist allows an in-depth review of a community's codes and ordinances in terms of their ability to protect forests from clearing and other impacts during development. It is not intended to evaluate how well these regulations are actually implemented and enforced, or to evaluate the ability of land use plans, programs, or institutional frameworks to protect forest land.

The first step was to identify and gather the relevant codes and ordinances available for free online through websites including municipal websites, ecode360.com, or elibrary.pacounties.org and through ordinances.com[1]. There were several municipalities in both NJ and PA that did not have their codes and ordinances available online. For these municipalities, Rutgers contacted the communities through email and phone calls to either obtain hard copies, an email version, or a weblink. In addition, a handful of municipalities were contacted to obtain specific ordinances not available online such as a floodplain management ordinance.

Of the initial 60 municipalities identified, code and ordinance reviews were completed for 53 municipalities; 43 in Pennsylvania and 10 in New Jersey. Glen Gardner Borough, New Jersey was eliminated as most of the Borough was located outside of the study area. In Pennsylvania, Banks Township, Byram Township, North Catasauqua Borough, Slatington Borough, and the Borough of Weissport were also removed from the study because a copy of their codes and ordinances was not able to be obtained.

While the goal of the ordinance review is to evaluate local development regulations, in some cases, regulations at the state level have a strong influence on the level of riparian forest protection provided during the local development process. Therefore, the PA and NJ state floodplain and stream buffer

[1] The company provided this project with free access to their website for one month.

regulations were also reviewed. Box 1 summarizes the stream buffer regulations in PA and the stream buffer and floodplain requirements for NJ. The PA stream buffer regulations only apply to High Quality (HQ) and Exceptional Value (EV) watersheds and as such do not apply a stream buffer requirement across the study area. In NJ, the Flood Hazard Control Act, establishes a Riparian Zone (RZ) for all regulated activities proposed adjacent to surface water bodes that includes a minimum 50 feet Riparian Zone.

Box 1. *Riparian Buffer Requirements*

New Jersey

New Jersey Department of Environmental Protection (NJ DEP) outlines riparian buffer requirements for **all major development** (1/4 acre increase in impervious area or 1 acre disturbance) in two sources - the *Stormwater Management Rule* (NJAC 7:13) and the *Flood Hazard Control Act* (NJAC 7:9B). Riparian buffer standards in the *Stormwater Management Rule* and *Flood Hazard Control Act* protect riparian vegetation only where vegetation exists. If no vegetation exists in a riparian area, the riparian buffer does not apply.

For all regulated activities proposed adjacent to a Category One (C1) designated surface water (or its tributaries), the *Stormwater Management Rule* establishes a 300 ft. buffer, called the Special Water Resource Protection Area (SWRPA). Applicable tributaries must be located within the same HUC 14 subwatershed as the C1 surface water body and be mapped on either the County Soil Survey or USGS Quad Map.

The Flood Hazard Control Act establishes a Riparian Zone (RZ) for all regulated activities proposed adjacent to surface water bodes. The RZ varies, depending on the characteristics of the surface water of interest, and is measured out from the top-of-bank along both sides of the surface water or centerline of feature, if no discernable banks are present (e.g. wetlands).

Pennsylvania

Pennsylvania's Act 162 of 2014 modifies the original Pennsylvania Clean Streams Law, 25 Pa Code Chapter 102.5 requirements regarding riparian buffers and riparian forest buffers in High Quality (HQ) and Exceptional Value (EV) watersheds. Act 162 allows implementation of substantially equivalent Best Management Practices (BMPs) in place of riparian buffer and riparian forest buffer protection within 150 feet of HQ/EV surface waters implemented elsewhere on the permit site to provide the same benefit as the compromised riparian buffer area.

Act 162 also includes an offset of riparian buffer or riparian buffer impacts within 100 feet of HQ/EV surface waters for NPDES General Permit sites. The applicant must provide a riparian buffer or riparian forest buffer of equal area (sq. ft.) to the disturbed 100 ft. riparian buffer elsewhere along surface waters of the same drainage class and as close as feasible to the permit site. Exemptions to Act 162 requirements include linear projects (pipelines, transportation projects, etc.), repair and maintenance operations, projects with disturbance under 1 acre, and all non-NPDES permits.
http://www.dep.pa.gov/Business/Water/CleanWater/StormwaterMgmt/Stormwater%20Construction/Pages/Act162.aspx

The checklist included 36 questions organized around six topic areas that represent common codes and ordinances that influence how much tree/forest protection and tree planting happens at a development site: Zoning, Buffers, Clearing and Grading, Forest Conservation, Floodplain and Wetland Protection, and Open Space Design and Management. Each checklist question focused on a specific forest protection practice. Table 6 provides a description of each code/ordinance type and provides some examples of how these regulations can promote forest-friendly practices.

Table 6. *Description of Checklist Categories and Example Forest-Friendly Elements*

Category/Type of Code	Description	Example Forest-Friendly Elements
Zoning (2 questions; maximum of 3 points)	Divides a jurisdiction into different districts, and defines rules for each regarding allowable uses, density, building footprints and height, signage, parking, setbacks, landscaping, and more	Allow a "natural resource protection overlay" zoning district that does not require special approval; require preservation of natural resources; set vegetated buffer standards
Buffers (9 questions; maximum of 14 points)	Requires preservation of the vegetated buffer within a specified distance from a waterway	Require a minimum 100-foot vegetated buffer along waterways. Identify allowable and prohibited uses, and expansion to include sensitive resources
Clearing and Grading (4 questions; maximum of 5 points)	Define requirements for clearing and grading	Limit clearing on sensitive resources; set maximum area that can be cleared; ensure that limits of disturbance are on plan and clearly marked at site
Forest Conservation (4 questions; maximum of 8 points)	Requires conservation and protection of some portion of existing natural areas at development sites	Establish conservation thresholds for natural resources, provide incentives and flexibility to developers to meet standards
Floodplain and Wetland Protection (2 questions; maximum of 3 points)	Restrict or prohibit development within the 100-year floodplain and wetlands	Prohibit or restrict activities within the 100-year floodplain, develop and adopt a local wetland protection ordinance
Open Space Design and Management (15 questions; maximum of 19 points)	A compact form of development that protects existing natural resources (open space) while concentrating density on another portion of the site	Allow "open space design" that does not require special approval; require protection of natural lands; identify a manger of the land and maintenance; identify allowable and unallowable uses

Codes, ordinances, and other related documents were referenced to answer the questions. If the development rule agreed with the forest protection practice, points were awarded. If the development rule did not agree with the forest protection practice, did not address it at all (i.e. the code is "silent"), or the practice was not applicable in the community then points were not awarded.

YES	*The practice is required or allowed*
NO	*The practice is prohibited*
CODES ARE SILENT	*The regulations do not address the practice at all*
N/A	*The practice is not applicable in my community*

A scoring spreadsheet was used for ease of completing the checklist for numerous municipalities (Table 7) In the spreadsheet, for each question, if the answer was "Yes," the associated number of points were awarded in the "Yes" column. Most questions were worth one point for a Yes answer, but BLUE questions were worth two points and ORANGE questions were worth 0.5 points. If the answer was No;

the question was not applicable (e.g. the question is about a requirement in the open space ordinance but the community did not have an open space ordinance); or the codes did not address the question at all, an "x" was entered in the appropriate column (No, N/A, or Codes are Silent). No points were given for these answers. Note that "Codes are Silent" was only an option for certain questions. Other questions had a clear Yes or No answer (e.g., Does the buffer ordinance outline prohibited and allowable uses?"). The Notes column was used to record details about responses, such as specific code language or a reference to the specific code section where the answer was found. Final scores are tabulated as the total points received as well as the percentage of possible points.

Results

Of the 53 municipalities reviewed, the average total score was 25.5%, with a range of 0% to 71%. The total score for each municipality (as a percent) is shown in Table 7, which also summarizes the score for each major category of questions. Figure 8, provides a visual representation of the total score for each municipality, and the average score for each county and state.

Figure 8. *Average score-range for 53 municipalities in the Delaware River Basin.*

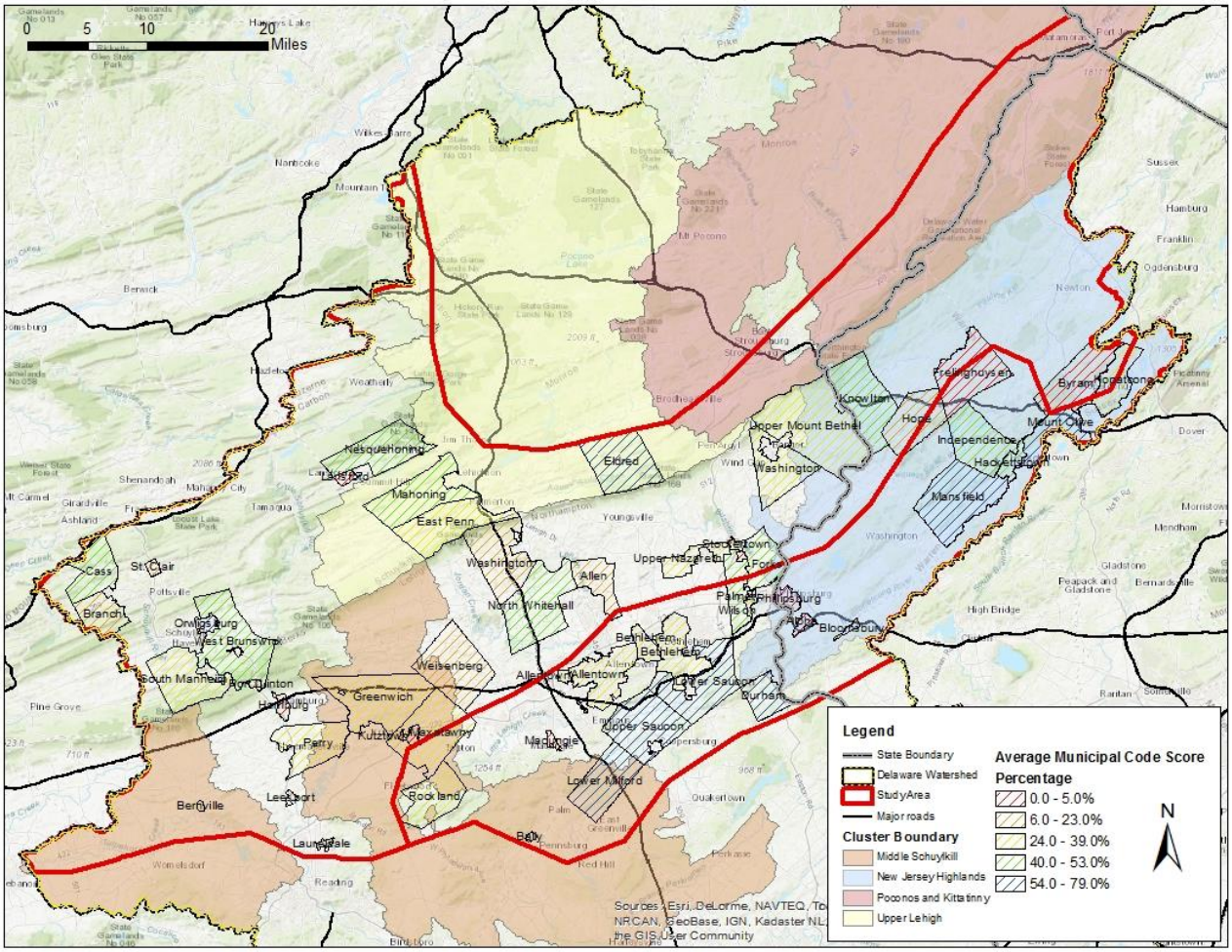


Table 7. *Municipal Code Review Total Score (%) and Score (%) by Code Review Category, County, and State*

Please contact authors for municipal data.

Of the six code review categories, the average scores were highest for the *Floodplain* and *Wetland Protection* and *Zoning* categories, with 58% and 30% respectively. The lowest scoring categories were *Forest Conservation* (17%) followed by *Buffers* (18%). Table 8 highlights the lowest scoring questions (<10%) and highest scoring questions (>40%). The categories were identified based on natural breaks in the dataset. Of the lowest scoring questions, two (#14, #15) fall within the Clearing and Grading category and two are within the Buffers category (#8, #11). The two highest scoring questions pertain to Floodplain Management (#20, 81%) and Open Space Design and Management (#22, 59%).

Table 8. *Summary of Questions with Lowest and Highest Scores*

Questions with Lowest Scores (<10%)	%
#14. Are the limits of disturbance required to be shown on construction plans and physically marked at the site?	6%
#18. Are there any incentives to developers (e.g., density bonuses, stormwater credits, or expedited design review) to conserve land above and beyond what is already required (e.g., steep slopes, wetlands)?	6%
#11. Does the buffer ordinance specify a preference for buffers to be located on a parcel of common ownership (e.g., a homeowners' association)?	2%
#15. Are reserve septic field areas allowed to be left undisturbed until needed?	4%
#8. Does the buffer ordinance specific that a minimum percentage of the buffer be maintained with native vegetation?	2%
Questions with Highest Scores (>43%)	
#20. Does a floodplain management ordinance exist that restricts or prohibits development within the 100-year floodplain?	81%
#22. Do the ordinances require or allow open space subdivisions?	59%
#29. Does the open space design ordinance require identification of an entity (e.g., conservation organization, community association) who will be responsible for managing the open space?	46%
#12. Is there any ordinance that requires the preservation of native soils, hydric soils, natural vegetation, or steep slopes at development sites?	41%
#23. Is a minimum percentage of the buildable portion of the site required to be set aside as open space?	44%

Table 9 provides a summary of the scores for each category of codes organized by percent impervious surface categories. The percent impervious surfaces were calculated using the land use land cover data from the 2011 NLCD. The data has four levels of developed land with ranges of impervious surface. The mid-point of the ranges were used to calculate impervious surfaces for each of the four categories (categories 21, 22, 23, 24) then summed the impervious surfaces for total acres and percentage. Across the board, municipalities with an impervious surface percent less than 10% had higher scores than municipalities with impervious surface greater than 10%. One exception is the Floodplain category with the second highest score of 63% for municipalities with impervious surfaces greater than 25%. For most of the code review categories, scores were highest for municipalities with 5-10 percent impervious surfaces and lowest for municipalities with 25 percent or greater impervious surfaces.

Table 9. *Average Percent COW Category Scores by Percent Impervious Surface*

% Impervious Surface	Average Score	Zoning	Buffers	Clearing	Forest	Floodplain	Open Space
0-5%	31%	43%	24%	34%	22%	60%	33%
5-10%	37%	29%	35%	31%	29%	71%	41%
10-25%	15%	21%	5%	22%	11%	42%	18%
25%>	13%	7%	4%	14%	3%	63%	17%

For cluster organizations working in the study area, the results of the code and ordinance review could help direct future technical assistance on regulatory changes. Overall, municipal development controls are weakest in the areas of Forest Conservation and Buffers. In municipalities where State buffer regulations do not apply (due to the absence of High Quality streams), adoption of local buffer regulations should be a priority provided the municipality has the authority to do so. The municipal scores provided in Table 7 can be used to identify municipalities with lower scores towards whom to target future assistance.

For future code work outside the study area, a logical approach may be to focus efforts where the greatest benefit can be achieved. The code review results showed that scores were generally lower with impervious cover > 10%; however above 25% imperviousness there is less forest to protect and less opportunity to prevent stream degradation, while areas with less than 5% impervious cover may still be in good condition. Code revisions could first be targeted towards communities that have between 5-10% impervious cover, and that have high development pressure, so that conservation efforts can be enhanced before remaining forest lands are lost and streams become degraded.

For municipalities who wish to use the results of the review to make improvements in their codes and ordinances to strengthen forest protection, guidance is provided below. This same guidance is applicable to cluster organizations assisting municipal staff with code changes. The individual completed checklists for each municipality will be provided to municipal staff and any relevant local cluster organizations. The code review responses can be used to identify both short-term (1-3 years) and long-term (3-5 years) action items by focusing on those questions with "No" or "Codes are Silent" responses. The questions themselves identify the recommended practice and the action would be to amend the code to allow or require the practice.

If there are many "No" or "Codes are Silent" responses, it will be important to prioritize the action items. Some factors to consider in determining the relative importance of the practice in the community, and whether actions are short or long term include:

- Time the revisions with planned updates to codes and ordinances
- Focus on the code changes that are under municipal control (as opposed to state or federal regulation)
- Focus on codes that give the most bang for the buck (for example, updating a single ordinance may address the majority of changes or the type of development that is most common in the community)
- Target specific areas that need the most improvement first
- Focus on changes that help to meet other community goals or mandates
- Consider local support/local importance of specific programs
- Prioritize changes that remove direct barriers to forest protection
- Consider relative ease of proposed changes (e.g., adopting a stream buffer ordinance may be a longer road than changing parking lot design standards)

Questions with "Yes" responses can also result in action items to improve riparian buffer and forest protection. For example, a municipality may wish to revise their stream buffer ordinance to increase the stream buffer width from 50 feet to 100 feet.

The ultimate goal is to make changes to programs and regulations that result in increased riparian buffer and forest protection in the community. Municipal staff may wish to proceed with the changes through their usual process of ordinance updates. Another option for regulatory changes is a site planning roundtable process conducted at the local government level. The roundtables are a consensus-based process initiated to create more environmentally sensitive, economically viable and locally appropriate

development, and they involve a diverse mix of stakeholders from environmental groups, transportation officials, planners, realtors, homebuilders, land trusts, fire officials, county managers and more. The primary tasks of a local roundtable are to systematically review existing development rules and then determine if changes can or should be made. By providing a much-needed framework for overcoming barriers to better development, the site planning roundtable can serve as an important tool for local change. The Better Site Design Handbook (CWP, 1998) provides detailed information on how to conduct a site planning roundtable.

C. Land Use Controls, Forest Cover, and Riparian Buffers

The third phase of this project used COW scores to analyze the relationship between the level of forest protection provided in the regulations and the resulting forest cover after development, to help answer the question of how well the regulations work to protect forest cover—or even the extent to which they are related. This particular inquiry was essential to the study and should be of great interest to policymakers.

Among the anticipated challenges at the outset of the work was controlling for some but not all of the variables associated with physiographic, demographic, ecological and political differences between places throughout the DRB. This was one of the reasons for selecting municipalities in a more constrained region within the "middle of the basin." This decision, made in consultation with the advisory committee, could help limit problems that would make interpretation more difficult, while also having both an adequate range of regulatory controls and conditions on the ground.

The analyses utilized all the information previously developed for selection of municipalities, including landcover at the subwatershed and municipal scales, and landcover data and mapping within 50', 100', and 300' portions of the riparian zone. Data sources included 2011 PADUS and 2016 NLCD datasets, as well as data generated by the SLEUTH models performed by Shippensburg University.

Analyses asked the question of whether COW scores for each of the studied municipalities were correlated with spatially-derived measurements of:

- % forest and natural landcover within the municipal boundary
- % forest and natural landcover within 50', 100', and 300'buffer widths within the riparian zone (inside municipal boundaries)
- % developed land (high, medium, and low) within the municipal boundary
- Proportion of development, forests and natural landcover located within the riparian buffers vs. elsewhere in the municipality

Each of these analyses was performed for aggregated COW scores, as well as sub-scores for regulations related to *forest conservation*, *buffers*, and *open space*. Also, the same analyses were carried out for scores for county and state groupings of the municipalities selected in the study. These latter analyses helped to indicate whether local land use controls derived from state/county requirements/capacity/guidance may be influencing scores and outcomes at the municipal level. Also influential would be sub-regional policies (e.g. the Highlands Act) and/or higher levels of statewide investment in open space.

Analyses first looked at patterns in landcover and landuse across municipalities in the study area, before considering COWI results. At the state and county level—i.e. grouping the 53 municipalities selected for spatial analysis—there are differences at the state level that consistently held from county to county. Initial results Figure 9 shows the percentage of "natural lands" within municipal boundaries that are protected (forests and other natural cover). Almost seven times the proportion of natural lands is protected within New Jersey municipalities included in the study, vs. Pennsylvania. For the purpose of this analysis unprotected lands are labeled "vulnerable." However, there is not a consistent nor significant difference in the total area of natural land, both vulnerable and protected.

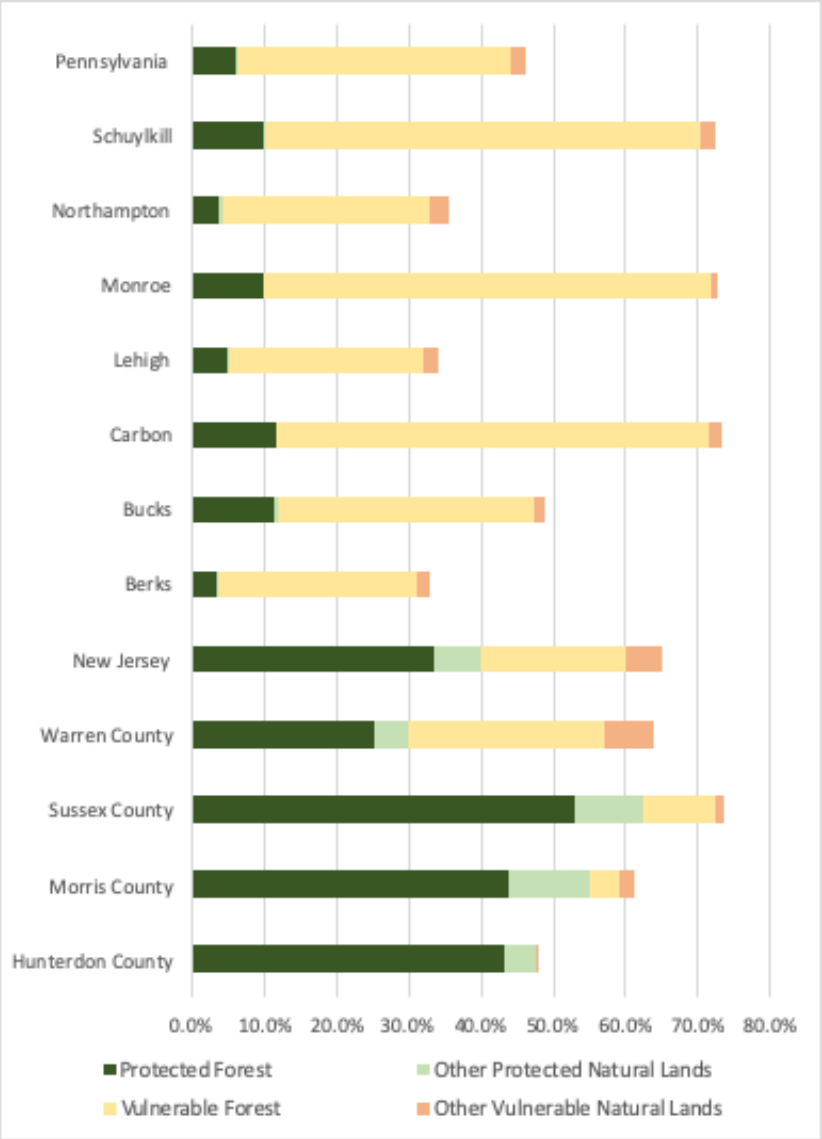


Figure 9. *Percent of the area within studied municipalities that are "Protected Forest," "Other Protected Natural Lands (natural cover)," "Vulnerable Forests (unprotected), or "Vulnerable Natural Lands," based on PADUS data (2011), shown by county and state.*

Additional analyses sought to determine what is driving this difference and whether it is consistent among municipalities within the counties and states, and reflected in COW scores. For example, data for individual municipalities show some variation in protected forests and other natural cover in New Jersey (Figure 10), which while much more consistent than the studied Pennsylvania municipalities, is not necessarily consistent even for nearby towns. As will be described in the next section of the report, Mt. Olive was selected as a case study to better understand how a moderately high level of forest conservation combined with growth pressure relates to regulatory controls imposed by the township.

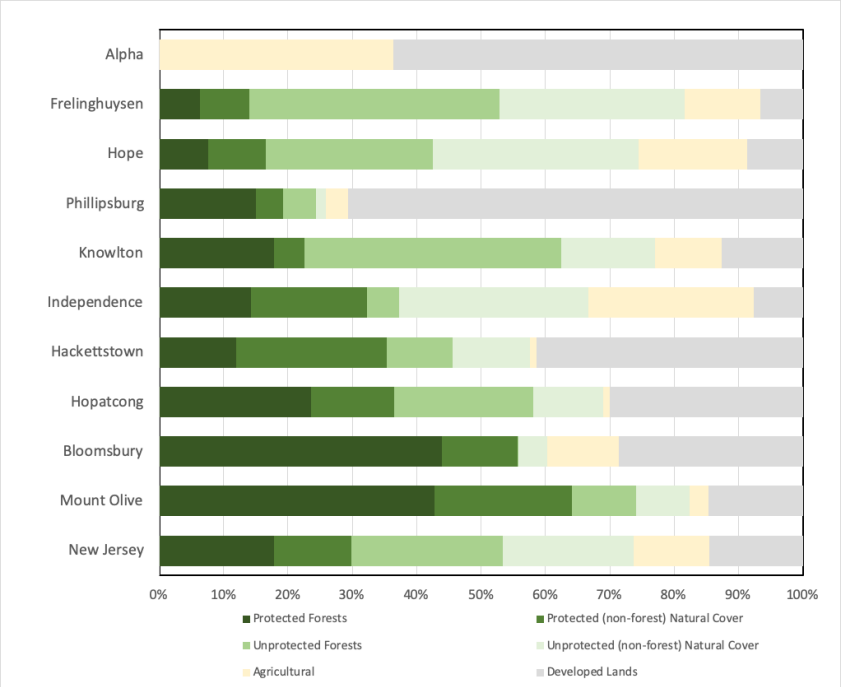


Figure 10. *Protected & Unprotected Forests and Natural Cover Compared with Other Uses for NJ municipalities included in the study.*

The more specific question being asked in the study is the degree to which regulatory controls have driven and could better drive forest conservation in riparian buffers. One way to consider this is to compare the relative allocation of development and forest cover to buffers in different municipalities. A higher percentage of developed area within 50' of a could owe to regulatory controls, or if not, signal greater need for them. Aggregating this data at the county and state level for the studied municipalities suggests that New Jersey municipalities have a lower portion of their development in streamside zones (@ 50' NJ=2.2%, PA=4.3%), but this breaks down with variation at the municipal scale, and there is wide variation in county scores as well (Table 10).

Table 10. Developed land and forestland for 60 municipalities within 50', 100', and 300' buffers of waterways as a percentage of that category of land-use within municipalities. *(other natural landcover not included)* NLCD 2016

	Developed Land			Forests		
	50'	**100'**	**300'**	**50'**	**100'**	**300'**
Hunterdon County	1.2%	2.6%	9.1%	0%	0%	8%
Morris County	0.7%	1.4%	5.8%	4%	7%	17%
Sussex County	3.8%	7.5%	23.3%	16%	25%	38%
Warren County	3.0%	6.1%	18.4%	6%	10%	21%
New Jersey	**2.2%**	**4.4%**	**14.2%**	**7%**	**11%**	**21%**
Berks	3.0%	6.4%	20.3%	17%	25%	31%
Bucks	8.5%	16.8%	39.8%	5%	8%	19%
Carbon	4.3%	8.9%	28.5%	18%	22%	25%
Lehigh	2.7%	5.6%	17.2%	17%	25%	33%
Monroe	5.5%	12.3%	36.5%	1%	2%	9%
Northampton	1.9%	4.0%	12.5%	8%	13%	20%
Schuylkill	3.5%	7.2%	22.1%	2%	3%	7%
Pennsylvania	**4.3%**	**9.0%**	**25.8%**	**11%**	**16%**	**23%**

The second stage analyses considered how COW scores relate to current landcover within municipalities, amount of protected lands and their distribution (e.g. within or outside riparian areas). The COW scores showed wide variation between studied municipalities, and between counties and states. Basic correlation analysis was done for many of the measures to test if regulatory controls were a strong predictor of buffer protections. Some of the best evidence that comprehensive land-use controls have, over time, conserved forests in buffers would have been a high correlation between COW scores for municipalities (especially regarding buffers, but also for wetlands and floodplains), and an increased proportion of forests within 50' riparian buffers within municipal landcover (2016 NLCD). This was not entirely the case, but the relationship is there and stronger for municipalities in New Jersey (Table 11). All buffer widths were analyzed, and while 300' is a valuable conservation objective, 50' buffer represents a tighter analytical test of whether on-the-ground forest retention abuts the waterway. Also, a 50' requirement is the most common across municipalities in the study.

Land use controls and related policies are more strongly associated with landcover along streams in NJ than in PA. The strongest relationship is between COW scores and protected lands in NJ municipalities (R= 0.77). And while it might seem straightforward that a high percentage of protected land automatically correlates with less development along streams, this was not the case. The relationship is relatively strong in NJ (R=0.60), but less so in PA (R=0.33). Among the reasons may be some definitional issues in data, but is likely more strongly related to the timing of historical development vs. new rules; background interest in land protection; the role of state/county guidance and funding; and in some cases a lower perceived threat to forestlands. Figure 9 shows that, in general, there were similar amounts of natural land cover across Pennsylvania municipalities, just less that is protected. These dynamics should be considered in light of how outreach on policies should be prioritized in places where buffer vulnerability is most acute and where there is less investment in open space preservation.

Table 11. *Correlation coefficients for selected relationships between landcover, buffers and rules.*

	R-Value
Natural lands protected within a municipality and land developed within 50' of streams?	
All Municipalities	0.37
New Jersey Municipalities	**0.60**
Pennsylvania Municipalities	0.33
Stream buffer ordinance/rule and land developed within 50' of a stream?	
All Municipalities	0.41
New Jersey Municipalities	**0.52**
Pennsylvania Municipalities	0.39
Land use controls (ordinances, zoning, regulations, etc.) and % of natural cover within 50' of stream?	
All Municipalities	0.30
New Jersey Municipalities	**0.48**
Pennsylvania Municipalities	0.28
Land use controls (COW score on ordinances, zoning, regulations, etc.) and % of protected natural cover?	
All Municipalities	0.28
New Jersey Municipalities	**0.77**
Pennsylvania Municipalities	0.14

D. Case Studies – Planning Scenarios

Two of the 53 municipalities included in the review of municipal codes and ordinances were selected to more closely evaluate: 1. How local development regulations may influence forest loss with buildout; and 2. water quality implications of forest loss. The selected municipalities were Mt. Olive, NJ and Greenwich, PA. These municipalities were chosen because they had water quality data available, moderate to high development pressure, low to moderate scores on the Forest-Friendly COW, and significant forest resources present (>40% natural areas, < 25% impervious cover). These factors were important because the COW scores showed room for improvement in local regulatory protection for trees and forests, and the growth pressure and forest resources meant the case studies were also targeted to areas with forests that are vulnerable to loss from future development.

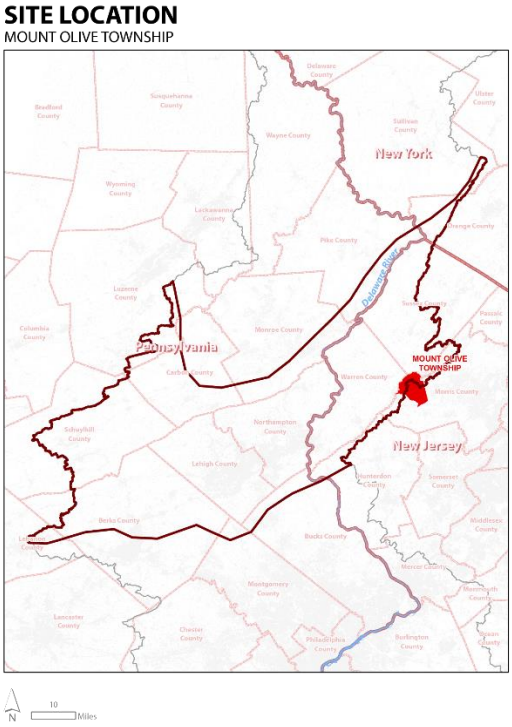
For each selected municipality, CWP conducted a future forest cover analysis which is a projection of future forest cover under buildout conditions. The future forest cover analysis is primarily a GIS exercise and can also be used to illustrate the impact of different levels of forest protection on forest loss. Data sources for the future forest cover analysis include local zoning, current land use/land cover, protected parcels, protected resources (based on local/state/federal regulations), and forest cover coefficients, which represent the average portion of a developed parcel that is covered by trees and forest. For each case study, the water quality benefits of forest protection were quantified as the increase in pollutant load associated with forest loss. These case studies illustrate the potential impact of specific development code changes on reducing forest loss and the implications for water quality.

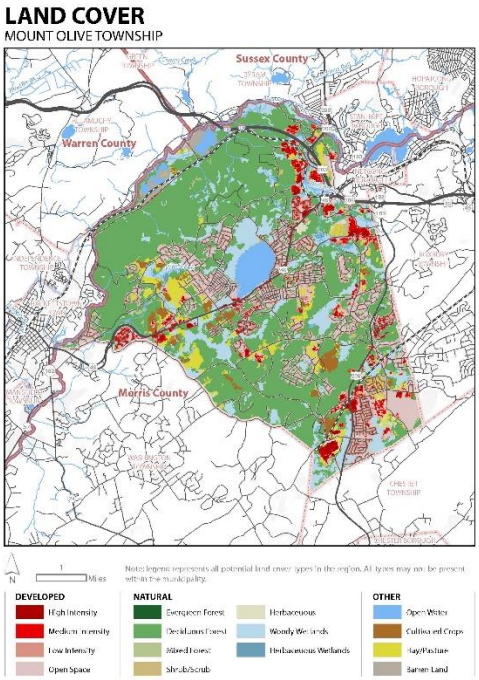
Mt. Olive, New Jersey

The Township of Mt. Olive is located in Northern New Jersey within Morris County (Figures 11a & b). The Township is located within the New Jersey Highlands region which is a vital source of drinking water for millions of people in the state. In 2004, New Jersey adopted the New Jersey Highlands Water Protection and Planning Act (Highlands Act) to systematically protect and improve the quality and availability of its waters. The Highlands Council was tasked with the development of a Regional Master Plan (RMP) that provides policy to balance protection of natural resources and accommodate growth.

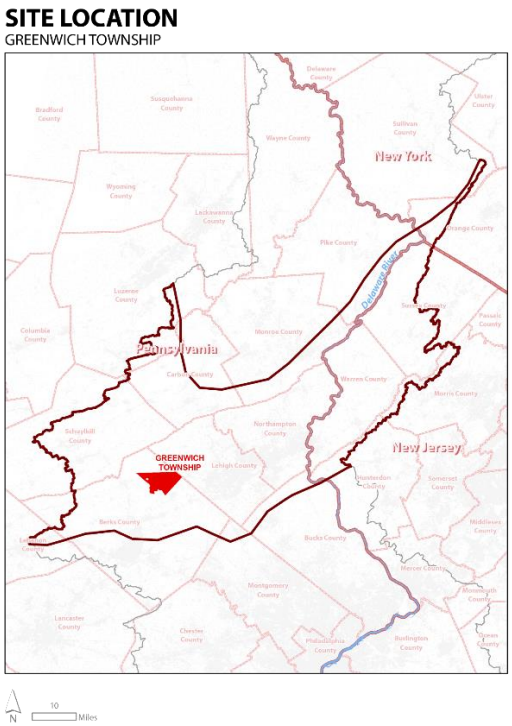
The Highlands Act identified specific boundaries as preservation areas, required to comply with the RMP, and planning areas, with voluntary compliance. The preservation area is established to protect natural resources while the planning area is focused on balancing environmental protection and land use planning. Mt. Olive Township contains both planning and preservation areas, and the buildout analysis was focused on just the planning area, as there is little development potential in the preservation area. The Township conforms to the RMP in the preservation area, as required, and not within the planning area. The planning area goals are to promote a balance between environmental protection and sound land use. Without conformance to the planning area standards, these goals are not met. Mt. Olive's planning area currently has 48% forest cover, based on 2013 high-resolution land cover data from the University of Vermont Spatial Analysis Laboratory. This data represents the most accurate and detailed mapping of land cover in the basin. Two scenarios were used to project how the amount of forest might change under future buildout conditions.

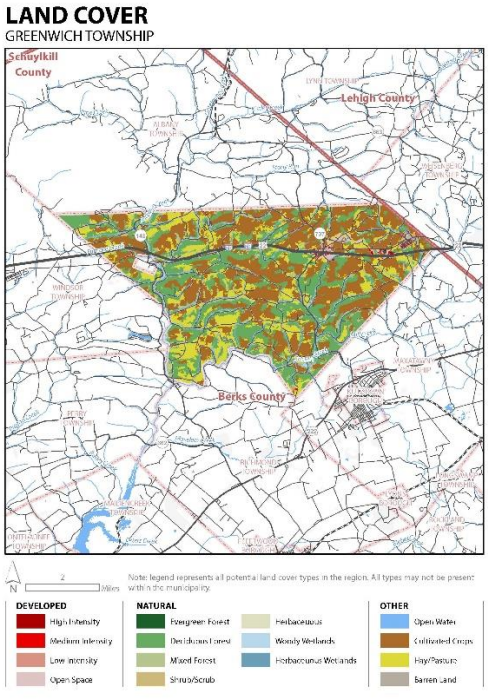
Figures 11a & 11b. *Location of Mt. Olive Township, NJ and landcover.*





Figures 12a & 12b. *Location of Greenwich, PA and landcover.*





Greenwich, Pennsylvania

The Township of Greenwich is located in southeastern Pennsylvania within Berks County (Figures 12a & 12b). It drains into the Maiden Creek and Saucony Creek that discharge to the Schuylkill River. The Township is not a regulated as a Municipal Storm Sewer System (MS4). The Township is not included in a DRWI cluster.

Greenwich Township currently has 39% forest cover, based on 2013 high-resolution land cover data from the University of Vermont Spatial Analysis Laboratory. This data represents the most accurate and detailed mapping of land cover in the basin.

Buildout Analysis: Status Quo Scenario

The future forest cover analysis was conducted to estimate future forest cover for the case study planning areas based on the current set of municipal development regulations and zoning. For this analysis, the Mt. Olive, NJ and Greenwich, PA planning areas were split into three categories:

1. Developed Lands – All currently developed parcels

2. Unbuildable Lands –Currently undeveloped lands that are protected by easement or state/local regulation, including:
   - Tax parcels that are preserved open space or preserved farmland in a combination of federal, State, county municipal, nonprofit, and private ownership
   - Land protected by municipal or state ordinance:
     - Perennial and intermittent streams and their buffers (100 feet on either side)
     - All wetlands protected under NJ law
     - Ponds and lakes

3. Buildable lands – Currently undeveloped land that is available to be developed (i.e., is unprotected)

For Greenwich, PA data sources for this categorization included the Berks County, PA tax data and parcel data, National Wetland Inventory for PA, protected easements recorded with the Berks County Recorder of Deeds, farms that participate in the Berks County Agricultural Conservation Easement (ACE) program, recreation areas in Berks County, and the National Hydrologic Dataset from USGS. For Mt. Olive, data sources for this categorization included the Morris County, NJ tax data and parcel data, preserved lands and wetlands layers from the New Jersey Highlands Council, and the National Hydrologic Dataset from USGS.

The buildout analysis for Mt. Olive and Greenwich assumed that there will be no net loss or gain of forest on lands that are already developed or unbuildable. It also assumed that buildable lands will be developed to the fullest extent based on zoning. Future forest cover for buildable lands was estimated using forest cover coefficients from the Cappiella et al, 2012. The total future forest cover was estimated as the sum of current forest cover on developed and unbuildable land and the future forest cover on buildable land. Table 12 provides a summary of the results.

Table 12. *Summary of current and projected future forest cover Mt. Olive, NJ and Greenwich, PA.*

	a. Current Forest Cover (ac)	b. Future Forest Cover on Buildable Lands (ac)	c. Current Forest Cover on Unbuildable and Developed Lands (ac)	d. Total Future Forest Cover for Municipality (ac) (B+C)	e. Change in Forest Cover (ac) (a-d)
Mt. Olive	1,970.9	15.82	1,637.31	1,653.13	(-) 317.77 16.1% Forest Loss
Greenwich	7,810.2	122.46	6,306.29	6,428.75	(-) 1,381.45 17.7% Forest Loss

Table 13 provides an estimate of the pollutant load increase associated with the projected forest loss by comparing total nitrogen (N), total phosphorus (P) and total suspended sediment (S) loads from forested land to that of developed land. The acres of forest projected to be lost were multiplied by land cover/pollutant loading rates for both forest and developed land[2]. The difference in pollutant load represents the water quality benefit that would be realized if the land had remained forested.

Table 13. E*stimated Pollutant Load Increase Associated with Forest Loss under the Status Quo Scenario in Mt. Olive, NJ and Greenwich, PA.*

	Forest Loss (acres)	Nitrogen (lbs/yr)	Phosphorus (lbs/yr)	Sediment (lbs/yr)
Mt. Olive	(-) 317.77	(+) 111.15	(+) 12.70	(+) 5,954.63
Greenwich	(-) 1,381.45	(+) 994.64	(+) 96.70	(+) 45,394.45

Buildout Analysis - Forest Conservation Scenarios

The "forest conservation" scenario for Mt. Olive reflects the level of forest retention that is expected to occur under buildout conditions if the Township conforms to the Highlands Act in their Planning Area. As the scenario was modeled using GIS, only two of the Highlands Act Planning area criteria were included in the scenario as listed below.

- A 300-foot buffer around all Highlands Open Water features, which may include streams, wetlands, seeps, springs, etc.
- Protection of Severely Constrained Slopes and Moderately Constrained Slopes from disturbance.

The "forest conservation" scenario for Greenwich, PA reflects the level of forest retention that is expected to occur under buildout conditions if the Township adopts several recommended code changes. As the scenario was modeled using GIS, the specific criteria included in the scenario are listed below.

- Adopt a 35-foot stream buffer requirement that applies to all streams. Currently there is no local stream buffer requirement in Greenwich. At the state level, there is protection for forest buffers within 150 feet of streams in Exceptional Value or High Quality watershed, none of which are present in Greenwich.
- Restrict clearing on slopes 25% or greater.
- Adopt a floodplain protection ordinance. This ordinance would also protect local wetlands as 75% of wetlands are located within the floodplain.

For both cases, the resulting land area was categorized as "unbuildable land." Future forest cover was then estimated using the same assumptions and calculations as in the Status Quo scenario. Table 14 summarizes the current and projected forest cover in Mt. Olive and Greenwich, PA for the conservation scenarios and Table 15 the projected pollutant load changes.

[2] *Values taken from www.wikiwatershed.org*

Table 14. *Summary of current and projected future forest cover in Mt. Olive, NJ and Greenwich, PA.*

	a. Current Forest Cover (ac)	b. Future Forest Cover on Buildable Lands (ac)	c. Current Forest Cover on Developed and Unbuildable Lands (ac)	d. Total Future Forest Cover for Municipality (ac) (B+C)	e. Change in Forest Cover (ac) (a-d)
Mt. Olive	1,970.9	8.61	1829.97	1838.58	(-) 132.33 6.71% Forest Loss
Greenwich	7,810.24	95.95	6,783.19	6,879.14	(-) 931.10 11.92% Forest Loss

Table 15. *Estimates of the pollutant load increase associated with the conservation scenario by comparing N, P and S loads from forested land to that of developed land.*

	Forest Loss/Gain (ac)	Nitrogen (lbs/yr)	Phosphorus (lbs/yr)	Sediment (lbs/yr)
Mt. Olive	(-) 132.33	(+) 46.31	(+) 5.29	(+) 2,481.11
Greenwich	(-) 931,10	(+) 670.39	(+) 65.18	(+) 30,595.95

Specific to Mt. Olive are the varying levels of protection provided in the Highlands Act for other features listed in Table 16, but these are more difficult to model in GIS for the reasons described. It includes the calculated area of tree canopy within each resource type (within the developable portions of Mt. Olive's Planning Area) to illustrate the additional forest resources that could potentially be protected through conformance with the Highlands Act.

Table 16. *Tree Canopy from Other Resources Protected in the Highlands Act*

Resource Type	Highlands Act Protection	Acres
Critical Habitats	Includes Critical Wildlife Habitats, Significant Natural Areas, or Vernal Pool Buffers. Disturbance must first be avoided, then minimized, then mitigated. Since development is not outright restricted, these cannot be considered fully protected.	300.91
Ground Water Recharge Areas	Development is restricted unless the entire site is in a GRA or if necessary, to prevent disturbance of Critical Habitat, Highlands Open Waters or Severely Constrained Slopes or Moderately Constrained Slopes. This one cannot easily be modeled in GIS as it is applied on a parcel basis.	207.76
Lake Management Areas	Includes 3 tiers with differing standards. Only a small portion of one LMA within Mt. Olive's Planning Area.	4.37
Protection and Conservation Zones	Forests within these zones are only allowed to be developed for low impact residential development. Permissible uses are limited.	585.17
Total Tree Canopy		**1,098.21**

Although both the Status Quo and Conservation scenarios result in future loss of forest cover in Mt. Olive, the Conservation Scenario reduces this loss by 185.44 acres or 9.41%. The water quality benefits of the Conservation Scenario can be quantified as prevention of an increased pollutant load: 64.84 lbs/yr for nitrogen, 7.41 lbs/yr for phosphorus, and 3,473.52 lbs/yr for sediment. Greenwich, PA faces the same situation, losing forests in the future in both the Status Quo and Conservation scenarios. The Conservation Scenario reduces this loss by 450.35 acres or 5.76%. The water quality benefits of the Conservation Scenario can be quantified as prevention of an increased pollutant load: of 324.25 lbs/yr for nitrogen, 31.52 lbs/yr for phosphorus, and 14,798.5 lbs/yr for sediment.

The U.S. Forest Service estimates that nearly 1 million acres of forest were converted to developed uses each year in the 1990s, and projects that by 2050, an additional 23 million acres of forests may be lost due to development. Municipalities and developers in urbanizing areas can take steps to protect existing forest resources and prevent forest loss while still allowing for development. Protecting existing trees and planting new ones in urban areas has great potential for helping to meet water quality requirements such as total maximum daily loads (TMDLs) and stormwater management regulations. Trees' primary impact on water quality is attributed to the prevention of water pollution by reducing the amount of runoff generated from areas where tree canopy is present. Trees also improve water quality through uptake of soil nutrients by plants and soil microbes, and filtering of sediment and associated pollutants from runoff. Beyond water quality, there are many other benefits provided by forests, such as removal of air pollutants, wildlife habitat, and improved health and well-being.

It is significant that the benefits in Mt. Olive are a result of only two regulatory changes: adoption of a 300-foot stream buffer and restriction of development on steep or moderate slopes. Additional ordinance changes required in the RMP for planning area compliance weren't included in the analysis as they didn't lend themselves to a GIS analysis. The addition of these requirements would increase the trees retained, resulting in a decline in nutrient loading to local waterbodies such as the Musconetcong River Watershed. Mt. Olive could provide an excellent example of how to integrate Highland Act conformance into their planning and zoning to foster forest protection. Some small steps to improve forest protection in municipal regulations for Greenwich Township can also help to protect water quality and maintain forest benefits as new development comes to the community.

E. Conclusion

Municipal codes, ordinances, zoning plans, and other land use controls incorporate federal and state requirements and guidance, but to a great extent are developed and enforced at the municipal level. It is also at this scale—in towns and communities—where welcome economic growth leads to new business, homes, and roads built in accordance with local requirements. These requirements vary across the municipalities in the four states of the DRB. This study looked at how land use controls vary among municipalities in a portion of the DRB, and the extent to which this variation is evident in how riparian buffer areas are protected.

Guided by an advisory committee (Appendix 1), the study team looked at the land use controls for 53 municipalities (60 towns/cities were included in the landcover analyses) in Pennsylvania and New Jersey within the Ridge and Valley and Highlands physiographic provinces. This geography was selected to represent a full range of development intensity/history within at least two states. Both the Ridge and Valley and Highlands provinces have extensive protected open space, as well as small and large towns/cities that variously protect their waterways through land use controls.

After selecting the geography, the first phase of analysis looked at the relative proportion of landcover types and the placement of protected lands within municipal boundaries to understand the prioritization of riparian forest protection. The analyses were carried out at the municipal level and the results are useful to understand what each municipality has accomplished and faces in recovering and saving riparian forests. Information from the landcover analyses is supplemented by municipal stormwater reports developed by Rutgers University (*linked in* Appendix 3, using wikiwatershed.org). There are some notable regional comparisons. County level results (Table 10) show significant differences among counties and between the states of Pennsylvania and New Jersey. As an example, municipalities in NJ have about half the amount of land area developed within 50', 100', and 300' of streamside zones compared to municipalities in Pennsylvania yet, by county, Pennsylvania municipalities have more forests in these areas. New Jersey municipalities have fewer forests but more than double the protected forests, and more protection in riparian areas. Reasons are historical, geographic, and sociopolitical, but illuminate a condition that may not endure, and future forest vulnerabilities that threaten water quality.

Current landcover and forest protection in riparian buffers were compared with land use control measures adopted and enforced by municipalities. This analysis used the Center for Watershed Protection's *Forest Friendly Code and Ordinances Worksheet* (COW, Appendix 2). Scores for scope and comprehensiveness of land use controls vary widely. There are significant differences between counties and states in how well COW scores correlate with the observed amount of forest in riparian buffers. Land protection in NJ is biased toward forests within 50 feet of streams (R=0.60), much more so than in Pennsylvania (0.33). In general, the land use controls—i.e. the combination of zoning, ordinances, regulations, etc.—in NJ municipalities highly correlates with the amount of protected land (0.77) in comparison with PA (0.14).

Adoption and enforcement of more land use controls corresponds with greater protection of forests in riparian areas in New Jersey, but not the amount of forest in these areas in Pennsylvania. The fate of forested riparian buffers in Pennsylvania may therefore depend on whether threats to these important areas are managed in the face of threats. Another part of the study modeled what may happen in two municipalities (one in PA and another in NJ) were they to build-out to the extent permitted by land-use controls currently on the books, relative to a "conservation scenario" tailored to the locality. The conservation scenarios result in meaningful pollutant loading reductions would result (Table 15). The study shows that fewer land use controls corresponds with less riparian forest buffer *protection* in the basin, but not always less forest area, and identifies municipalities whose rules pose the greatest threat of forest loss and pollutant loading in the future.

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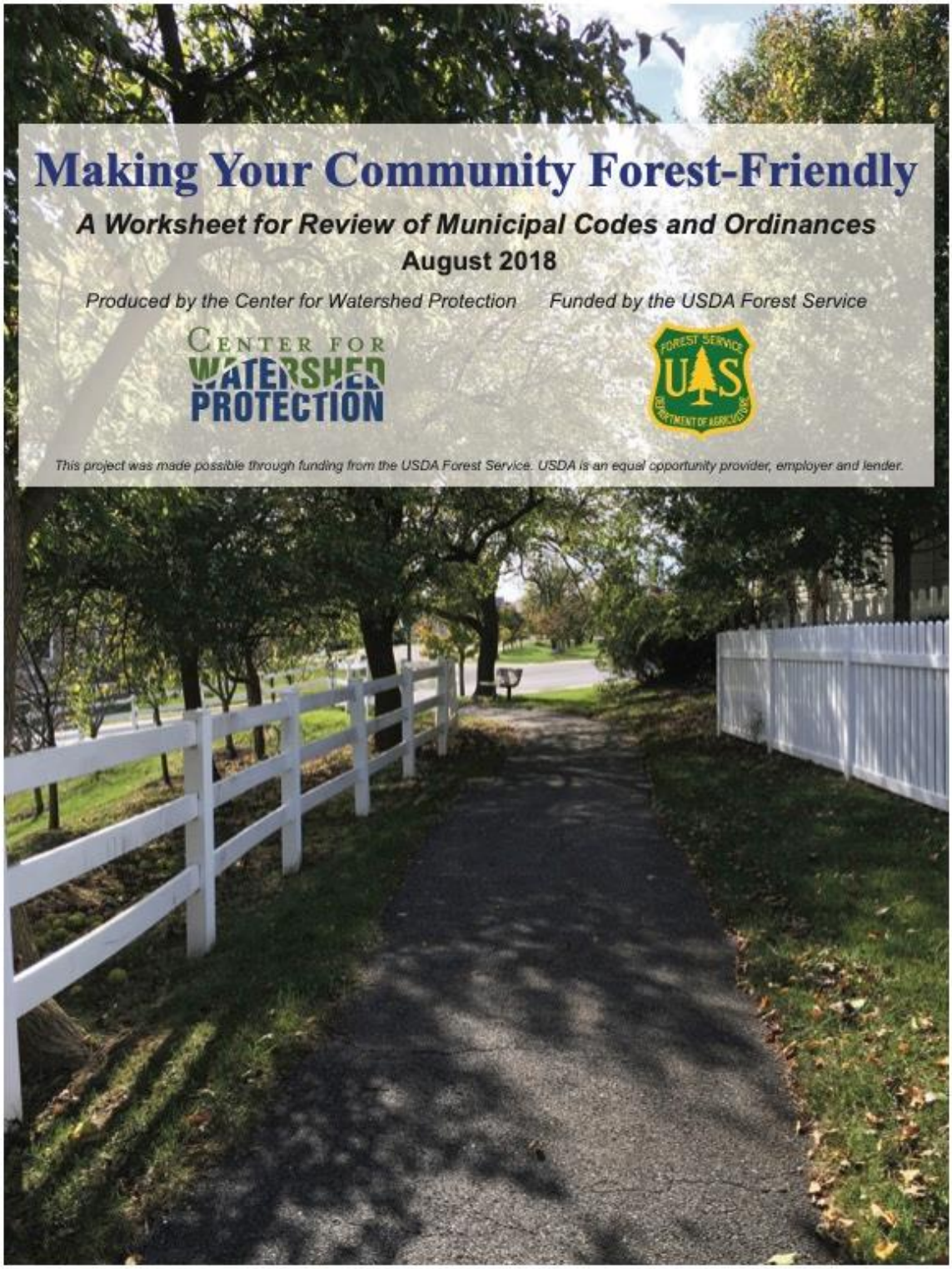
H. Appendix 1 – Advisory Committee

Abigail Pattishall, Wildlands Conservancy
Ann Hutchinson, Natural Lands Trust
Antonia Price, Shippensburg University
Brooks Mountcastle, Appalachian Trail Conservancy
Carla Hahn, National Park Service - Upper Delaware Scenic & Recreational River
Chris Linn, Delaware Valley Regional Planning Commission (DVRPC)
Christina Arlt, Delaware Valley Regional Planning Commission (DVRPC)
Claire Jantz, Shippensburg University
David D. Shields, Brandywine Conservancy
David Peifer, Association of New Jersey Environmental Commissions (ANJEC)
David Steckel, Natural Lands Trust
Diane Rosencrance, Delaware Highlands Conservancy
Don Hamilton, National Park Service - Upper Delaware Scenic & Recreational River
Elliott Ruga, New Jersey Highlands Coalition
Eric Olsen (Delaware Basin), The Nature Conservancy
Heather Jacksy, Sullivan County, NY Division of Planning & Environmental Management
Heather Kerr, Pennsylvania Bureau of Forestry
Jean Marie Hartman, Rutgers University
Jen Adkins or representative , Partnership for the Delaware Estuary
Jennifer M. Coffey, Association of New Jersey Environmental Commissions (ANJEC)
Jeremy K., New Jersey Forest Service
Jim Haas, New Jersey Forest Service
John Cecil, New Jersey Audubon
Jon Klischies, New Jersey Forest Service
Julia Somers, New Jersey Highlands Coalition
Julie Schneider, Center for Watershed Protection (CWP)
Julie Vastine, Alliance for Aquatic Resources Monitoring (ALLARM)
Juniper Leifer, New Jersey Highlands Coalition
Karen Cappiella, Center for Watershed Protection (CWP)
Kate Raman, Natural Lands
Kim Murphy, Berks Nature
Liz Deardorff, American Rivers (PA)
Madeline Emde, Coalition for the Delaware River Watershed (CDRW)
Melissa Andrews, Delaware Valley Regional Planning Commission (DVRPC)
Nissen, John, Pennsylvania Bureau of Forestry
Patty Elkis, Delaware Valley Regional Planning Commission (DVRPC)
Rachel Reyna, Pennsylvania Bureau of Forestry
Rick Tralies, Natural Lands Trust
Scott Haag, Drexel University / Academy of Natural Sciences
Stephanie Dalke, Pinchot Institute
Su Ann Shupp, Pennsylvania Bureau of Forestry
Susan Myerov or other, Pennsylvania Environmental Council
Teddy Spark, Pennsylvania Bureau of Forestry
Will Price, Pinchot Institute
Will Ryan, Academy of Natural Sciences

Appendix 2 – Forest-Friendly Code and Ordinances Worksheet

Included are pages 1 through 4, and 9 to 12 of 37 pages total, which includes 52 questions. The worksheet can be downloaded at https://owl.cwp.org/?mdocs-file=9223.



About the Forest-Friendly Code and Ordinance Worksheet

This worksheet was designed to help communities review and revise their development regulations, so that future projects conserve and protect valuable trees and woodlands and encourage new plantings. It provides a set of questions to help local officials determine whether local codes require, allow, or prohibit "forest-friendly" development practices. These practices were developed with input from subject matter experts including foresters, planners, transportation engineers, homebuilders, and fire administration representatives, to ensure that they maximize tree cover protection without compromising other goals, such as public safety, visibility, access, and economic value.

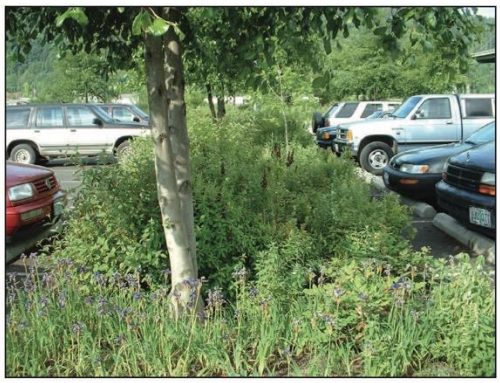
Following community "rules" for development often results in more pavement and fewer trees

Development regulations in many communities today have changed little since the post-WWII-era when mass production of homes was the norm. Using simple, uniform layouts in large tracts—called subdivisions—housing developments resulted in wholesale clearing and grading of forested areas, expansive parking lots, and excessively wide streets in residential areas. These regulations often acted as barriers to conservation of trees during development, even when developers wished to employ innovative or "green" techniques.

For example, local codes often specify minimum street widths that reflect a blanket application of design standards developed for high traffic volume streets. What this means is that even residential neighborhoods with little traffic end up with very wide streets that are designed for a much greater traffic volume. Constructing wider streets requires more clearing, limiting the ability to save existing trees along roadway edges. What green space does remain in the right-of-way is often planted with grass because it is too narrow to support healthy trees.

This assessment worksheet provides a tool to help bring trees and forests back into our neighborhoods

The following codes and ordinances are the most common ones influencing how much tree/forest protection and tree planting happens at a development site. Examples of how these regulations can promote forest-friendly practices are also identified.



Type of Code	Description	Example Forest-Friendly Elements
Zoning	Divides a jurisdiction into different districts, and defines rules for each regarding allowable uses, density, building footprints and height, signage, parking, setbacks, landscaping, and more	Allow "open space design" that does not require special approval; require trees to be part of all landscaping; set parking standards based on local demand; establish minimum width for parking lot islands to support large trees
Forest Conservation or Tree Protection	Requires conservation and protection of some portion of existing forest or trees above a certain size at development sites	Establish conservation thresholds and require planting if existing forest is minimal to none
Subdivision/ Land Development	Defines standards for elements of a subdivision, such as street widths and layout, right-of-way widths, turnarounds, utilities, driveways, sidewalks, and management of open space	Ensure that street and right-of-way widths are the minimum needed; require planting of street trees in a minimum 6 foot wide planting strip; establish a funding source for long term open space management
Riparian Buffer	Requires preservation of the forested riparian zone within a specified distance from the stream	Establish a minimum 100 foot buffer width and identify allowable and prohibited uses
Erosion and Sediment Control or Grading	Define requirements for clearing, grading, and erosion and sediment control	Limit clearing on steep slopes; set maximum area that can be cleared at one time; ensure that limits of disturbance are on plan and clearly marked at site.
Stormwater Management	Define requirements for post-construction management of stormwater runoff	Provide developers "credit" towards meeting stormwater requirements if they conserve existing forest or plant trees

Completing the Forest-Friendly Code and Ordinance Worksheet is the first step in changing what development looks like in your community. If the questionnaire seems overwhelming, you can pick just one section as a place to start, and work your way through the rest at your own pace.

Part 1: Introduction

"Forest-friendly" communities are those that protect trees and forests by:

1. Directing growth away from large, ecologically intact forest land using zoning, land use planning and Smart Growth techniques
2. Permanently protecting valuable forest land (e.g., riparian corridors) through purchase of land and conservation easements
3. Limiting overall forest loss during development through local regulations that:
    a. Limit clearing of trees and forests
    b. Require forest conservation
    c. Require forested stream buffers
    d. Promote open space development
    e. Protect trees during construction
    f. Provide stormwater credits for planting and tree conservation
    g. Require tree planting as part of landscaping requirements
    h. Require tree planting on Brownfield sites, agricultural land and vacant sites where old structures have been removed
4. Developing programs for community reforestation of public lands, providing incentives for planting trees on private property, and establishing municipal tree programs that support the long-term maintenance of the urban forest.
5. Promoting sustainable forest harvesting activities and management on working forest lands

Figure 1: Land use planning and zoning in Baltimore County help to direct growth away from important forest lands such as those surrounding the County's water supply reservoirs.

Part 2: Forest-Friendly Code and Ordinance Worksheet

About the Forest-Friendly Code and Ordinance Worksheet

This worksheet is intended to help communities evaluate their local development regulations to identify revisions that will better promote protection and management of trees and forests as well as tree planting. It can inventory regulations that directly protect forests (such as forest conservation or stream buffer requirements) as well as ones that indirectly protect forests (by limiting development on steep slopes or promoting open space design). It can also identify potential barriers to forest conservation and tree planting that are often buried within local codes and ordinances related to land development. These barriers may not prohibit trees outright, but can still act as disincentives to tree conservation or planting, or otherwise affect tree health. For example, many communities' street and sidewalk design standards specify a four-foot-wide planting strip in between the street and sidewalk. When large street trees are planted in this small space, their health is compromised because they receive only a fraction of the soil volume needed to support healthy tree growth.

The worksheet can be completed by municipal staff who have a vested interest in protecting and increasing the urban forest (e.g., watershed or environmental planning staff, urban foresters, local tree boards) or by non-governmental organizations who wish to make their community more forest-friendly by working in concert with municipal officials who have the authority to make these regulatory changes. It is a tool that can be used by communities of all types (e.g., urban, suburban, rural) although not all questions will be relevant everywhere. The questions evaluate what is "on the books" and are not intended to assess how the current programs and regulations are implemented and enforced.

The Forest-Friendly Code and Ordinance Worksheet was originally created in 2006 by the Center for Watershed Protection through a grant from the USDA Forest Service. Updates were made based upon recent revisions to the Center for Watershed Protection's more comprehensive Code and Ordinance Worksheet (CWP, 2017), a tool to help communities evaluate and improve their local development regulations so they reduce impervious cover, conserve natural areas, and reduce stormwater pollution. Since its creation, the Code and Ordinance Worksheet has been used by the Center to conduct 13 local site planning roundtables and review local development regulations in over 75 communities in Maryland, Pennsylvania, Virginia, South Carolina, Ohio, Wisconsin, New York, Alabama, and the District of Columbia. Other organizations, such as the Cumberland River Compact, Southeast Watershed Forum, Pennsylvania Environmental Council, Potomac Conservancy, James River Association, and Tennessee Valley Authority have used the Better Site Design process to make updates to their local codes or to conduct their own roundtables. Additional changes were made based on input from the following reviewers:

- Danielle Fitzko, Vermont Department of Forests, Parks and Recreation
- Donna Marie Foster, USDA Forest Service, Northeastern Area State and Private Forestry
- Marian Honeczy, Maryland Forest Service, Department of Natural Resources
- Julie Mawhorter, USDA Forest Service, Northeastern Area State and Private Forestry
- Phillip Rodbell, USDA Forest Service, Northeastern Area State and Private Forestry

How to Complete the Forest-Friendly Code and Ordinance Worksheet

The worksheet includes a series of questions related to local land use and development regulations. The first step is to identify and gather the relevant codes, ordinances and program documents or website links. A list of potential documents to gather includes:

- Subdivision and Land Development Ordinance
- Zoning Ordinance
- Stormwater Management or Drainage Ordinance
- Buffer or Floodplain Regulations
- Wetland Protection Ordinance
- Tree Protection or Landscaping Ordinance
- Erosion and Sediment Control Ordinances
- Grading Ordinance
- Natural Resources Protection Regulations
- Street and Sidewalk Standards
- Parking Lot Design Standards
- Stormwater Best Management Practice (BMP) Design Manual

Few communities include all of their development rules in a single document. Rather, the development process is usually shaped by a mix of local regulations and policies, each of which may be administered by a different agency. In some cases, state and federal agencies may also exercise some authority over the local development process (e.g., wetlands, floodplain management). Where this is the case, the local code will reference these state or federal standards. The codes, ordinances, and other related documents you compile will be used to answer the review questions.

The worksheet is presented in the next section of this document and includes 52 questions organized around nine topic areas. Each question focuses on a specific forest protection or tree planting practice, aka "forest-friendly" practice. For each question, there are four possible answers:

Answer	Description
YES	The forest-friendly practice is required or allowed
NO	The forest-friendly practice is prohibited
CODES ARE SILENT	The regulations do not address the forest-friendly practice at all
N/A	The forest-friendly practice is not applicable in my community

For each question, check off the appropriate answer box. Use the Notes section to record details about your responses, such as specific code language, program details, or a reference to the specific document where the answer was found. The worksheet also includes a space on page 31 to list all the codes and ordinances reviewed (including date of publication, author and other relevant information) and to identify short and long term action items resulting from the review.

Once you have completed the Forest-Friendly Code and Ordinance Worksheet, go back and review your responses. For questions with "No" or "Codes are Silent" answers, you can use the worksheet on page 32 to identify short-term (1-3 years) and long-term (3-5 years) action items. Questions with "Yes" responses can also result in action items to improve forest protection. For example, a municipality may wish to revise their zoning ordinance to require open space design in certain zoning districts rather than simply offering it as one allowable option.

If there are many "No" or "Codes are Silent" responses, you may need to evaluate the relative importance of these practices in your community to help prioritize your action items. Some factors to consider in determining relative importance and whether actions are short or long term include:

- Time the revisions with planned updates to codes and ordinances
- Focus on the code changes that are under municipal control (as opposed to state or federal regulation)
- Focus on codes that give you the most bang for your buck (for example, updating a single ordinance may address the majority of changes or the type of development that is most common in your community)
- Target specific areas that need the most improvement first
- Focus on changes that help to meet other community goals or mandates
- Consider local support/local importance of specific programs
- Prioritize changes that remove direct barriers to forest protection
- Consider relative ease of proposed changes (e.g., adopting a stream buffer ordinance may be a longer road than changing parking lot design standards)

The ultimate goal of the Forest-Friendly Code and Ordinance Worksheet is to make changes to programs and regulations that result in increased forest cover in the community. Municipal staff may wish to proceed with the changes through their usual process of ordinance updates. Another option for regulatory changes is a site planning roundtable process conducted at the local government level. The roundtables are a consensus-based process initiated to create more environmentally sensitive, economically viable and locally appropriate development, and they involve a diverse mix of stakeholders from environmental groups, transportation officials, planners, realtors, homebuilders, land trusts, fire officials, county managers and more. The primary tasks of a local roundtable are to systematically review existing development rules and then determine if changes can or should be made. By providing a much-needed framework for overcoming barriers to better development, the site planning roundtable can serve as an important tool for local change. The *Better Site Design Handbook* (CWP, 1998) provides detailed information on how to conduct a site planning roundtable.

Forest-Friendly Code and Ordinance Worksheet

1. Planning and Zoning

Question 1	Yes	No	Codes are Silent	N/A
Is there a natural resources protection zone or an overlay zone that includes important forest resources, such as high-quality forest stands, forested stream buffers, forests on steep slopes, or headwater forests?				
Notes:				

Forests can be protected using either natural resources protection zones or overlay zoning. Natural resources protection zones map out the areas to be protected and outline permitted and prohibited uses within these zones. To protect specific types of forest resources, such as forested stream buffers or forests on steep slopes, an overlay zone may be more desirable than natural resources protection zoning. With an overlay zone, additional standards, such as protection of a 50-foot wide stream buffer, are superimposed on existing zoning provisions. Because the overlay zone 'floats' over existing zoning, a map of the specific areas to be protected is not required.

Question 2	Yes	No	Codes are Silent	N/A
Do zoning requirements for natural resources protection/overlay zones outline prohibited uses that negatively impact forests and permitted uses that have the least impact on forest resources?				
Notes:				

Generally, only low intensity uses (e.g., passive recreation) are allowed within natural resources protection zones or within protected portions of overlay zones to provide the maximum protection for natural resources.

2. Natural Resources Protection Regulations

Question 3	Yes	No	Codes are Silent	N/A
Is a natural resources inventory required that identifies and maps natural areas?				
Notes:				

Ideally, the regulation will require that significant natural areas, such as high-quality forest stands, rare, threatened and endangered species, wildlife habitat and travel corridors, groundwater recharge areas, and headwaters, be identified.

Question 4	Yes	No	Codes are Silent	N/A
Is there an ordinance that requires conservation of some portion of trees or forests at development sites?				
Notes:				

The most effective ordinances will identify specific conservation thresholds.

Question 5	Yes	No	Codes are Silent	N/A
If forest/tree conservation is required, does the ordinance specify planting new trees at sites where existing forest is minimal to none?				
Notes:				

Question 6	Yes	No	Codes are Silent	N/A
Does a floodplain management ordinance exist that restricts or prohibits development within the 100-year floodplain?				
Notes:				

In many areas of the US, both the magnitude and frequency of large storm events has been increasing. Local floodplain maps may need to be updated to reflect these changing climate conditions and more effectively protect from flood-related damages.

Question 7	Yes	No	Codes are Silent	N/A
Is there a local wetland protection ordinance?				
Notes:				

Strommen et al. (2007) provides guidance on local wetland ordinances.

3. Buffers

Question 8	Yes	No	Codes are Silent	N/A
Do the subdivision/land development standards in the community require a vegetated buffer along waterways?				
Notes:				

Question 9	Yes	No	Codes are Silent	N/A
Is the definition of waterway, or the regulated buffer, expansive enough to include:				
Perennial streams,				
Ephemeral and intermittent streams,				
Lakes,				
Estuaries and shorelines,				
Wetlands,				
Vernal ponds				
Notes:				

Many buffer ordinances apply only to perennial or mapped "blue-line" streams, and some buffer ordinance cover a variety of water resource types. Buffers are important for all stream types and waterbodies. Waterway definitions that include all of the aforementioned water bodies are preferable.

Question 10	Yes	No	Codes are Silent	N/A
Is the minimum buffer width 50 feet or more?				
Notes:				

Recommended buffer widths vary depending on the type of resource and desired benefit. It may also be desirable to have flexible buffer widths to account for things like existing structures (reduce the width to accommodate) and sensitive natural resources (expand the width to protect). Minimum recommended buffer widths (per side) range from 50-100 feet for streams (>100 feet preferred), and 100-350 feet for wetlands.

Appendix 3 – List of Municipal Stormwater Reports (link)

http://landarch.rutgers.edu/stormwater-reports/