

ENVIRONMENT

INTRODUCTION

Environment is defined by Webster's Dictionary as "the circumstances, objects, or conditions by which one is surrounded" and "the complex of physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival." These amenities also provide additional, less visible qualities, such as cleaner air, recreational areas, and wildlife habitat that are important to a community. Development has an effect on the physical and social environment of a community, and this can affect many of the characteristics which make the community unique or those qualities that its residents feel are important. Therefore, development should preserve and promote an overall high quality of life while allowing a reasonable economic return.

While it's true that Boone County is located less than 15 miles from downtown Cincinnati, has three interstate highways, an international airport, and a regional shopping mall, a significant part of the county can still be considered rural. This rural character is a desirable environmental quality which attracts people to become residents of Boone County. Prime agricultural land, woodland areas, scenic valleys, streams, and hillsides are the most significant environmental resources that exist in Boone County. This quality, which attracts many new residents, is often replaced by the development built to accommodate them. This element is prepared from an environmental perspective and is to be used as one factor in determining the future land use of this plan. This element establishes the fact that environmental impacts should be addressed up front rather than allowed to accumulate and therefore require much more expenditure in the future.

GEOLOGY

The University of Kentucky Geological Survey for Boone County indicates that interbedded shale and limestone layers are the predominant rock outcroppings, and alluvial and glacial deposits occur that overlay the limestone and shale. Some of the deeper limestone layers in the geologic column are pure enough to provide a stone resource for mining. These formations are approximately a thousand feet below the higher surface portions of Boone County.

One notable rock formation is the Kope Formation, which contains a large percentage of shale interbedded with limestone. According to the Kentucky Geological Survey, this formation has characteristics of poor drainage and soft shale which typically results in hillside slippage when exposed to the weather. The Cincinnati area is well known for landslides largely because of this formation. Kope is generally present at the surface along stream beds and the lower portions of the stream valley walls in Boone County. Maps prepared by the Kentucky Geological Survey show that this formation is most prevalent in the Big Bone Lick and southern portions of the county, but is also found on all major hillsides in the western and northern portions of the county.

Regarding gravel resources, the Existing Land Use maps in this and the previous Comprehensive Plans indicate that most mining has occurred along the riverfront areas of the county. A few areas were mined years ago, and have been reclaimed or allowed to revert to natural vegetation. A dedicated study examining how much gravel and sand resource may still exist in Boone County has not been conducted.

SOILS

Soils data are based upon the United States Department of Agriculture Soil Conservation Service publication Soil Survey of Boone, Campbell, and Kenton Counties, Kentucky, published in 1973. Soils are an important resource because they provide for agricultural production. They affect drainage, flooding, permeability, slope stability, siltation, as well as development practices and costs.

Alluvial Soils - Alluvial soils are composed of the remains of former stream beds and deposits of materials generated by natural water erosion. Such soils are found in designated flood zones of major rivers, and along the banks of tributary streams. Alluvial soils are highly permeable, subject to high water tables, and are usually connected with underground streams or aquifers. Alluvial soils are often highly erodible, serve as aquifer recharge areas, and should be addressed in development.

Permeability - Soil permeability is a measure of the rate and depth to which a soil absorbs water. Permeability rates are determined by the soil's porosity, slope, depth to bedrock, depth to seasonal high water table, vegetation cover, and other factors.

Almost all land in Boone County, except river and stream valley bottoms and a small number of isolated locations are subject to permeability limitations. Nearly half of the undeveloped land area within Boone County contains soils which have poor permeability (0.63 inches per hour or lower). This land area, which is primarily located within the southern and western portion of the county, has slopes of 20% or greater and is shown on **Figure 3.1** as Developmentally Sensitive (DS) areas. The land area which has a permeability of 0.63 to 2.00 inches per hour covers approximately 50% of the county and is primarily comprised of slopes of less than 20%. These areas are usually prime agricultural land or agricultural land of state-wide importance, and coincide with the parts of Boone County that are projected to experience residential development within the 25 year planning horizon. Severely impermeable soils are found primarily along ridgelines where the bedrock is near the surface and in low-lying areas where the water table is high.

Soils of poor permeability are subject to ponding and runoff since the soil cannot absorb concentrated storm waters. Nonporous surfaces of urban uses, on or adjacent to impermeable soils, can significantly increase the runoff volume, and aggravate ponding, erosion, and surface water pollution.

Depth to Seasonal High Water Table - Water filters through porous soil until it reaches a substratum material with nonporous characteristics, normally bedrock or clay deposits. Water so entrapped will back up toward the surface forming a ground water table, or flow through underground bedrock fractures or limestone deposits until it is collected and filtered back up through natural stream beds. In both circumstances, ground water is an important resource since it provides a naturally filtered water supply.

Soils of moderate water table depth are usable when subject to exacting design and performance standards. In Boone County, extremely high water tables occur in only a small number of thin belts along the Ohio River and a few other scattered areas. There are more areas of moderate depth water tables, concentrated primarily on ridgelines in the northeastern uplands of the county.

Strength of Soil - Soils vary considerably in compressive strength and stability. Sandy silts are the most stable; clays the least. Slope, depth to bedrock, vegetation cover and ground water drainage patterns are related factors which determine soil material use limits.

On flat to shallow sloped lands, all soils are usable for development (aside from water table limitations). Clay and silty clay soils, however, are particularly susceptible to mudslides when steeper slopes are present in areas with shallow bedrock depth and little tree cover.

According to the USDA Soil Survey (1989) all soils contain some form of limitation for urban uses. Ridgelines, stream beds of the lower reaches of major streams, sloping lands, and the upper reaches of stream valleys are the most notable. The rugged terrain in some of the western and southwestern parts of Boone County contains broad areas of poor soil conditions for development. More moderate conditions prevail in the gentler topography of the north and eastern portions of the county.

Depth to Bedrock - Major concentrations of extremely shallow bedrock depths are located in the northern portion of the county along the steep hillsides that overlook the Ohio River, and in some stream beds. The southeastern portion of the county between Walton, Richwood and Beaverlick also has a large area of shallow bedrock depth. In addition, the Gunpowder Creek Valley and Woolper Creek Valley have many areas which have shallow

bedrock depths. Most of the land in the northeastern portion of the county, which includes the airport and most of the City of Florence, does not contain this limitation for development.

Slope/Erosion - Erosion hazard is caused by the combined effects of soil material characteristics and slope. Different soil types are affected differently by slope. Steep slopes descending into stream valleys and bottom lands of small streams are highly erodible. These extend into the western and northern edges of the county. Less steep upper slopes near ridgelines are moderately erodible, while ridgelines, plateau, and large stream bed areas are free from significant erosion hazard.

Other factors contributing to erosion hazard at lower slope percentages include the absence of tree and ground cover, shallow depth to bedrock, low permeability, and shallow surface drainage channels. Erosion from improperly modified slopes can disrupt natural drainage channels, pollute surface water runoff, and cause mudslides.

Agricultural Values - The U.S. Department of Agriculture grades the agricultural potential of different soil types and assigns them to a capability classification. The classifications are based on the suitability of soils for field crops employing normal field management techniques. Prime agricultural land is important for the sustainability of a region. Furthermore, agricultural lands provide the majority of the open space within a community, as well as creating a visual identity that often defines the character of a community.

Topography - The unique glacial topography of Boone County offers many astounding vistas of the Ohio River and its bottomlands. The steep tree covered hillsides which parallel the river and creeks, as well as the valley bottoms themselves offer majestic countryside vistas of a quality not commonly found within 15 miles of a major city. The views and vistas of such natural beauty are arguably some of the most important amenities to residents within the county. They help to establish a quality of life desired by the residents of Boone County. It should also be recognized that Boone County has over 40 miles of Ohio River frontage of which the majority is adjoined with steep hillsides.

In Boone County there is a broad area of scenic value in the flood plains along the Ohio River, and along the valleys of major tributary streams on the western side of the county. Outstanding scenic areas include a series of cliffs along the Ohio River bordering the north edge of the county which affords dramatic views of the Ohio River and beyond. Notable man-made features such as individual historic homes/farm buildings and the towns of Burlington, Petersburg, Rabbit Hash, and Belleview/McVille also provide scenic amenities to the county.

WATER

Stream Tributaries - Glaciers determined the topography of Boone County and also created a vast network of streams which cover the entire county. As the land descends to the Ohio River, major tributaries are formed, including Mud Lick, Big Bone, Gunpowder, Lick, Middle, Woolper, Sand Run, and Elijah's Creeks. Also included are many smaller tributaries and intermittent streams. This natural drainage system provides an efficient storm water collection system, as well as a natural water supply. **Figure 3.2** shows the major stream tributaries in Boone County and defines the watersheds which are such an important resource for land use planning. Furthermore, natural drainage networks provide efficient storm water collection systems, and ultimately are the headwater system for a natural water supply.

Floodplains - Flood zones are defined by historical records of high flood water levels or by engineering estimates of the volume and channel changes which may affect, or be affected by urban improvements within the drainage network. **Figure 3.3** identifies the 100 year floodplains recently updated by FEMA which correspond to areas that were flooded during the 1937 flood.

Although the highest flood of record occurred on the Ohio River in 1937, it is not the worst that could possibly occur. Significant flooding has also occurred in 1945, 1964, and 1997. U.S. Army Corps of Engineers studies of the Ohio River Basin indicate that more critical combinations of storms and runoff can reasonably be anticipated to occur in the future.

Protective flood control structures do not alleviate all flood zone hazards. In fact, they may even increase high water levels upstream from a backwater dam, alter the natural channel through which a flooding pattern would be expected, or alter the water table and underground drainage pattern serving local areas.

In Boone County, the lands designated as flood zones include primarily bottom lands along the Ohio River and its major tributaries. However, minor tributaries typically experience flooding problems as more impervious area is created in each watershed. Portions of the upper Gunpowder, Woolper, Elijah's Creek, and Mud Lick watersheds frequently experience flooding. The most extensive flood zone area is the lower East Bend Bottom at the mouth of Gunpowder Creek. Spots of moderate flood hazard from possible dam breaks are located downstream from small dammed lakes scattered throughout the county.

The Boone County Building Department is the administrator of the National Flood Insurance Program (NFIP). The NFIP enables communities to buy insurance protection from losses due to flooding and is designed as an alternative to disaster assistance in order to meet the rising costs of repairing damage caused by flood events.

Water Quality - The Clean Water Act (adopted in 1977) includes goals, water quality standards, monitoring, controls, and revision of strategies. The stated goal of the Act is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." An interim goal passed in 1972 by Congress established benchmarks for the year 1983 for protection and propagation of fish and wildlife and water recreation. As of 2004, 40% of the state's waters did not meet this goal. By statute, Kentucky designates water uses; water quality criteria have also been established to protect the uses. Anti-degradation, including minimum goals for each water body, is a required component of these standards.

The Kentucky Agriculture Water Quality Act was passed in 1994 to bring Kentucky into compliance with federal laws. The goal of the act is to protect surface and ground water from potential pollutants as a result of agriculture and forestry operations. The act did not establish any new water quality laws other than requiring that all agriculture and forestry operations of ten or more acres develop and implement a water quality plan by October 23, 2001. The Boone County Conservation District continues to assist in developing individual water quality plans. The water quality plan consists of best management practices (BMP) identified by the Kentucky Agriculture Water Quality Authority (AWQA) that keep non-point source or runoff pollutants such as sediment, animal waste, and fertilizers and pesticides from reaching our waterways. The AWQA asks landowners to address water quality issues in the areas of crops, farmstead, livestock, pesticides and fertilizers, silviculture, and streams and other waters. Not only are landowners required to install best management practices, they are also required to document their efforts to improve and protect the natural resources of the Commonwealth. By writing and carrying out a water quality plan, producers and landowners can be assured that they are helping to protect our water.

In 2007, SD1 entered into a Consent Decree with the US Environmental Protection Agency (USEPA) and the Kentucky Division of Water (KDOW) that utilizes an adaptive watershed management approach to address water quality in the streams of Northern Kentucky. This approach has been endorsed by USEPA as offering the greatest opportunity for identifying and prioritizing cost-effective and protective solutions to municipal government waste-water and storm water management obligations. As one component of this management strategy, SD1 delineated sixteen (16) major watersheds throughout Northern Kentucky for intensive study. Initial efforts focused on the collection and compilation of existing data for each watershed (i.e. water quality, topography, geology, land use, land cover, etc.), which resulted in the development of an individual Watershed Characterization Report (WCR) for each of the sixteen watersheds. These reports provided a starting point for further investigation into individual watershed condition. Additionally, SD1 undertook a large monitoring effort in order to establish a baseline of current conditions of the receiving streams within each of these watersheds. This effort included biological (fish and aquatic insect), water quality, hydrological, and physical characterization (hydromodification)

surveys at nearly 80 stations across Northern Kentucky. The results of these surveys are currently being analyzed, and are crucial to understanding the linkage between receiving stream quality and changes in watershed land cover/use at the local level. It is also important to highlight that preliminary results of these surveys indicate that the highest quality streams in Northern Kentucky reside in the lesser developed areas of western Boone County and that there is a direct relationship to stream quality and the amount of impervious surface within a watershed (consistent with findings across the nation), further emphasizing the importance of broadening the understanding of how land conversion can impact water quality. This information will also provide insight on how to lessen the impact of land use changes (i.e. minimize alterations of the natural flow regime) and should be used to optimize watershed management and planning efforts.

In accordance with Section 303 (d) of the Clean Water Act, the State of Kentucky has developed a list of water bodies that do not meet their designated uses and are declared impaired waters. Being listed as such, a Total Maximum Daily Load (TMDL) must be developed for these waters. A TMDL includes strategies and controls, and is designed to be regulatory. A TMDL is remedial, and is an option for the Division of Water if local communities do not noticeably improve or plan for improvements in stream quality. However, both Elijah's Creek and segments of Gunpowder Creek were listed for TMDL development in the 1998 report issued by the Kentucky Natural Resources and Environmental Protection Cabinet Division of Water. Since that time, TMDL's have been developed and approved by the Environmental Protection Agency - Region 4 for these two streams and there has been discussion of studying Woolper Creek and Sand Run Creek. Most of the pollution issues center around siltation, high nutrient levels, and low dissolved oxygen, while Gunpowder Creek in particular includes industrial sources and urban runoff issues. According to the Kentucky Division of Water, Gunpowder Creek and Elijah's Creek have been "severely impacted" by de-icing fluids used by the airport. The airport has implemented a glycol recovery and recycling system and an aeration system in attempts to decrease permit violations. Much of these facilities came on line early in 2004 and their success will be determined over time. An important consideration is that the creeks have been impacted by this pollution for many years and may require an extended period of time to recover even after the impact is decreased to an acceptable level because of pollution and anaerobic conditions within the stream sediment.

The Kentucky EPA Division of Water monitors and collects data within a basin management cycle of five years. This monitoring includes water quality and bacteriological sampling at 70 ambient stations statewide as well as rotating watershed locations, determination of least-impaired conditions, nutrient and trophic status of public reservoirs, fish tissue sampling, biological survey of streams, nonpoint pollution sources, BMP implementation, and Total Maximum Daily Load (TMDL) development. Data and reports, including the 2008 State Integrated 305b Report that contains Boone County in its study area, can be accessed at www.water.ky.gov. Parts of Double Lick, Garrison, Little South Fork, and Second Creeks are designated as outstanding resource waters. The EPA can require the State to develop strategies to help attain water quality standards, including TMDLs, Watershed Restoration Action Strategies, or other watershed-based strategies.

Storm Water Phase II is a set of requirements implemented by the EPA that include local permits to do the following as a minimum: public education/outreach, public involvement/participation, illicit discharge elimination, construction site stormwater controls, post construction stormwater management, and pollution prevention. These local stormwater programs were required to be implemented by March of 2008, and periodically undergo review by EPA. SD1 issues the permits within their stormwater service area for most of Northern Kentucky with the exceptions of the City of Florence and City of Walton. One method of addressing these issues is the Section 319 Nonpoint Source (NPS) Program that can be grant supported and is designed to produce best management practices (erosion control and stream protection). These programs have a 5 year focus and are to be updated every 5 years and can affect National Pollutant Discharge Elimination System (NPDES) permits. The Gunpowder Creek project is underway, and a Woolper Creek project is being designed. These projects are important because they enable strong citizen and land owner involvement. All of the efforts described above are designed to protect public health, drinking water supplies, stewardship, property values, and recreation/tourism.

The EPA is concerned about water quality in Kentucky and the issuance of permits, and may become more involved from a regulatory standpoint in the future. EPA rulemaking can replace the Kentucky regulations that have been found to be deficient. Local communities, land owners, and developers may be able to avoid much

federal intervention and maintain some local control over water quality measures if successful local initiatives are undertaken. The water characterization reports being prepared by SD1 for each major watershed in Boone County contain extensive valuable information.

The 2010 Northern Kentucky University (NKU) Center for Applied Ecology 'Stream and Wetland Restoration Program' annual report shows seven restoration projects in Boone County: Split Rock Conservation Park, Big Bone Lick State Park, Adair Wildlife Management Area, City of Florence Golf Course, Boone Woods Park, Sand Run, and a small stream segment behind Burlington Elementary.

PLANT AND ANIMAL LIFE

According to the Kentucky State Nature Preserves Commission, in 2009, Boone County had 31 animal and 8 plant species listed as Endangered, Threatened, or Rare. 5 of the 8 plant species were not located in any of the 7 other counties in the OKI region when compared to the Ohio Dept. of Natural Resources.

Wildlife Habitat - The capability of land to support wildlife is determined by types and patterns of vegetation, and by the supply and distribution of water. These factors are closely related to properties of soil types. The U.S. Department of Agriculture rates the potential of soils to accommodate three types of wildlife: wetland, woodland, and open land. Wetland wildlife requires soil conditions least capable of supporting urban uses. Woodland wildlife can exist within and adjacent to urban land uses, but is susceptible to habitat loss. Open land wildlife can be found within croplands, pasture and meadowlands, often adjacent to areas of urban use.

Preservation of wildlife habitats is utilitarian, as well as having social value. Various species of wildlife perform ecological functions necessary to control bacteria, plant, and insect growth in natural drainage areas. Some species of predator wildlife are required to control wildlife population cycles.

Woodlands - Woodlands are significant natural resources as well as valuable social landscape features. Trees improve the quality of life within a community by reducing the visual impacts between conflicting land uses, and by reducing noise, light, and air pollution. In addition, tree roots stabilize soils by reducing storm runoff volumes, velocity, and soil erosion. Tree roots also stabilize stream banks, and filter runoff before it reaches and pollutes streams. Woodland cover diminishes the effects of strong winds, filters air pollutants, adds humidity, creates shade, and provides specialized wildlife habitats, as well as providing a visual beauty to the landscape.

The slopes of stream valleys in the western portion and along the northern edge of Boone County are heavily wooded, while the eastern uplands have limited and scattered forest cover. While it is important to preserve the wooded areas in the less developed areas of the county, it is also imperative to protect the scattered vegetation remaining in the urbanized portions of the county and along major public roadways for both function and appearance.

As of 2009 Boone County contains approximately 58,651 acres of woodlands (see **Figure 3.4**) which is an increase of over 1,300 acres from 2004 as a result of expanding woodland areas in the western half of the county. Approximately 32,564 acres of woodland are located within areas of the county containing slopes over 20 percent. The remaining 26,087 acres of woodlands are located on slopes less than 20 percent and are considered to be easier to develop. These woodland areas primarily exist within the areas projected to experience growth within the 25 year planning horizon.

In 2002, the Northern Kentucky Urban and Community Forestry Council performed the Forest Quality Assessment For Boone County in order to determine tree canopy cover (see **Figure 3.5**). In 2003 the Boone County Forest Canopy Cover: Public Health and Safety Function Analysis and Development of Guidelines for Environmental Protection determined the size location and relative quality of forest canopy on tracts over ten acres in size in rural areas and five acres in size in incorporated areas. The document also describes many of the public health and productivity benefits of a healthy community-wide forest cover, and makes general recommendations on how Boone County should preserve and improve forest cover. It also serves as a resource

guide for property owners who want to know what is on their property. The methodology of the study identified forest cover as three crown size classifications, large, medium, and small, which correspond generally to the age and maturity of the forest. **Table 3.1** shows the summary acreage statistics for Boone County.

In 2002, 66% of the forest cover in the county was classified as small crown. This means the forest cover is largely a result of agricultural field areas being left fallow for twenty or more years, or routine timber harvesting occurring on the sites. The large crown forest areas comprised only five percent of the total forest and only 1.7 percent of Boone County's land cover, mainly on steep slopes and in stream corridors. Only one percent of the county's forest resources existed within incorporated boundaries.

Stormwater Runoff Reduction - Trees and soils function together to reduce stormwater runoff. Trees reduce stormwater flow by intercepting rainwater on leaves, branches, and trunks. Some of the intercepted water evaporates back into the atmosphere, and some soaks into the ground reducing the total amount of runoff that must be managed in urban areas. Trees also slow storm flow, reducing the volume of water that a containment facility must store.

The Florence and Boone County Urban Forest Boards continue to implement urban forestry projects and have projects planned for the future. To date, the Urban Forest Boards have been effective on publically-owned land or right-of-way.

Table 3.1 - Boone County Canopy Forest Cover

	Area in acres	% of County
Boone County	164,469	
Large crown canopy	2,865	2%
Medium crown canopy	17,398	11%
Small crown canopy	39,132	24%
Total canopy cover	59,396	36%

Source: Boone County Forest Canopy Cover Study, 2002

AIR

Boone County has the advantage of being southwest of much of the Cincinnati metropolitan area, so that the prevailing wind is away from the county. In general this results in better air quality in the county but it also means that any air quality issues originating in Boone County typically will impact other parts of the metro area. However, the fact that Boone County has 33 miles of interstate highways and an international airport will have an impact on the air quality in the county regardless of geographic spatial relationship to the remainder of the Cincinnati metropolitan area.

Congress adopted the Clean Air Act Amendments (CAAA) in 1990 as an attempt to address air pollution problems in the nation. Six major pollutants are regulated by the CAAA (sulfur dioxide, nitrogen dioxide, lead, carbon monoxide, particulate matter, and ozone). In April of 2004 the U.S. Environmental Protection Agency (EPA) classified the greater Cincinnati metropolitan area as basic nonattainment under the 0.084 ozone standard. This area of nonattainment included Boone County. In 2008, the U.S. EPA completed its review of the national air quality standard for ozone and replaced the 0.084 parts per million with a new 0.075 parts per million standard.

Furthermore, in December of 2004 the EPA designated the greater Cincinnati area as nonattainment under the annual fine particulate matter (PM2.5) standard. The particulate matter is dangerous especially to children and elderly as well as people with respiratory problems due to them being more prone to infection. In 2011 the EPA

announced that northern Kentucky, including Boone County, has been re-designated as a fine particulate matter attainment area.

Boone County should continue to work with the Ohio-Kentucky-Indiana Regional Council of Governments (OKI) who develops strategies, programs, and plans that aim to improve the air quality in the greater Cincinnati region. Among these are the 2030 Regional Transportation Plan and the OKI Regional Clean Air Program.

SPECIAL STUDIES

Allen Fork Headwater Feasibility Study

In 2005 Boone County Public Works, in partnership with the Sanitation District Number 1 (SD1), commissioned a study to explore the potential for improving the management of storm water flows, restoring creeks and floodplains, and providing passive recreation opportunities throughout the headwater catchment of Allen Fork in Boone County, Kentucky. The project area is composed of the 684-acre upper drainage basin of Allen Fork and incorporates suburban development, light industrial development, public parklands, public and private school grounds, a YMCA recreational center, open woodlands, and major and minor roadways. It is bounded to the south by State Route 18 and divided north to south by North Bend Road (SR 237). The Cincinnati/Northern Kentucky International Airport lies immediately to the northeast and outside of the drainage basin. After exiting the project area, Allen Fork eventually flows into Woolper Creek and then into the Ohio River. The impetus for this effort was the Darlington Farms development, at the downstream limit of the project area, which was concerned about flooding and sedimentation of the development's artificial lake, formed by the impoundment of Allen Fork. This study, available through SD1, focuses on issues related to storm water volume and sediment production in the watershed.

Sand Run Creek Preliminary Ecological Study

As an example of this type of study, a Preliminary Ecological Survey of the Sand Run Creek Watershed in northern Boone County was performed in August of 1999. The Environmental Resource Management Center at Northern Kentucky University prepared this report to provide preliminary ecological information regarding existing wildlife habitats. The document examined plant species diversity, rare species, unique landscape features, ecosystem health, historical features, and potential long-term management opportunities. This project was prompted by the Boone County Fiscal Court as a result of land donations by an area developer, which raised the potential for a significant public recreation corridor. This Survey was also prepared in conjunction with the 2000 Boone County Parks and Recreation Master Plan analysis and recommendations. This study is available through NKU-CAE – <http://appliedecology.nku.edu>.

Western Boone County Study

The 1995 Comprehensive Plan recommended that a study of the western part of Boone County be undertaken so that before these areas begin to develop and the rural character is changed, a visioning process is undertaken which identifies how these areas should develop, and what characteristics should be preserved to foster and promote a quality of life desirable for future generations to come. During 1996, 1997, and 1998, the Western Boone County Study was prepared by the Boone County Planning Commission. Although never reviewed at a public hearing or adopted as an official planning tool or land use control document, it does contain valuable research in report form and suggests a series of specific corridor and area plans for specific locations in the western part of the county. The Planning Commission reviewed the findings of the report in August of 1998 and suggested that the study be accepted as a technical report and its recommendations be considered as future work projects for the Planning Commission. The study is not proposed as a land use regulatory tool by this Comprehensive Plan. This plan is available on the Boone County Planning Commission website for review at <http://www.boonecountky.org/pc/Publications/WesternBC.pdf>

Banklick Creek Watershed Analysis and Issue Characterization Project for Education and Outreach (BACE)

Based on a four-year, interagency prioritization process coordinated by the Kentucky Division of Water, the Banklick Creek watershed was designated as one of the three "highest-priority" watersheds in the Licking River

region in 2004. The severity of its water quality and quantity problems, the large number of stakeholders (land owners, businesses, and agencies affected by the creek's conditions), the high rate of projected growth, and the large number of water quality violations contributed to this designation. Most of the watershed is in Kenton County, however, a portion of the head waters area is in eastern Boone County, primarily east of Dixie Highway. The BACE project was designed to assist the Banklick Watershed Council to prioritize issues, set goals, and identify potential solutions to flooding and water quality problems. A major goal of the project was to establish the connection between forest cover, stormwater impacts, and landowner activities. The project has identified critical areas for protection and restoration and recommended many ways for individuals and agencies to positively affect water conditions in the Banklick watershed. This project's findings are important for Boone County because it creates a model for similar activity within watersheds, such as Gunpowder Creek, Mudlick Creek, Sand Run Creek, Elijah's Creek, Woolper Creek, and Middle Creek that either are or are expected to experience the same issues and potential solutions as the Banklick Creek. Positive results and implementation are occurring in the Banklick Creek valley, and this study should continue to be used as a model for other areas. Copies of this study are available at NKCAPC for reference.

IMPACTS OF DEVELOPMENT

This section addresses some of the impacts that development has on the environment in Boone County. Several factors have led to the growth the county has experienced over the past couple of decades and, as a result, the environment has also changed. The extension of infrastructure, such as water and sanitary sewer lines, determine the rate and location of growth as much as any other single factor. As Boone County's growth continues and environmental issues become more critical, issues such as water quality, air quality, noise and light pollution, stormwater, and decreased open space all can combine to affect the quality of life within Boone County.

SOILS

Soils - Erosion control is critical in preventing sediment from leaving sites experiencing development of any kind. As mentioned previously, special care needs to be taken when developing on alluvial soils due to their highly erodible nature and the fact that they often serve as aquifer recharge areas.

Permeability - Since soils of poor permeability will not filter water, neither will the soils filter or absorb septic effluent or other surface pollutants. An extreme health hazard can be created when such pollutants are directly mixed with storm and surface waters. When poor permeability is caused by high water tables, septic systems and general urban uses can transfer pollutants directly into the streams and the ground water supply. Major advancements have been achieved in Boone County by implementing the regional sewer system that has eliminated many individual treatment systems. Boone County Fiscal Court has assisted with the installation of sanitary sewers for existing subdivisions served by individual treatment systems by funding up to 1/3 of the assessment costs. This type of activity should be encouraged.

Poorly drained soils are subject to frost action and settling which can crack foundations, fragment roads, displace utility lines, and generally damage or impair urban improvements. Public sewerage, artificial drainage systems, special road bed fills and foundation designs can overcome some permeability limitations through increased cost and exacting design criteria.

Depth to Seasonal High Water Table - Areas of high water table are easily polluted since runoff from urban areas can pass pollutants directly into the ground water table. Heavy storms can also back the water table up to the surface and cause surface ponding and flooding. Urban uses provide additional storm runoff and aggravate this problem.

The depth to a particular area's water table should always be addressed before developing on it. As the ground water level gets closer to the surface, potential pollution and construction problems increase. Very shallow water table depths are risky areas on which to develop, and should not contain urban uses. High and moderate depths are developable.

Strength of Soil - Because all soil types are more subject to erosion when the ground cover is removed, erosion control measures are vital in preventing sediment from leaving the developing site. All soils will erode on moderately to steeply sloped lands, particularly where such lands have been cleared of tree and ground cover.

Depth to Bedrock - Like soil materials, bedrock characteristics have more impact when they occur with other factors, than when they exist alone. The presence of shallow bedrock conditions increase trenching and other utility placement costs. Select fill must sometimes be used to absorb storm runoff or provide pads for roadbeds, parking, and building foundations. While such actions are costly improvements, the resulting modifications are not environmentally hazardous. When shallow bedrock depths occur on impermeable flat lands, however, high water tables are likely to be created, which are subject to flooding and/or groundwater contamination. Steep slopes with shallow bedrock depths, Kope geologic formations, and unstable soils without tree cover are landslide prone. When these situations exist, the capability of the land to support urban uses without serious environmental hazards is minimal.

Slope and Erosion - Most soils within Boone County are considered to be highly erodible soils, therefore, during the construction of any site in which the ground cover has been removed erosion control measures are extremely important until such time as ground cover can be re-established. The sediment which is removed from sites diminishes the water quality, which not only affects drinking water, but inhibits the many recreational aspects that water provides, such as fishing. Sediment that fills in drainage channels can aggravate flooding and cause more property damage.

Agriculture Values - Farmlands in the path of urban growth have disappeared in recent years in metropolitan areas across the nation. Land that is good for farming; flat to gentle slopes, well-drained, cleared of dense vegetation, moderate to deep bedrock; also happens to be the most suitable land for urban development. Growing urban populations in our nation will increase demand for continued agricultural productivity, while they displace agricultural activity. Increased energy and transportation costs may also require urban areas to depend more on local agricultural production than before.

The suburban growth patterns found within Boone County are very similar to those found throughout the country. In 1994, 85,338 acres of land considered to be developable existed within Boone County, while in 2009, 59,661 acres were considered developable. Of the 2009 developable land acreage, 18,558 acres or 31.1% is considered prime agricultural land. Therefore, within the 25 year planning horizon portions of the most suitable agricultural land which remains within the county could be converted to other land uses, even if the relatively slow 2008-2011 development trend continues.

As pressures increase to develop the prime and state wide important agricultural lands of the county, the character of Boone County will be altered. Future studies and visioning efforts should determine whether Boone County will retain the rural identity of the county, or whether agricultural lands should be developed. If the agricultural lands should develop in a more urban manner, then standards should be established which attempt to preserve the unique character of these areas.

Topography - Scenic areas within Boone County that are identified by special study should be protected from insensitive development. Therefore, the river views will propel future development which can disrupt or destroy the scenic hillsides. There are extensive recommendations, prepared mainly by the Hillside Trust, that present accepted methodologies to influence new development design so that the hillside views are not changed dramatically. A study should be conducted to identify significant scenic areas, and to outline measures to be taken to preserve or enhance these views. The Geographic Information System (GIS) should be used as a tool to accomplish this task.

Criteria should be established which help define and map the scenic areas within Boone County. If these areas are to develop, standards should be created which outline the procedures and methods necessary to protect and minimize negative impacts to the scenic landscape. In addition, standards should be developed for the vast areas of Developmentally Sensitive land within Boone County. These standards should establish procedures for how these areas may develop without creating an environmental hazard.

Requirements for the control of dust, noise, dirt on public right-of-ways, and erosion in all public and private construction activity should be reviewed and revised where needed. In addition, the re-establishment of ground cover and reuse of resources such as removed trees for mulch, lumber, or firewood should be evaluated.

WATER

Stream Tributaries - Runoff from urban and agricultural uses add suspended soil particles and chemicals which lower water quality and consequently increase water purification costs. Runoff from land uses sited close to a stream's natural drainage channel can contaminate a stream's purity, fill stream channels with sediment, cause flooding and erosion, and damage the aquatic and animal life balance, thereby permitting uncontrolled algae and bacteria development.

Man-made storm drainage systems can be designed to handle stormwater runoff volumes and to contribute to groundwater recharge. However, such systems do not replace natural water filtering processes. Developments should look at a mix of man-made and natural stormwater mitigation measures and use structural solutions, such as detention basins and pervious pavement, with non-structural solutions, such as natural vegetation buffers along streams. Maximum runoff limits, as established through specific drainage basin calculations, can also keep stream pollution levels within manageable limits and reduce flooding.

Throughout Boone County, the effects of commercial and industrial development on stormwater conditions have long been understood. However, the potential cumulative stormwater runoff impacts from residential development occurring in Boone County cannot be overlooked by stormwater management officials. Even with required detention basins and other facilities that control the rate of stormwater flow, the overall amount of stormwater reaching the county's creeks is increasing as a result of new impervious areas. Because of the difficulties in implementing public regional stormwater detention, studies such as those conducted in the Banklick Creek watershed that suggest vegetation and buffer areas as one way to minimize storm runoff should become more common. Aside from regional detention, Boone County has made improvements in the upper Gunpowder Creek watershed that help water flow downstream. Sanitation District Number 1 (SD1) now administers stormwater management throughout most of the developed areas of Northern Kentucky. Two notable exceptions are the City of Florence and the City of Walton which plan to continue to operate their own systems. In the meantime, municipalities and counties continue to administer stormwater requirements and maintain public stormwater facilities for parts of the system.

Floodplains - As was learned in the 1993 Mississippi River floods and the 1997 Ohio River and Licking River floods, floodplains are not suitable for permanent urban uses. These areas must also be protected from urban improvements on adjacent lands which may alter drainage patterns and volumes. SD1 has been conducting watershed characterization reports in an attempt to quantify the impacts of impervious area on the condition of each stream. This information can be used for planning purposes. GIS can also be used to plan infrastructure and to help in emergency efforts. The Federal Emergency Management Agency (FEMA) recently updated its floodplain mapping. For decades, the Flood Insurance Rate Maps have been used by public agencies and citizens to determine many site related issues regarding flooding extent, precautions, and insurance needs.

Water Quality - Pump stations and the availability of sewer service could have a significant impact in the western portion of Boone County as it would allow it to develop at much greater densities. The Public Services and Facilities element explains this in greater detail, as well as identifying some of the incremental effects of development within these areas. Most of these western areas currently have a rural character. The rural character that many residents desire may be at risk if development within these areas is not sensitive to the environmental factors mentioned within this element.

PLANT AND ANIMAL LIFE

Woodlands - The Boone County Forest Canopy Cover Study examined in detail forest affects on air quality, stormwater management, floodplains, ground water recharge, erosion, steep slopes, and analyzed where the existing forest canopy lies in relation to future land usage and zoning. The study describes the benefits of tree canopies to offset the effects of impervious areas.

Tree cover is directly related to environmental quality. Maintaining a robust enough tree cover to function as green infrastructure reduces the need and expense of building infrastructure to manage air and water resources. Local agencies can use CITYgreen software to calculate the environmental and economic values of the ecosystem services that trees provide.

Wildlife Habitat - The loss of habitat can also result in animal control problems to residents and automobiles because of displaced animals searching for food and nesting areas. Woodland wildlife should be the primary concern in Boone County, because of the extent of woodland habitat and its vulnerability to urban growth. Corresponding with the pattern of woodlands, woodland wildlife habitats appear predominantly on the western side of Boone County, and diminish to small and isolated spots in the eastern and more urban portion of the county.

AIR

Air Quality - Low density land use requires people to travel much further distances to their places of employment, schools, shopping, and recreation. Across the United States experience has shown that existing road systems are becoming overwhelmed and congested with traffic, affecting the air quality of the county and the region. Federal regulations which include the Clean Air Act Amendments of 1990 (CAAA), the Transportation Efficiency Act of the Twenty-first century (TEA 21, follow-up legislation to ISTEA), and SAFETEA-LU (Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users) were created to limit the effect that increasing mobility in the future in metropolitan regions have on air quality. The effect that low density development has on the transportation system and how it relates to the federal legislation for the county and the region is explained in further detail in the Transportation Element.

According to OKI, vehicle emissions from transportation sources are projected to decrease as newer vehicles, meeting stricter federal emission standards, are incorporated into the fleet mix. **Table 3.2** compares different types of emission measurements in the three Northern Kentucky counties. VOC stands for Volatile Organic Compounds, CO stands for carbon compounds, and NOx stands for nitrogen compounds. New transportation facilities must undergo air quality analysis to attempt to forecast each facility’s impact on future air quality. OKI generally performs this analysis in concert with federal agencies.

TABLE 3.2 – Emissions Measurements; Northern Kentucky Counties

	2005	2008	2010	2015	2020
Boone County					
VOC	4.33	4.00	3.92	3.17	2.96
CO	47.20	44.46	42.36	37.41	38.21
NO _x	10.27	8.53	7.42	4.63	3.45
Campbell County					
VOC	2.52	2.29	2.21	1.74	1.55
CO	27.50	25.52	23.98	20.39	19.97
NO _x	5.98	4.88	4.21	2.54	1.81
Kenton County					
VOC	4.32	3.85	3.65	2.85	2.56
CO	47.19	42.76	39.54	33.68	32.97
NO _x	10.39	8.37	6.91	4.23	3.01
OKI KY Total					
VOC	11.17	10.14	9.78	7.79	7.09
CO	121.89	112.74	105.88	91.48	91.14
NO _x	26.64	21.78	18.54	11.40	8.27

Source: OKI and Kentucky Division for Air Quality

Furthermore, air traffic at the Cincinnati-Northern Kentucky International Airport will continue to be a factor in the air quality of Boone County. The airport anticipates an increase in cargo traffic and will be addressing this issue in their Master Plan update.

CONSERVATION TOOLS

LEED

The Leadership In Energy and Environmental Design (LEED) Green Building Rating System is an independent certification program that provides voluntary guidelines for developing high-performance, sustainable buildings. Created by the U.S. Green Building Council (USGBC), the program awards varying levels of certification to buildings that meet LEED rating standards in five major categories: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. LEED standards exist for new construction as well as existing buildings and remodeling, and can be

applied to homes, commercial facilities and even neighborhood development. Architects, engineers, interior designers, landscape architects and facilities managers use LEED in developing new projects. When redesigning your home or office, you can look for LEED Accredited Professionals (LEED APs) who can implement LEED standards and help make your project a more sustainable building.

LEED has special rating systems that apply to all kinds of structures, including schools, retail and healthcare facilities. Rating systems are available for new construction and major renovations as well as existing buildings. The program is designed to inform and guide all kinds of professionals who work with structures to create or convert spaces to environmental sustainability, including architects, real estate professionals, facility managers, engineers, interior designers, landscape architects, construction managers, private sector executives and government officials. State and local governments around the United States are adopting LEED for public buildings of all kinds, and LEED initiatives at the US Departments of Agriculture, Defense, Energy and State drive activity at the federal level. In addition, various types of LEED projects are currently underway in over 40 other countries.

PDR and TDR

Transfer of Development Rights (TDR) and Purchase of Development Rights (PDR) programs are based on the concept that property owners have a bundle of different rights subject to reasonable local land use regulations. These include the right to use land, lease, sell and bequeath it, borrow money using it as security, construct buildings on it, develop it, or protect it from development. Normally all of these rights pass from seller to buyer; however, they do not have to. These types of programs allow the property owner to separate and sell their right to build on the land separate from the other property rights. A TDR program allows private interests to purchase these development rights to use on designated lands elsewhere. A PDR program allows the government or non-profit organizations to purchase the development rights with the responsibility to prevent development on the subject parcel(s) according to program objectives. As can easily be seen, both types of programs are voluntary and intended to pursue a community objective while offering the property owner an incentive regarding compensation for property rights. In these programs, there is not an outright sale of property but the sale or transfer of development rights. The property owner is capable of enjoying all the remaining rights on the property that have not been sold. For example, a farmer can continue an agricultural operation forever, while no, or a reduced number of houses, industrial development or other urban land use would be developed. These programs can enable considerable beneficial estate planning options and tax benefits for the property owner as well. TDRs are permitted by state law and referenced by the Boone County Zoning Regulations. They must be based on a fair and equitable appraisal formula for generating land values and exchange methods.

Kentucky has a Purchase of Agricultural Conservation Easement Program (PACE), however, generally, Boone County land is too expensive to make this program viable by itself. Some communities have used a designated tax, or leveraged PACE funds with a local bond.

Under direction of the Boone County Fiscal Court, in 2001/2002 the Boone County Planning Commission conducted a feasibility study of two growth management tools which have been employed elsewhere in the United States: 2002 Study of PDR and TDR for Boone County, Kentucky. The purpose of this study was to evaluate how PDR and TDR programs have been used by other communities and to determine whether either technique may be appropriate in Boone County. An Advisory Group composed of individuals representing a range of interested parties in Boone County was assembled for this study. The group was selected by the staff and created as a sounding board for varied interests, which range from farmers and residents to homebuilders and the economic development community. The project included a presentation of the PDR/TDR case studies by American Farmland Trust.

The characteristics of both PDR and TDR were explored at length using detailed case studies and data from current literature on the subject. Important issues and necessary implementation steps for both techniques were discussed in general terms. A "toolbox" of other land conservation techniques was also examined. This research was then assessed relative to Boone County. Together, data from existing PDR and TDR programs, a review of current literature, and an analysis of Boone County lead to the conclusion that PDR was a workable tool for Boone County at that time. However, land prices were found to be high enough in Boone County to make the tool

unlikely. The study also emphasized that PDR is only one of a number of tools designed to preserve open space and make farming viable. Some tools (PDR, Ag Districts, differential assessment for taxes) help make farming more lucrative. Others (zoning and Conservation Subdivision Design) encourage orderly and cost-effective growth in Boone County by concentrating development near existing or planned infrastructure and affecting the physical design of development. TDR was found not to be appropriate for Boone County because of lack of public acceptance of higher density development in the urbanizing portions of Boone County. As a result there was little potential for density receiving areas to allow the TDR formula to work.

CONCLUSION

While acting as an attraction to new residents, prime agricultural land, wooded hillsides, and stream corridors are the factors that are most impacted by new development. Future development in the county should utilize environmentally sound design criteria and Boone County needs to place a value on the mitigation of environmental impacts of development. Flooding caused by urban and suburban development is increasingly affecting both the major and minor tributaries. In the early 1990's relatively few creeks, such as Gunpowder and Elijah's Creeks experienced significant flooding, however, this Plan notes that many others now are partially affected, such as Sand Run, Woolper, Big Bone, and many smaller tributaries of the Gunpowder Creek watershed. Regional and local stormwater detention, as well as erosion control and enforcement, need to be addressed in more detail in local regulations. Soils in Boone County are generally not well suited for septic leach activity. Water line extensions must be carefully examined to determine its effect on water usage and resulting effect on septic performance. Stormwater regulations should be applicable to all types of development, and should be in effect before the undeveloped areas develop to prevent flooding, and costly stormwater control measures in the future.

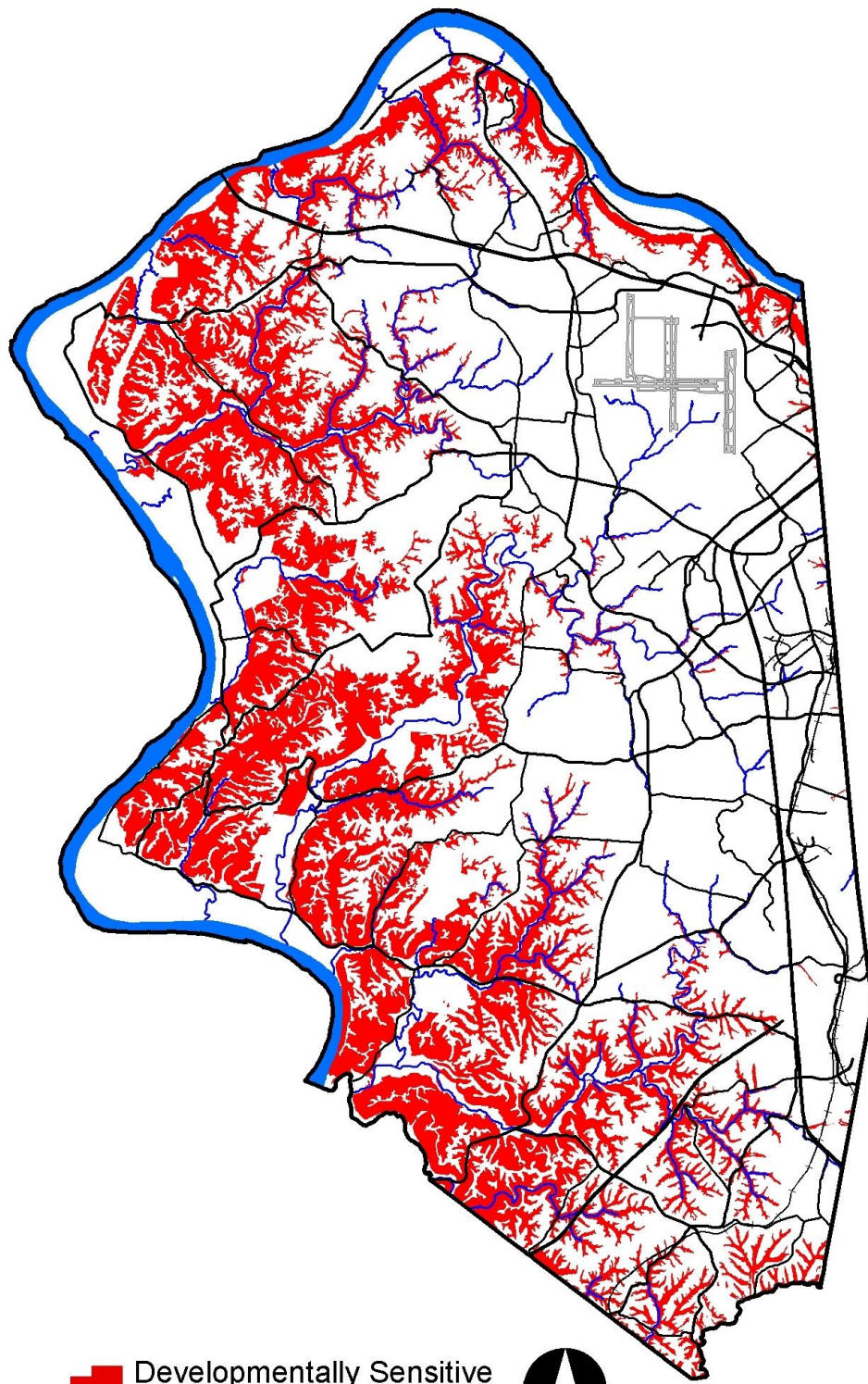
Development and environmental conservation can benefit each other instead of being treated as opposing factors. There are innovative tools that can provide incentives, tradeoffs, or simply good design to result in development patterns that make use of or conserve natural resources instead of building over them. These objectives can be achieved without excessive regulation. Special corridor studies should be conducted on a continuing basis to consider natural areas in Boone County for innovative development design, conservation, recreation, or preservation.

To anticipate what changes can occur to Boone County's environmental resources within the 25 year planning horizon a forecast of the county's future development patterns is needed. The Population, Housing, and Business Activity Elements of the Comprehensive Plan identify the areas of Boone County which are projected to experience rapid growth in the short range, as well as the 25 year planning horizon. In addition, these Elements generally identify the type of land uses which will develop within these areas. When examining where the growth of Boone County will occur, one needs to consider where the developable land is within the county. For example, the land areas which are located within flood plains or have slopes over 20% are considered to be developmentally sensitive, because of the environmental costs which can result from the development of these areas. Development should mitigate its impacts within these areas.

Low density residential development creates further environmental impacts. Direct impacts include decreases in air quality from increased automobile miles traveled, increased waste products such as yard waste in landfills, water quality issues from increased stormwater runoff containing many household and yard chemicals, and sanitary sewage. Indirect environmental impacts can include the extensions of public services, increased transportation distances for daily products, and a greater consumption of natural resources such as trees and oil.

Overall, land planning in Boone County should enable the developable lands to be developed at a higher density, thus reducing the need to develop the developmentally sensitive areas. This would be the most effective way of preserving the environmental characteristics of the rural portions of the county, while reducing the air pollution within the region and making mass transit more feasible and effective. Based on developed and non-developed acreage analysis it appears that significant additional development areas, particularly for residential development, do not need to be provided for in the 2035 Future Land Use Plan. This would be subject to review in future

Comprehensive Plan updates. As Boone County's development continues, design will become increasingly important. Attention to water runoff, traffic congestion, and visual impacts will require more attention so that the cumulative impacts of development on the environment can be addressed.



Developmentally Sensitive (DS)



0 1 2 Miles

Figure 3.1 - Developmentally Sensitive

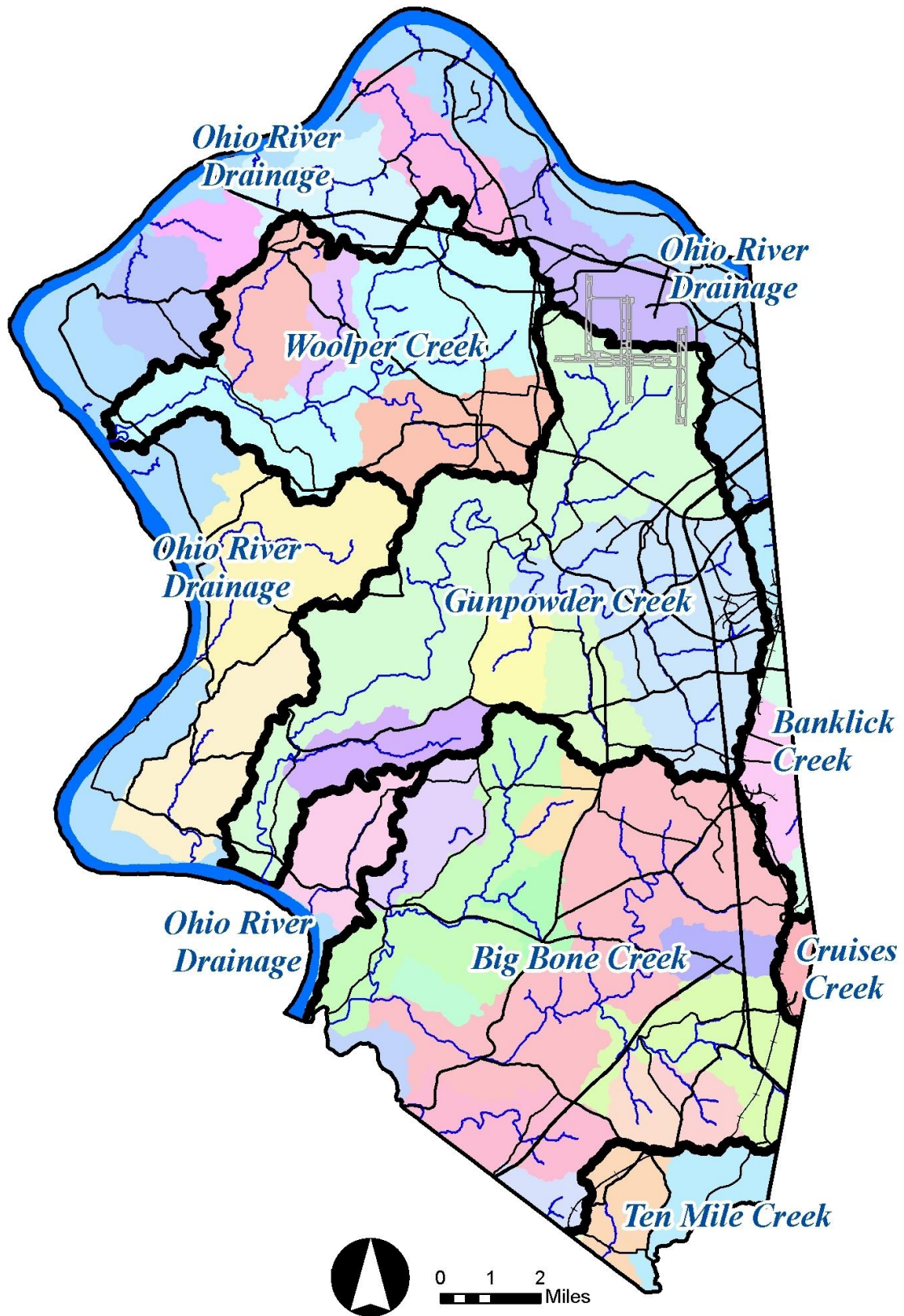


Figure 3.2 - Major Watersheds and Stream Tributaries

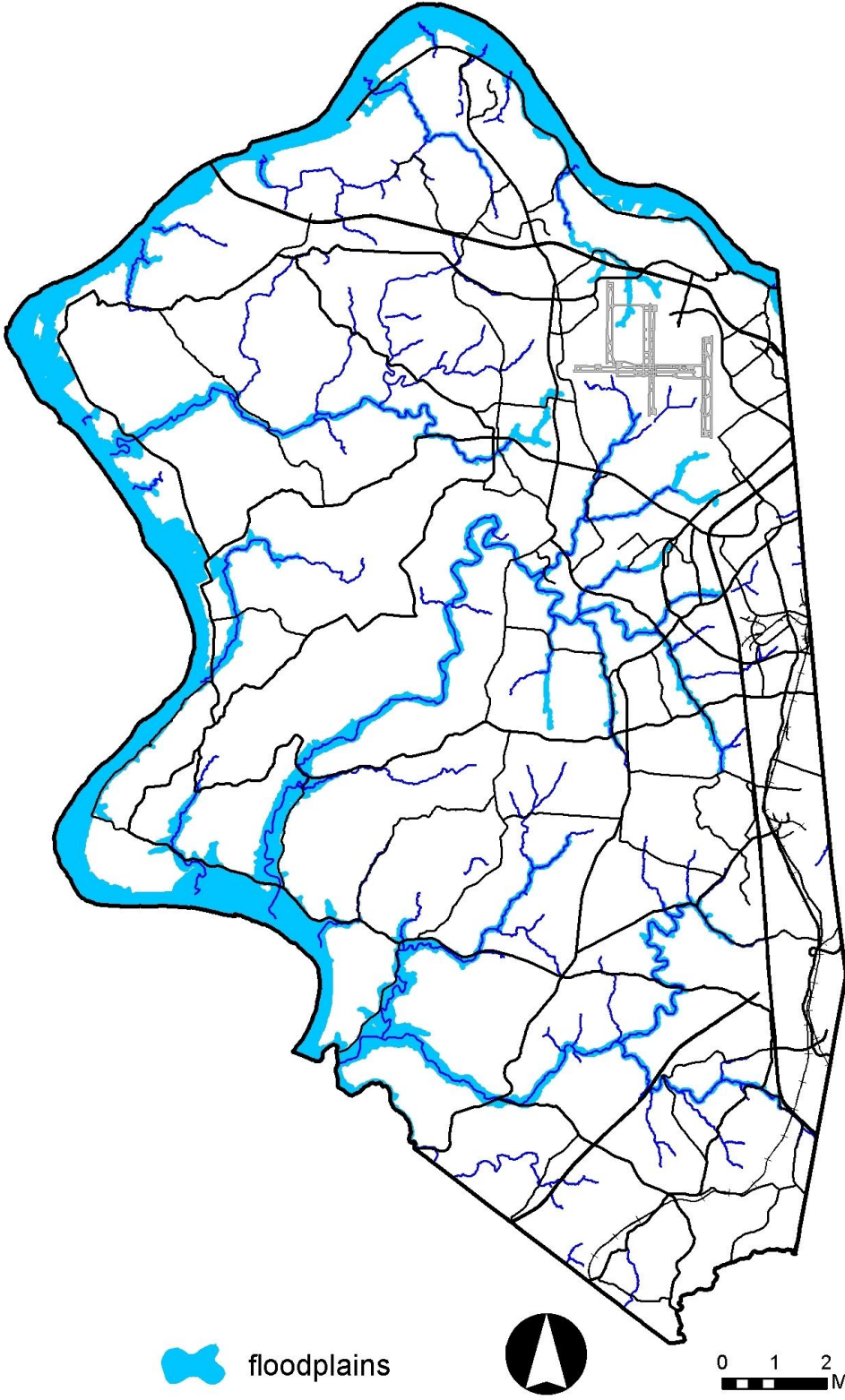


Figure 3.3 - 100-year Floodplains

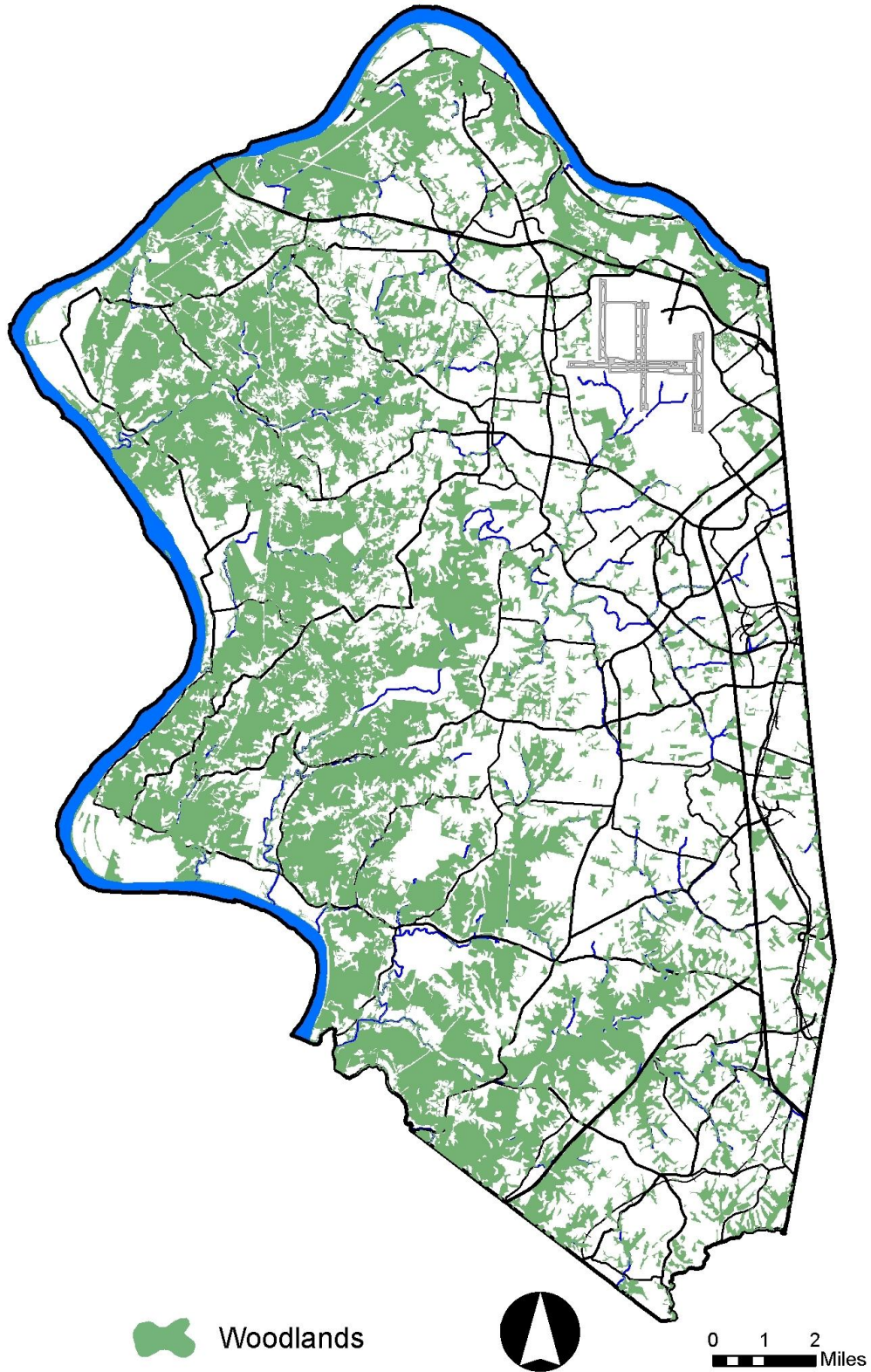


Figure 3.4 - Woodlands

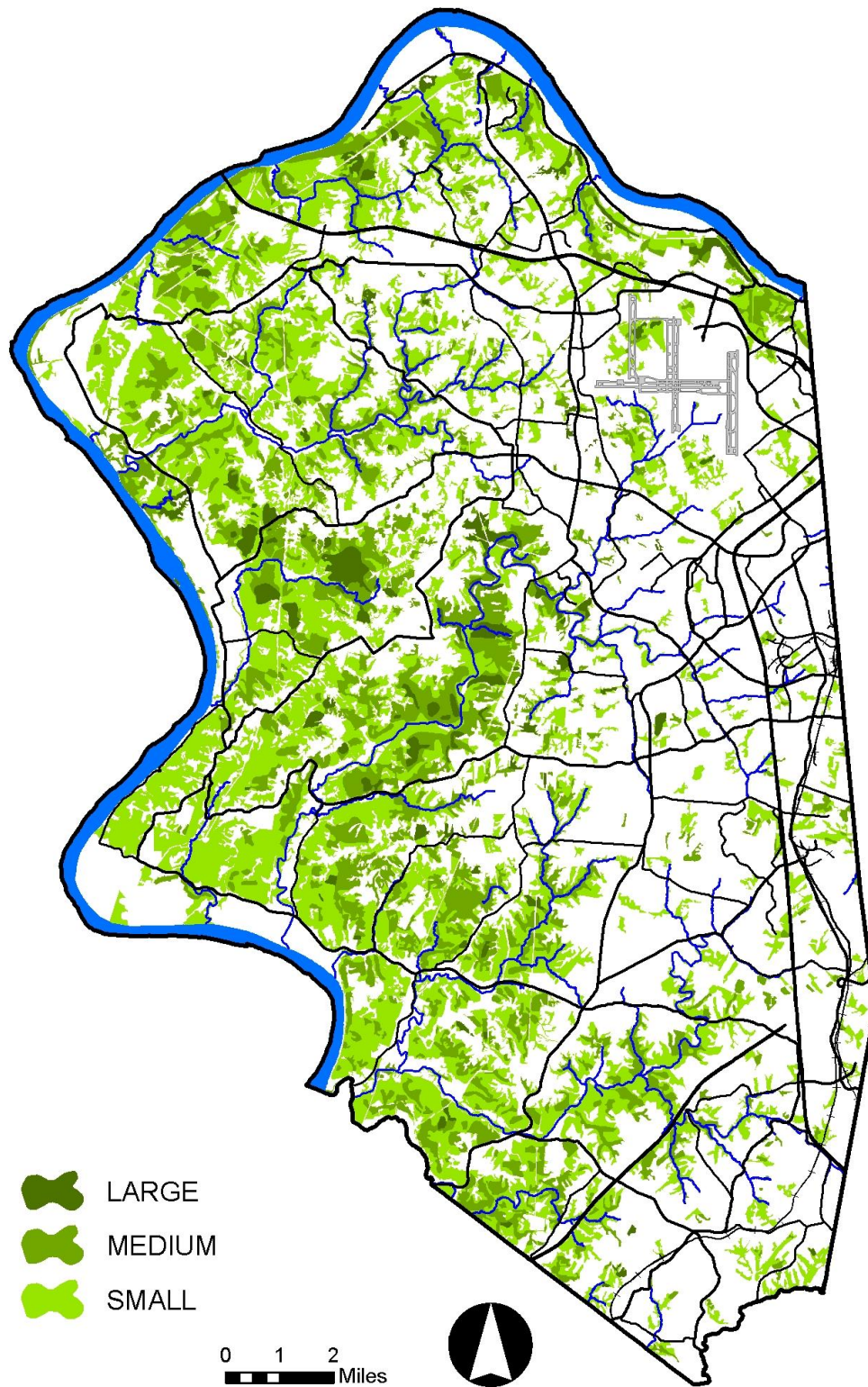


Figure 3.5 - Canopy Cover