The Benefits of Green Infrastructure

Why Delaware County Needs More Parks, Open Spaces, Trails, Street Trees, & Natural Areas

Final Report for the DMMPC
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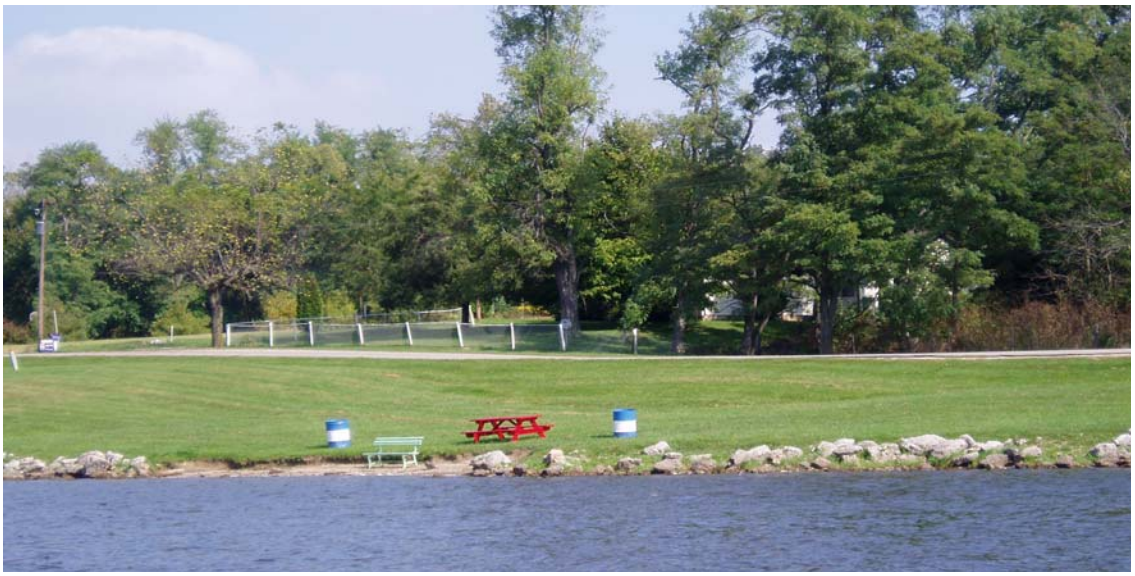
TABLE OF CONTENTS



LIST OF TABLES AND FIGURES

EXECUTIVE SUMMARY

Land is being developed today faster than ever. As cities grow they need to plan for the expansion of built infrastructure like roads and sewers as well as green infrastructure like open spaces, trails, and wetlands. City parks, trails, open spaces, urban forests, and greenways make neighborhoods more attractive places to live, strengthen community pride, offer natural environmental protection, and improve physical health and mental wellbeing.

Despite the aesthetic, environmental, and recreational benefits of green infrastructure, budget constraints have left local governments across the United States with inadequate funding and staff for maintaining and preserving city parks and open spaces. In addition, haphazard development patterns threaten the nation's existing green infrastructure and associated ecological, recreational, and social benefits. Fortunately, a growing body of hard evidence suggests that urban greening offers significant economic benefits, in addition to the quality-of-life enhancements already mentioned.

Indicators to determine the sufficiency of green infrastructure, such as street trees or park acreage per capita, suggest that some elements of Muncie's and Delaware County's green infrastructure system are inadequate for its population. For example, Muncie's urban forest ratio of street trees per capita is 0.2—approximately 1 tree for every 5 people—which is well below the mean ratio of 0.37 reported for 22 U.S. cities. Some of the city's parks do not meet the National Recreation and Park Association's level of service standards. In addition, Delaware County's wetlands consist of approximately 3,656 acres—a decrease of approximately 2,000 acres since the 1980s.

Green infrastructure presents a framework that can be used to guide future growth, future land development, and future land conservation decisions to accommodate population growth and protect community assets and natural resources. This framework helps communities identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature. By creating a *Map of Potential Conservation Lands*, local officials can identify areas that are the most important to protect from development where two or more critical conservation areas overlap.

Numerous studies have shown that passive parks and trails increase the value of neighboring residential property, and there is growing evidence that points to similar benefits on commercial property values. In addition, the positive effect of natural open space, wooded areas, and trails on property values can result in higher assessments and thus property tax revenues for local governments. When greenway corridors are preserved instead of intensively developed, municipalities may reduce costs for public services like sanitary sewers, roads, fire and police protection, and school facilities.

The availability of parks and trails is an important quality of life factor for corporations and other businesses choosing where to locate facilities and for retirees and new homebuyers choosing a place to live. A study conducted by the National Association of Homebuilders found that a majority of home shoppers surveyed felt that parks would seriously influence them to move to a community. Other green infrastructure components like green roofs provide additional economic benefits for developers and homeowners by reducing energy heating and cooling costs, increasing the lifetime of the roof, and providing a cheaper way to meet stormwater requirements.

A study of the Cardinal Greenway in Muncie, Indiana conducted by the Eppley Institute in 2001 provides useful information for local decision makers when examining the costs and benefits of urban trails. Most trail users in Muncie are from upper-middle class income households, Caucasian, college educated, between 26 and 55 years old, and use the trail primarily for health and fitness. Over 77% of

Cardinal Greenway trail users are satisfied with the trail, and their view of Muncie as a community is positively affected by the trail. The most common problems reported by trail neighbors were illegal vehicle use, littering, and unleashed pets.

In light of the abovementioned benefits, green infrastructure is a good financial investment for Muncie and Delaware County. This report inventories Muncie and Delaware County's existing green infrastructure system to analyze the system's adequacy to meet the needs of its population using available indicators found in the literature; provides a *Map of Potential Conservation Lands for Delaware County* to identify and prioritize areas that should be protected from development; and finally, examines the benefits of green infrastructure, with special emphasis on the economic benefits.

INTRODUCTION

Green infrastructure is a term that is emerging more frequently in land conservation and development discussions throughout the nation and world. Green infrastructure means different things to different people depending on the context to which it is used. For the purposes of this document, green infrastructure is the network of open space, woodlands, wetlands, parks, trails, greenways, and other natural areas that sustains clean air, water, and natural resources and enriches our quality of life. As communities grow, they need to upgrade and expand their built infrastructure such as roads and sewers as well as their green infrastructure. The concept of green infrastructure repositions open space protection from a community amenity to a community necessity (Benedict and McMahon 2001).

Green infrastructure differs from conventional land conservation and natural resources protection approaches because it looks at conservation in cooperation with land development and built infrastructure planning. Other conservation methods typically are undertaken in separation or in opposition to development. Green infrastructure provides a framework for conservation and development that acknowledges the need for providing places for people to live, work, shop, and enjoy nature.

Green infrastructure in the city is valued for its relief from traffic and noise, opportunities for exercise and recreation, and aesthetic views for the walk or ride home. It also helps create a sense of community pride, particularly in instances where residents provide hands-on care. On a broader scale, green infrastructure filters the air and water, absorbs storm runoff, provides shade, moderates temperatures, and can even reduce violence and crime.

Yet there are pressures to justify the costs of preserving and maintaining green infrastructure with many municipal budgets stretched thin; especially when the costs are compared to the revenue generated by new commercial or residential development. Opportunely a growing body of hard evidence suggests that urban greening offers significant economic benefits, in addition to the quality-of-life enhancements already mentioned.

WHY DO WE NEED TO PLAN AND PROTECT GREEN INFRASTRUCTURE?

Land is being developed faster today than ever before at a rate that exceeds population growth creating challenges in our cities across the nation (Benedict and McMahon 2006). For example, from 1982 to 1997, the nation experienced a 47% increase in urbanized land, while the population only grew 17% (Benedict and McMahon 2006). This trend holds true in Muncie as well. According to the Muncie-Delaware County Comprehensive Plan, the amount of urbanized land area doubled from 1960 to 1995; however, the population in 1995

was about the same as it was in 1960. In other words, Muncie has increased its size of urban land to accommodate for the same amount of people—not an increased population.

Haphazard growth has leapfrogged beyond cities and older suburbs into many rural areas creating urban sprawl. Sprawl creates traffic jams, reduces opportunities for hunting, fishing, and other forms of outdoor recreation, and is an expensive land use pattern for governments to build and maintain (Benedict and McMahon 2006). Even more devastating effects of urban sprawl include fragmented wildlife habitats, endangered viability of forests and farms, polluted air, and threatened water supplies (Benedict and McMahon 2006). Consequences of fragmented and haphazard development patterns include:

- *Loss of natural areas*—For example, about 25,000 acres of wetlands continue to be lost each year due to urban sprawl (Benedict and McMahon 2001). As natural areas diminish so does habitat diversity resulting in a decline of species and fewer individuals of those species.

- *Degradation of water resources*—Developing in wetlands and riparian zones reduces their ability to control floods, trap sediments, filter out toxins and excess nutrients, and support wildlife and plant species (Benedict and McMahon 2001).

- *Fragmentation of natural spaces*—As land is converted, it is fragmented into smaller and more isolated patches which greatly alters the way in which natural systems function (Benedict and McMahon 2001). Fragmentation increases edge habitat, isolation between patches, and plant and animal species diversity.

In addition to these ecological effects, there are also social and economic consequences of haphazard development and associated loss of open space. These include:

- *Loss of "free" natural services*—Natural systems provide important services like flood control, stormwater management, and filtration of pollutants. The loss of these natural systems increases the risks of flooding and other natural disasters costing communities billions of dollars in mitigation efforts and disaster relief (Benedict and McMahon 2001).

- *Increased costs of public services*—Haphazard development often increases public services by requiring new roads, sewers, schools, and other public infrastructure. The inefficient use of land and other resources requires municipalities to provide services for a larger geographic area. Since buildings are spread further apart, sprawl stretches municipal services resulting in higher taxes. In addition, the loss of farmland affects a community's bottom line (Benedict and McMahon 2001).

A city, county, or state would not build a road, water, or electrical system piece by piece, without any advanced planning and coordination between different system components and jurisdictions. These built infrastructure systems are planned, designed, and invested in far in advance of their actual use. The same should hold true for green infrastructure systems. Incorporating green infrastructure into planning efforts offers a better solution to land conservation challenges because it seeks to plan land development and land conservation together in a way that is consistent with natural environmental patterns.

INVENTORY OF MUNCIE AND DELAWARE COUNTY'S GREEN INFRASTRUCTURE SYSTEM

Using the available data from the Delaware County Geographic Information System (GIS) Office, a basic inventory was conducted to determine the extent of green infrastructure in Delaware County. It should be noted that, in some cases, the data has not been periodically updated or completed. Therefore, this inventory serves as an approximation of the coverage of Muncie's and Delaware County's green infrastructure system for planning purposes.

Urban Forest

It is not only large rural forests that provide ecological benefits to communities. Research during the past 20 years has shown that city trees are far more than ornamental and decorative. Creating landscapes with trees reduces fire danger, water use, and stormwater runoff; improves air quality; conserves energy; increases property values; and reconnects residents with their local environment (Center for Urban Forest Research 2004).

Trees Per Capita

Trees that grow in cities and towns are called the "urban forest." Based on a tree inventory conducted by the Muncie Urban Forestry Board in 1999 and 2000, Muncie's urban forest contains approximately 19,500 actively managed trees: about 11,300 located throughout Center Township and 8,200 located on the Ball State University (BSU) campus (See Figure 1). Calculations of street trees per capita are important in determining how well-forested a city is. Assuming a city household population of 56,843 (American Community Survey 2005), Muncie's ratio of street trees per capita is 0.2—approximately 1 tree for every 5 people. This is well below the mean ratio of 0.37 reported for 22 U.S. cities in 1989 (McPherson and Rowntree 1989). Assuming a student population of 20,351 (BSU 2005 enrollment), BSU's ratio of street trees per capita is 0.4—approximately 1 tree for every 2.5 students—which is consistent with the mean ratio.

Tree Health and Condition

For the City of Muncie, trees are generally in good health (about 72% in good or excellent condition) with approximately 2% in need of removal and 8% needing pruning. Problems including conflicts with power lines, obstruction of signs, visible pests, and sidewalk damage are few (10%). Muncie's urban forest is very diverse with over 100 different kinds of trees. Yellow Poplar, Willow, White Willow, White Spruce, White Poplar, and White Oak represent the majority of trees.

On Ball State University's campus, trees are in excellent health (96% in good or excellent condition) with only 0.5% in need of removal. Trees pose no significant problems with only about 3% causing conflicts with power lines, sidewalk damage, or obstruction of signs. BSU also has a diverse range of trees with over 180 different kinds of trees. The most frequent tree types appearing on BSU's campus include White Pine, Apple, and Green Ash.

Tree Age Structure

The age structure of Muncie's and BSU's street trees differs from the ideal because they have more young and maturing trees and fewer mature trees. However, as these maturing trees age, the benefits they produce will increase. Mature trees were considered to have trunk diameters (DBH) greater than 18 inches, while younger, still maturing trees have DBHs less than 18 inches. Eighty-eight percent of Muncie's street trees are young or maturing, and 98% of BSU's street trees are young and maturing.

For many tree species, the DBH is correlated to the diameter of its crown. In other words, larger, more mature trees have a larger canopy that covers a larger surface area. This is important because a larger tree canopy will provide more shade, absorb more carbon dioxide, and soak up more stormwater. Assuming a 4-foot wide crown diameter for the city's and university's still maturing street trees, about 3.4% of the city's surface area is covered by the trees' canopies.

Urban forests are a significant and increasingly valuable asset of the urban environment. Many studies have measured the significant returns that trees provide for people in cities. For example a 25-foot tree reduces annual heating and cooling costs of a typical residence by 8% to 12%, producing an average $10 savings per American household (Wolf 1998). The American Forestry Association estimates that a 50-year old urban tree saves about $75 a year in air conditioning, $75 a year in stormwater and soil erosion control, $75 a year in wildlife shelter, and $50 a year in air pollution control (Benedict and McMahon 2006). Yet a complete assessment of both benefits and costs is challenging without collecting detailed data city-wide. Nonetheless, a full understanding of this information is valuable if decision makers wish to make cost-effective policy and budget decisions. Investments in the planting and care of trees represent long term commitments of scarce dollars. Adequate resources for both planning and management of urban trees are necessary if Muncie wishes to optimize the values and benefits of its urban forest.

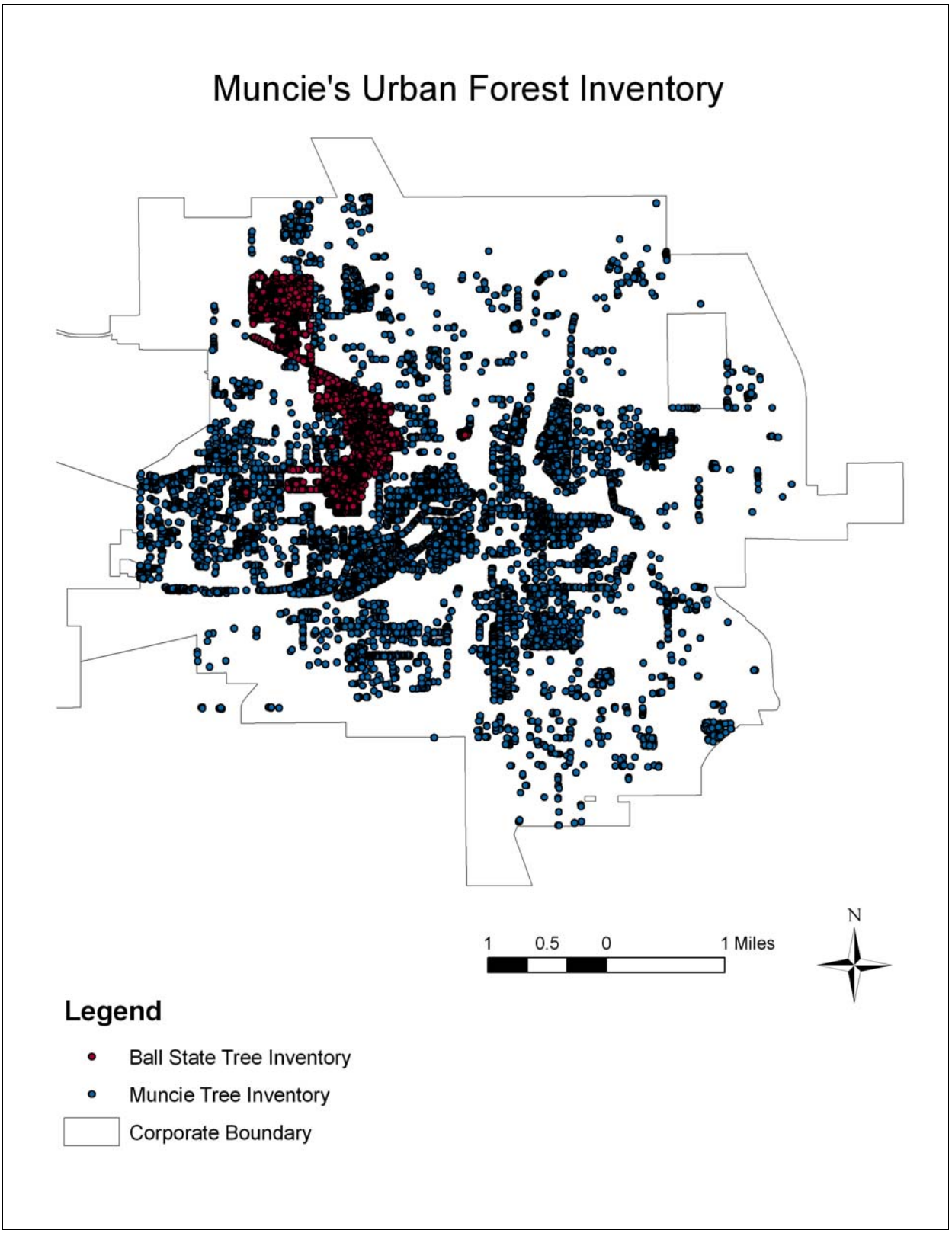


Figure 1: Map showing Muncie's urban forest. Combined, Muncie's and BSU's street tree canopy covers about 3.4% of the City.

Wetlands

Attitudes toward wetlands have changed significantly over the past several decades. Previously regarded as nuisances, wetlands are increasingly valued today for the numerous ecological services and amenities they provide. Nonetheless, extensive conversion of wetlands to other uses has occurred as settlement expands across the nation, and wetlands continue to be under development pressure in many areas (Leschine et al 1997).

Wetlands provide Delaware County with many vital physical, ecological, and economic functions and benefits that are listed below.

- *Flood Control*: During heavy rains, wetlands store massive amounts of water and slow down the flow of surface water. This function reduces the danger of flooding during peak water flow (INDNR 1996)

- *Water Quality*: Wetlands play a major role in maintaining the county's water quality. Wetlands absorb excess nutrients such as farm fertilizers and septic system runoff, filter sediments like eroded soil particles, and trap pollutants such as pesticides and some heavy metals (INDNR 1996).

- *Groundwater Discharge and Recharge*: Wetlands are sites of groundwater discharge (i.e., where groundwater moves upward to reach the surface). The reverse is also thought to be true—that wetlands recharge the aquifers and groundwater systems that provide the drinking water many of us get from our faucets (INDNR 1996).

- *Fisheries*: Wetlands support Indiana fisheries by providing habitat and a variety of food sources for fish. Most freshwater fish can be considered wetland dependent because they use the wetlands for spawning and as nursery grounds (INDNR 1996).

- *Wildlife Habitat*: About 900 species of vertebrate animals require wetlands at some time in their lives. Muskrats and beavers are examples of Indiana mammals that are totally dependent on wetland environments. Wetlands provide the principal habitat for virtually all species of waterfowl nationwide, and also for many other birds, mammals, and reptiles. In Indiana, 11 species of waterfowl use wetlands for nesting, and 28 species use wetlands as migration and wintering habitat (INDNR 1996).

- *Erosion Control:* Wetland systems help stabilize shorelines and prevent soil erosion. The roots of wetland plants bind the soil, holding it in place, while the above-ground portions of these plants absorb wave energy, slowing the water's flow. Wetlands with emergent plants (such as cattails) can remove up to 95% of the sediments from flood waters (INDNR 1996).

The term wetland loss refers to the loss of a wetland's functions and benefits. The land itself is not gone, and in fact the wetland nature of the land may still remain, but the functions and benefits are lost—at least temporarily. Among the 50 states, Indiana ranks 4th (tied with Missouri) in proportion of wetland acreage lost. (Dahl 1990). The vast majority of the 85% of wetlands lost was due to drainage for agricultural production. According to the National Wetland Inventory, Delaware County had 5,657 acres of wetlands in the 1980s. The majority – 3,709 acres – were forested wetlands. Currently, there are approximately 3,656 acres of wetlands scattered throughout Delaware County, a decrease of about 2,000 acres since the 1980s (See Figure 2).

Delaware County's wetlands are included in the White River basin which spans nearly the entire width of south-central Indiana and encompasses about 5,603 square miles. According to the Indiana Wetlands Conservation Plan (IWCP), special concerns for water quality and flood control in the watershed include:

- Urban areas (Anderson, Bloomington, Muncie, Indianapolis, Hamilton County)
- Agricultural (livestock, crops)
- Rural septic systems

Putting an economic value on something as abstract as the ecological services of wetlands is difficult. In the case of wetlands, there is no direct market for services such as clean water, maintenance of biodiversity, and flood control (Environment Canada 2001). There is, however, a growing recognition that such natural benefits do have real economic value and that these values need to be included in decision making processes.

Economic valuation of natural wetland services such as flood control can reinforce the argument for protecting wetlands in order to strengthen a community's green infrastructure system. Unfortunately estimates made of the value of wetlands and other environmental services vary widely, and there is often no clear consensus among economists on the best way to value a particular service. Leschine and colleagues' 1997 report *The Economic Value of Wetlands: Wetlands' Role in Flood Protection in Western Washington* tries to estimate the economic functions of wetlands in 1996 dollars. Using the Consumer Price Index (CPI), these values were converted from 1996 dollars to 2006 dollars (see Table 1). According to Leschine's study, one acre of wetlands is valued at a minimum of $371 per year for storm or flood control. So the 2,000 acres of wetlands that have been lost in Delaware County since the 1980s have a minimum value of approximately $742,000 per year for storm and flood control. Seven hundred thousand dollars per year is a significant amount of money that could have been used for other improvements in Delaware County if the county's wetlands were conserved and used for their natural stormwater management services.

Table 1. Estimates of Wetland Function Values From Various Published Studies.

Wetland Function	Value $/acre/year
Commercial Factors	
• Fish and Shellfish Habitat	62[a]
• Waterfowl Habitat	325[b]
• Mammal and Reptile Habitat	23[c]
• Water Supply	10,520[d]; 31,500[e]
Damage Prevention Factors	
• Erosion, Wind, and Wave Barriers	0.86[f]
• Storm or Flood Control	371[g]; 11,011[h]
Recreational Opportunities	
• Consumptive and Non-Consumptive Uses	11.6[i]; 49[j]; 147[a]; 146[k]; 15[l]

[a] Bell, 1989- Factor Income
[b] Gupta and Foster, 1975- Revealed Preference of Resource Managers (land acquisition decisions)
[c] Farber and Constanza, 1987- Factor Income
[d] Gupta and Foster, 1975- Replacement Cost
[e] Thibodeau and Ostro, 1981- Replacement Cost
[f] Farber, 1987- Damage Cost Avoided
[g] Gupta and Foster, 1975- Damage Cost Avoided
[h] Thibodeau and Ostro, 1981- Damage Cost Avoided
[i] Farber and Constanza, 1987- Travel Cost
[j] Thibodeau and Ostro, 1981- User Day Values
[k] Farber and Constanza, 1987- Contingent Valuation
[l] Bergstrom, Stoll, Titre, and Wright, 1990- Contingent Valuation

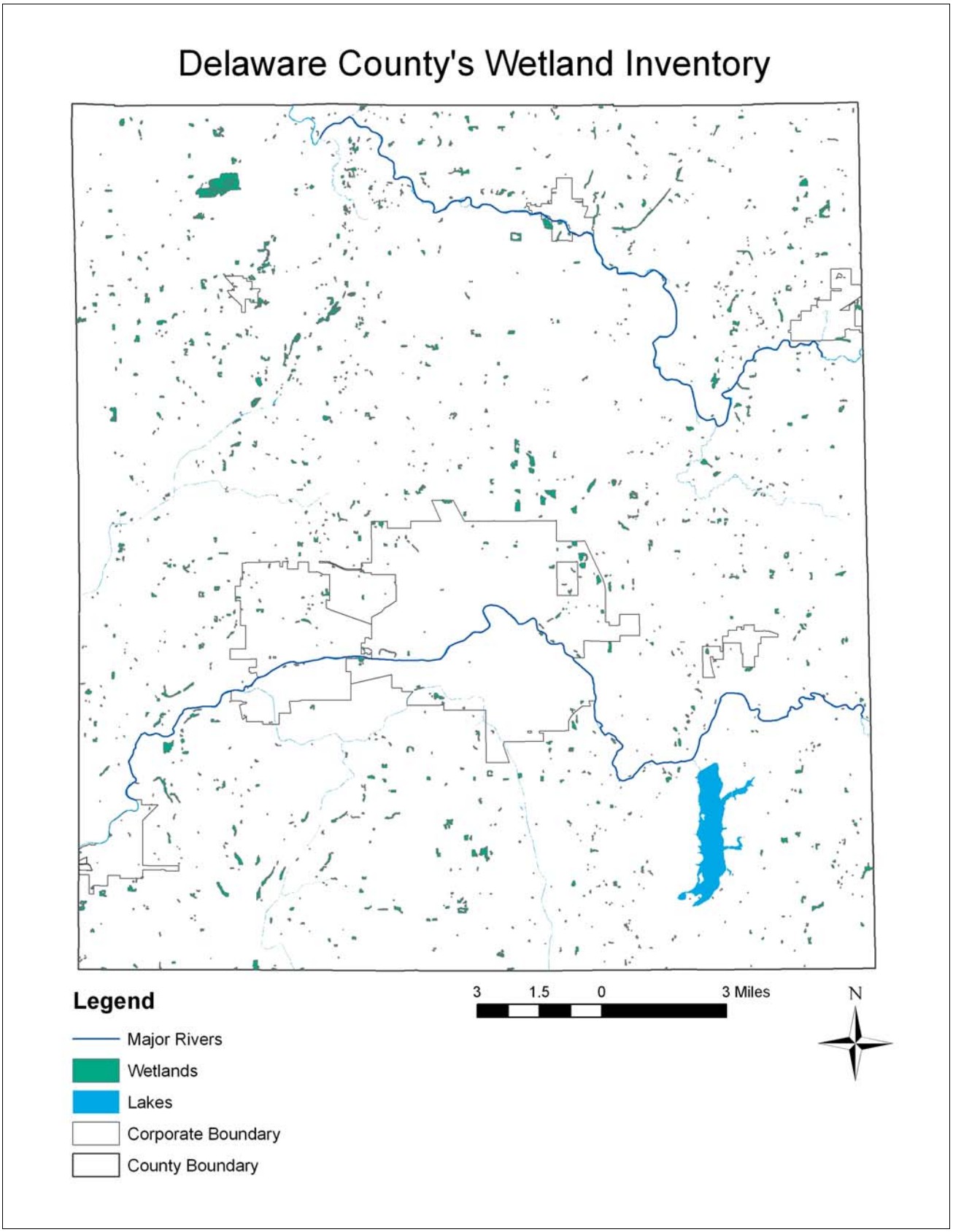


Figure 2: Map showing Delaware County's wetlands.

Trails/Greenways

Trails and greenways offer many benefits including recreation, commerce and job creation, retail and property value appreciation, traffic congestion relief, enjoyment of nature, and improvement of mental and physical wellbeing. These benefits will be discussed in more detail later in the document.

The Cardinal Greenway in East Central Indiana, formerly a section of the CSX railway line, is part of the 6,356-mile American Discovery Trail system. It is the longest rails-to-trails project in Indiana. The first leg of the rail-trail between Muncie and the Prairie Creek Reservoir opened in 1998 using federal transportation funds for design and construction. Since that first ground breaking ceremony, the trail has been extended from the Wysor Street Depot to the Town of Gaston north of Muncie. This provides the trail user with about 28 miles of completed Cardinal Greenway in Delaware County.

Other trails and greenways in Delaware County include: The White River Greenway, a 2.8 mile long paved trail that follows the White River as it winds through Muncie; and The Cardinal Greenway Equestrian Trail, a 2 mile long horseback riding trail that connects with the horse trails at Prairie Creek Reservoir. There are approximately 4 miles of horse trails located along the west side of the Prairie Creek Reservoir. In total there are approximately 37 miles of trails and greenways in Delaware County and surrounding Henry and Randolph Counties (See Figure 3). No indicators could be found in the literature to determine if the number and mileage of Delaware County's trails and greenways are adequate to meet the needs of its population.

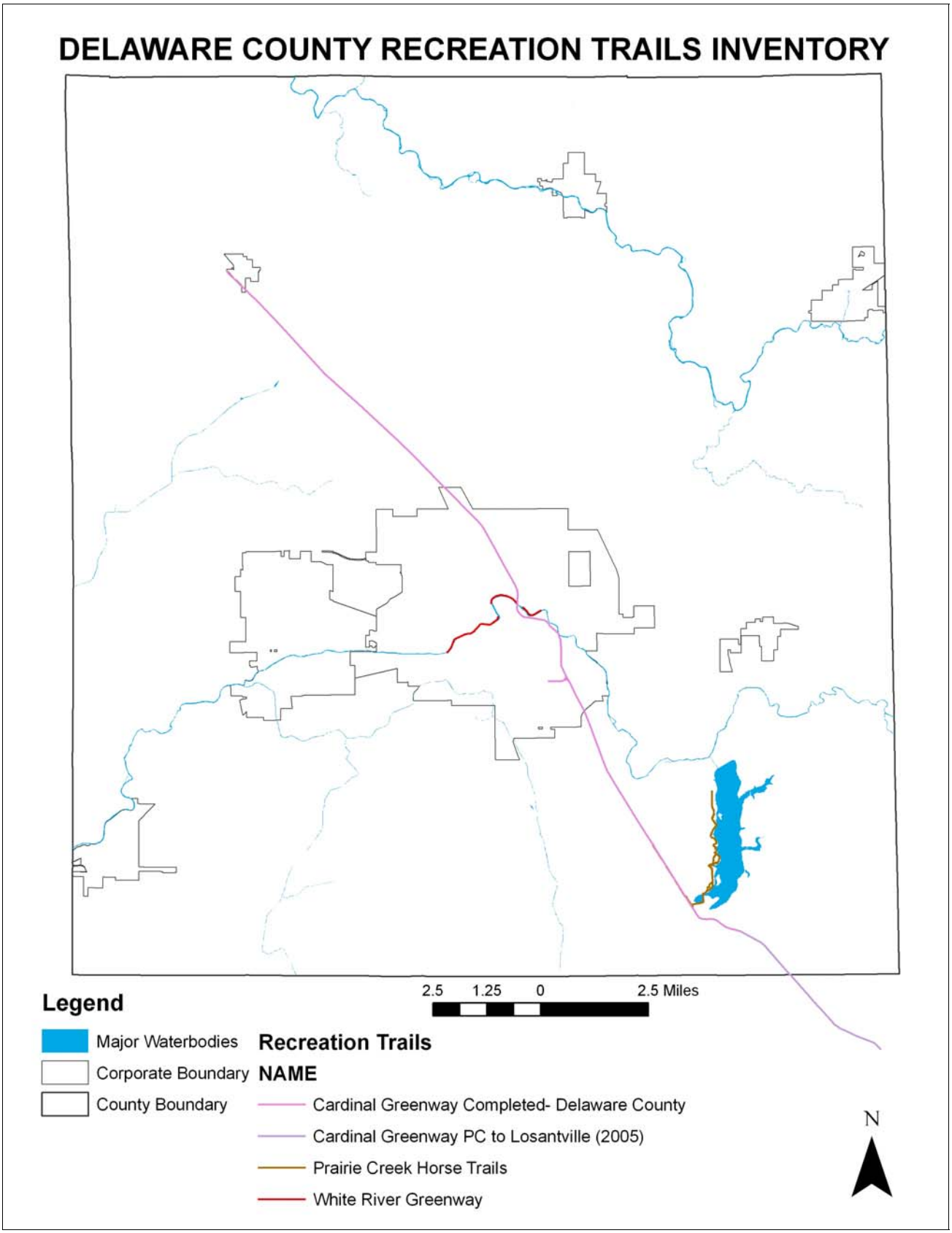


Figure 3: Location of trails and greenways in Delaware County

Wooded Areas

Although urban areas are covered with street and other shade trees, existing wooded areas are being fragmented and lost at rapid rates. This is the result of inefficient land use practices for urban development and a lack of implementation of reasonable reforestation efforts (MN DNR 2000). Wooded areas have unique compositions, structures, and functions. They provide a wide range of economic, social, and environmental benefits.

Economic benefits of wooded areas include increased property values and marketability, generation of higher property and sales tax revenue by increasing appraisal and sale price, and energy savings (MNDNR 2000). The social benefits of trees include health benefits, aesthetic values, recreational and educational opportunities, and screening and privacy (MNDNR 2000). Wooded areas and trees provide a number of environmental benefits such as clean air, clean water, and wildlife habitat (MNDNR 2000). To conserve wooded areas, local and regional units of government including decision makers, planners, and community members should work together as partners and recognize wooded areas as community assets and implement conservation options.

Delaware County has approximately 27,700 acres (about 11% of the county) of wooded areas. The majority of the wooded areas are located along the major waterways and smaller creeks: 1) the southern part of the county along Bell Creek and the White River; 2) the southeastern part of the county near the Prairie Creek Reservoir; and 3) the northeastern part of the county along the Mississinewa River (See Figure 4).

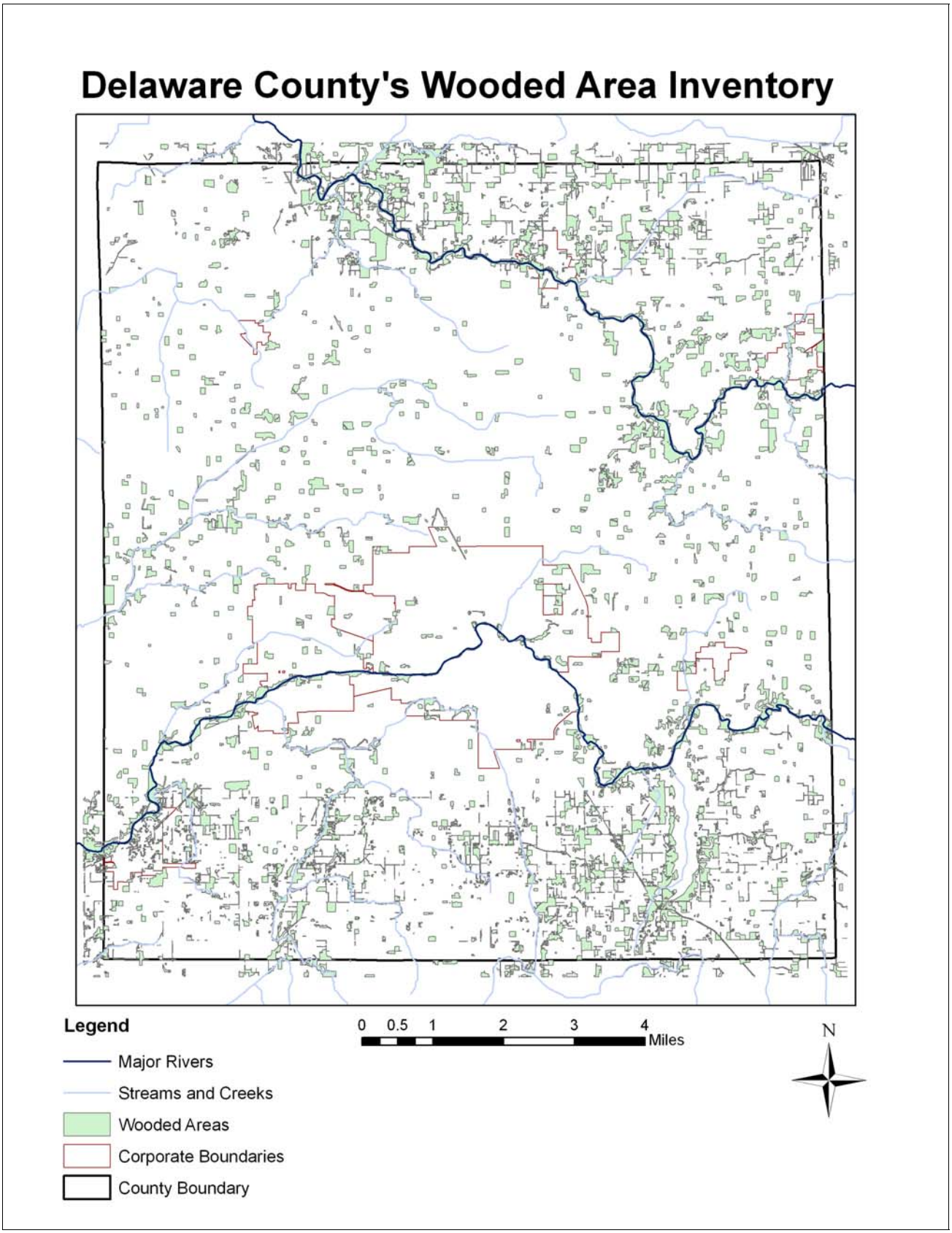


Figure 4: Wooded areas in Delaware County

Parks

Parks improve our physical and psychological health, strengthen our communities, and make our cities and neighborhoods more attractive places to live and work. Community parks and recreation services provide many personal, social, environmental, and economic benefits. Personal benefits include exercise and health, entertainment, relaxation, and education. Examples of social benefits are community awareness, interaction with adults and children, and getting to know fellow residents while environmental benefits consist of fresh air and water. The economic benefits will be discussed in more detail later in the report. The National Recreation and Park Association (NRPA) have developed community standards for parks and active recreation. Table 2 summarizes the NRPA parkland classification system and level of service (LOS) standards.

The City of Muncie has approximately 339 acres of parks distributed in 25 parks with an average park size of 13.6 acres. Based on the NRPA guidelines, the City of Muncie's park inventory can be broken down into mini-parks, small neighborhood parks, neighborhood parks, and community parks. At the regional scale, Delaware County contains one regional park located at the Prairie Creek Reservoir.

The 1890-acre Prairie Creek Reservoir (PCR) recreational area meets the NRPA's definition of a regional park. The NRPA level of service standard for this type of park is 5 to 10 acres per 1,000 persons. Accounting for Delaware County's estimated 2005 population of 116,362; the LOS for the PCR regional park comes out to 16.3 acres per 1,000 residents, which is well above the LOS range set by the NRPA.

Heekin, McCulloch, and SportsPlex Parks meet the NRPA's definition of community parks with a combined acreage of 230. "Community" is defined by the City of Muncie since the community park space is concentrated within the city. According to the city's 2005 estimated population of 66,146, the LOS is 3.5 acres per 1,000 residents. This LOS is below the NRPA's recommended LOS of 5 to 8 acres per 1,000 residents.

There are 2 neighborhood parks, Mansfield and Westside Parks, in Muncie with a total acreage of about 44 acres. The LOS for these two neighborhood parks is 0.66 acres per 1,000 residents which is well below the NRPA recommended LOS of 1 to 2 acres per 1,000 residents. Muncie also has 15 small neighborhood parks containing about 62 acres. Muncie's small neighborhood parks have a LOS of 0.95 which falls within the recommended range of 0.5 to 1 acre per 1,000 residents. The remaining 5 parks qualify as mini-parks with a total area of approximately 2.4 acres. Muncie's mini-parks fall short of the NRPA's recommendations with an LOS of 0.04 acres per 1,000 residents. Table 3 summarizes acreage, classification, and level of service for all of Muncie and Delaware County's parks.

Table 2: NRPA Park Classification and Level of Service Standards

Type	Service Area	Desirable Size	Acres/1000 residents
Mini-Park	Less than ¼ mile radius	1 acre or less	0.25 to 0.5 acres
Small Neighborhood Park	¼ to ½ mile radius	1-15 acres	0.5 to 1.0 acres
Neighborhood Park/Playground	½ to 1 mile radius	15+ acres	1.0 to 2.0 acres
Community Park	1 to 2 mile radius	25+ acres	5.0 to 8.0 acres
Regional/ Metropolitan Park	Several communities	200+ acres	5.0 to 10.0 acres
Source: Lancaster, 1990 Recreation, Park, and Open Space Standards and Guidelines, Page 57			

Table 3: Park Size, Classification, & LOS, City of Muncie and Delaware County		
Park/Facility	**Acreage**	**Acres/1000 residents**
Mini Parks		0.04 acres/1000 residents—Below LOS
Appeal to the Great Spirit	0.3	
Gilbert Historic Park	0.2	
Matthews Park	0.8	
Riverbend Park	0.4	
Washington Park	0.7	
Total	2.4	
Small Neighborhood Parks		0.95 acres/1000 residents—Meets LOS
Aultshire Park	2.5	
Ball Corp Park	10.5	
Buley Center	1.9	
Chambers Park	2.3	
Cowing Park	4.1	
Cooley Park	5.2	
Emerson Memorial Park	1.4	
Guthrie Park	2.4	
Jack's Park	2.1	
Morningside Park	1.2	
Riverview Park	3.2	
Rose Park/Ross Center	3.6	
S. Madison St. Center	1.1	
Thomas Park	11	
Tuhey Park	10.1	
Total	62.6	
Neighborhood Parks		0.66 acres/1000 residents—Below LOS
Mansfield Park	22	
Westside Park	21.9	
Total	43.9	
Community Parks		3.5 acres/1000 residents—Below LOS
Heekin Park	60.3	
McCulloch Park	86.9	
SportsPlex Park	83.5	
Total	230.7	
Regional Parks		16.3 acres/1000 residents—Well Above LOS
Prairie Creek Park	1890.8	
Total City and County Parks	**2,230.4**	**10 Parks Below LOS; 16 parks at or above LOS**

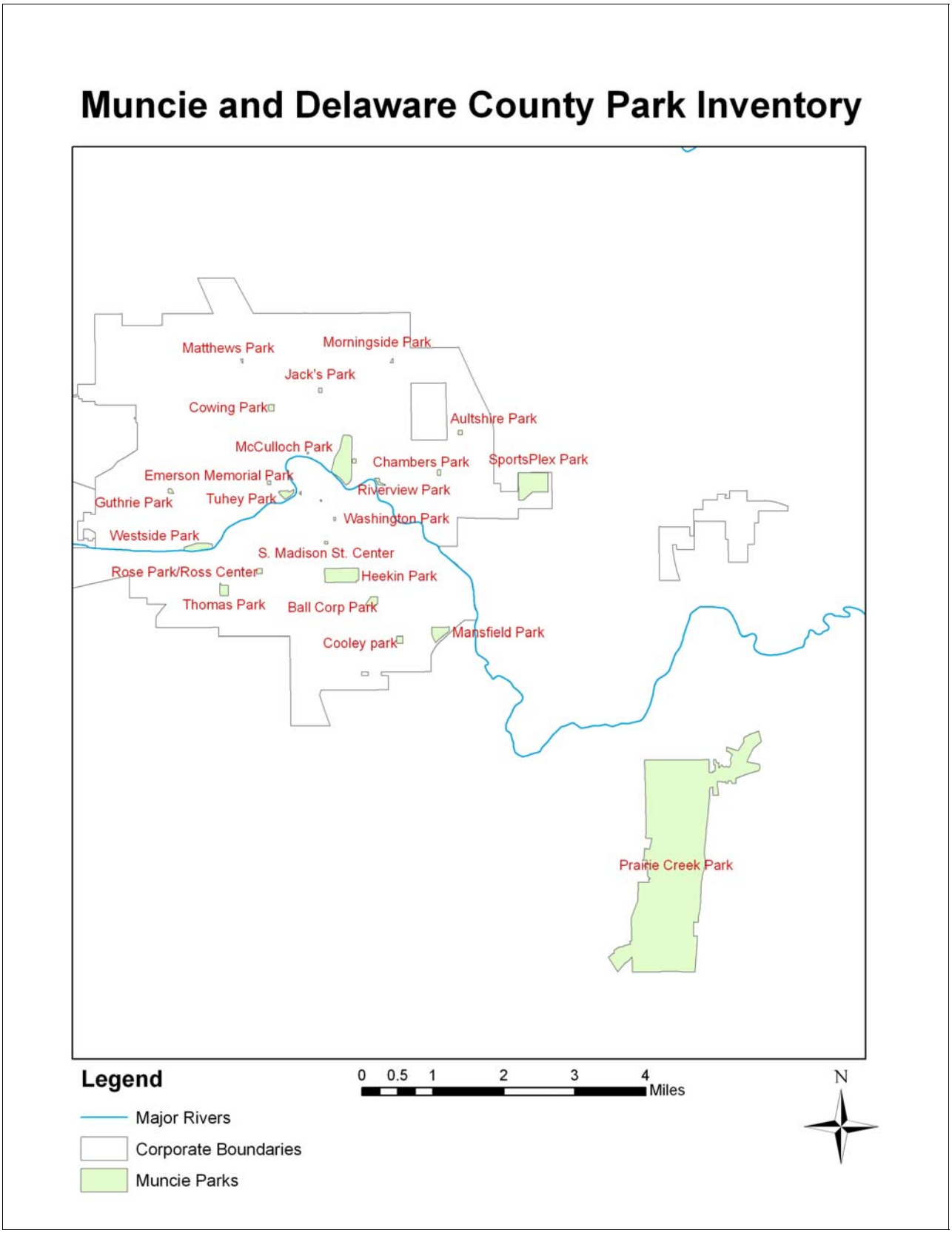


Figure 5: Map showing the name and location of Muncie and Delaware County parks.

Groundwater Recharge Areas

Rain fall and snow melt either runs off into streams or soaks into the ground (see Figure 6 below). The process of water soaking into the ground to become groundwater is known as groundwater recharge. The area on the surface where water soaks in is called the recharge area. In some areas more precipitation will infiltrate into the soil than in others. These areas which transmit the most precipitation are often referred to as "high" or "critical" recharge areas. There are many factors that affect how much precipitation will infiltrate into the soil such as vegetation cover, slope, soil composition, and the depth to the water table. Groundwater recharge is promoted by natural vegetation cover, flat topography, permeable soils, and a deep water table (Washington St. Dept. of Ecology 1986).

The majority of homes and businesses in the unincorporated parts of Delaware County rely on groundwater from underground wells for their source of drinking water. Thus, critical recharge areas are particularly important to protect because misuse of these areas can lead to depletion of potable water supplies and increased groundwater contamination (Washington St. Dept. of Ecology 1986). One way to protect these vital resources is to locate areas of high groundwater recharge and protect them from future land use considerations.

Using precipitation, soil, and land-cover GIS data, areas with high groundwater recharge potential were identified in the county. The Groundwater Recharge Potential Map (see Figure 7) shows low rankings (1-3) primarily concentrated in the northern half the county (particularly north-central and northwestern areas). This is likely due to the characteristics of the soil which are poorly drained and clay-like. Soils like these with low permeability and decreased soil drainage slow the downward movement of water. It is likely that more of the precipitation stays in the root-zone of plants rather than infiltrating into the groundwater.

Higher rankings (8-10) are found in the southern half and northeastern corner of the county along the surface water bodies (streams and rivers). The land cover and soils in these parts are the main contributing factors to the higher rankings. There are more surface water bodies with natural vegetation which promotes groundwater recharge. Surface water percolates downward to recharge groundwater. In addition the soils in these parts have slightly better drainage and permeability characteristics also enhancing groundwater recharge potential.

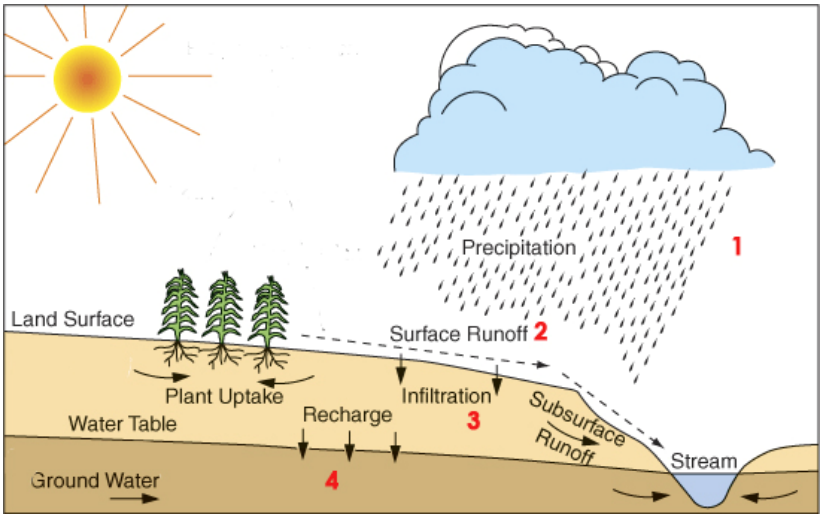


Figure 6: Groundwater Recharge Process: 1) Precipitation (rain or snow) falls onto the land surface; 2) Some runs off into streams; 3) The rest infiltrates into the soil; and 4) Recharges the groundwater.

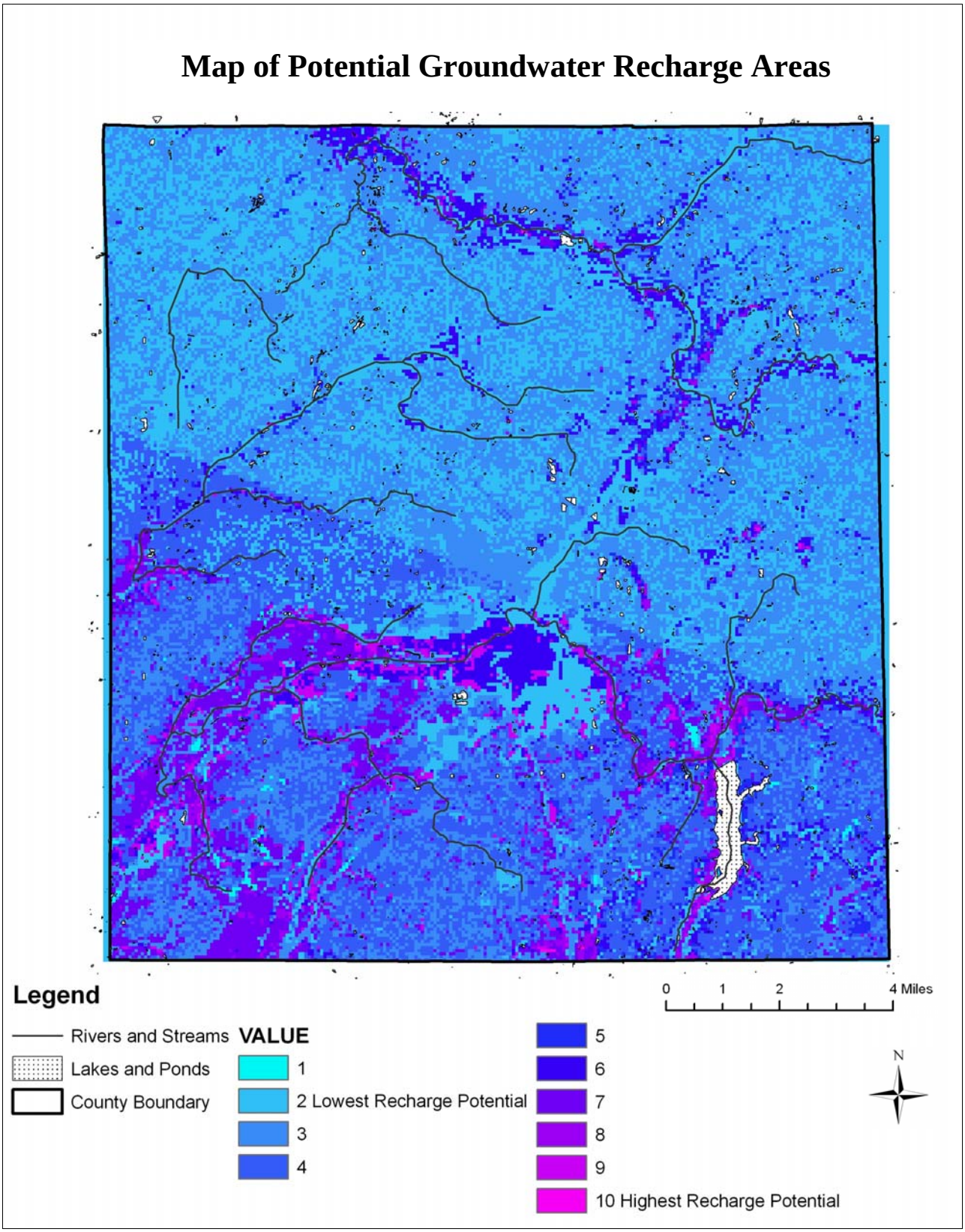


Figure 7. Shows areas in the county with the greatest potential to recharge groundwater. The areas with the highest rankings (8-10) should be targeted for preservation.

IDENTIFICATION AND PRIORTIZATION OF POTENTIAL CONSERVATION LANDS

Successful communities have a good understanding of their natural and cultural resources. They establish reasonable goals for conservation and development— goals that reflect their special resources, existing land use patterns, and anticipated growth. Green infrastructure presents a framework that can be used to guide future growth, future land development, and future land conservation decisions to accommodate population growth and protect and preserve community assets and natural resources. This framework helps communities identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature (Benedict and McMahon 2006).

While many communities, like Muncie and Delaware County, have adopted Comprehensive Plans containing detailed inventories of their natural and historic resources, very few have taken the next logical step of pulling together all that information and creating a *Map of Potential Conservation Lands.* This map can serve as the tool to guide decisions regarding which land to protect, and it helps local officials and residents visualize how various kinds of resource areas are connected to one another (Natural Lands Trust 2001).

Using the Natural Lands Trust (2001) model for developing a *Map of Potential Conservation Lands*, information contained in Muncie and Delaware County's existing planning documents were used to identify areas such as public parks, Red Tail Nature Preserve properties under conservation easements, and parcels zoned as flood area (FA) and recreation and conservation (RC). These areas were combined into a base map. The next task was to identify two kinds of resource areas. Primary Conservation Areas include only the most severely constrained lands, where development is typically restricted under current codes and laws (such as wetlands, floodplains, and slopes exceeding 25%). Secondary Conservation Areas consist of all other locally noteworthy or significant features of the natural or cultural landscape—such as mature woodlands, prime farmland, groundwater recharge areas, greenways and trails, river and stream corridors, and historic sites and buildings.

Using GIS, the base map, primary conservation areas, and secondary conservation areas were weighted based on their importance and potential to be conserved. Lands that are already protected through ordinances, regulations, or conservation easements were weighted the highest (10) when performing the calculations. These lands include Red Tail Nature Preserve properties, parks, greenways, conservation/ recreation and flood zones, and Muncie historic districts. Since these lands are already protected through some sort of regulations, they have the highest potential of being conserved because they will most likely be conserved in perpetuity, or unless a change is made in the ordinances.

Figure 9 shows the *Map of Potential Conservation Areas* for Delaware County. The map indicates that lands located along the surface water bodies are the most important and have the highest potential of being conserved. These lands, also called riparian zones, are significant in ecology, environmental management, and civil engineering due to their role in soil conservation, their biodiversity, and the influence they have on aquatic ecosystems. These zones are important natural biofilters, protecting aquatic environments from excessive sedimentation, polluted surface runoff, and erosion. They supply shelter and food for a majority of the wildlife in communities. Finally, riparian areas are also instrumental in water quality improvement for both surface water and groundwater, recharging groundwater, and decreasing the severity of flooding.

It is impossible and impractical for Muncie and Delaware County to conserve all of its natural and cultural resources from development. Development, after all, benefits a community by

providing tax revenues among many other things. It can, however, use this *Map of Potential Conservation Lands* as a guide when considering new development proposals. Riparian areas are the most important lands to protect so the county planning officials and other decision makers should try to encourage development to happen away from these riparian areas. Instead, new development projects should be targeted next to areas already developed to decrease the cost of public services. This can be done in a variety of ways such as by offering incentives for developers to encourage infill development where they redevelop an existing site instead of build on new, unoccupied land. The county's subdivision ordinance could be modified to require detailed site surveys and analyses that identify the special features of each property, and introduce ways to lay out new development so that the majority of those special features will be protected. Cluster or conservation subdivisions are a way to do this where the county can legally encourage subdivisions that set aside at least 40-60% of the land as permanently protected open space and to incorporate substantial density disincentives for developers who do not conserve any significant percentage of land (see Figure 8 below).

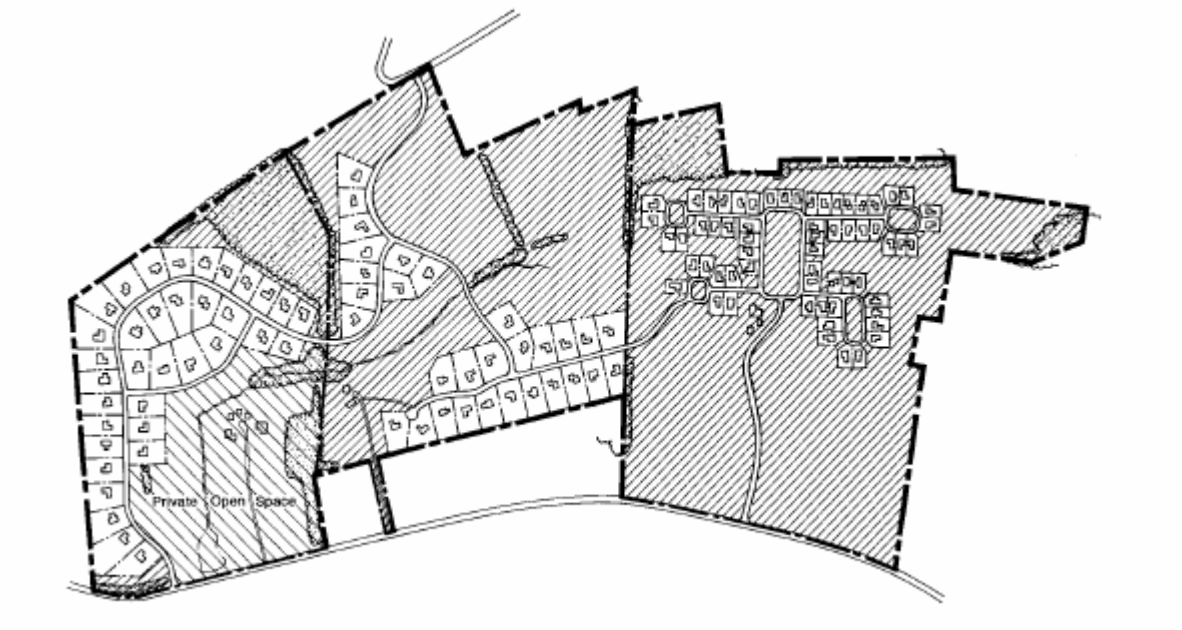


Figure 8: Example of conservation subdivision layout. The conservation lands (shown in gray) were deliberately laid out to form part of an interconnected network of open space in 3 adjoining subdivisions.

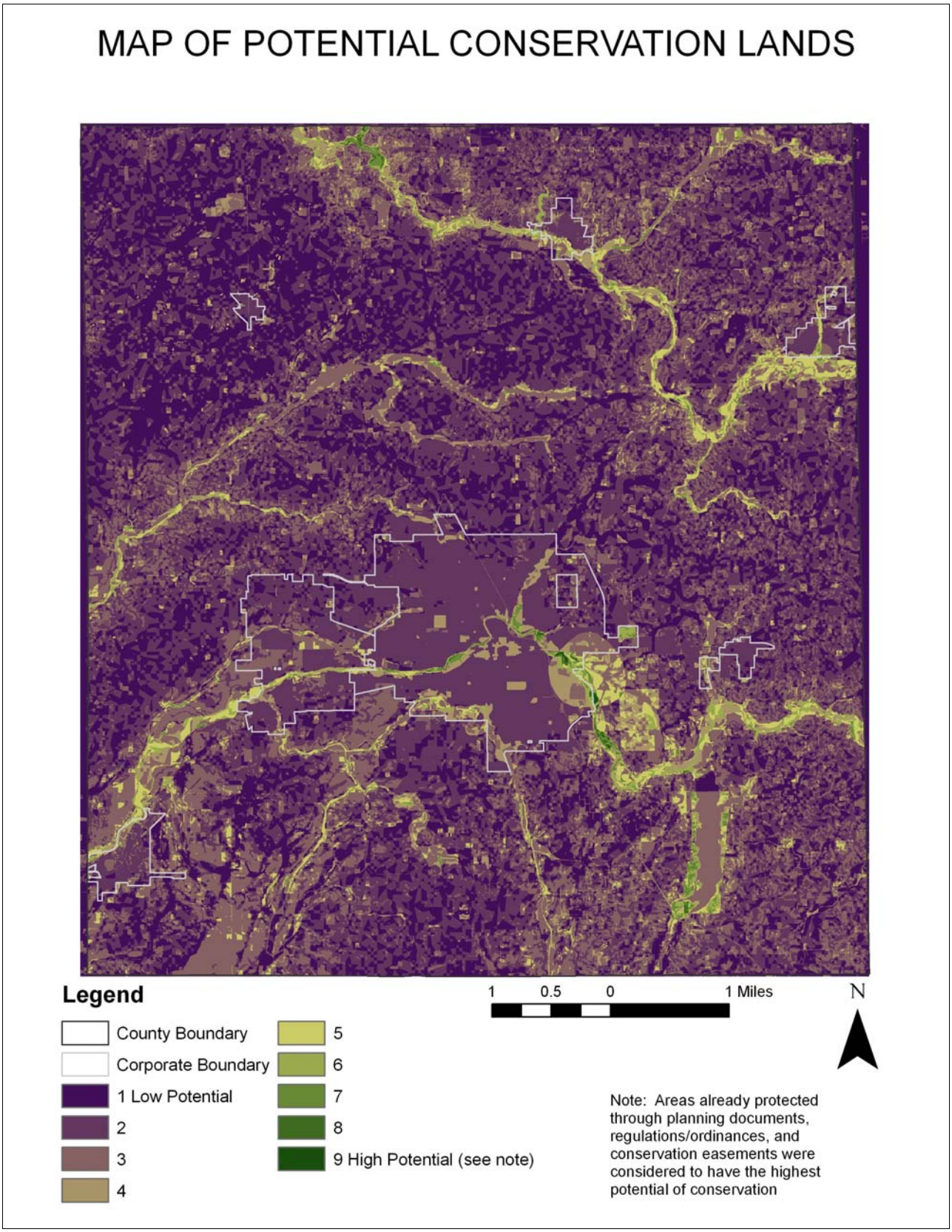


Figure 9: Shows lands with the highest potential and importance for conservation in Delaware County. The majority are riparian zones located along surface water bodies.

ECONOMIC BENEFITS OF GREEN INFRASTRUCTURE

Municipalities of every size and in every geographic area share a common need to increase the tax base to support essential government services and programs. Since most local governments rely upon property taxes for a greater part of their revenues, every development proposal is examined for its impact on the bottom line.

Proposals to develop land as open space are scrutinized just as are proposals to build subdivisions and shopping centers. More and more, supporters of open space preservation have successfully persuaded local officials that the benefits of not developing the land for homes and businesses are greater than converting the land to developed uses. This section describes ways in which communities benefit economically from green infrastructure.

Property Values Enhanced

Green infrastructure provides a variety of amenities like attractive views, open space preservation, and convenient recreation opportunities. People value these amenities, and this is reflected in increased real property values and increased marketability for properties located near open space and trails (National Park Service 1995). Developers also recognize these values and incorporate green infrastructure into planning, design, and marketing new and redeveloped properties (National Park Service 1995).

The effect on property values of properties near a park or open space has been the focus of several studies. The common method used to measure this effect has been statistical analyses. Statistical analyses attempt to isolate the effect of open space from other variables which can affect property values like age, square footage, and condition of homes (National Park Service 1995). Results have been varied because isolating the effect of open space can be difficult (National Park Service 1995). Nonetheless, several studies have shown increases in property values in cases where the property is situated near or adjacent to parks and open space (National Park Service 1995).

Most studies have addressed traditional parks or greenbelts (large open space areas), though a few studies are available for greenways (National Park Service 1995). Greenways and parkways tend to have much smaller and less certain impacts on property values than do parks and other larger areas (Anton 2005). In the 1990s a number of studies were undertaken as greenway development became popular in cities across the nation (Anton 2005).

- Professor John L. Crompton of Texas A & M University's report, *The Impact of Parks on Property Values: A Review of the Empirical Evidence*, reviewed 30 empirical studies that examined the extent to which parks influenced the market value of nearby properties (Crompton 2001). Analysis showed that well-maintained parks had a significant positive effect on residential property values (Crompton 2001). Some high use areas can actually have a negative influence on adjacent property, but still contributed to increased value of nearby properties. Crompton found that passive recreation parks resulted in greater aggregate property price increments than do heavily used park whose main focus is active recreation, having things like swimming pools or lighted ball fields (Crompton 2001).

- Another Crompton report, *The Impact of Parks and Open Space on Property Values and the Property Tax Base*, lays out the argument: "The real estate market consistently demonstrates that many people are willing to pay a larger amount for a property located close to parks and open space areas than for a home that does not offer this amenity" (Crompton 2000). For example, Crompton found that the empirical evidence suggests that properties adjacent to passive recreation parks were likely to sell for a 20% premium (Crompton 2001). This

premium declined to zero for properties 2,000 feet away from the parks (Crompton 2001).

- In 1994 a detailed study of the impacts of the Northern Central Rail Trail (NCRT) was completed for the Maryland Greenways Commission (PKF Consulting 1994). Local property owners were surveyed, and real estate brokers, appraisers, developers, and tax assessors were interviewed. Sixty three percent of the surveyed property owners believed that the NCRT added an average of $2,459 to the value of their properties (PKF Consulting 1994). Sixty eight percent thought that proximity to the trail would be a positive selling point for their home; this figure rises to over 90% for respondents living within 1-mile of the trail (PKF Consulting 1994). Sixty two percent of property owners noted that proximity to the trail would positively influence their decision to buy a house (PKF Consulting 1994). The professionals that were interviewed reported that the NCRT increased the salability of the property. Yet, their perceptions were not empirically tested due to the limited amount of development and small number of sales in the area of NCRT to the date of the study.

- In 2003, researchers from the Center of Urban Policy and the Environment (Center) began to explore the relationship between property values and public choices in the Indianapolis metropolitan region (Lindsey et al 2003). They showed that neighborhood characteristics such as school quality and property taxes have significant effects on property values. They used greenways as an example to illustrate the complexity of these relationships (Lindsey et al 2003). Center examined the impacts of property locations within a 1/2 mile straight-line distance of 14 greenway corridors on sales prices (Lindsey et al 2003). Analysis indicated that properties located within 1/2 mile of the Monon Trail and conservation corridors had a significant, positive effect on property values (Lindsey et al 2003). When aggregated across all properties within 1/2 mile, the additional taxable property value generated by the 8 greenbelts equaled $166.5 million ($120.4 million for the Monon Trail and $46.1 million for the 7 conservation corridors). However, properties within the 1/2 mile distance of the other 6 public greenways did not experience any significant price premium (Lindsey et al 2003). Although Center's results may complicate policymaking; it emphasizes the need for careful evaluation of the effects of public choices.

One implication of these studies might be that increases in nearby property values depend upon the ability of planners, developers, and greenway proponents to effectively incorporate neighborhood development and open space (National Park Service 1995). Greenways and parks can be designed to minimize potential homeowner - user conflicts and to maximize the access and views. This in turn can help to avoid a decrease in property values of immediately adjacent properties.

Increased property values and increased municipal revenues go hand in hand. Property tax is one of the most important revenue streams for cities. The positive effect of natural open space and trails on property values can result in higher assessments and thus property tax revenues for local governments (Curran 2001).

- Improvements like cleaning the air, acquiring open space, and constructing parks and trails in Chattanooga resulted in an increase in annual combined city and county property tax revenues of $592,000 from

1988 to 1996, an increase of 99%, while property values are up more than $30 million (124%) (Lerner and Poole 1999).

- A greenbelt in a Boulder, Colorado neighborhood increased aggregate property values by $5.4 million, resulting in $500,000 of additional annual property tax revenues. The tax alone could recover the initial cost of the $1.5 million greenbelt in 3 years (Correll, Lillydahl, and Singell 1978).

With few exceptions, the findings of studies analyzing the relationship between property values and open space and trails lead to the conclusion that open space increases property values from 5% to 20% (Community Open Space Partnership 2003). Open space and trails contribute to property value by improving the quality of a home's view and improving the residents' access to outdoor recreation and nature. This property value increase benefits both homeowners, who benefit from public investment in open space through increases in the value of their homes, and local government, which benefits because higher home values procure larger property tax revenues (Community Open Space Partnership 2003).

Municipal Expenditures Decreased

Communities are increasingly becoming aware that local population growth and real estate development do not automatically provide net fiscal benefits to local governments (Lilieholm and Fausold 1999). In other words, providing built infrastructure and other public services to support new development may cost more than the development produces in property tax and other revenues. Conservation of green infrastructure is one way local governments can reduce costs because it produces services that a city would have to go out and buy otherwise.

When greenway corridors are preserved instead of intensively developed, municipalities may reduce costs for public services like sewers, roads, fire and police protection, and school facilities. The establishment of greenways, trails, and parks in areas prone to hazards like flooding may decrease costs for potential damages (National Park Service 1995). In addition, green infrastructure and associated vegetation can help control water, air, and noise pollution by natural means, resulting in potential decreased pollution control costs (National Park Service 1995). Greenways and trails may promote physical fitness, leading to decreased public health care costs as well. Below are some examples.

Decreased Costs to Service

A common strategy for local governments looking to increase revenues is to encourage development. Several studies on the costs of community services have shown that residential development usually does not generate enough tax revenue to cover the costs associated with serving an increased number of residents (Community Open Space Partnership 2003; Auger 1995).

- In 1999 Robert Lilieholm and Charles Fausold reviewed several fiscal impact analysis studies. They reported that economists have found that residential development often incurs a net fiscal deficit while open space lands incur a surplus (Lilieholm and Fausold 1999). For instance, one study of 6 New England rural towns reported that residential development required $1.13 in municipal services for every $1.00 of revenue generated. Conversely, open space lands required only $0.29 in services for every $1.00 of revenue generated (Lilieholm and Fausold 1999).

- For every dollar generated in tax revenue, it costs approximately $0.35 to service farmland and $0.35 to service commercial and industrial areas, but $1.20 to service residential areas (American Farmland Trust 1999; Smart Growth Network 2000; Brookings Institution 2000).

- In more than 70 studies, American Farmland Trust (AFT) has found that the cost of residential development surpasses the revenues raised from the increased tax base. For every dollar of tax revenue generated from residential development in the 70 communities studied, service costs were $1.16 (Community Open Space Partnership 2003).

A limitation to these data, however, is that they may be less accurate in an "urban" context. First, urban open space is normally owned by a government unit or by a non-profit organization, rather than by private individuals, as may be more often the case in rural areas. As a result, in urban areas, open space may generate no direct tax revenue, whereas privately held open space in rural areas may generate tax revenue (Community Open Space Partnership 2003). Second, urban open space may be more costly to serve, requiring more intensive maintenance and security than rural open space (Community Open Space Partnership 2003).

All in all, the fiscal impacts of diverting land from being developed for homes to preserve open space likely yield a net benefit except for communities with excess capacity to provide community services and specialized parks, such as zoos and botanical gardens that entail substantial development of facilities and/or maintenance costs (Community Open Space Partnership 2003).

Decreased Pollution Control Costs

Green infrastructure plays a critical role in managing stormwater and reducing pollution. Expanding impervious surfaces like streets and parking lots results in heavy flows and flooding of stormwater into streams, wetlands, and lakes. Even though municipal storm sewer systems can be efficient at conveying water to help evade local flooding, they also transport the polluted runoff directly into nearby receiving waters without the benefit of wastewater treatment. Nationwide, urban stormwater runoff ranks as the second most common source of water pollution and third most common source for rivers (Community Open Space Partnership 2003).

- A study of the Roanoke, Virginia area using "CITYgreen" software showed that the number of acres with more than 50% tree cover dropped by one-quarter from 1973 to 1997 resulting in a 17% increase in runoff and 2.9 million fewer pounds of pollutants removed from the air annually (El Nasser 2005). The software also calculated how much the city would save if it added trees in parts of the city. The software showed that increasing trees by 25% in Fallon Park would save the city $27,965 a year to control stormwater (El Nasser 2005).

- In 2003 the Cedar Fire swept through San Diego, California affecting 28,466 acres of land, about 13% of the entire city. Comparing pre- and post-fire conditions in the Cedar Fire area, American Forests reported a loss of 49% tree canopy and 73% each of chaparral and shrub (Kollin 2006). This loss in vegetation resulted in an increase in stormwater runoff by 12,674,490 cubic feet. The value of retaining this additional stormwater, replacing what the trees did for free, is estimated at $25,349,000 (Kollin 2006).

Green infrastructure, particularly the urban forest, plays an important role in maintaining and enhancing local air quality. Trees remove gaseous and particulate pollutants from the air—pollutants that can affect human health, damage vegetation, and shorten the economic life of manmade materials like concrete and steel.

- One U.S. Forest Service scientist found that trees in the city of Chicago removed 17 tons of carbon monoxide, 93 tons of sulfur dioxide, 98 tons of nitrogen dioxide, 210 tons of ozone, and 234 tons of particulate matter in one year (Community Open Space Partnership 2003).

- According to American Forests' research, a 35% decline in the Charlotte, North Carolina metropolitan area's tree cover from 1984 to 2003 led to a similar reduction in the amount of carbon monoxide, ozone, and other

pollutants that trees removed from the air (El Nasser 2005).

Decreased Healthcare Costs

Communities spend millions of dollars on health care each year for people with diseases and illnesses that could be remedied by increased physical exercise and improved air and water quality. Green infrastructure provides trails and parks in which residents can engage in physical activity for recreation or their daily commute. Despite the importance of parks and other recreational open spaces to health, many people do not have adequate access to parks and open space. This is particularly true in cities, where park access is often inequitably distributed, putting certain populations at higher risk for health problems associated with inactivity (Goldman 2006). Parks, open space, greenways, and trails are also needed in fast-growing suburban areas, where low-density, automobile-dependent development may discourage walking, biking, and other exercise.

- Studies show that walking or hiking a few times per week can improve a person's health and lower health care costs. A study conducted by the National Park Service compared people who led sedentary lifestyles to those who exercised regularly (Greenways Incorporated). The exercisers filed 14% fewer healthcare claims, spent 30% fewer days in the hospital, and had 41% fewer claims greater than $5,000. (Greenways Incorporated).

- More than 60% of adults (59 million people) are overweight or obese; 13% of kids and 15% of teens (9 million young people) are overweight. Obesity contributes to 300,000 deaths a year in the U.S., costing an estimated $100 billion per year to the U.S. economy (Department of Health and Human Services 2003).

- A group of studies reviewed in the *American Journal of Preventive Medicine* showed that creation of or enhanced access to places for physical activity combined with informational outreach produced a 48% increase in the frequency of physical activity (Kahn et al 2002). The same studies showed that easy access to a place to exercise results in a 5.1% median increase in aerobic capacity, along with weight loss, a reduction in body fat, improvements in flexibility, and an increase in perceived energy (Kahn et al 2002).

- In a 2003 study, researchers related sprawl in U.S. counties with the body mass index (BMI) of people living in those counties. They found that people in sprawling counties walk less, weigh more, and have more hypertension than people who live in more compact counties, where they could more easily walk in the course of daily life. Comparing the most compact county, New York, with the most sprawled, Geauga County, Ohio, researchers found that New York residents walked 79 minutes more per month and weighed 6.3 pounds less (Ewing et al 2003).

Retirees Attracted and Retained

According to the U.S. Census Bureau, by the year 2050, approximately 1 in every 4 Americans will be 65 years of age or older, creating a prosperous group of retirees with financial benefits that include Social Security, military benefits, and pension plans (American Planning Association 2002). In a 1994 study by Miller et al., a retiree sample was asked to review 14 features and indicate their importance in the decision to move. The first 3 in rank order were scenic beauty, recreational opportunities, and mild climate.

Retirees also bring expendable income into their communities. According to a 2001 American Planning Association report, if 100 retired households come to a community in a year, each with a retirement income of $40,000, their impact is similar to that of a new business spending $4 million annually in the community (Crompton 2001). In addition, retirees increase the tax base and are positive taxpayers because they use fewer services than they pay for through taxes. For instance, they pay taxes to school districts but do not send children there (American Planning Association 2002).

Commerce and Jobs Attracted and Retained

Parks and open space create a high quality of life that attracts tax-paying businesses and residents to communities. Owners of small companies ranked recreation, parks, and open space as the highest priority in choosing a new location for their business (Crompton et al 1997). While corporate CEOs say quality of life for employees is the third most important factor in locating a business, behind only access to domestic markets and availability of skilled labor (National Park Service 1995).

In addition, greenways often provide business opportunities, locations, and resources for commercial and tourism activities such as recreation equipment rentals and sales, lessons, and other related businesses. When workers are attracted to an area they are then positioned to put money back into the local economy through jobs, housing, and taxes, which then contributes more to parks and trails.

- A National Park Service study showed that after just one season, 61 businesses located along the 35-mile-long Missouri River State Trail reported that the trail was having a positive effect on their businesses. Eleven of the businesses reported that the Trail had strongly influenced their decision to establish their business, and 17 (28%) had increased the size of their investment since the Trail had opened (Barthlow and Moore 1998).

- According to the Outdoor Industry Foundation's Active Outdoor Recreation Economy Report for Fall 2006, the recreation economy:
    - Contributes $730 billion annually to the U.S. economy
    - Supports nearly 6.5 million jobs across the U.S.
    - Generates $88 billion in annual state and national tax revenue
    - Generates $289 billion annually in retail sales and services across the U.S.
    - Touches over 8% of America's personal consumption expenditures — more than 1 in every 12 dollars circulating in the economy
    - Supports 60 million bicycle participants

- Indiana is located in Census Division 3. The Active Outdoor Recreation Economy Fall 2006 Report states the following statistics for Division 3:
    - Total Contribution: $61,953 million
    - Jobs Generated: 691,507
    - Gear Retail Sales: $7,007 million
    - Trip-related Sales: $34,665 million
    - Taxes (federal, state): $7,151 million

Homebuyers Attracted to Purchase Homes

By promoting, supporting, and revitalizing urban parks and trails, cities can help attract a significant portion of the homebuying community. The National Association of Realtors (NAR) in conjunction with the National Association of Home Builders (NAHB) has conducted several homebuyer surveys over the years. Below are some of their findings related to open space and trails:

- A 2001 survey by NAR revealed that 57% of voters would choose a home close to parks and open space over one that was not (American Planning Association 2002).

- NAHB found that 65% of home shoppers surveyed felt that parks would seriously influence them to move to a community (American Planning Association 2002).

- A survey conducted by NAR and NAHB in 2002 asked about the importance of 18 community amenities, the highest ranking features were (with % ranking as important or very important): highway access, 44%; jogging/bike trails, 36%; sidewalks, 28%; parks, 26%; playgrounds, 21%, and shops within walking area, 19% (NAR and NAHB 2002).

- When asked to rate the importance of different types of open spaces on a scale of 1 to 5, the highest ranking features were natural/undeveloped lands, 3.95 and park/recreational area, 3.62 (NAR and NAHB 2002).

- Fifty percent of voters would be willing to pay 10% more for a house located near a park or other protected open space but only 42% said they would be willing to pay as much as $10,000 more (NAR 2001).

- When asked how important the maintenance and creation of various types of open spaces was in their communities, respondents ranked the following as very important: playgrounds for children, 75%; playing fields for soccer/baseball, 61%; neighborhood parks within walking distance, 60%; walking trails, bike paths, and horse trails, 48%; large backyards, 35%; golf courses, 13% (NAR 2001).

Construction Costs Decreased for Developers and Homeowners

At times, the economics of land development direct the construction of unnatural structures and spaces because they are less expensive to build. This philosophy should be reversed, and we should invest in the future by initially expending more financial capital to construct buildings that will garner biological and financial savings later. For example, many communities and developers are considering green roofs as a viable roofing alternative (Greenroofs.com 2006).

Green roofs, sometimes called vegetated roofs or eco-roofs, consist of layers of specially designed and selected materials combined with shallow-rooted living plants to form a biological system. The initial extra short-term capital costs of greenroof construction can be offset through long-term energy and maintenance savings. The economic benefits represent real reasons for municipalities, developers, and private residence owners to consider opting for a greenroof although initial costs may be higher. In fact, the U.S. Green Building Council and others say that new advances in green design have shown that a green building does not necessarily have to cost any more than a conventional one (Greenroofs.com 2006). Below are some examples of the benefits of using green roofs.

- *Reduced overall building energy costs*--Due to the green roof's natural thermal insulation properties, structures are cooler in summer and warmer in winter**.** The urban "heat island" effect can also be greatly reduced since vegetative roofs reduce ambient air temperatures. Therefore, less electricity costs are expected from lower air conditioning and heat usage. For example, the Weston Design Consultants conducted an energy study for the city of Chicago which estimated that it would be possible to save $100 million in saved energy annually with the greening of all of the city's rooftops (Greenroofs.com 2006).

- *Increased service lifetime of the roof*--Vegetated areas heat up much less than exposed surfaces of asphalt or bitumen. During winter months, erosion damage and fracture of most roof surfaces by frost and ice can be lessened or eliminated (The London Ecology Unit 1993). Reduced stresses on roofing materials typically double the service life, prolonging the practical life by 20 years. Therefore, the costs for rehabilitation or replacement of roofs can be delayed (Greenroofs.com 2006).

- *Reduced impervious coverage restrictions*--Depending on local ordinances, greenroofs may be installed in lieu of conventional stormwater practices. They can significantly reduce the size, or even completely eliminate the necessity for unsightly, space-wasting, and expensive detention ponds or underground galleries (Greenroofs.com 2006). Although hard to quantify, there is also potential for downstream stormwater treatment savings (Greenroofs.com 2006). A 2003 study conducted by the Russell E. Larson Agricultural Research Center at Rock Springs, Pennsylvania showed an average 40% reduction in runoff from the green-roofed buildings (DeNardo et al 2003).

- *Wasted rooftop space is turned into usable space*--The high price of land may hinder creating green areas at ground levels, therefore, property values could rise as a result of utilizing the roof space. Green roofs may create open space for human interaction like terraces or plaza as well as simply beautifying the building. In turn, value is added for building occupants, clients, and guests (Greenroofs.com 2006).

- Toronto, Canada recently commissioned a multidisciplinary green roof benefits study by Ryerson University. Researchers discovered that 8% coverage of existing rooftops with extensive green roofs would generate more than $300 million in initial cost savings in stormwater management, combined sewer overflow reduction, energy savings, and urban heat island reductions. Operational cost savings for the city were calculated at approximately $40 million per year (Buildings 2006).

Green roofs provide outstanding benefits through their thermal, hydrodynamic, and protective abilities as well as act as a synthesis between nature and shelter. Not only can the vast and empty expanses of acres of rooftops be used to mitigate ecological problems, it can also be used to transform the visual and spatial quality of our urban, commercial, and industrial landscapes.

Yet green roof infrastructure is in a precarious position. Its many benefits are accumulated mainly in the public sector, yet in order to be effective it must be implemented by the private sector. In order for green roof technology to be effective and its economic impact be fully appreciated, it must be implemented on a large scale. This will not occur without allowing variances to already established standards and codes for roof systems incorporating vegetation or some sort of new facilitating policy. A public-private partnership is the key to the successful implementation of green roof infrastructure in communities (Green Roofs for Healthy Cities 2006).

INDIANA TRAILS STUDY: CARDINAL GREENWAY TRAIL

As shown throughout this document, green infrastructure systems provide numerous economic, environmental, and social benefits to individuals as well as whole communities. However, without the support of the whole community—residents and decision-makers alike—these benefits cannot be fully realized. This sections looks at how the people of Muncie view the Cardinal Greenway Trail—one part of the county's green infrastructure system.

In 2001, the Eppley Institute for Parks and Public Lands at Indiana University completed a comprehensive survey of trails in 6 Indiana communities called The Indiana Trails Study. The study was developed to focus on the growing need for more information on trail use and the general attitudes of trail users and trail neighbors (Wolter et al 2001). The Indiana Trails Study analyzed trail use, effects of trails on neighboring property, and economic impacts to determine negative and positive effects arising from trail development and conservation in Indiana (Wolter et al 2001). The study used 3 methodologies to complete the research: trail counts, survey of trail users, and survey of trail neighbors.

Trail Counts

Trail counts were conducted using infrared trail counters placed at different locations on the Cardinal Greenway in Muncie during the months of September and October 2000. Total traffic estimates were 9,275 during September and 9,063 during October (Wolter et al 2001). These estimates are adjusted counts of the total number of users that went past the counter, not estimates of the number of different user visits or separate trips to the trail (Wolter et al 2001). Estimates of the number of different user visits to the trail are not available so the study used a simple approximation that the number of user visits is approximately equal to half of the total traffic (Wolter et al 2001). Therefore, the Cardinal Greenway had approximately 4,637 users in September 2000 and approximately 4,531 users in October 2000.

Other conclusions from the study include: 1) trail counts showed some consistent patterns of use, with use higher in September than in October and higher on weekends than on weekdays; 2) peak use on weekends and weekdays occurred at different times: in the mid to late afternoons on weekends and in the late afternoon or early evening on weekdays; and 3) Saturday morning use was higher than Sunday morning (Wolter et al 2001). Additional analyses of the effects of weather on patterns of use would help to explain the variations that have been identified in the study.

Trail Users

Subjects were selected randomly at different locations during a 15-hour day, over a 7-day week for 2 weeks in July and August 2000. There were 108 trail users intercepted on the Cardinal Greenway Trail that agreed to be surveyed (Wolter et al 2001).

The survey examined trail user characteristics such as trail activity, travel time, purposes of visits, and trail user demographics. Seventy seven percent of people intercepted on the trail were bicycling while 11% was walking (Wolter et al 2001). Fifty two percent of trail users drove to the trail, 29% walked, and 5% biked (Wolter et al 2001). A very significant majority of trail users lived close to the trail and/or

utilized the same parking area for entry and exit if they drove (Wolter et al 2001). A large majority (56%) of trail users indicated they were using the trail primarily for health and fitness, 39% for recreation, and 3% for commuting. Most trail users were from upper-middle class income households, Caucasian, college educated, and between 26 and 55 years old.

The survey also asked questions pertaining to trail user attitudes and lifestyles. The vast majority of surveyed trail users were local residents who were very committed to use of the Cardinal Greenway Trail and felt the trail was very important to their activity level and continued participation (Wolter et al 2001). Over 77% of Cardinal Greenway trail users indicated they were satisfied with the trail and that their view of Muncie as a community was positively affected by the trail (Wolter et al 2001).

Trail user satisfaction and benefit was a third category of survey questions included in the trail study. In general, trail users found very few problems with the Cardinal Greenway trail. Only 35.6% of the trail users completing the follow up survey indicated they had experienced a problem (Wolter et al 2001). The highest-ranking satisfaction factors for the Cardinal Greenway Trail included trail maintenance, the trail surface, its natural surroundings, quiet setting, parking facilities, perceived personal safety, and lack of congestion on the trail (Wolter et al 2001). Trail users indicated that the most important factors for the Cardinal Greenway Trail and its management were the perceived personal safety of trail users, safe road and stream intersections, the prevention of trail vandalism, trail maintenance, and the prevention of reckless behavior by trail users (Wolter et al 2001).

Trail user economic factors were the final category of questions on the survey. Economic issues related to Cardinal Greenway trail use included trail user willingness to pay for parking and trail use, rationales for fee decisions, and trail related expenditures. About 60% of respondents said they would pay a user fee to use the Cardinal Greenway, and indicated they would pay a fee of $5 to $20 annually (Wolter et al 2001). Respondents who indicated they would not pay a trail use fee further indicated they felt taxes should pay for trail maintenance and operations (Wolter et al 2001). Only a small number of respondents reported expenditures related to trail use.

Trail Neighbors

The Muncie trail neighbor population represented those individuals who have property that borders along the Cardinal Greenway Trail (which includes parks and open space and is often larger than the trail right-of-way) as found in the Delaware County Clerk's Office. Trail neighbors were mailed a survey asking them to reflect on management issues, and their experiences with the trail in their area.

The Trail Neighbor Survey was divided into various topical sections. The first section asked about trail neighbors' property and its relationship to the trail (Wolter et al 2001). Neighboring properties of the Cardinal Greenway Trail were largely residential lots, less than 1-acre in size, and used primarily for single family residential uses. Over half of the properties were within 200 feet of the trail and the back of the house faces the trail right of way (Wolter et al 2001).

Trail neighbor attitudes toward the Cardinal Greenway were the second section of questions on the survey. Trail neighbors were most dissatisfied with a lack of safety patrols (26%) and parking problems (20%) in the vicinity of

their property (Wolter et al 2001). The most common problems reported by neighbors were illegal vehicle use (28%), littering (20%), and unleashed pets (18%).

The next section of the survey was designed to determine how trail neighbors felt their property was affected by the Cardinal Greenway. A very large percentage of trail neighbors viewed trail development as having either no effect or a positive effect on their property's value and on the salability of their property (Wolter et al 2001). About 12% of respondents indicated they felt the trail had increased the resale value of their property, while almost 14% felt the trail had lowered their property value (Wolter et al 2001). Finally, for those individuals that purchased property by the Cardinal Greenway trail after it was constructed, about 25% indicated trail proximity was an appealing factor in their decision to purchase the property (Wolter et al 2001).

CONCLUSION—MAKING IT HAPPEN

Green infrastructure is a good financial investment for a community. Overwhelming evidence demonstrates the benefits of city parks, forests, open spaces, and trails. They enhance property values, increase municipal revenue, decrease municipal expenditures on public services and utilities, bring in homebuyers and workers, attract retirees, and provide environmental protection such as natural filtration of the air and water.

Widening the scope beyond parks and playgrounds, Delaware County can craft an integrated system of green infrastructure that will serve its residents as they confront a future of rising obesity rates, global climate change, and constantly stressed natural systems. Delaware County can make green infrastructure an integral part of its land use planning process by taking the forward step of viewing streams, shorelines, wetlands, bikeways, parks, and urban forests as not just amenities; but as providers of essential, life-sustaining services.

To ensure that the work does not simply become a map in the file drawer or a plan on the bookshelf, Delaware County cannot stop after it has a green infrastructure design and implementation plan. Delaware County must work in an ongoing fashion to make sure that the design and plan are adopted, incorporated, and used in a variety of programs. Here are a few suggestions offered by Benedict and McMahon (2006) and others on ways to include green infrastructure in the city and county's planning process:

- Link green infrastructure and watershed planning—broaden the scope beyond jurisdictional boundaries
- Incorporate green infrastructure principles into community revitalization, brownfields redevelopment, and other development initiatives—encourage infill development
- Make preservation of the community's green infrastructure the paramount priority of the Comprehensive Plan, and restore the comprehensive plan to its rightful place of dominance over zoning.
- Help fund green infrastructure projects through the use of TIF districts, special assessment districts, CDBG funds, local ballot referendums, and capital campaigns
- Re-examine and align local zoning ordinances, subdivision ordinances, building codes, landscape regulations, architectural control regulations, sign ordinances, and storm water management ordinances so as to implement green infrastructure principles.
- Eliminate common obstacles to conservation development like lot size minimums; offer incentives, advice, and support to developers interested in applying conservation planning principles to new developments.

Government plays a vital role in the creation of a green infrastructure system, but governments cannot do the job alone especially with increasing budget constraints. Green

infrastructure is not a government program nor is it just a conservation nonprofit group or land trust's responsibility. The creation and improvement of Muncie and Delaware County's green infrastructure system depends on the planning and transactional skills of the city planners, nonprofit groups, citizens, and business leaders. The economic benefits of Delaware County's green infrastructure will depend on a coordinated effort and lasting partnership between all stakeholders.

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