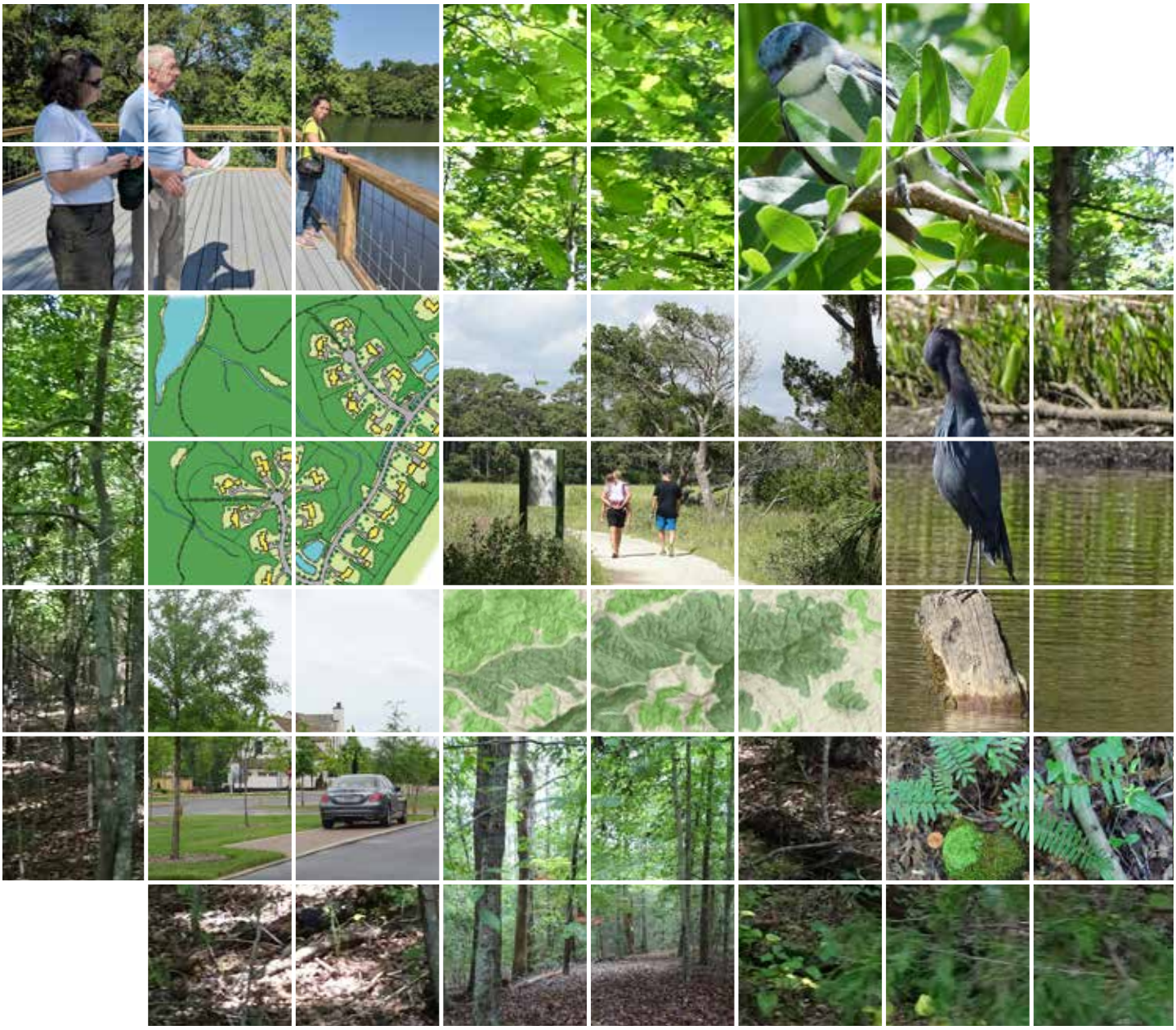
Forest Connectivity in the Developing Landscape

A Design Guide for Conservation Developments

By Karen Firehock
Green Infrastructure Center Inc.



Green Infrastructure Center

September 2019

The work upon which this publication is based was funded in whole, or in part, through an Urban and Community Forestry Grant awarded by the Southern Region, State and Private Forestry, U.S. Forest Service, and administered by the North Carolina Forest Service and the South Carolina Forestry Commission.

Publication Date: September 2019

Green Infrastructure Center

PREFACE

This guide provides the reasons, steps, processes and marketing tools for conservation subdivision design. It builds on other works on this topic by incorporating modern tools of Geographic Information Systems (GIS) analysis, habitat modeling, and best design practices for maximizing forest conservation and connectivity. It also takes a strong conservation approach to this design by focusing, not just on the notion of 'open space', which could be a lawn or a plaza, but rather on conserving habitat and restoring it where it has been impaired. Two case studies of real sites were designed in tandem with this guide's writing, one in North Carolina and one in South Carolina. Referring to both studies, this guide takes the reader step-by-step through the design process and the challenges posed by implementing ideal design principles in the real world—with all the inherent site and policy constraints they typically encounter.

Audience for This Guide

This guide was written for:

- Developers who want to design developments that cost less to build, sell faster and for better profits, or who want to leave a green legacy.
- Foresters who want to ensure that their forests are conserved as much as possible, and to help them communicate the value of forested landscapes to developers, builders and planners.
- Planners who want to show developers, county commissioners, and city councils how and why forests can be accommodated in the developing landscape, while avoiding the creation of new risks for fire, water quality or loss of open space and scenic and cultural assets.
- Land Trusts who may either:

  —wish to sell or share parts of their land for development, but want to create assurances that the land can still function for wildlife, recreation, water recharge and other values

  —become holders of open space easements within conservation developments
- Conservationists who want to ensure connectivity and habitat for wildlife or to protect rare, threatened or endangered species.
- Elected officials such as County Commissioners can use this guide to determine how growth can occur in patterns that minimize the costs of development and maximize property values.
- Community members who want to see new types of development that use less land, while creating healthy communities of lasting value.

About the Author

This guide was written by Karen Firehock, who brings thirty-three years of practical knowledge, design and planning skills, and field experience to the topic of conservation-based development. She is educated in natural resources management and has spent twelve years overseeing stream and wetland monitoring and restoration projects across the United States:

After years of fixing impaired streams and wetlands, she realized it is better to prevent destructive land development practices that are the cause of this degradation. So after twelve years in the field, she returned to college to obtain a master's degree in planning, in order to address the large-scale sprawl development enveloping America's wild places.

In 2006, Karen founded the nonprofit Green Infrastructure Center Inc. to provide research, practice and education in how to consider our natural resources as 'green infrastructure.' America's forests, rivers, wetlands and lakes provide us with habitat, clean air, drinking water, recreation and natural beauty that we all need to survive – and these natural resources should be included in everyday planning. So, just as we plan for our 'grey infrastructure' of roads, sidewalks, bridges or power lines, we need to plan for our 'green infrastructure' of forests, agricultural soils, rivers, lakes and wetlands.

Funders

This guide is funded by the Southern Region of the USDA Forest Service and the forestry agencies of the Carolinas: the North Carolina Forest Service and the South Carolina Forestry Commission. Both agencies promote forest conservation and the continuation of a strong forest industry. They also support urban and community forests to provide healthy forests where people live. This guide supports these agencies' missions by showing how we can conserve forests as these states continue to grow and develop.

CONTENTS

1 A BETTER WAY TO DEVELOP

1.1 Development of Our Forested Landscape in the United States

Land development for commercial and residential uses is the single greatest threat to our southern forests and the potentially the most impactful practice to our landscape. Development in forested landscapes also can significantly impact water supply by removing trees that filter runoff or help recharge aquifers. When land is stripped – lot line to lot line clearing – it can take decades for newly planted trees to replace the values mature trees provided for shade and urban cooling, stormwater uptake, natural beauty and real estate values. The habitat of a forest is lost when we replace woodland with street trees. However, we do not have to design in ways that are so impactful. Every development does not need to start with the landscape as a blank slate entirely stripped of its trees.

In America, and especially in the southern United States, where we are rich in natural beauty and abundant water, it is easy to forget that our land is a finite resource. Fifty years ago, in 1969, Ian McHarg penned his now famous book *Design With Nature* in which he advised developers, builders and land planners to "design with nature" by first considering, mapping and evaluating a site's natural features and functions, before creating development plans. McHarg promoted a respect for nature and advised that it is easier and more effective to design in ways that adapt to the landscape rather than adapting the landscape to our will. This saves development costs by working with natural drainage patterns rather than engineering and piping them out of existence – which often leads to other problems, such as poor drainage, erosion and a legacy of expensive maintenance.

McHarg's overlay maps of waterways, slopes, soils, views and vegetation formed the underpinning for the digital overlays we create today using GIS (Geographic Information Systems). In the 21st century, we have a wealth of data at our fingertips, Indeed, we have better data than ever before to evaluate, map, model and design habitable landscapes. Unfortunately, in the meantime, the advent of large earth moving machines has made it very easy to flatten a landscape, pipe and bury a stream, fill a wetland, remove topsoil, and create places that, while they are easier to develop, are devoid of ecological function and character.

"It is easier and more effective to design in ways that adapt to the landscape rather than adapting the landscape to our will."

Natural systems should be respected and protected from harm.

Clearing an entire site before building destroys the site's natural beauty and removes nourishing topsoil.

"Ironically, we often name developments for the very features we destroy in making them, such as Tall Oaks or Pine Lake.

Clearing and flattening a site entirely before building – a scorched earth method – while easy, is not without consequences. Places built on top of filled wetlands complain of poor drainage and excessively humid environs, while people downslope complain of new 'floods' that didn't happen before the filling. People move to lakes to enjoy the water and build their dream homes, but strip their lots of all vegetation and then wonder why the lake is so cloudy and the fishing so poor. Neighborhoods developed in this way suffer tremendous heat without shade trees, while little tree saplings wither in yards built on clay, since all the nutrient-rich topsoil has been stripped away.

Ironically, we often name developments for the very features we destroy in making them, such as Tall Oaks or Pine Lake. One development was named 'Still Meadow,' which to those who know anything about meadows, connotes a 'dead meadow.' A living meadow is anything but still – it should hum with the sounds and sights of birds, bees, crickets, beetles, dragonflies, butterflies – and perhaps the sounds of children playing a game of hide and seek in the tall grass. A meadow is a very alive landscape, especially when it is populated with native plants and enjoyed by all manner of avian and earthly creatures.

This guide asks you, the reader – whether designer, forester, developer, planner, elected or appointed official, or concerned citizen – to ask for, demand and design land developments that conserve the best aspects of a landscape while maintaining or restoring landscape connectivity with adjacent lands and beyond.

We can all design developments of lasting value that are also healthful places for both people and wildlife. We can all build in ways that not only don't disrupt habitats, but actually reconnect pathways and flyways.

This guide shows how to think and plan in a better way, using 21st century tools, knowledge and conservation principles. There is a better way to grow, and consume less of the landscape, while generating communities of lasting value and legacies of which we can all be proud. Let's begin.

1.2 Why This Guide Is Needed

This guide shows how to develop in ways that maximize forest abundance and connectivity and provides best practices for ensuring trees planted during development will survive. So, why do we need a guide for how to protect forests in developing landscapes?

Today our forests are under threat from pests, storms and alternating droughts and floods; however, the greatest impacts are from forestland conversions. What is different today from decades past is the rate at which we are using up the land. Development is occurring across the southern United States at a rapid pace. And it is not just the rate of growth, but the sprawling patterns of that growth.

Sprawl-patterned development uses more land but accommodates less people. Larger lot sizes and road networks that wind around and are not connected take up more space. Since many subdivisions lack inner-connectivity, they rely on access to feeder roads, requiring wider, multi-lane roads to carry the traffic volume. All of this translates to more land disturbance.

In addition, the practice of lot-line-to-lot-line clearing so that there are no obstacles to earth moving, such as a woodland grove, means that sites are stripped of their trees and other vegetation before site plans are even reviewed. Not all communities allow land clearing before obtaining a permit, but many do.

In addition to large subdivisions that convert forests, individual houses built at the edges of cities – in areas referred to as the 'wildland-urban interface' – can also cause impacts to forests. These developments within rural areas add to forest fragmentation. In fact, according to the Southern Forest Research Station, the number one threat to forests in the Southern Region of the U.S. is breaking them up into smaller and smaller parcels. As forested land is subdivided, those smaller parcels are more likely to be developed. Small, developed lots impede wildlife movement, impair surface waters, increase fire risks, hinder groundwater recharge and are too small to manage for forestry or wildlife uses.

A key trend that will affect loss of forested land in the south is the transfer of forest ownership to real estate investment trusts (REITs). According to the USDA FS Southern Research Station, this change in ownership to REIT corporations makes forest land a more liquid asset class that will trade more frequently in the future. When strategically located, those lands are more likely to be sold for development. Over time, individual

"Species are at risk now more than ever. According to the United Nation's Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service, more plants and animals are threatened with extinction now than at any other period in human history. The average abundance of native species in most major land-based habitats has fallen by at least 20%, mostly since 1900."

corporate forest holdings could decline in size. To learn more about these threats, see: https://www.srs.fs.usda.gov/futures/technical-report/06.html#keyfindings

Although logging is commonly blamed for forest losses, harvested landscapes that are managed for forestry are usually regrown and represent a stable land cover of forest over time. But when land is cleared for development, that forest is lost forever. Yet it does not have to be that way. We can design patterns for development that utilize far less land and allow for both wildlife passage and opportunities to enjoy nature-based recreation, as well as groundwater recharge, beautiful vistas and many other benefits of increasing forested land cover. We can develop in ways that minimize development footprints and maximize the preservation of forest connectivity and function.

Section Three describes how to develop and conserve in a new way that maximizes the Carolinas' forest values and provides healthful places for people to thrive by experiencing nature in the landscapes where they live. It also shows how to avoid, or minimize, forest fragmentation by clustering homes and commercial areas. Clustering involves putting homes on smaller lots closer together, to consume less land per lot while offering amenities, such as hiking trails, fishing or birding, that other developments cannot.

Although clustering is not a new concept, not all "cluster subdivisions" protect forests or maintain connections within and outward from the development. In addition to *Design with Nature* (1969), mentioned in the preface, many readers will be familiar with Frederick Steiner's *The Living Landscape* (2000) or the work of Randall Arendt *Conservation Design for Subdivisions* (2006), both of which describe how to inventory natural features and cluster development lots closer together to maximize open space and avoid despoiling critical natural features.

This guide is different. While it also advocates clustering, it focuses specifically on maximizing forestland conservation and wildlife values. It eschews the vague notion of simply protecting 'open space,' which can be made up of anything from chemically treated acres of lawn to paved plazas. Rather, this guide focuses on creating healthful landscapes that support a multitude of species. This is a key distinction because the quality of the open space and how it functions matters – for both wildlife and people!

Designing "Conservation Subdivisions" — Additional Standards

- **Preserve at least 50 percent of the site as undeveloped land**
- **Protect and restore native habitats within that open space**
- **Respect and maintain natural hydrology by avoiding stream crossings, stream piping or wetland filling**
- **Avoid cutting or severing natural wildlife corridors and restore them where needed**
- **Plan for the site in the context of the surrounding landscape, with sensitivity to adjacent land uses and regional connectivity**
- **Avoid development in remote rural areas that will spur more growth in those areas**
- **Avoid steep slopes and unstable or wet soils, in order to prevent erosion**

Meriam Webster's dictionary defines conservation as:

> *1: A careful preservation and protection of something, especially the planned management of a natural resource to prevent exploitation, destruction, or neglect water conservation wildlife conservation, or;*
>
> *2: The preservation of a physical quantity during transformations or reactions.* [1]

We are implementing definition No. 1, which not only removes land from a development footprint but also plans for the ecological health and integrity of that landscape.

In this guide, when we refer to "**conservation subdivisions**" we are not merely suggesting we leave some developable land undeveloped. Although we draw upon established standards, which will be discussed in detail later in this guide, we maintain that a stricter set of standards are necessary, in keeping with the meaning of conservation. Specifically, we apply the commonly accepted standard of preserving at least half a site's acreage as open space, but we also set standards that require adherence to additional principles, listed in the box above.

This guide considers how to plan for a site within the context of the larger landscape. It shows how to maintain and foster key relationships that exist at multiple scales to accommodate drainage, as well as movement of both wildlife and people into and out of the site. It also considers both adjacent and possible future land uses to ensure that development is as harmonious and unobtrusive as possible.

We draw on past work in guides written previously for South Carolina and North Carolina that have dealt with conserving green infrastructure networks, as well as the author's own work on stream buffer design, comprehensive planning, forest conservation and watershed planning. Lastly, to avoid creating a work of hundreds of pages, as some authors have done (the kitchen sink approach), we provide just the key design ingredients in this text and refer the reader elsewhere for more general information, such as how to choose a planting palette or selecting the right street trees for the site.

This guide also shows how to efficiently use 21st century digital data, models and tools to generate base maps that can guide conservation subdivision design. It utilizes new state and national forest models, which were not available when prior authors tackled conservation subdivision design. Now, many hours of analysis can be saved by combining digital data to quickly map areas that should be conserved and areas more appropriate for development. For more see Section 4 on design.

"This guide focuses on creating healthful landscapes that support a multitude of species. This is a key distinction because the quality of the open space and how it functions matters — for both wildlife and people."

1 From Meriam Webster on line https://www.merriam-webster.com/dictionary/conservation

1.3 Creating the Dream Team – What Expertise Is Needed For Conservation Design?

Before beginning the design process, it's important to assemble the right team. Randall Arendt recommends that a landscape architect lead the development team. But in practice, not all landscape architects are land planners; some may have a focus on garden design or may tend toward a more manicured landscape based on their practice and training. Similarly, an engineer could be very experienced in alternative landscape design principles, such as low-impact development, or could know very little about the subject. Rather than focus on one discipline, it's important to assemble a multitude of experts and bring them in early to ensure a holistic look at the landscape's critical resources, highest value resources, and opportunities for meeting both conservation values and development potential.

Many developers will not have ecologists or landscape architects in their employ. Some engineers may not be accustomed to working with wildlife biologists. So what expertise is needed? The good news is that there are many models and data sources available, so that not every important discipline needs to be there 'in person.' The following are recommended options for how to tackle design needs – and some experts combine skills, so they are 2-for-1 or 3-for-1. For example, some landscape architects are also trained planners and engineers, while some developers are also engineers and planners.

In the list on the next page, an asterisk (*) shows the additional skills helpful to a team considering a conservation subdivision. If the team does not possess these skills, they can be learned and developed over time. A specific project would not necessarily need *all* of these experts, or not all of the time, at least: they may be included at key junctures, though hopefully not too late for their advice to be considered. In addition, some data and models discussed later in this guide suggest alternatives for some of these experts.

Note that the site's developer may or may not also be the builder. If they will be obtaining permission to develop the site from the locality, but then selling lots for development to a third party, it will be important to ensure that all design requirements are codified, understood and monitored to ensure designs are followed throughout the development process. In addition, if the site's extensive open space is to be held by a third party, such as a land trust or land preserve, then that party should also be at the original design table to ensure that their conservation standards are upheld – or at least jointly created, so that they can agree to take on the easement or management when the time comes to transfer such management or even ownership. Similarly, if the site will require extensive marketing – e.g. an unusual product in a traditional market – it may make sense to include the realty or marketing team in early discussions, so that they understand the site's design principles.

"It's important to assemble a multitude of experts and bring them in early to ensure a holistic look at the landscape's critical and highest value resources, and opportunities for meeting both conservation values and development potential."

Wildlife need to cross the roads!.

List of possible experts:

Land Developer: Possesses or manages the land to be developed and works with financiers to fund the project. *May also be familiar with financing and persuading others about conservation developments.

Planner: Familiar with rules of development and the development process. *May also have experience in conservation subdivision design.

Civil Engineer: Layout of road network, lots and stormwater infrastructure. *May also have knowledge of low-impact development principles and alternative lot designs. Can supervise site survey teams.

Landscape Architect: Selection of plant materials, planting plans and landscape standards. *May also have knowledge of native plants, conservation development design and alternative best management practices, such as bioswales.

Forester/Conservation biologist/natural resource manager: Design of wildlife corridors, habitat protection or restoration zones. *Ensure that this person has experience in large landscape conservation and not just small sites – they need to be able to see the 'big picture.' This is why a horticulturalist is not suggested here – unless they have such experience.

Geographer/GIS Analyst: Creation of overlay maps and collation of key data for conservation design. *May also have requisite knowledge to design habitat cores and corridors or to access and use additional models to inform site design.

Note: an asterisk (*) shows the additional skills helpful to a team considering a conservation subdivision.

2 WHY DESIGN FOR FOREST AND HABITAT CONNECTIVITY

"Developments that include green space or natural areas in their plans sell homes faster and for higher profits than those that take the more traditional approach of building over an entire area without providing for community green space."

2.1 Economic Reasons for Selling Nature's Values and Protecting It

There are many economic reasons to incorporate forests within developments. Healthy forested landscapes and well-treed home sites attract home buyers who are willing to pay more for a home. To put it simply, nature sells! Developments that include green space or natural areas in their plans sell homes faster and for higher profits than those that take the more traditional approach of building over an entire area without providing for community green space (Benedict and McMahon 2006).

In fact, buyers prefer greener developments with opportunities for outdoor recreation. A study by the National Association of Realtors (NAR) found that 57 percent of voters surveyed were more likely to purchase a home near green space and 50 percent were more willing to pay 10 percent more for a home located near a park or other protected area. In a related study, nature paths were found to be the number one most desired amenity. The existence of a park within 1,500 feet of a home increased its sale price between $845 and $2,262 (in 2000 dollars) (The Economic Benefits of Recreation, Open Space, Recreation Facilities and Walkable Community Design 2010).

Another study found that large natural forest areas have a greater positive impact on nearby property prices than small urban parks or developed parks, such as playgrounds, skate parks and even golf courses. Homes located within 1,500 feet of natural forest areas enjoy statistically significant property premiums, on average $10,648, compared to $1,214 for urban parks, $5,657 for specialty parks and $8,849 for golf courses (in 1990 dollars).

Similar studies in Howard County, Maryland; Washington County, Oregon; Austin, Texas; Minneapolis-St. Paul, Minnesota; and other areas used data from residential sales, the census and GIS to examine marginal values of different types of parks. They too found that the type of open space affects the benefits for property values. (The Economic Benefits of Recreation, Open Space, Recreation Facilities and Walkable Community Design 2010.)

Many people who can afford to pay more for a home – the creative class of artists, media personnel, lawyers, analysts, and so on – make up 30 percent of the U.S. workforce and they place a premium on outdoor recreation and access to nature (Florida 2002). So, to sell to these buyers, the key is to provide them with green areas and outdoor recreation where they live.

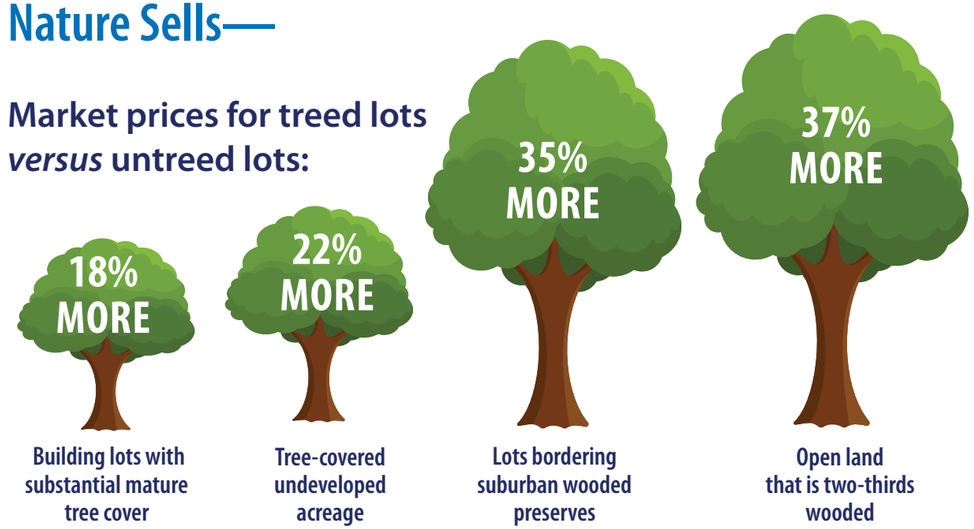
The companies that employ them are also looking for green communities in which to locate. Small companies with a skilled workforce place a strong importance on the 'green' of the local environment (Crompton Love and Moore 1997).

Even at the individual lot level, treed lots sell for higher values. A hedonic evaluation of home values by Kathleen Wolf (controlling for all other factors, such as location of the development)

This mature tree adds 5% to the home's resale value.

Nature Sells—

Market prices for treed lots *versus* untreed lots:



Source: Kathleen Wolf, 2007, *City Trees and Property Values.*

showed price increases based on the condition and location of residential trees as follows:

- 2% more for mature yard trees (greater than 9-inch dB)
- 3-5% more for trees in front yard landscaping
- 6-9% for good tree cover in a neighborhood
- 10-15% for mature trees in high-income neighborhoods (Wolf 2007)

The same evaluation showed the benefit to the development overall, when comparing market prices for treed lots *versus* untreed lots (see list above). Thus, trees and forested land clearly add value to development.

Wolf also notes that one study found that development costs were 5.5 percent greater for lots where trees were conserved. In fact, builders have reported that they were able to recover the extra costs of preserving trees in a higher sales price for a house and in faster rates of sales for homes on wooded lots (Wolf 2007).

In addition, applying simple math leads to an understanding that clearing less land equals more profits, especially when the lots are smaller. For example, for a 100-acre site, with 5 acre lots, a developer will realize 20 units of development and have to build roads and stormwater features to treat the runoff. If the locality requires curb and gutter and sidewalks, that cost increases exponentially. In a site that GIC designed called Adam's Park at the edge of Richmond, Virginia, the developer shrank their lots to half their approved size, realized an extra four units of housing (44 lots instead of 40) and created 30 acres of open space with a trail and lake. The developer saved hundreds of thousands of dollars in shorter roads and forewent stormwater management costs by creating less impervious surfaces.

Ironically, the park in the development's name "Adam's Park" didn't actually exist until the developer changed the site plan. Why did the developer change his mind? Quite simply, he learned that his site contained important forest habitat and decided that his legacy could include conservation. It also allowed him to offer a different and competitive product – homes abutting green spaces and trails – the top attractor for homebuyers!

"The developer saved hundreds of thousands of dollars in shorter roads and forewent stormwater management costs by using less impervious surfaces."

"The duff layer acts as a sponge on the forest floor, soaking up water and providing nutrients to the soil."

2.2 Ecological Reasons for Forest Conservation

Forests support healthier landscapes for both people and wildlife

Forests support our very existence. Everyone who breathes air, drinks water or eats food is benefiting from ecosystem services provided by trees. Correspondingly, as we lose trees, our ability to provide 'ecosystem services,' such as absorbing and filtering land runoff, providing oxygen, filtering air pollution, shading cities, supporting pollinators or wildlife and providing recreation are likely to decline. Concerted attention and action are needed to ensure we create and care for a robust forested landscape to protect both our future and the future of the ecosystems we rely upon for our economy, community health and for fish, birds and wildlife. And that requires foresight and planning to grow in ways that don't completely eliminate the natural landscape, but that incorporate trees and intact forested landscapes within our developments. People should not have to journey long distances to experience the benefits of nature – they should be able to find them right in their backyards.

Forests and woodlands provide vital habitat for wildlife, fish, birds and pollinators. Forests also support the habitat for local game species to forage and reproduce. In urban areas, forests provide shade and beauty for residential and commercial areas and parks, or buffer runoff for a locality's rivers, lakes and streams. They create attractive and welcoming entrance corridors for cities and towns, provide habitat for rare and endangered species, are essential for supporting fish and wildlife, and afford outdoor recreation.

Forests also provide the setting for many tourist and leisure activities in the Carolinas, framing the beauty of marshlands and estuaries, generating attractive areas in the coastal lowlands, piedmont and mountains where people can kayak, vacation, camp, hunt or fish, or simply enjoy the wonderful scenery these states offer.

In cities, urban forests provide myriad benefits, including keeping urban areas cooler, improving air quality, calming traffic, improving property values, facilitating tourism, offering a more pleasant shopping experience, and providing beauty. Even at the neighborhood scale, trees provide benefits such as stormwater uptake, lower energy costs for residences and feelings of wellness amongst residents. Trees also facilitate walking, as routes with trees are perceived to be shorter distances than sidewalks and paths without trees (Tilt, Unfried and Roca 2007).

Mature forests matter

Oftentimes, developers remove mature trees and replace some of them with smaller trees (e.g. 1-2 inch caliper trees about 7 feet tall) and these new plantings usually represent a fraction of those lost. Instead, it's important to protect as much forested land as possible and to reduce mature tree removals. A new forest, or a new tree, does not immediately replace the value of a mature forest.

Mature, older forests also have a thick layer of organic matter (the 'duff layer') beneath them, which builds up over time as leaves, bark and other detritus collect on the forest floor. This layer plays a key role in the biogeochemical process of the forest, helping transfer nutrients as materials decay, keeping soils moist and absorbing the impact of rainfall. The duff layer acts like a sponge, holding water and filtering it so that there is less runoff, less erosion and cleaner water for both wildlife and people. It provides exceptional habitat for invertebrates and fungi. It also provides food and habitat for small mammals, reptiles and amphibians, which in turn are a food source for larger predators, such as foxes, raccoons and bobcats.

The duff layer of a well-established forest supports a rich variety of microbes that play a key role in the forest ecosystem. However, in new forests, this layer is very thin, or is non-existent, since it takes many years to build up. Furthermore, tree roots and microbes in surface soils trap and take up nitrogen and phosphorus, both of which pollute our water supplies.

While these biochemical processes need not be detailed here, the key fact to understand is that forested landscapes have the lowest amount of runoff of these pollutants. Nitrogen and phosphorus are plant nutrients, but when they run off the land and enter streams, they are considered pollutants because they can cause excessive algal growth that robs the stream or lake of oxygen.

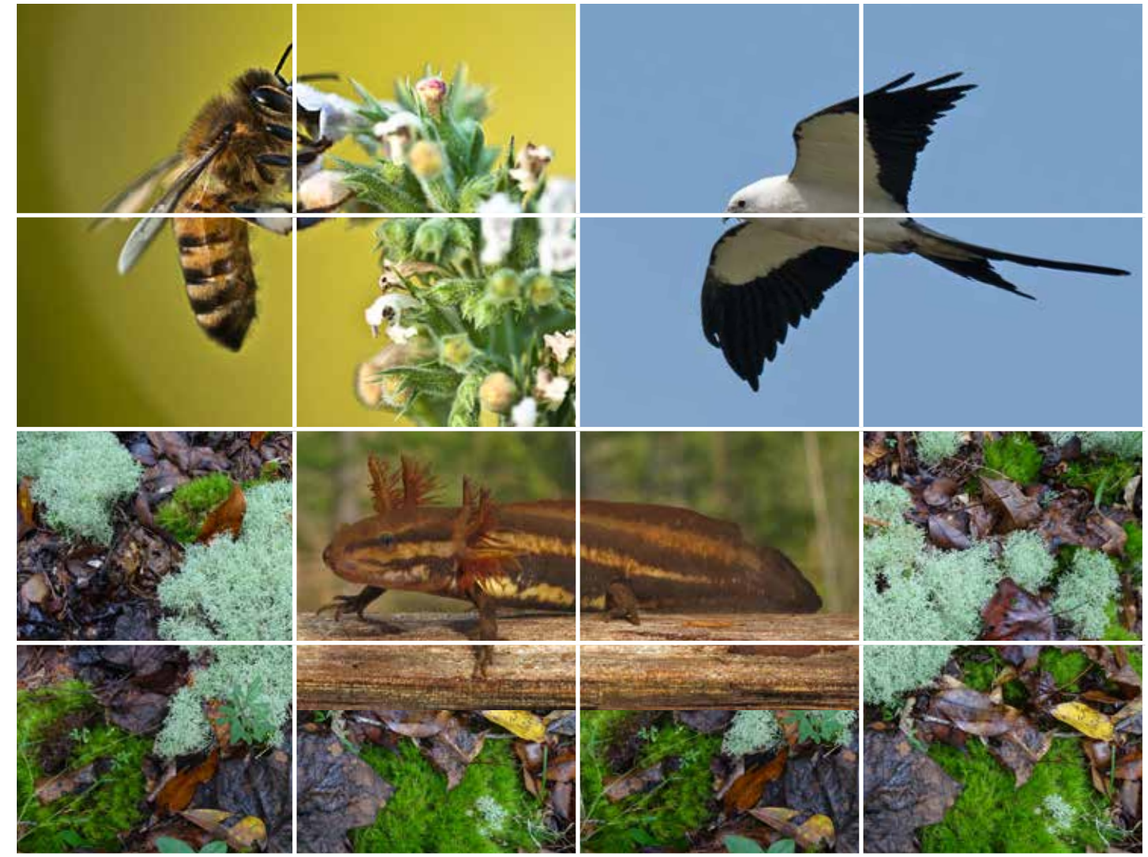
A healthy forest has different-aged trees and under-story vegetation.

“Forests also trap sediments and trees break up the erosive force of rainfall, so forests also prevent sedimentation of streams and lakes. Their roots bind together river banks and stop large scale erosion during high-rainfall events.”

Beech tree in a forest.

Forests also trap sediments and trees break up the erosive force of rainfall, so forests also prevent sedimentation of streams and lakes. Their roots bind together river banks and stop large scale erosion during high-rainfall events.

A new forest of small trees, that is re-growing in a previously disturbed area, such as an old farm field, is not the same as a mature forest, which will tend to support rarer species of indigenous plants, animals and larger trees. It will take decades to even approach the same quality as an established forest cut down and converted to development. Trees that are growing in a former field may be stunted by poor soils from overly intensive farming or grazing, or uprooted by excessive runoff, leading to more invasive or opportunistic species, such as ailanthus (‘tree of heaven’). Oftentimes, trees growing in disturbed areas consist of invasive species that are adept at taking over such areas. Although young forests provide other values (more open meadows for quail or ruffed grouse, for example), they can’t provide the same assets and function as a mature forest.



Forests and pollinators

Much has been made of the importance of pollinators and Americans are increasingly aware of the threats facing bee populations. Hive deaths seem to be on the rise as mites infest once healthy bee hives, and there is also the problem of “colony collapse disorder.”

As a result, wild bees – of which the United States supports 4,000 species – have declined from such causes as habitat loss, pathogens, parasites, climate change, invasive species, pesticide use and other factors. However, pollinators rely on forests for foraging and building nests. Solitary bees are America’s only native bee and they don’t build a hive; they mate for life and inhabit small holes in logs and other openings.

Changes to our forested landscapes can affect whether pollinators can make use of forests. Researchers at the USFS Southern Research Station found that forests of dense even-aged pine or closed canopy forests are far less desirable for bees (Hanula, Horn and O’Brien 2015). As land is cleared and not managed, dense pine forests may spring up in remnant lands and in areas where fires are suppressed – usually near where people live. Those forests are not thinned naturally and become dense and less optimal for wild bees.

Similarly, forested wetlands – swamps and treed islets within marshes — provide unique habitats for amphibians, reptiles, plants and insects, such as the common red-spotted newt and the frosted flatwoods salamander, and for migratory birds, such as the swallow-tailed kite. For example, the Savannah, Combahee, Ashepoo, Edisto, Cooper, Santee, Congaree, Wateree, Pee Dee, and Waccamaw rivers in South Carolina support highly significant wildlife habitats, including adjacent palustrine forested bottomland hardwoods forests across 3.7 million acres, primarily in the coastal plain. As these forested wetlands lie along the fastest growing coastline in the eastern U.S., they are at serious risk.

Characteristics of Carolina Forests

Forests of North Carolina[2]

According to the North Carolina Forest Service, bottomland and swamp forest cover types occupy a relatively small percentage of the forested area, accounting for just 13 percent of the state's forest lands. However, they are rich in ecological, cultural and commercial benefits. Some of North Carolina's coastal forests are also older than one might imagine. University of Arkansas researcher Dr. David Stahle discovered a coastal forest in Bladen County that contains trees more than 2000 years old, including a documented 2,624-year-old bald cypress along the Black River.

Moving inland from North Carolina's coastal plain, mesic forests occur on moist portions of upland habitat not affected by fire, on north-facing slopes, and sometimes on upland flats surrounded by peatland or on island ridges surrounded by swamps. They consist of well-developed understory and shrub layers, characterized by mesophytic canopy. Mesophytic forests are found on deep and enriched soils in sheltered topography, such as coves and low-elevation slopes.

Coastal plain mesophytic species include trees such as American beech, tulip poplar, sweetgum, bitternut hickory, shagbark hickory, American elm, black walnut, white oak, swamp chestnut oak and red oak. According to the NC Forest Service, many of North Carolina's forests have been cut over several times – which is usual for many of the Atlantic colonial states, the forests of which first supported ship-building and later colonization.

Forests provide unique habitats for an extensive variety of species, such as the bobcat, black bear and pileated woodpecker, and in South Carolina and southern North Carolina, the alligator. They also support pollinators vital to our food supply. Preserving their habitats allows both animals and humans to thrive.

A bearded heron enjoys a wetland in North Carolina's Piedmont forests.

2 Excerpted in large part from the North Carolina Wildlife Resources Commission https://www.ncwildlife.org/Portals/0/Conserving/documents/Coast/CP_Mesic_forest.pdf

Forests of South Carolina[3]

The Blue Ridge in South Carolina constitutes a small portion of the state's land area (328,500 acres or 1.69 percent of the total area), but supports an extensive upland hardwood forest complex. Its rich floral diversity is seen in the Mixed Mesophytic Forest vegetation community (Braun 1950), which includes moist broadleaved forests that can harbor over 30 different tree species and many types of fungi and ferns.

The next lower elevation is the Piedmont-Sandhill Zone, which is characterized by extensive river channels of shoals and rock ledges that form the "fall line." Agriculture, primarily cotton, led to conversion of much of the original hardwood and shortleaf pine (*Pinus echinata*) forests into fields, as well as the filling in of wetlands. Poor agricultural practices led to erosion of valuable topsoil. Although agricultural practices improved, even as farming declined during the 20th century due to the Great Depression and outbreaks of bollwevil, floodplain sediments persist over former piedmont wetlands. loblolly pine (*Pinus taeda*) was introduced to the Piedmont during the nineteenth century as a cash lumber crop and now dominates much of the region.

Bordering the South Carolina's fall line, the Sandhills Ecoregion comprises the inland portion of the coastal plain. This ecoregion has been recognized as a physiographic province distinct from the coastal plain and includes sand ridges that have more clay and silt mixed with sand which support subxeric sandhill scrub vegetation and mesic pine flatwoods. More moderate growing conditions in this region have led to increased plant diversity.

Comprising the largest ecoregion in South Carolina, the coastal plain's land elevation ranges from 300 feet at the inland boundary with the sandhills and reaches sea level at the coast. Compared to the adjacent ecoregions, upland forest cover is relatively unbroken. Although rare, upland forests are dominated by hardwoods, primarily with oaks and hickories, and typically on fire-suppressed upland slopes near river floodplains or between rivers and tributaries. Vegetation composition is similar to oak-hickory forest in the Piedmont, where it is a major vegetation type.

Piedmont forest

Hardwood-dominated woodlands with moist soils are associated with major river floodplains and creeks. Characteristic trees include: sweetgum (*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), willow oak (*Quercus phellos*), laurel oak (*Quercus laurifolia*), cherrybark oak (*Quercus pagoda*) and American holly (*Ilex opaca*). Spruce pine (*Pinus glabra*) may be found on drier sites to the south. The cypress-tupelo swamp subtype occurs on lower elevation sites as seasonally flooded swamps.

A South Carolina coastal plain forest and wetland.

3 Excerpted in large part from the South Carolina Comprehensive Wildlife Conservation Strategy http://www.dnr.sc.gov/cwcs/

Careful planning for future growth and development are critical to ensuring that the Carolinas' landscapes, quality of life and economy are not just sustained, but enhanced. In the next section, we discuss the *values* that people have identified for their natural landscapes – values that are best met by conservation subdivisions.

2.3 Legacy: Developments Should Create Places of Lasting Value and Healthful Landscapes

Many studies point to the desire of people to live more active lifestyles. People are seeking more healthful places to live where nature – with trails! – is nearby. Research has shown that, of all the activities people seek, running, jogging and trail running were the top desired activities.[4] Of those who enjoy the outdoors, 47 percent stated that their enjoyment came from being close to nature. Indeed, the National Association of Realtors has found that trails are the number one desired amenity for homebuyers. Similarly, the National Association of Home Builders report, *Preferences of the Boomer Generation: How They Compare To Other Home Buyers*, found that, across boomers, genXers and millennials, every age group chose as their top most-wanted amenities within a suburban pattern to be close to a park area and to have access to walking/jogging trails. And not just any park was desired. People specifically choose natural park settings rather than manicured areas.

"The National Association of Realtors has found that trails are the number one desired amenity for homebuyers."

Parks undoubtedly raise property values for nearby homes. However, the larger the park, the more significant the property value increase. And most importantly, large natural forest areas have a greater positive impact on nearby property prices than smaller urban parks or developed parks, such as playgrounds, skate parks or golf courses.[5]

People who enjoy the outdoors for recreation also have the ability to pay a little more for such access. About half of the U.S. population participates in outdoor recreation, while about 19 percent of those participants earn more than $50,000 annually and 47 percent of those earned more than $75,000.

However, it is not just about access to forests and parks for the wealthiest people. We stress that everyone should have the ability to access nature nearby to where they live, regardless of income, often known as the "social equity" component of sustainability. In this guide we highlight mixed income and affordable developments that also provide access to nature.

Residents enjoy the trails in this low country SC park.

4 2018 Outdoor Recreation Report: https://outdoorindustry.org/resource/2018-outdoor-participation-report/

5 Economic Benefits of Recreation, Open Space, Recreation Facilities and Walkable Community Design, 2010

This bridge over Greenville's falls serves as a recreation and commuter pathway.

Nature does not just provide benefits. The lack of access to nature can have significant consequences for people's health and mental wellbeing. A lack of access to outside spaces can affect people's sense of happiness and health.

Lack of access to nature is known as *nature deficit disorder* and this issue has seen growing attention in recent years. It refers to the effects that occur when children do not have close interaction with outdoor natural areas. The popular book *Last Child in the Woods* by Richard Louve synthesized literature that highlighted the importance of nature to reduce Attention-Deficit/Hyperactivity Disorder (ADHD) and create healthier kids. Louve demonstrates that we need to actively ensure that our kids are out in nature as part of their emotional, physical and cognitive development.

Studies of children with ADHD found that time outdoors provided the same benefits as taking the prescription drug Ritalin. Providing developments with local, safe outdoor space can allow kids to play outside and improve their physical and mental health, while also easing parents' fears about knowing where their children are. Developments that incorporate nature are attractive to families seeking safe, outdoor spaces for their children to play.

Finally, we should not forget our older generation, who prefer to age in place. More and more, seniors are choosing active lifestyles over 'retirement homes.' This means that, in terms of the theory that we are as old as we feel, active lifestyles are increasingly preferred by people nearing or at retirement age. Providing this generation with residential developments where they can take a nature walk or visit a park without having to get in their car is a strong motivation for where they choose to buy. Regular physical activity in green spaces also provides older people with mental health benefits. Numerous studies have shown extensive links between exercise and positive mood states, decreased likelihood of depression, lower incidence of stress and improved cognition throughout the entire life span.[6]

Communities that incorporate nature are more resilient. 'Resiliency' is a term that has been gaining in popularity in recent years. It refers to the degree to which communities can adapt to change and still maintain the same values and functions as before. Since well-treed landscapes are better able to absorb rainfall and buffer areas from wind, they have less runoff, better air quality and are cooler in the summer. Even at the neighborhood scale, trees improve air quality by removing particulate matter from the air and reducing the formation of ground-level ozone. Thus, developments that are well treed can boast that they have better air quality than neighboring developments where trees have been removed. Since trees buffer runoff from the land, lakes, ponds and streams will likely have better water quality as well, along with other benefits of clean water, such as a thriving fishery and safe places for people to boat and swim.

In the next section, we discuss key site design principles that facilitate these activities.

"Studies of children with ADHD found that time outdoors provided the same benefits as taking the prescription drug Ritalin."

6 Elder Briefing: https://naturesacred.org/wp-content/uploads/2011/04/Elder-Briefing_Final_Web.pdf?45ab59

Spring Island offers abundant natural views. Credit: Spring Island Development.

CASE STUDY: A completed conservation subdivision that meets design principles

In addition to the many reasons already articulated for conserving nature, the following is an example of a conventional development plan that was converted to a conservation subdivision and subsequently benefited from adopting key conservation principles.

Spring Island – Beaufort, SC

Spring Island comprises 3,000 acres of barrier island near the Colleton and Chechessee rivers, in Beaufort County, SC. Landowners Jim Chaffin and Jim Light had an approved plan for the land from 1996 that authorized 5,500 housing units plus several golf courses on the island. But the owners wanted to create something special – to retain for all time as much of the integrity of this sea island's original state as they could. Instead of the approved density, they decided that the land should have no more than 500 units, with just a single golf course, located on the site of existing cornfields.

Spring Island Trust, co-founded by the developers, focuses on best practices of land conservancy, land management and sensitive development. It provides a wealth of educational programs through the Mobley Nature Center on Spring Island. The Trust also offers a day-long Habitat Workshop that gives homeowners an overview of landscaping and how to live with the indigenous nature of Spring Island, as well as how to landscape individual properties in ways that meet the Spring Island philosophy.

The island supports more than 600 species of recorded plants, 700 species of animals and 19 soil types. Native American artifacts dating back to 10,000 BCE have been recovered from nearby Dawes Island and artifacts from the Woodland Period, around 1,000 BCE, have been discovered on Spring Island.

While the main road is paved, secondary roads are made of permeable materials. Callawassie Creek meanders around maritime forest, saltwater estuaries, freshwater ponds and remnants of ancient hardwood bottomland swamps. On the higher elevations, longleaf pine testifies to prior lightning-induced wildfires that may have burned on the island.

There is a 1,200-acre nature reserve with extensive equestrian facilities, riding paths and water access for boating and fishing. The development's Waterfall Farm, a 4-acre community farm provides free produce for members, staff and the local community. There are currently 400 homes planned, of which half have been built, as of 2019. These homes, however, are primarily for those with large budgets, as prices begin at seven figures.

For more about Spring Island see http://www.southeastdiscovery.com/blog/2014/12/spring-island-2-steps-forward-1-giant-step-back-in-time/

Conservation Tax Incentives

North Carolina state tax credits may be applied if the open space land is dedicated as a conservation easement within a conservation subdivision. However, this credit may only be applied to lands that are in excess of the open space already required by the zoning or development codes. Land that exceeds the open space requirements may be eligible. For example, required open space is 15 percent but say the development conserves 50 percent. This means that 35 percent of the land that is additionally conserved could qualify as an easement.

To qualify, a land protection agreement must meet federal and state tax code requirements by providing public benefit through permanent protection of important conservation or historic resources. To qualify as a charitable contribution for federal tax purposes, a conservation agreement must be perpetual and must do one of the following:

- conserve land for public outdoor recreation or education
- protect relatively natural habitats of fish, wildlife or plants
- conserve open space, including farm and forestland
- preserve historically important land or buildings

An accountant or lawyer can help determine the tax advantages that may be available from donating an easement, or contact the Conservation Trust for North Carolina for more information: http://www.ctnc.org

South Carolina also provides tax credits. Since June of 2001, South Carolina has allowed landowners who give qualified conservation contributions or gifts of land for conservation to claim a portion of the land's value as a credit toward their state income tax. To qualify, the conservation contribution must be claimed on the land owner's federal taxes. The state tax credit is then limited to 25 percent of the federal deduction, and is capped at a value of $250/acre and $52,500 total. If the value of the conservation exceeds $52,500, the state credit may be carried over to the next year, or transferred to a third party.

For more information, consult this document on the South Carolina Conservation Incentives Act: https://www.scdhec.gov/sites/default/files/docs/HomeAndEnvironment/Docs/ModelOrdinances/SCExamples/SCConservationIncentivesAct.pdf

This little blue heron appreciates the conserved wetland.

3 GUIDING PRINCIPLES FOR FOSTERING CONNECTIVITY AND FOREST HEALTH

Forested acreage:

North Carolina
18.4 million acres

South Carolina
12.9 million acres

In this chapter, we outline the key principles that determine conservation values and the guiding principles for how to think differently about site selection when habitat conservation is a key aspect of an intended development.

3.1 Thinking like a network (not an island)

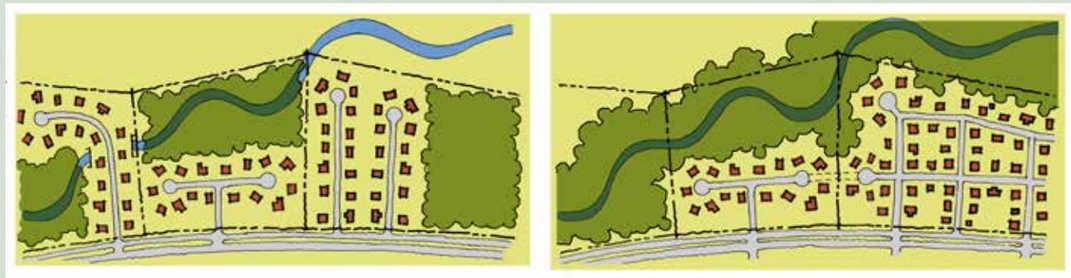
Most developments begin with an evaluation of where to develop based on market forces, land cost and availability, trends in growth and ease of the development process (compatible zoning, comprehensive plan designations, and the like). However, when conservation is a key value, then the site under consideration must be viewed in the context of where it is located and what flows into and out of it in terms of landscape corridors and neighboring habitat cores. These "flows" include riparian species, mammals, birds, insects and people, in terms of recreation needs and other desires. Some flows are natural – such as a stream that enters or originates on the site and flows into another, or a pathway flown by raptors or migrating monarchs that prefer ridge lines, or a well-travelled corridor that animals take to reach foraging or nesting areas.

Other pathways may be those that people use. Although they might not be "natural," they may facilitate uses such as fishing, hunting, hiking and birding. There could also be a potential future use such as a nearby rail trail or regional greenway to which the site could connect. Identifying these key entry, exit and flow pathways can both reduce conflicts with wildlife and ensure that local concerns – such as access to a family burial plot or a favorite community view, are not foreclosed. This requires identifying these items by categories (e.g. consulting biologists can help with wildlife pathways, or nesting areas, regional and local trail planners can describe any current or planned trail connections; and community members can identify cultural concerns).

While it is impossible to develop land without any impacts, many of them can be avoided or minimized with careful planning. Connections to and from a site should be considered before the development is designed, so that opportunities to maximize functionality and avoid harmful impacts are fully realized.

Forests have long been an integral part of the Carolina landscape, from the mountainous Piedmont region in the west to the coastal plains and forested marshes in the south, which include the eastern 'low country' of South Carolina. In

disconnected open space **connected open space**



In the left image, each developer clustered and conserved open space but it is disconnected. In the image on the right, one parcel is protected, the middle is developed at moderate density and the parcel at the end is most developed such that the wildlife riparian corridor can function.

This 'community green' is devoid of character and underutilized because the space is undefined and unprogrammed.

"Green space should not be trapped in the middle of the site and there should be adequate natural area preserved"

2017, in South Carolina, forested acreage was estimated at 12.9 million acres (67percent), a slight decline from 2016, while North Carolina had 18.4 million acres (2015 data) which had decreased slightly (about 1 percent) from 2013. However, forested landscapes are not distributed equally statewide and some areas are at risk of losing their remaining forests to land conversion – changing them permanently from rural forest land to developed landscapes. Areas especially at risk are those closest to major highways, large cities and towns, as well as event places, such as a new equestrian center or large racetracks that attract development.

But, as stated at the beginning of this guide, while total acreage is important, the quality and intactness of forests is of even greater significance. Indeed, *forest fragmentation* remains the greatest threat to southern forests. Even though the Carolinas' forest cover has been relatively stable overall in recent years, this may be in the process of changing, since development is accelerating rapidly.

But, can development occur without causing forest fragmentation? Well, yes and no. It's virtually impossible to develop a landscape without some tree loss. However, how the landscape is developed – what types of landscape are preserved and how much is protected, directly relate to whether or not the development is supportive of wildlife habitats, good water quality and other uses.

There is actually a science behind designing a conservation subdivision in order to meet the needs of wildlife. This science is well accepted on the national and international level. To be a conservation subdivision – not just an open space – mammals, amphibians, birds and other creatures need to be able to move about the site and to enter and exit the area. As noted earlier, this means that green space should not be "trapped" in the middle of a site and there must be adequate natural area preserved – not a lawn or golf course, but native habitat – whether that is a wetland, a Carolina Bay or an intact forest.

In the following sections we explain the key components – cores, corridors and buffers – and the science of designing the natural landscape to maximize survival of wildlife. Beyond supporting native wildlife, these conservation habitats also serve to reduce noise by absorbing sound, buffer against wind damage, filter and clean surface and ground waters, and provide natural beauty and shade, amongst other benefits.

However, the extent and structure of tree conservation will determine whether intact habitat zones – known as habitat cores and connecting corridors – remain in place. Next, we describe what these are and how to recognize them. There are also guides written by the GIC that focus on planning for landscape connectivity. To obtain them, visit www.gicinc.org.

Key Components for conservation design – cores, corridors and buffers

There follows is a quick primer on the key concepts of conserving forest cores and corridors.

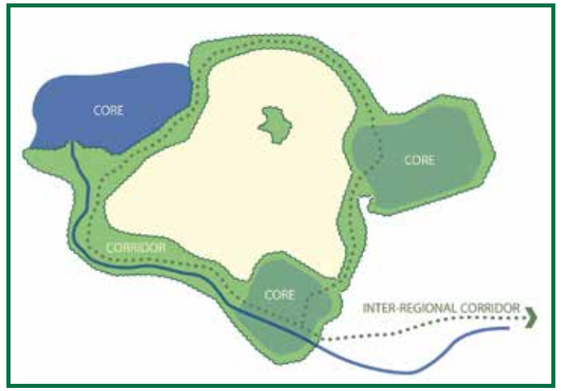
Forest cores and corridors

When evaluating a landscape, whether it is in a rural area or urban, many animals require substantial acres of habitat in which to forage, breed and thrive. These are called habitat cores, and consist of an inner area that is undisturbed of at least 100 acres and an outer edge that is usually about 300 feet wide, where the impacts of disturbances from human activity, wind or excess sunlight can impact forest habitat negatively. Core sizes were developed by scientists who studied minimum acreages required by interior forest birds. If these interior species are supported, other smaller species, such as spotted newts or minks, with smaller habitat area needs, will also be supported.

Wildlife, pollinators and plants need to move between these cores through *corridors*, which can either be continuous, such as a riparian corridor along a river or stream, or in *patches* that together form a corridor between larger cores. When these corridors are along streams and rivers, they are referred to as *riparian buffers*. The corridors support biodiversity as they allow species to intermingle and to repopulate areas following disturbances, such as hurricanes.

In a rural landscape, there are usually many large cores of intact habitat, with both corridors and patches of undisturbed forest and woodland that animals can use to move between those cores. However, in cities and suburbs, there are few large tracts of undisturbed habitat, which means that species have to rely upon smaller areas, such as parks and streams, to move around. But even in cities, corridors can be provided along streams and pathways for smaller animals, such as birds and pollinators, can be maintained through lines of interconnecting back yards.

Taken together, this network of intact forest, wetland or riparian habitats can be considered as our 'green infrastructure' because they support our health (air quality, recreation, food) and our economy (drinking water needs, forestry, hunting, or tourism). Just as we plan for grey infrastructure, we also need to plan for 'green infrastructure.' For more, see the resources section of this guide.



Rules to plan by:

Forest cores should be at least 100 acres of intact landscape – usually comprised of mature trees, plus at least a 300-foot-wide buffer to protect the interior area. The buffer serves as the edge area. The edge is where disturbances occur, such as from invasive species, wind or noise, or a road that cuts through the core.

The rounder the core, the better it is for protecting interior species. Measured from the outside edge, the deeper the core, the greater is the 'depth to interior' measurement. A "deeper" core means more protection for species that depend on interior forests. A rounder area has less edge relative to the interior. A long skinny core has a lot of edge but only a short depth to interior – it is less protected and more at risk from disturbances from invasive species.

The shape of the core determines if it has sheltered interior spaces for wildlife. If it is too skinny, it may be all 'edge' and thus suffer from outside impacts and not support interior forest species.

Having more protected pathways for movement allows species to be more resilient, as it increases options for genetic diversity and foraging for food. The more these options are available, the more resilient the species will be. If one area is disturbed or damaged, such as from a tornado, then a species can migrate to a new area to find food and shelter.

The importance of interior habitat for species survival is why roads through these areas should be avoided. In the image below right, a core is bisected by a road. The road creates more disturbance – edge habitat – and the resulting undisturbed areas become too small to support interior species, leading to their decline and eventual loss.

Riparian areas should also be considered as they provide pathways for species such as frogs, salamanders, turtles, fish and wading and diving birds. Forests along streams filter land runoff, such as nitrogen and phosphorus, which are plant nutrients that can harm streams since they lead to algal blooms and oxygen decline. Forests also trap sediments that can cloud the water, smother spawning areas and block light to aquatic plants. Other contaminants adhere to these soil particles, so keeping excess sediment from a stream is always wise. A 100-foot forested buffer has been shown to remove more than 90 percent of the nitrogen, phosphorus and sediment that might otherwise enter surface waters through overland flows.

Even in the housing areas within a development, street and open-space trees should be planned. Trees planted poorly (wrong site or too little room for root spread), not well managed (inadequate care), or planted inappropriately (wrong tree for the site or climate) can also lead to tree loss within the development.

See Resources Section for sources on urban tree planting standards and care needs.

Many species, such as this cerulean warbler, depend on large interior forest areas for their survival. Cornell Labs found a cumulative loss of nearly three billion birds since 1970, across most North American biomes, signaling a pervasive and ongoing crisis, caused largely by habitat loss. https://www.birds.cornell.edu/home/bring-birds-back

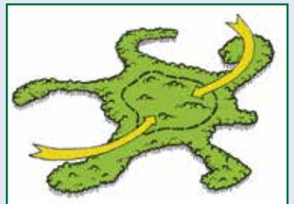
Landscape design principles for connectivity and resilience.

Habitat cores need to be linked by corridors to facilitate species movement.

Interior forest species in the south need at least 100 acres of interior forest habitat protected by an outer edge of an additional 300 feet.

Corridors are essential pathways for wildlife (and people) movement and should be at least 300 feet wide.

Too much edge area allows invasive species and other disturbances to impact wildlife.



Multiple pathways are needed to allow animals, birds and insects to move in and out of core habitats.

When corridors are missing, wildlife can sometimes use patches to move across the landscape.

If the habitat patches are lost, movement is disturbed and damaged areas may not repopulate.

When forested cores are bisected by roads and other disturbances, it creates more edge and results in reduced space for interior forest species.

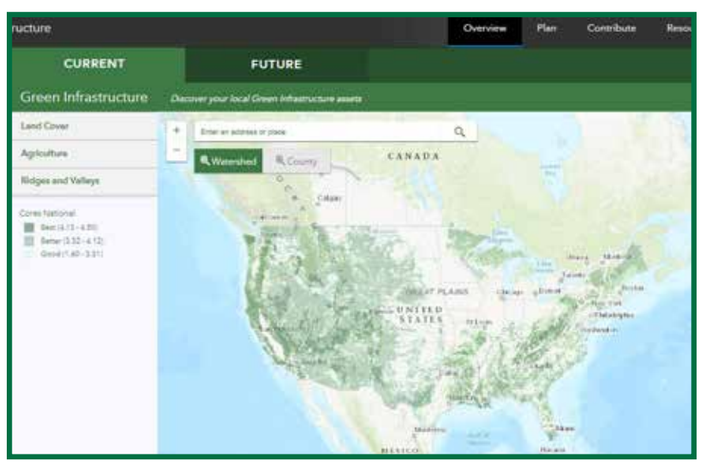
Determining forest cores in the Carolinas

In South Carolina, the Green Infrastructure Center created a model of intact forest habitats for the State Forestry Commission that shows where the highest quality forest habitats are found. It can be downloaded and utilized to create local maps for any area, but does require the use of GIS software. It finds and ranks intact forests of 100 or more acres. Forested areas that are at least 100 acres and not significantly bisected by fragmenting features, such as roads, housing developments or railways, are more likely to support key species of mammals, birds and other wildlife. The model utilizes soils, forested acreage size, surface water, elevation, endangered species presence and other factors that provide the underlying data to rank those areas most likely to support a diversity of species.

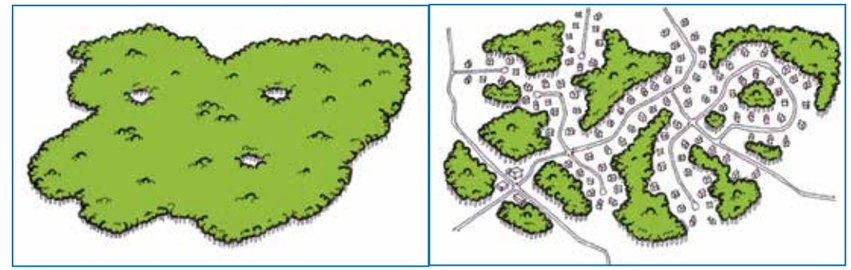
The GIC has also written a guide showing how to create and use maps of these high-value landscapes, so that better decisions can be made about where to concentrate growth and which areas are more suited to rural land uses, such as farming or forestry or water protection. For example, before determining where development should be located in any future land use map, all areas should be evaluated for suitability for development or conservation. Development should be located where it will have the least impact and maximize utilization of existing infrastructure, such as already existing roads, schools, water and waste disposal systems, shops and other amenities, while sensitive landscapes and valuable natural resources should be protected and reconnected. To access the model, contact GIC at www.gicinc.org .

For North Carolina, the national cores model that GIC built for Esri can be used. Data for each state can be downloaded and used with Geographic Information Systems (GIS) to analyze and map forest cores. Most developers have access to GIS, or work with engineering or planning firms who do. However, the Esri model can also be accessed as a print map by scrolling down and typing in the name of a county or watershed to view the habitat cores. This is an easy way to take a 'first look' at a proposed development site to determine whether or not it has been identified as an important forest habitat.

ESRI Models



https://www.esri.com/en-us/industries/green-infrastructure/overview



Land cover data should be checked for new developments and other impacts that may have disturbed forest cores to the point that they are no longer intact habitat.

Anyone using or accessing models should know that field verification is important since ground-truthing what is on the landscape can reveal differences from the model. For example, in the South Carolina site studied for this project, a tornado several years prior had torn up much of the forest on the eastern side of the site and greatly disturbed it. In this case, the forest was no longer a high quality core, as it had been broken into smaller patches of habitat. In another instance, field staff found the forest on the northwestern area of the site to be highly impacted with invasive species, such as English ivy, autumn olive and ailanthus. This is common when old farm fields re-grow, since the base soils are poor and highly impacted. So, once a forest core has been identified, it is advisable to collect some field data at the site, and apply that data as a new overlay that brings the site map up-to-date.

Developers and planners should request assistance from regional forest staff from their respective state agency and ask them to visit the site and make observations. They should conduct the visit along with a representative from the site's development team to determine whether or not the forest has been unduly disturbed. Such field visits can determine whether or not some sections of forest on the site are in poor health or have grown up in unsafe or unstable patterns. For example, at the North Carolina site studied by the GIC, some forest areas were found to be young and to consist of overly dense pine, which can occur when prior fields or clear cuts regrow quickly from a harvested pine plantation.

It may be the case that the core is so disturbed that it longer warrants being classified as a high quality habitat core, or it may comprise a monoculture of pines and invasive species which need to be thinned and managed to reduce fire risk. It may also be that those cores that have poor quality should be de-valued to mere habitat patches. It may be decided that these areas need rehabilitation, such as removing invasive species or thinning, or it may be determined that the impacted areas are actually the most suitable for development. In Section 4, design options for what to conserve and connect and where to develop are discussed.

On the positive side, field investigations could reveal that a forested area supports a rare species or large, significant patch of old growth forest. In this case, these areas may be flagged for preservation, ranked higher for conservation or placed off limits for recreation, since even narrow pathways may not be appropriate there.

3.2 Selecting/Designing the Site for Connectivity

When considering a site to develop as a conservation subdivision, it's important that the site be accessible to a wide variety of wildlife, whether mammals, reptiles, birds or other creatures. In addition, if there are trails, greenways or other nearby elements to connect to, consider how the development site could connect to them. It may be that key areas should be left undeveloped, or replanted and fenced off, so that these connections can be made. This is the opposite way of designing a development site from how it is usually done, whereby all land is cleared before design begins.

As mentioned in the introduction, conventional developments usually begin by determining all possible areas to develop, how they can be cleared and regraded, where the roads, sewers and power lines will go, and determining site access in order to maximize the built environment. Open space, natural areas or trails

"It may be that key areas should be left undeveloped, or replanted and fenced off, so that these connections can be made. This is the opposite way of designing a development site from how it is usually done, whereby all land is cleared before design begins."

Site Connections

Ask the following questions to aid in determining site connections into and out of the site:

1) Map stream corridors – where do they enter and exit the site? What watershed are they a part of? Where do they drain to? Streams and rivers are key corridors for mammals, birds, insects, fish and other wildlife.

2) Look to ridgelines – some serve as migratory routes for raptors or butterflies. Contact raptor groups to determine if your ridgelines are part of a key migratory route, if they are high enough to be an advantageous mountain ridge that offers updrafts, which can provide lift to birds, assisting them in a more energy-efficient journey. Monarch butterflies also migrate along ridgelines.

3) Play "connect-the-dots" with cores and corridors. Using GIS (or a land cover map and scale ruler), how many cores can be connected though 300-foot-wide forested corridors? Alternatively, are there enough habitat patches that could serve as stepping stones? Areas with denser clusters of patches will be more significant for migrations.

4) Most importantly, look beyond borders. Is your site part of a unique network of habitats, such as mountain range, series of coastal bays, a coastal marshland, etc. (This will require consultation with your state's natural heritage agency).

5) Does you site contain geologically unique features such as Carolina Bays? Unique geology can give rise to rare plants and animals.

are often placed in left over areas, such as narrow edges – cut off from neighboring woodland and farmland with high fences – floodplains and steep slopes. But these scraps of undevelopable land are difficult to weave into a useful trail network and these 'scraps' of open space usually leave animals trapped rather than facilitate movement and foraging needed for survival.

In South Carolina, the GIC cores model can be used to identify areas that are intact, while in North Carolina the GIC's model, housed at ESRI, can be used. The Esri model can be used for the whole of the United States and provide data at various scales, allowing developers to view their site in relation to neighboring sites, and at the county, state and regional level. Both models require GIS software to download and use the data. As noted earlier, the on-line map viewer can be used to take a first look to locate forested cores.

See the Resources section data list for steps to obtain cores model data.

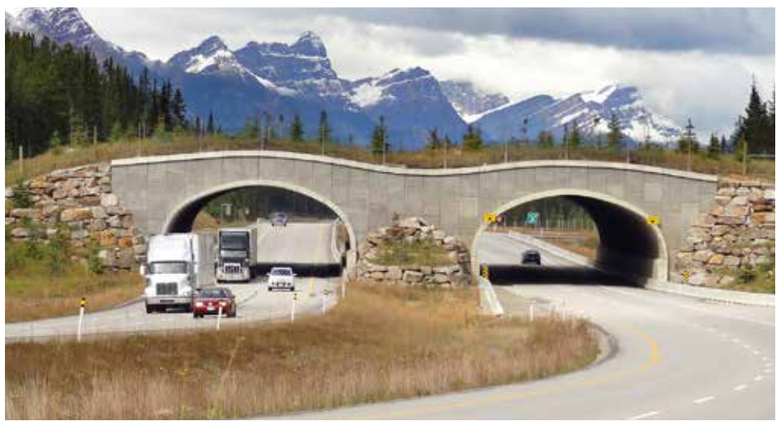
Some conservationists create maps of pathways needed by animals and then overlay the different habitat needs to determine key corridors. While this can be done, it is time-intensive to assemble the data and consult the experts. Use of the cores and corridors approach will likely capture more species of concern. However, consultation with local experts can reveal unknown needs, such as a salamander breeding area that may be in the proposed development site. One developer, who learned his site was accessed seasonably by breeding salamanders, did not shy away from the problem. He adopted the salamander as a key motivator and built salamander tunnels under the road to help them access the site without risking death by auto and he left the site's stream network in a natural state.

There are other ways to build wildlife tunnels and bridges and, depending on the species of concern, there are optimal tunnel sizes, depths, etc. Ideally, major wildlife pathways should be kept intact, but if they cross the only access to the site, a bridge or tunnel for local wildlife may be the best option.

See the resources section of this guide for more on green infrastructure planning.

3.3 Communities That Work – What Makes For Good Design

As noted earlier in this guide, seniors and retirees often choose to age in place while millennials and genXers are choosing lifestyles that don't involve mowing large lawns but do involve active recreation, such as boating, hiking or mountain biking. People also crave gathering spaces, and increasingly those spaces are parks and riverbanks, rather than paved plazas or shopping malls. They like neighborhood coffee shops with outdoor seating, rather than food courts at indoor malls. Telecommuting is another trend that



Wildlife overpasses or tunnels facilitate movement across roads and reduce conflicts.

This pocket park is too small to use and awkwardly situated next to a parking lot.

is affecting how people live and what they want their home to offer. Those working at home take breaks by taking a walk or visiting a coffee shop with Internet access – and if they can have that with a scenic view – all the better!

Conservation subdivisions are not just houses set amongst large nature reserves. They also provide access to recreation options. Also consider that residents will have different abilities, so there should be some areas designed for active play, such as a mowed field that can be used to picnic, fly a kite or throw a football. Other members of a neighborhood may want a community garden or a restful arbor. A caution with a community garden or any space with planned active recreation is that it will require interested community members willing to maintain it (e.g. are their gardeners in the community who want to take care of it?) as well as someone to manage the space and provide for collective needs, such as a watering source or a shed to store tools or sports equipment, and perhaps a committee to schedule events. So when planning for 'open spaces,' avoid large community greens that have no real purpose. They become too large to enjoy as there is no defensible space and they are often unshaded and have no specific activities.

The key is to ensure that open spaces are not just 'left over' after-thoughts, such as a lot that was too hard to build on or a sinuous-shaped remnant that remained after carving out the lots. Developers and planners should integrate these areas into natural landscaping than make them into just pocket parks, just to preserve those odd spaces of leftover land too small for a real park. Pocket parks have been placed in the middle of traffic circles, in green strips between malls and highways, and at entrances to gated communities. Unfortunately, the one thing these locations have in common is that no one ever visits them (except groundhogs). In short, avoid the too large or too small open spaces with no purpose. Instead, either program the open spaces to meet real need) or divide up the space to allow for a variety of uses, such as picnics, volley ball or passive seating with shade and good views.

For spaces that are tempting as pocket parks, consider converting them to a wildflower meadow or a demonstration of xeriscaping or pollinator plantings. If there is a concern that the space does not look "intentional" or if a more manicured space is desired, consider adding a sign that says "Conservation Area" or "Habitat Demonstration Planting" and list some of the key species and animals that will benefit. This is much preferred to large expanses of lawn that must be mowed, do not mitigate stormwater runoff, nor provide habitat. Rather, consider leaving some as open meadow – mowed just once a year – which can be enjoyed by birds and pollinators such as butterflies or bees.

Housing orientation can be a key factor in terms of providing sunlight into homes for brightness or to camouflage homes from various views. The designer of the subdivision needs to determine whether the desired aesthetic is of tightly clustered homes along a street with porches to facilitate neighborly closeness or to tuck homes into the landscape and shield each home by screening them with vegetation or topography.

If home lots are intended to function as little private oases, avoid building unnatural berms (mounded piles of earth often planted with

"For spaces that are tempting as pocket parks, consider converting them to a wildflower meadow or a demonstration of xeriscaping or pollinator plantings."

"Each neighborhood should provide avenues to walk to amenities, such as parks, swimming pools, community centers, tennis courts, or scenic views."

screening materials such as pampas grass and crepe myrtles). Use native vegetation as screens and avoid disrupting native soils. See more in the next section on thicknesses of forests left in place. In Southampton, on Long Island, New York the community has long forbidden people to put fences or hedges around their lots, thereby encouraging an open landscape. This and other options can be written into an agreement with new homeowners, or can be proscribed by a housing association.

Well oriented homes can save on energy costs by facilitating active heating or cooling and improve the mental health of residents too. 'Daylighting' refers to the use of windows and skylights to bring sunlight into a home. Strategic shading can minimize unwanted sunlight – using trees, exterior walls/fences, structural additions, such as a porch or trellis, or window glazing or coverings. For homes in hot climates, shading is an effective way of keeping homes cool in summer. In general, plant trees with lower crowns on the west side of the house to block afternoon and sunset rays and use tall deciduous trees with high crowns for the southern side of the house (unless the home has solar panels or uses passive winter sun for heating the home).

The U.S. Green Building Council offers specific guidance for how to orient neighborhood blocks or houses to obtain credits under their Leadership in Environmental Design (LEED) standards at https://www.usgbc.org/credits/ea51

As many people are tending to work from home, or to bring extra work home with them, houses having an entrance for clients and a patio or porch off the office space can facilitate live/work arrangements (or they can be used for an elderly relative or returning post-graduate family member). Each neighborhood should provide avenues to walk to amenities, such as parks, swimming pools, community centers, tennis courts, or scenic views – walking often is motivated by a destination. Developments with trails that go in circles to nowhere in particular or are too short are less likely to be used or to provide the type of trail amenity that conservation buyers are seeking.

Tips from the South Carolina Forestry Commission

adapted from USDA Forest Service

Trees save energy through cooling in the hotter months and can function as a windbreak during winter.

Strategically placed shade trees – about a minimum of three large trees around a home – can reduce air conditioning costs by up to 30 percent. Shade trees offer their best benefits when:

- **deciduous trees are planted, since they shed their leaves during winter, allowing light and warmth in, and block heat from the sun during hotter months**
- **trees are placed on the south and west sides of buildings**
- **hard surfaces, such as driveways, patios and sidewalks are shaded to minimize landscape heat load.**

Evergreens, which retain their leaves/needles year-long, can be planted in a pattern to serve as windbreaks; saving from 10 to 50 percent in energy used for heating. Evergreens offer their best benefits when placed to intercept and slow winter winds, usually on the north side of a home (and not on the south or west sides of the home, as they block warming sun-light during winter). They will also provide some shading benefits during summer.

3.4 Designing With Both People and Wildlife In Mind

Conservation subdivisions have been criticized for protecting land at too small a scale to provide meaningful conservation benefits, while simultaneously promoting "leapfrog" development that ultimately exacerbates the problem of landscape fragmentation (Daniels 1997). To address these limitations, Arendt (2004) and others advocate incorporating conservation subdivisions into larger conservation networks, planned at the municipal or county level, that protect native habitats, agricultural lands, and water resources.

Forest fire is another key concern. The best way to avoid fire risk is to not build subdivisions in areas that are:

1) prone to fire
2) difficult to access or remote from fire stations
3) in conflict with other rural land operations, such as large forestry or milling operations

For existing subdivisions, communities can become *fire wise* by following principles from the International Association of Fire Chiefs' Ready, Set, Go Program. Foresters should contribute their expertise on the key locations for forestry, milling and processing operations and areas where forestry may be at risk, as well as any knowledge of significant trees. See the resources section for more.

In conservation subdivisions, people are put closer to nature by design. This can increase wildlife conflicts. Rules may need to be established for placement or use of bird feeders, trash storage and other wildlife attractants, as well as rules covering feeding (or not) of wildlife. In large developments, especially those backing up to a wilderness area, there may be problems with bears, raccoons, and with deer.

Invasive plants are also a problem when they escape from planted gardens into the forest. Common plants, such English ivy, can escape from a garden and strangle trees in the forest. A conservation subdivision should have a list of disallowed plants. See the appendix for sources that can provide 'Do and Do Not Plant' lists in the Carolinas, and that are available from state agencies. Similarly, if the conservation subdivision intends to preserve landscaped areas in common spaces, they should have a list of species not to plant and a list of native species to plant – and that are not fire prone.

A patch of forest in a conservation subdivision should be maintained in its natural state. This means that instead of manicured lawns underneath trees, the forest should have a mix of understory trees and shrubs supporting the ecosystem. Rather than mowing under the trees, nature trails should be created to allow for access without disturbing native plants and animals.

"Instead of manicured lawns underneath trees, the forest should have a mix of understory trees and shrubs."

This forest has been over cleared in this subdivision.

This forest has been allowed to retain its understory which helps capture stormwater and supports healthy soils.

A forest, or other natural habitat, may already have a problem with invasive species. In this case, there are a few options. A consulting forester can be engaged to conduct field visits to determine if there are invasive trees such as ailanthus that should be removed, or other plants that have overgrown the area, such as rhododendrons that have overpopulated and created shade conditions that prevent other native trees from coming up. This may require manual removal and some use of herbicides to prevent re-growth for the first few years. Fuel that builds up can be reduced with prescribed burning. These images below show a Carolina forest before, just after and six weeks following the removal of excess buildup of potential fire fuels.

Another forest health issue is the over-abundance of a single species, such as in an area that was previously logged but has grown up in small pine trees that are over-crowded and creating a significant fire risk. It may be necessary to thin the forest to give desired trees a better chance for light and nutrients, while also reducing the risk of fire.

It is also possible that a forester will advise clearing the landscape and restarting the forest with the right mix of native trees. Left alone, a site that was cleared should regenerate with native trees, but if it has been manipulated for years (for rural homesteads, grazing or a plantation forest) it may need assistance to properly regenerate – this is where the advice of a consulting forester is key.

Landowners should first contact their county or regional forester to ask about the process for generating a Forest Management Plan. In addition, if some areas need to be cleared of trees for development, there may be commercial benefits to consulting a forester who can advise on which areas have commercially viable timber. Consider keeping some of this wood to mill and use in the housing development, as part of the interior design of any community buildings, or for custom furniture such as 'live edge' countertops.

Prescribed Burning

"It may be necessary to thin the forest to give desired trees a better chance for light and nutrients, while also reducing the risk of fire.

1. This pine forest regrown on a clear-cut has not been thinned and is overly dense, presenting a higher fire risk.

3. Just after the prescribed burn.

2. A prescribed burn is implemented to clear extra debris.

4. Six months later the forest floor is revegetated and fire risk has been reduced.

Images credit:
SC Forestry Commission

4 DESIGNING FOR FOREST CONNECTIVITY AND PRODUCTIVITY

4.1 Site Inventory and Data

In this chapter, we discuss elements to evaluate for conservation subdivision design and will describe two case examples created for this guide and relate them to a general site design process. This process assumes that one has collected basic data for the site under consideration, so the first action required is to map and walk the site to determine actual land cover. Initial data for a land cover map can be created (if the locality does not already have such data) with aerial imagery analysis tools. Land Image Analyst (LIA) is one such freeware tool that classifies land cover types. Land cover maps are especially important when designing conservation subdivisions, in order to determine what types of vegetative cover exist on site, as well as disturbed areas and areas of mature forest – all of which can then be ground-truthed through a site visit.

Overlaying relevant data layers

In addition to land cover, other data layers should be brought into the analysis, such as:

- Streams and water bodies:
- Steep slopes:
- Types of soils
- Suitability for building

Constraints on development

Constraints on development include, among others:

- highly erodible or poorly drained soils: available from USDA SURGO data
- wetlands: available from the National Wetlands Inventory
- rare species: State Divisions of Natural Heritage can provide information on the presence of rare, threatened or endangered species
- areas of old forest: If the site is well treed, there may be significant individual older trees worthy of conservation, or groves of older trees that should be preserved (see earlier discussions of the importance of intact duff layers)

For large sites, it is not practical to survey individual trees, so forest loss can be reviewed over several years to determine if the site's land cover has changed significantly. This is defined as *stand-replacement disturbance*, or change from a forested to a non-forested state. The Hansen model depicts changes over time[7]. Historic aerial photos can also be viewed to determine site history. Obviously, if an area of the site was completely cleared twenty years ago, it will not contain any old growth trees. Examples of this analysis are provided with the site case studies found later in this chapter.

If the site design capacity is low (e.g. the site is just at the idea exploration state and the designer is not yet ready to bring on a full technical team), recall from Section Three that Esri's on-line green infrastructure map includes habitat from the GIC model of the United States. These data can be used to see intact habitat cores for an area. Recall that conditions on the ground will change, or be different from the map, depending on the age of the data, any recent traumatic events, such as fires or storms that have occurred, or any recent changes in land use. Or, the community may have already mapped its habitat cores. In South Carolina, the GIC's statewide habitat model has been used and updated by several local governments.

When using models, it is very important to conduct field verification. For example, since LiDAR is not available for the entire U.S. and is too hard to incorporate into the national Esri model, any trees mapped as a core could actually be relatively young. The Hansen model can be overlaid (using GIS) to determine which habitat cores were recently logged or are growing on land cleared in the past. This is an important factor in determining the age of the trees.

It is also critical to determine whether public water and sewer are available for the site, as this will affect minimum lot sizes, as well as other site constraints. For example, a vertical drop for

"If the site is well treed, there may be significant individual older trees worthy of conservation, or groves of older trees that should be preserved."

7 The Hansen Global change dataset for forest cover can be accessed here:
https://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.6.html

"It will need to be determined whether those structures need to be preserved because of their historic value, such as an Indian burial mound or old cemetery, or if they can be removed."

a backyard may be okay for a lot, but not be practicable if a septic field needs to be located there. Similarly, road access into and out of the site should be determined at an early stage, as well as likely layouts for a road network.

Current structures or debris on the site may also serve as constraints. It will need to be determined whether those structures need to be preserved because of their historic value, such as an Indian burial mound or old cemetery, or if they can be removed (derelict buildings in poor condition, dump sites, etc.). Steep slopes that are sensitive to disturbance or cliffs with dangerous drop-offs or unstable geologies, such as landslide zones, are also constraints to be avoided.

Two maps are needed to get started on design:

1) an assets map

2) a constraints map

Developers should create of these maps separately and then overlay the data to see where intersections occur. Examples of these maps are provided in the case studies.

As noted earlier, connections to off-site resources are also opportunities, such as the opportunity to connect to a regional greenway trail, gain access to a boat ramp or lake for swimming and fishing, or the proximity of a nearby state forest. But, most importantly, they will enable the site to maintain connectively of any intact forest landscape, wetland, river or other natural resource that crosses the site's boundaries. The site designs developed for this guide showcase these principles.

Remains of a structure found on a site that require removal.

4.2 Design Options – Deciding What to Protect/ Conserve/Restore/Connect

If a site developer has set a goal for a conservation subdivision (e.g. to conserve at least 50 percent of the land), then he or she needs to determine which areas are best suited for conservation. This is the flip side of development planning – asking where the most significant conservation zones should be and ensuring connectivity *before* the layout of roads and lots. This requires determining where areas of intact trees are located, as well as wetlands, streams, vistas, and so on. It will require setting standards for protection zones, such as stream buffers and set-backs from lake edges, and setting those areas aside as non-developable. If a stream meanders its way through the site, a standard may be established to avoid crossing it (and disturbing its channel) as much as possible, so that the environmental impact is minimized.

Sources for on-line data are found in the Resources Section of this guide.

Forests

Large chunks of intact forest should be protected whenever possible and connected to facilitate passage of wildlife from one forest block to another. When developing a well-treed landscape – known as a greenfield – it is worth understanding the site's history to learn what may already have been disturbed. People may have manipulated that landscape for generations. It may not be quite the "greenfield" it is believed to be.

The types of forests present, such as mature mixed hardwoods, early succession pine forests or forest plantations (often discernable from aerial images by their row patterns) may affect choices on where the built environment should be located. Areas already disturbed may be more suitable for development, as they are less likely to contain rare species or sensitive features. Conversely, there may be areas that are now open spaces, but which would make a good forest corridor if planted, and there may be forested areas that could be restored by removing invasive species.

If there are areas of the forest with excessive fuel build-up, the landowner could implement a prescribed burn to remove excess woody and plant debris that have built up over time.

Uninformed fire suppression allows fuel loads within a forest understory to build up to dangerous levels. A county forester, especially one trained in fire-safety practices, can be enlisted to walk the land and note areas where prescribed burns are required. A prescribed burn in the east is usually a low-grade ground fire that removes excess combustibles from the forest floor while leaving large trees intact. This type of forest management work is easiest to implement before the site is developed.

An important consideration when developing within or near a forest edge is to plan for fire safety. In the design section of this work there are additional factors offered for fire-safe designs within the development area, while the Resources Section provides links to fire-safe subdivision designs. Fire risk maps are available from state forestry agencies. For developments within forested landscapes, harm from fire will be reduced if lots are closer to major roads, since that reduces the travel time to reach an emergency exit or to allow emergency vehicles to reach the site. Access roads and driveways should be wide enough to allow emergency vehicles to reach all homes on the site. Proximity to water supplies should also be considered. Having more than one entrance/exit (even if the second entrance is for emergency use only) will also create a safer development.

"Conducting forest thinning or removing debris should be done well in advance of development."

Riparian features/streams/ wetlands

It is important to identify and respect as much as possible any river or drainage systems that run through a site. Although heavy equipment can relocate drainage channels and pipe streams, these actions are not advisable if you wish to protect water quality or the riparian life that depends on them. Streams often support rare plants and highly sensitive animal species, so disturbances should be avoided. A natural stream network left untouched will best serve to drain the landscape and, since larger trees are often found in stream valleys, where they tend to be less disturbed than on an upland site, the entire riparian buffer should be left untouched. Cove forests, which are found in steep stream valleys, are rich in species composition and tend to support rare or unusual species.

"Quartzite geology at Long Branch."

Forested wetlands are another feature that may not show up on the National Wetlands Inventory, since it is derived from satellite data and the tree canopy may hide them. So these features will need field verification. The presence of hydric soils, wetland plants, such as forest cabbage, or significant root flaring at the base of the trunks of trees can all be evidence of a forested wetland.[89]

Certain trees and plants are "obligate" species, such as Overcup Oak (*Quercus lyrata*) https://www.carolinanature.com/trees/quly.html, which means they almost always occur in wetlands.

FEMA has regulated floodways and 100-year floodplains and they should also be mapped. Although some communities only regulate development in the 'floodway fringe,' which is the area along a stream that is subjected to frequent flooding, avoiding the 100-year floodplain will save future homeowners from having to buy flood insurance. To determine which areas are at risk and may require insurance, consult the community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map.

Some developers elevate low-lying land with fill to raise it above the 100-year floodplain. While this is technically doable, it tends to increase downstream flooding and is highly destructive to the landscape. Furthermore, artificially created fill areas can fail as a result of uneven settling and other problems.

Building houses on stilts or with an elevated first floor is another construction method to avoid floodplain risks, but a more environmentally-sound decision would be to avoid the floodplain entirely. Insurers also charge more for homes within floodplains, so avoiding them altogether will save on expensive flood insurance policies, which have dramatically escalated in cost in recent years.

Short of conducting extensive wetland surveys, various GIS layers should be obtained. These include the National Hydrography Dataset; SURGO soils data for wetlands and poorly drained soils; and NWI for known wetlands and suspected wetlands, springs and drainage areas (some of which may be intermittent). For smaller drainages and streams, GIS can add a digital elevation model with "'hillshade" shown, so that topographic features can be highlighted to find unmapped streams. Keep in mind that intermittent streams are also important as they provide a key drainage function, and although they do not flow year-round, they may be utilized by rare species at key times of year, such as for springtime breeding salamanders, and provide vital drainage pathways during high-volume or seasonal rainfall.

8 Wetland plants and tree of NC: https://files.nc.gov/ncdeq/Water Quality/Surface Water Protection/401/Policies_Guides_Manuals/Common Wetlands Plants of NC.pdf

9 Wetland plants and trees of SC: https://www.fws.gov/wetlands/documents/South-Carolinas-Wetlands-Status-and-Trends-1982-1989.pdf

Geology

There may also be unique or striking geological features to conserve, such as rock outcrops, cliffs, large deposits of granite or quartz, caves, springs or seeps. It is also important to know where these areas are, especially if they will be difficult to build over and may present unstable dangers. They may also be dramatic landscape features worth highlighting by routing trails near to them (or, if dangerous, away from them!).

Steep slopes should also be avoided. Disturbing such slopes can lead to excessive soil erosion, with those soils draining into surface waters, even when the best methods are used to limit erosion. Even if the locality has not established steep slope standards, it is best to avoid disturbance of slopes over 25 percent. Slopes for road standards will be far less, but anytime steep gradient changes can be avoided will save on the costs of cut and fill during construction.

Cultural artifacts

There may also be some built elements – cultural artifacts – that are worth conserving, such as old stone walls, boxwoods, remnants of historic gardens, fishing piers, or historic barns. Should those elements be fenced off, avoided altogether (no access provided), or be more visible and incorporated into the site's overall design. For example, by uncovering an old stone wall or clearing and restoring an old cemetery, the developer could protect the site's cultural history.. There may even be areas known to have arrowheads or old pottery shards. If enough artifacts are known to be located within a certain area, it may be advisable to not develop those areas, since they may represent Native American fishing sites, burial grounds or a lost village. Contact the local historical society and current landowners to learn more. This information would not necessarily mean that the site can't be developed, but rather that these features will need to be incorporated within the development in order to preserve them.

Viewsheds

Views are a key selling point for a developer. They usually need to be protected from multiple vantage points. For example, a trail user walking downslope along a lake may want to look up and see green hills, just as a homeowner on the hilltop wants to see the lake. However, providing a clear view to the homeowner may ruin the sense of undisturbed nature for the resident enjoying the trail below. One option is to provide keyhole, or sliver views – cuts across a specific point to allow for views down the valley from above. However, this may still require cutting down large trees and lead to slope instability, so they are not generally recommended – but it is an alternative to topping trees or clearing large areas, to insert new views where they are lacking. Alternatively, observation towers or rooftop gathering spots allow people to look out over the landscape without causing undue blight to a scenic view. Structures can also be painted colors that blend in with their surroundings, and natural materials can be used to mimic natural rock features, which allow built structures to fit in more harmoniously and unobtrusively.

Adjacency and Buffering

Compatibility with adjacent land uses is another key factor. Developers and site designers should consider whether the density and type of uses they are proposing are compatible with those adjacent. For example, is a commercial zone to be located across from a farm (not generally compatible) or next to an active logging operation? Or perhaps the development abuts a scenic roadway. This is always a tricky decision to make, since land uses may change and one person's compatibility is another person's incompatibility. Zoning will often determine whether such adjacent uses are permissible or not, but the sensibilities of future home buyers also needs to be taken into consideration. A farmer who regularly sprays his arable field with cow manure upwind of your million-dollar properties is not going to help them sell.

Designers also need to consider any immanent use changes that are already in the planning process. Perhaps the farm across the road is already planned and zoned for development or a new electrical sub-station is planned for right next door. One way to address adjacency issues is to place the development behind a 100-foot forested buffer that protects all homeowners from the farm, road or new car repair shop. If the site is already wooded, the forested buffer can solve many adjacency conflicts.

In the next section, we provide design standards for the two sites evaluated and created by the GIC for this guide. In each case where a design standard is offered, we provide information for whether it is specific to that site or is a standard criterion reflecting best practices in that particular field.

"There may also be some built elements — cultural artifacts— that are worth conserving, such as old stone walls, boxwoods, remnants of historic gardens, fishing piers, or historic barns."

"The Green Infrastructure Center designed two conservation subdivisions—Long Branch, in Greenville County, South Carolina and Little White Oak Mountain, in Polk County, North Carolina."

4.3 Case Examples

As part of creating this guide, from 2018 to 2019, staff from the GIC designed two conservation subdivisions. Each site was very different from the other. Both are located in the Piedmont region of the Carolinas. The design principles discussed here can be applied anywhere that a conservation design is being contemplated.

Both the process to set standards for design and the outcomes are presented. Each completed design was provided to the landowners for them to proceed to approval and construction. These landowners were consulted throughout the process to ensure that the designs met their needs for the number and size of units, site amenities, land usage, road layout, and so on. In both cases, site layouts existed, but they were not conservation subdivisions. The new layouts provided site amenities that made them very special places that truly meet conservation goals.

Working through local land trusts (Conserving Carolina and Upstate Forever), the GIC evaluated several sites, before it choose to design one in South Carolina and one in North Carolina. Each site had unique constraints, opportunities and design challenges. In addition, each had a landowner with specific needs and development goals. Both developers were conservation-minded, in that they had identified land conservation as a site goal. In other real-world situations, the landowner or developer may need to be convinced of the importance of conservation subdivision design, using many of the arguments identified in this guide.

CASE 1: South Carolina: Long Branch, Greenville County

Long Branch is a privately owned site located in Greenville County, SC, about 30 miles east of the City of Greenville. The town of Simpsonville (population 22,000) is located nearby. The 819 acre site is mostly wooded, gently rolling Piedmont. To the west, there are a number of subdivisions on dense lots, while to the east the site is bordered by small farms and several homes on large lots set back from the road. The Long Branch Creek flows northeasterly through the site and discharges into Gilder Creek, which then flows into the Enoree River. In addition, there are many small, unnamed first-order creeks and springs that discharge into both a 37.5 acre lake that occupies the center of the site and an unnamed 2.4 acre upstream pond.

Site development history

The Long Branch site has likely been inhabited by Native Americans for millennia, since the Cherokee had been inhabiting the area for at least ten thousand years. While there are no known cemeteries or other documented cultural sites, the area has not yet be subjected to an in-depth survey. Several buildings do exist on site, but they originate mostly from the 1960s and '70s. There are a few older structures in a rundown state, possibly from the 1900s. One of the owner's family homes is situated in a nice location alongside the lake and could serve as a community center, a usage that was proposed in the original site development plan by the landowners.

The Long Branch site was selected for study after consultation with several land trusts in South Carolina. Upstate Forever was most helpful in linking the GIC with a landowner who had a forested site planned for development. This site had an

CASE STUDY Long Branch, Greenville County, South Carolina

existing conceptual development plan and its rezoning had been approved in 2007. However, it had not yet been built because the country had experienced a significant economic downtown at that time. The developer's promotional materials from 2007 described the site as follows:

> *The owners and development team feel that this property will best serve the community as a Planned Development. Greenville County established the Planned Development (PD) district zoning to encourage innovative and creative designs of residential and neighborhood commercial developments…The goals of the PD district are to promote efficient use of the land and protect the natural features and scenic beauty of the land, while providing a full range of residential facilities and neighborhood commercial and public services…[The development] has been planned in response to these PD district goals and fulfills the wishes of the neighbors, who have provided input to the County Planning Commission...*

In July 2016, Greenville County created the Scuffletown Rural Conservation District (RCD). This new zoning meets many of the GIC's principles for conservation, such as requiring that "designated open space shall be contiguous with open space areas on adjacent parcels to provide uninterrupted expanses of open space where possible." This new zoning law also requires 50 percent open space conservation to "maintain interconnected networks of open space lands," which shall also have access from internal subdivision roads. It also mandates 50-foot buffers for perennial streams draining 50 or more acres, and 150-foot buffers for rural scenic roads, one of which runs near the site.

The Scuffletown RCD established minimum lot sizes of 6,000 square feet (0.13 acre). The RCD requires 35 percent open space for neighborhood centers, 25 percent for community centers, 30 percent for "suburban transitional residential" and 50 percent for "rural residential and rural preservation" zones. These zones also establish standards for public access and usability. In addition, street trees are required at 30-foot intervals along every public street and at least two species of trees must be planted on each parcel in the neighborhood and community center zones.

UPSTATE FOREVER

Upstate Forever is a nonprofit conservation organization that protects critical lands, waters, and the unique character of Upstate South Carolina. Over the past two decades, they have protected the natural assets that make the Upstate so special — farmlands, forests, natural areas, rivers, and clean air. To learn more about their history, work, and goals, visit www.UpstateForever.org

EARLY SETTLEMENTS

These arrowheads, scraping and pounding tools were all found at the Long Branch site by the landowner.

This landscape was likely used by the Cherokee people. They originally called themselves "Ani Yunwiya," which meant the "Principal People." While there is no documented village at the site, the landowners have found evidence of use by Cherokee people in the form of arrowheads, scraping tools and related items (see images), although it is not known exactly where on the site these items were found.

Since there are documented Cherokee settlements within the three adjacent counties to the west (Anderson, Ocone and Pickens) it is likely that Native Americans were also in Greenville County. The treaty boundary of 1765 which separated settlers and Cherokee ran though the County. See the NC case study of Little White Oak Mountain for more.

CASE STUDY

The Developer's Green Goals

(for the 2007 rezoning)

Green areas will be designated along a greenway throughout the property to connect the neighborhoods and commercial areas to encourage walking and biking and potential use of Segway people movers. During the first phase, greenways will likely be restricted to use by the property owners within the development, and possibly turned over to the County Parks and Recreation at some future point as part of a county-wide greenway. The 50 acre lake will be restricted to use by the property owners during the early development phase, with careful regulations as to the type of water craft allowed.

They described their vision for a "conservation-oriented green development that will consist predominantly of single family residences clustered in such a way as to leave large areas of undeveloped natural areas and open spaces throughout the entire tract."

The Green Design Team ponders how to fit in lots while protecting corridors for wildlife.

Green Design Team

- Karen Firehock, natural resource scientist and planner
- Chris Lepetiuk, natural resource scientist and arborist
- Stuart Sheppard, GIS analyst and modeler
- Reed Muehlman, planner and architect
- Tim Miller, civil engineer
- Frances Waite, SC Forestry Commission Forester
- Dena Whitesides, SC Forestry Commission Forester

Although the Long Branch site is located in the Scuffletown RCD, the landowner's 2007 rezoning approval to rezone from Residential-Suburban (R-S) to Planned Development (PD) meant that they did not need to meet the Scuffletown RCD rules.[10] However, the rezoning approved for the site during the 2007 rezoning established several conservation-minded standards (although they are not as strict as the 2016 RCD zoning).

The 2007 PD zoning set up the following 'green standards.' A total of 233.5 acres was set aside as parks and green space, including the lake and pond. 1,865 units of housing would occupy about 75 percent of the total acreage, leaving just over 25 percent as open space. PD zoning requires sidewalks or paths on at least one side of all internal streets and a nature corridor/linear footpath to link neighborhoods to the lake. The developers also proposed that a trail be located on top of sewer lines running alongside Long Branch Creek below the lake's dam.

Developing a new conservation design

The first step for the GIC's design team (see box) was to identify the important environmental features on the site, including forested cores and connecting corridors, surface waters, elevations and other features. The GIC's cores model was used to show those most intact habitats that offered the greatest value for wildlife, interior forest birds, amphibians and other animals. The map on page 42 shows the habitat cores modeled for the site.

The next step was to develop the criteria for conservation development. Staff met with the landowner to learn about the site's history, the owner's willingness to be a test-case for a conservation subdivision design, and his general level of interest in conservation development. Early on in the process, the landowner stated that he did not want to see a development that destroyed the unique values the site offered, such as the clear, clean lake, which supported a multitude of fish, wading birds such as herons and kingfishers, and amphibians and other aquatic life. He noted that developments around lakes often destroy the very asset that attracted people in the first place by removing all the lakeside vegetation and placing homes right at the water's edge.

These values (see The Developer's Green Goals, above) meant that the landowner was highly motivated to create a conservation design. Protecting the water quality of this site and the beautiful lake vista meant that a wide buffer was necessary to prevent runoff from development into the lake and to avoid disturbing the wildlife habitat.

In addition, the site's location served as one of the largest remaining open spaces in the new Scuffletown Rural Conservation District. This led to the decision to buffer the eastern side of the subdivision to protect the views from adjacent rural lots across the road.

10 Residential-Suburban zoning is intended to provide reasonable safeguards for areas that are in the process of development with predominantly single-family dwellings but are generally still rural in character. Minimum lot size - 25,000 sq. ft. with public water or 37,500 sq. ft. without public water or as mandated by SCDHEC for lots requiring septic tanks. Density = 1.7 units per acre with 25,000 sq. ft. lots or 1.2 units per acre with 37,500 sq. ft.

SCFC and GIC staff meet with the land manager for the site.

A 100-foot wooded buffer was recommended in the new design. The GIC's cores model also showed large intact forested lands on the site and a significant linear wildlife corridor provided by Long Branch Creek.

Design criteria were developed to promote forest health, water quality, landscape connectivity and access to natural landscapes for the enjoyment of the residents. These design principles were based on the design team's expertise, as well as established standards for conservation of wildlife, birds, amphibians and water quality and quantity. They were then tested against the site to determine what sort of conserved landscape pattern would emerge.

Forest core at Long Branch

Landscape design principles for Long Branch

- Preserve at least 50 percent of the natural landscape, especially those lands containing habitat cores.
- Identify and protect key habitat cores and corridors. While some encroachment will be necessary, do not break connectivity though the site. Ensure wildlife corridors connect all the way through the site, from top to bottom, to maintain wider-context regional connectivity into and out of the site.
- Maintain a 100-foot wooded buffer around the lake and third order (larger) streams. Buffer streams by size, with 50-foot wooded setbacks for small streams (first order) and 100 feet for larger (second order and greater) streams. Smaller buffers can be used on first and second order streams, but do not dam or impact headwaters and springs.
- Consider the present and future context of the setting in site design, with respect to adjacent land uses. For example, if abutting rural land, consider less dense development with wide forested buffers to shield the pastoral viewshed. Therefore, maintain a 100-foot buffer for development along the road and abutting property owners on the eastern edge.
- Identify and maintain key viewsheds from the lake. Maintain viewsheds to the lake (but do not cut trees to create views to the lake from above).
- For commercial areas (likely to have the greater footprints), select already disturbed areas first when siting development.
- Avoid disturbance of steep slopes and poorly drained soils.
- Minimize site clearing and grading to avoid erosion and topsoil loss.
- Avoid the flood hazard area below the dam, to protect public safety and follow state rules.
- Account for and treat both volume and velocity of stormwater on-site and use low-impact development principles wherever possible – such as permeable pavement and bioswales along the roads, rather than curbs and gutters.
- Adhere to Fire Safe principles to minimize fire risk throughout the development.

CASE STUDY

Site assessment

The next step was to assess the site's condition. This required two steps: first, to create a base map of the site's assets, such as intact forests, soil types, streams, lakes and wetlands, known amenities, and other unique features. The second was to map limiting factors, such as areas that could not be built upon.

For more on source data for planning forest models, soils, etc., see the Resources Section of this guide.

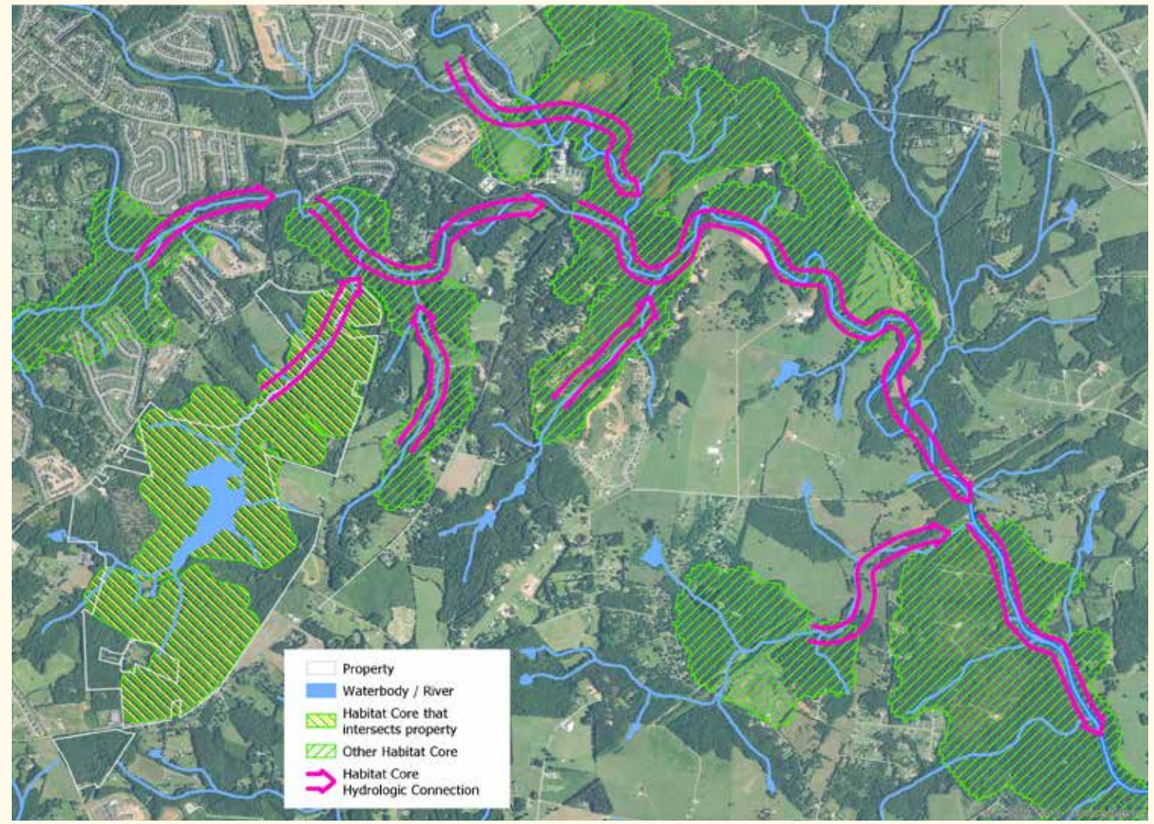
Once the two maps had been created, the next process was to evaluate the open space. The first step here was to map the land cover to know which land was forested, in meadow, under water, impervious, and so on. The GIC used Land Image Analyst (LIA) digital recognition software to map the land cover. This takes spectral signatures from infrared light reflections (4-band) and uses them to catalog surface types. LIA can be found at the GIC's website and is free to use. As a second step, GIS was used to calculate area statistics from the land cover types.

Flared tree at Long Branch indicating a wet site.

Habitat cores

Next, habitat cores were mapped using the GIC's model[11]. Much of the site was originally categorized as habitat core. Of the 819 acre-site, 570 acres were designated as habitat cores (all core surface) and 88 acres as fragments (smaller habitat parches with some value, but too small to be a core). Other land uses comprised 161 acres.

11 This model is available for the entire U.S. However, it may need updating for an area, depending on when the input data were last created.



The habitat cores at Long Branch and its riparian corridor link to the other cores in the region.

It was also important for the Green Design Team to understand how the site connected to the region and whether it served as a connecting core or occupied what would otherwise be a gap in the regional habitat network.

Staff from the GIC and the SC Forestry Commission conducted several site visits to understand the site and ground truth the site data. The GIC's site visits were used to verify core areas. Since the National Land Cover Dataset is only updated every 5 years (approximately) and changes can even occur in between the date of the imagery and the forest core modeling, ground truthing is always a good idea.

Several selected forestry plots were evaluated to determine the character of different forest types. After conducting field visits, the team identified a number of areas within the 570 acres modeled as cores that were actually too disturbed to be considered any longer as cores. In some areas, the forest was so disturbed that a site plot would not be useful. These disturbances were the result of past storms, logging, prior settlements and the encroachment of invasive species such as English ivy. Those areas were considered more appropriate for development. The other key factor to consider was whether or not the developed area would cut off a core or infringe on an area worthy of protection based on other criteria, such as proximity to a headwater stream.

SCFC Forester Dena Whitesides takes a core sample to judge tree age.

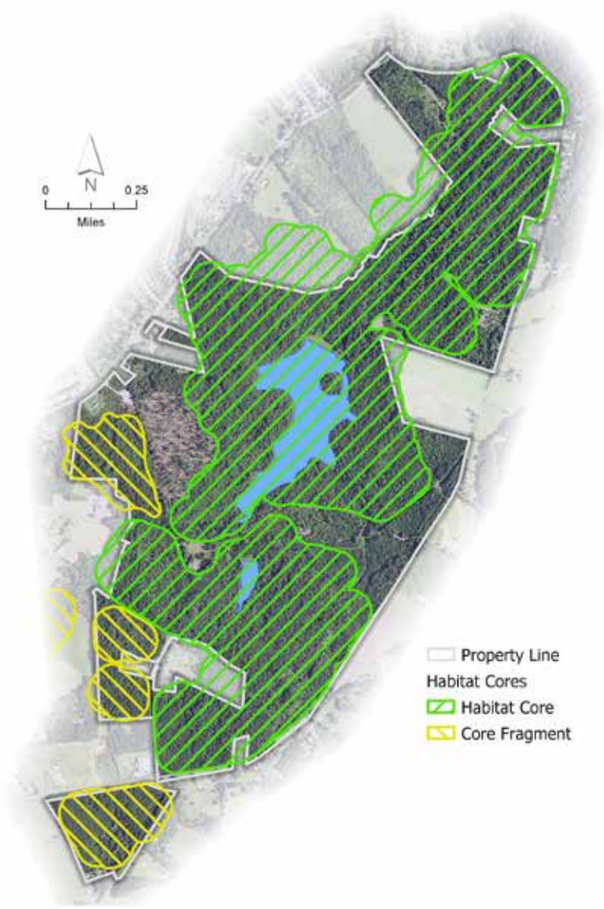
CASE STUDY

Long branch is a previously developed landscape and many remnant roads remain.

Previously cleared land on the eastern side of Long Branch where houses are proposed.

Site Habitat Cores

The areas shown in yellow hatching were found to be too disturbed to be habitat cores after field review and overlaying more recent aerial images. Some areas were re-classified as core fragments.



The original proposal for the site developed 777 acres out of 819, leaving just 42 acres of open space. However, a conservation subdivision requires at least 50 percent of the land be left unbuilt. But even this requirement did not mean that all areas of the site of high habitat value could be protected. In order to meet the developer's need to realize a profit from the development, some habitat cores still had to be impacted.

When determining development area, the key is to avoid blocking wildlife pathways, so the interior of the site was avoided. This had the added benefit of reducing the amount of roads that would be needed. As a result, of the 570 core acres, 124 acres were proposed to be developed, leaving 437 acres of core habitat protected from development.

For additional site statistics, see the box at right.

Now that the areas of forest cores had been established, the next step was to layer on the site's limitations. This included those elements excluded because of conservation goals and those that could not be built upon or that lacked adequate access.

Site Statistics

(derived from data and GIC's proposed plan)

- **Total area of the site: 819 acres.**
- **1,118 housing units, comprising a combination of single and multiple family units.**
- **Developed (includes all developed surfaces, including parcels, roads and stormwater pond areas, but not pocket parks, trails or green spaces): 257 acres.**
- **Undeveloped (this includes all areas outside the development bubble plus any open spaces left in parks and trails): 561 acres.**
- **Water: 39 acres (a 36.34 acre lake and a 2.36 acre pond).**
- **Miles (or feet) of proposed trails: 28,812 feet/5.46 miles.**

A remnant barn surrounded by invasive Japanese stiltgrass in the disturbed area to the northwest of Long Branch.

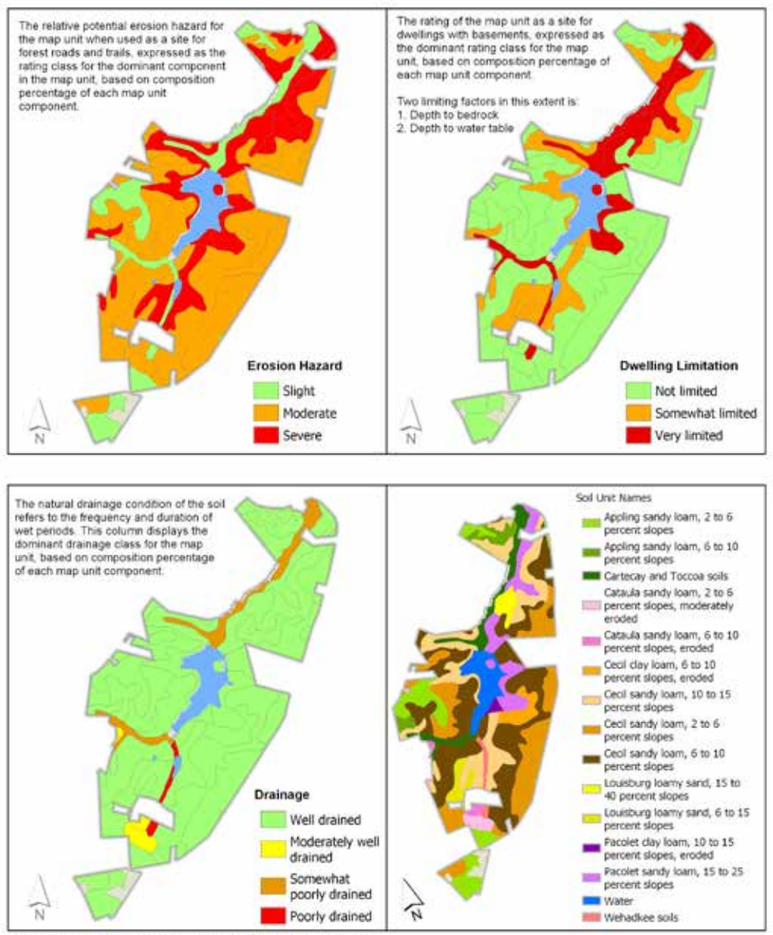
Site limitations

As noted, soils can result in many limitations to development. For example wet soils with high water tables; soils that are highly erodible, and thus unstable; or clays that may become liquefied when wet, or may crack when dry. The Soil Limitations map shows the various limitations by type: erosion hazards; depth to bedrock and water; and drainage abilities. It also provides a breakdown by soil type.

Water and sewer, as well as stormwater treatment, are not usually designed at the conceptual stage. However, all developers will want to know whether the site has access to public utilities or not, where they might hook up to them, or whether these services need to be handled on site through such facilities as community wells, bioswales and septic systems. Stormdrains and sewer lines are often run along creeks because they make sense for gravity-fed systems and can be located in floodplains. Creeks are often used to transport stormwater from the site.

"The dam flowed through a steep ravine characterized by quartzite sandstone and other hard, large rock formations, making it difficult to dig trenches for utilities, such as water or sewer lines."

Soil Limitations

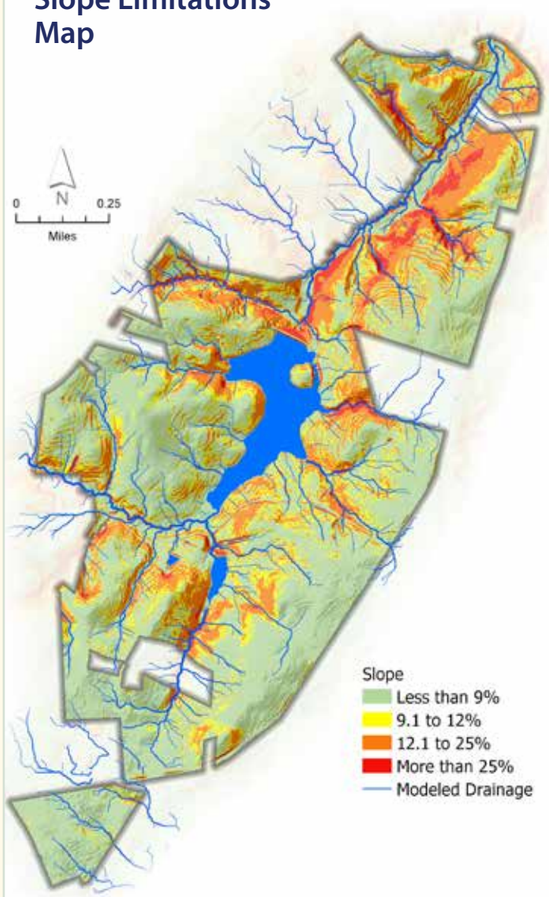


https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx
https://data.nal.usda.gov/system/files/SSURGO_Metadata_-_Table_Column_Descriptions.pdf

The developer's original plan was to run sewer lines down the creek and to have houses in close proximity to those lines. However, this was problematic for several reasons. The most significant was that the creek below the dam flowed through a steep ravine characterized by quartzite sandstone and other hard, large rock formations, making it difficult to dig trenches for utilities, such as water or sewer lines. Laying a sewer line, would have required significant blasting and earth removal, causing severe disturbance of slopes greater than 25 percent.

See the Slope Limitations map, below.

Slope Limitations Map



Long Branch Creek

Vegetation growing on large boulders below the dam.

Protecting the buffers around the lake and streams was another development limitation imposed by the GIC's design. Scuffletown area zoning required 50-foot buffers for streams draining 50 acres or more. The GIC's design generally follows this principle, but increases it to 100 feet on both sides of major streams, while maintaining the 50-foot buffer for secondary streams and a 25-foot buffer for smaller streams and headwaters (including known springs). 100-foot buffers remove more than 90 percent of the nitrogen, phosphorus and sediment entering the stream.

Conservation developments often need to exceed local standards!

In addition, the area of Long Branch Creek below the lake's dam was protected from development by dam safety regulations. As the lake was large enough to be regulated, the dam inundation zone could not be built upon. Therefore, the design team proposed a series of small pump stations to move sewerage through the site to reach the main system immediately below the development. In some areas of the site, connections to sewer were not possible or allowed, thus requiring septic fields. This limited smaller lot sizes and several areas where smaller cottage lots had been proposed had to be doubled in size to accommodate drainage fields.

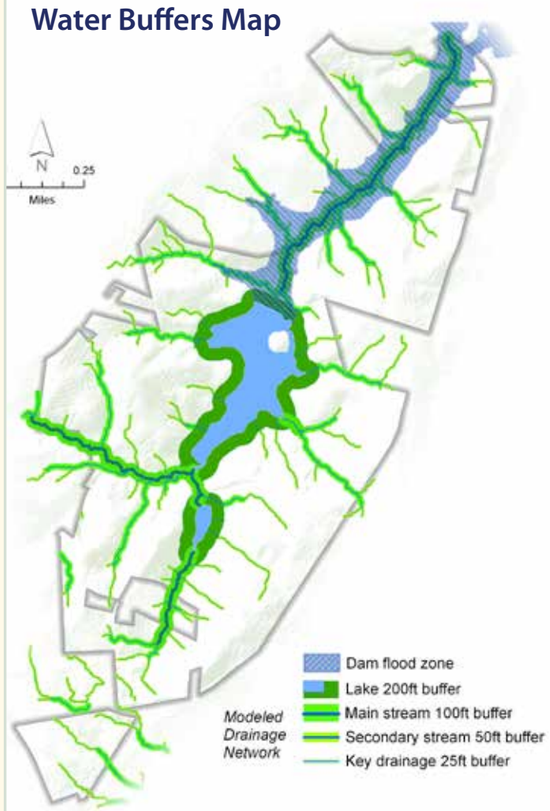
Putting all the constraints together provided the following overlay of what to avoid. This map combined all of the factors listed under constraints.

Next, the conservation priorities (cores + streams + lakes, etc.) were added together to see what should be protected.

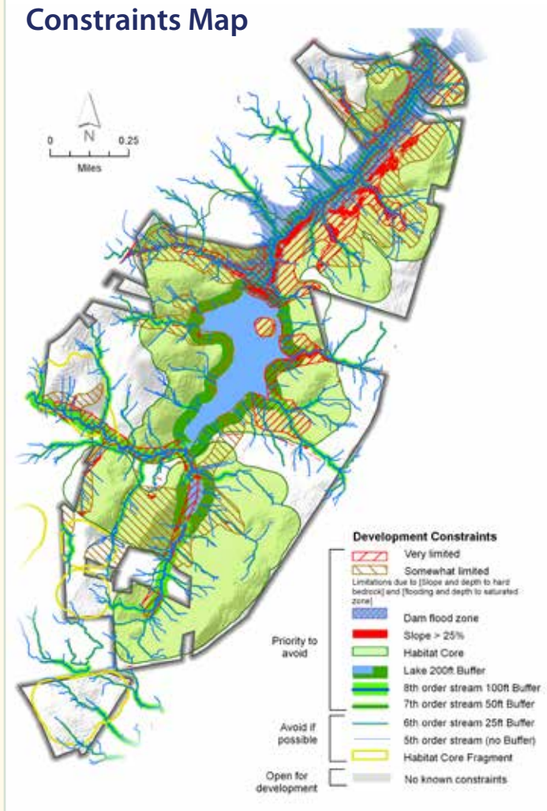
The following is the resultant development scheme, which met the earlier stated principles while avoiding the site's constraints. It resulted in developing 1,118 units, or about 60 percent of the originally proposed 1,865 units. This was acceptable to the landowner in exchange for preserving the health of the lake, streams and natural areas, and lost revenue would be recouped through higher unit prices for some of the larger lots as well as the units bordering the reserve area.

The full development map listing units per area is available from the GIC.

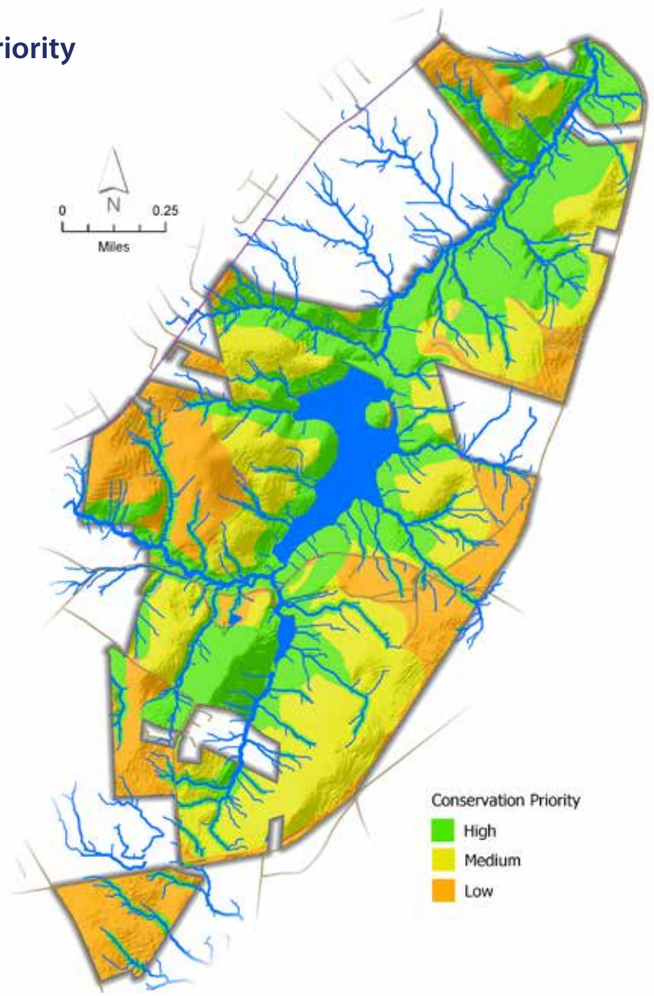
Water Buffers Map



Constraints Map

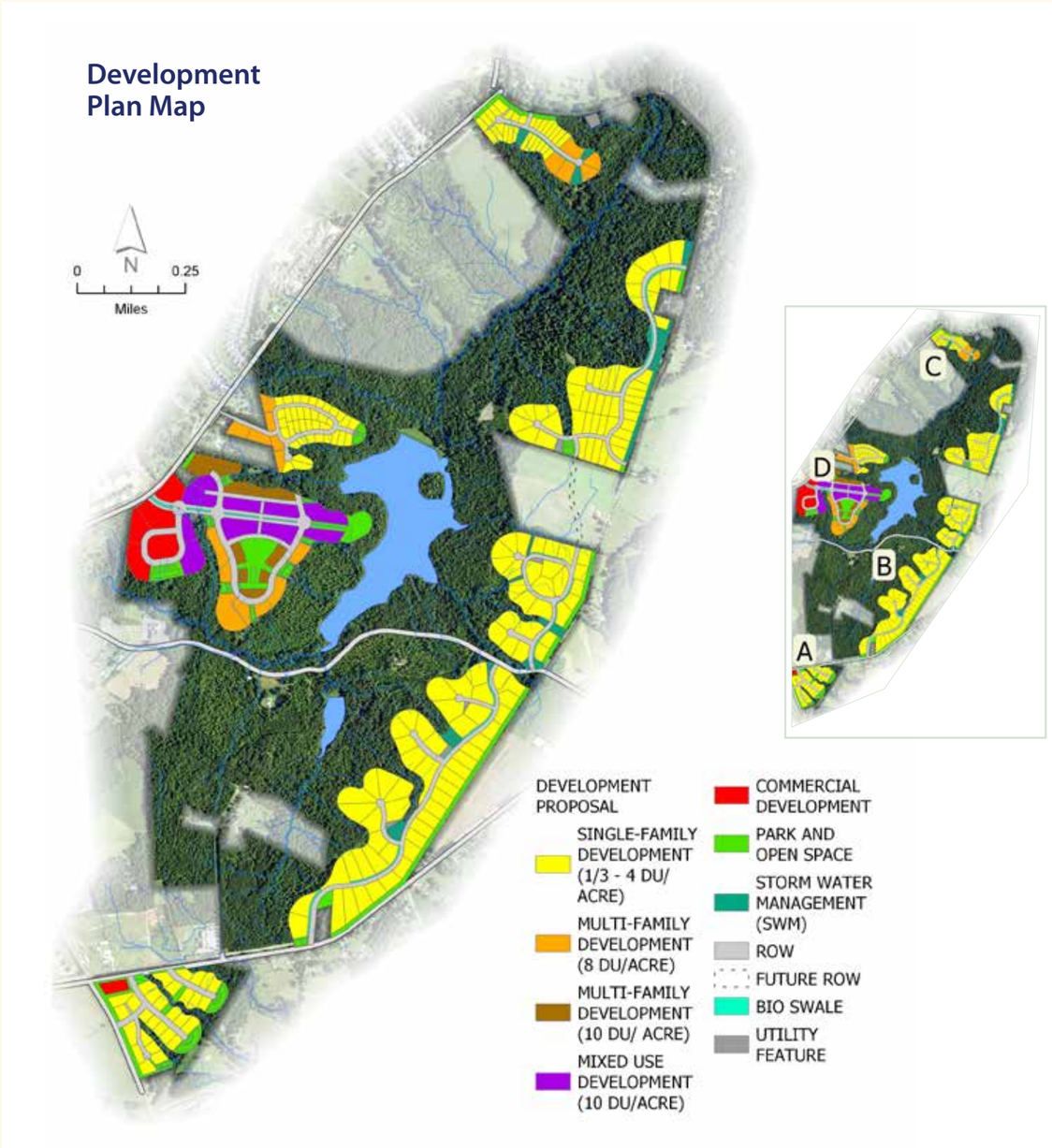


Conservation Priority



CASE STUDY

Combining the Constraints Map (areas limited to development) with the Conservation Priority Map (what not to develop) resulted in the Development Plan Map.

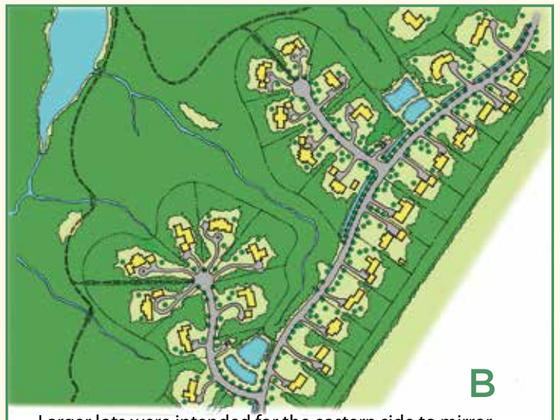


Development schema

This development uses cul-de-sac designs, necessitated to avoid stream crossings, burying streams or putting them in culverts, all of which are highly impactful to hydrologic function and water quality. A trail network connects each street to other neighborhoods and to the rest of the site, including the lake.

The following zoom-ins show some of the details for each development area.

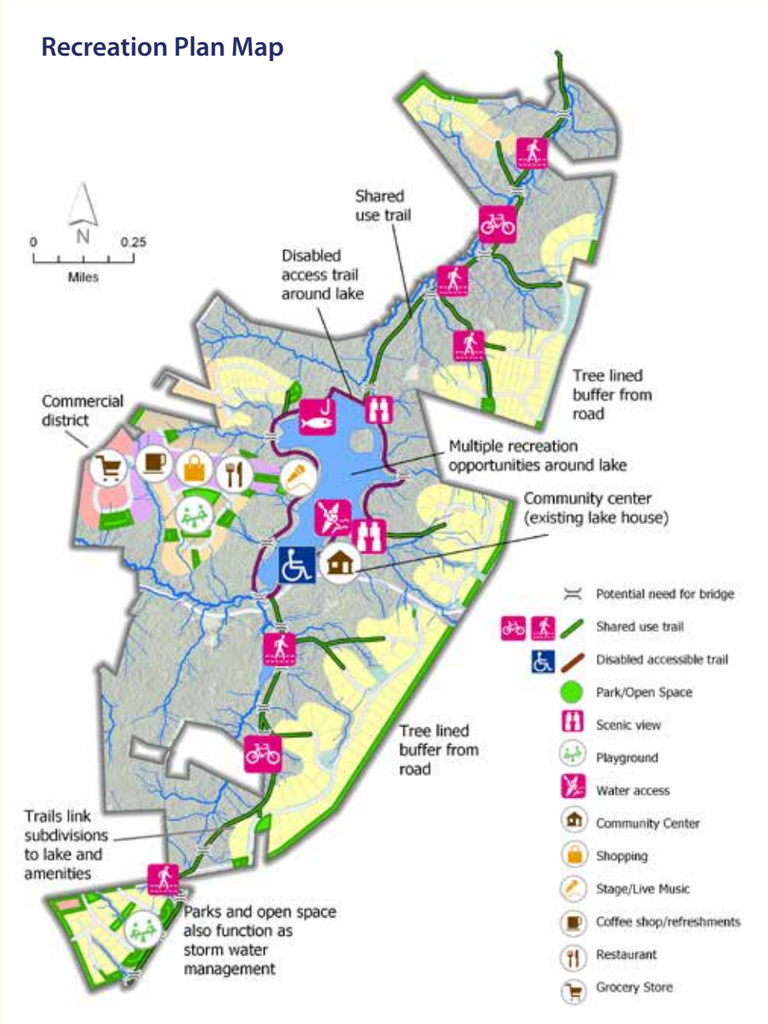
The cottages were designed for smaller lots and affordability. Originally imagined as smaller than a third of an acre, they had to be enlarged to meet the limitation that only septic systems were allowed on those lots. A gas station/convenience store is located at the corner. Trials lead from this area to the large developments and a linear park with a bridge connects the streets over the stream.



Larger lots were intended for the eastern side to mirror the larger lot character of adjacent ownerships across the street. A 100-foot buffer screens the development. These larger lots were intended for more expensive homes , to offset the opportunity costs of the undeveloped land.

The neighborhood to the north consists of single family units with larger multifamily (garden style 3-4 story) units at the back of the lot. This site is connected by trails to the rest of the development.

The town center area consists of mixed use, with larger institutional uses, such as assisted living apartments and large commercial uses such as grocery store. The main street runs through the center, with a bioswale planted with large trees. This, and other streets can be closed off for community events. A large community green with a stage was provided at the southern end, surrounded by apartments and condominiums. On the eastern side, an open-treed park and large deck provided a manicured park space for relaxation, as well as events. Rooftop terraces and mixed use flank this road, while small shops and cafes create a vibrant street life, similar to that found in the City of Greenville. Roundabouts provide smooth traffic movement without traffic lights. Trails from this site connect to the rest of the development.

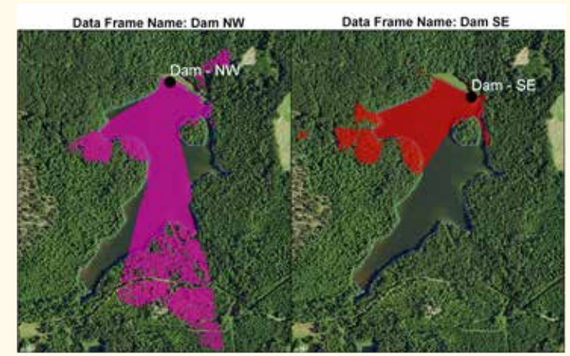


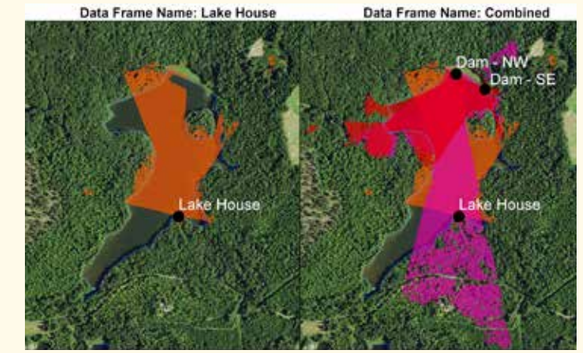
Recreation

To allow access through the site to reach such amenities as the lake and pond, it was proposed to construct approximately 5.5 miles of trails. Several trails were designated to meet ADA standards for access, while others were to be dirt or mulch lined, to limit the disturbance of sensitive areas. Pocket parks and 'tot lots' were located within several areas to provide spaces for smaller children (and adults!) to play closer to home.

There is a boat dock and observation deck at the proposed nature center. These are spaces available to launch boats and they may also include lockers for non-motorized boat and equipment storage for residents. It was recommended that some of the HOA fees for the development be used to upkeep the public boating areas and trails, and to provide maintenance and education staff. Having regular programs for residents about native plants, environmental stewardship, tree care and fire safety are examples of the programs that could be offered. The nature center could also function as a day camp for children. Fees from the camp could support educational staff and building upkeep.

Views from the lake were mapped to determine what could be seen from various angles. This ensured that development above was not viewable from the lake below, giving the recreationist a peaceful, serene natural setting. Viewsheds were also tested from above, looking down at the lake, but the team found that the lake was not visible due to tree heights. Since tree protection and minimizing core disturbance are central tenets of the development, the Green Design Team proposed that no trees should be cut to provide lake views. The lake should thus be intended solely as a natural retreat for quiet enjoyment .





Stormwater

As this site was, at the time of writing (late 2019), at the conceptual design stage, a full stormwater management plan had not been completed. However, at the conceptual stage, the developer expressed interest in using design standards for stormwater that followed low-impact design principles. In a conventional development, developers often clear the entire site first. At Long Branch, the goal was to avoid removing trees and to minimize clearing and grading. This resulted in a far smaller developed area with far less stormwater management requirements, since only non-forested areas need treatment.

In addition, a conventional design would simply send most of the stormwater to the lake. Since, in this case, the lake had the capacity to accept the stormwater, why not do this? This is not a good design since the clean and healthful lake, would become murky and polluted by the addition of stormwater.

So, when designing a stormwater plan, set environmental standards before engaging the engineering team. Most civil engineers are going to begin with those conventional stormwater designs (pipes, ponds and outfalls to lakes and streams) that are easiest and cheapest. But, for a conservation design, maintaining clean surface and groundwater should be a key outcome.

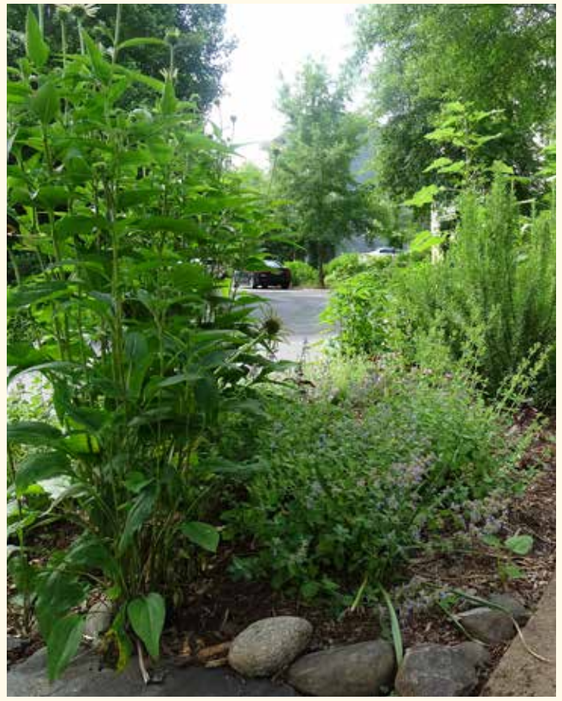
Bioswale in a new Greenville subdivision.

CASE STUDY

Areas above the stormwater ponds shown on the maps are intended to be usable green spaces during dry periods. This idea comes from the concept of stormwater playgrounds or stormwater plazas that are designed as open spaces when not in use. This avoids the need to waste open space by restricting it to a single purpose. In addition, stormwater ponds are intended to have planted edges to support pollinators, birds and other wildlife, while providing designated ingress and egress zones for annual maintenance. This is in contrast to having every side mowed.

The overall need to treat stormwater from this development is reduced dramatically by the limited use of impervious surfaces. In general, stormwater should be treated as close to the source as possible, to avoid overloading stormwater pipes and ponds. In some areas of the development, these pipes can be avoided altogether by treating the runoff on site. Limiting the need to construct pipes and large ponds saved the development time and funds. In the commercial center, the treed median was designed as a bioswale and to be planted with wet-loving species, such as cypresses.

In neighborhoods on the eastern side of the development, sidewalks were not proposed. Instead, mowed roadsides provided space for walking and drainage ditches were designed as bioswales to infiltrate stormwater on site.



Strips between streets and sidewalks can also provide habitat.

Permeable parking in a residential subdivision.

It is also possible to incentivize water conservation by reducing HOA fees for homeowners who install rain barrels and cisterns. Driveways can also be permeable. For commercial areas, other best management practices (BMPs) can be employed, such as permeable parking areas, cisterns and tanks located under parking lots to catch stormwater. Greywater can also be recycled to water vegetation and lawns. See the resources section for other LID method guides.

"It is also possible to incentivize water conservation by reducing HOA fees for homeowners who install rain barrels and cisterns."

This butterfly bush planted in a street median supports pollinators.

Tree care and conservation: street trees

In developed areas of the site, street trees are proposed. Often, street trees do not live long because they are planted improperly, in poor soils and without enough soil volume to allow proper root establishment and strength, so this site plan avoided those mistakes. Trees must also have a plan of care that lasts at least two years while they become established. Companies that install the trees should ensure that planting and pruning is done by trained professionals.

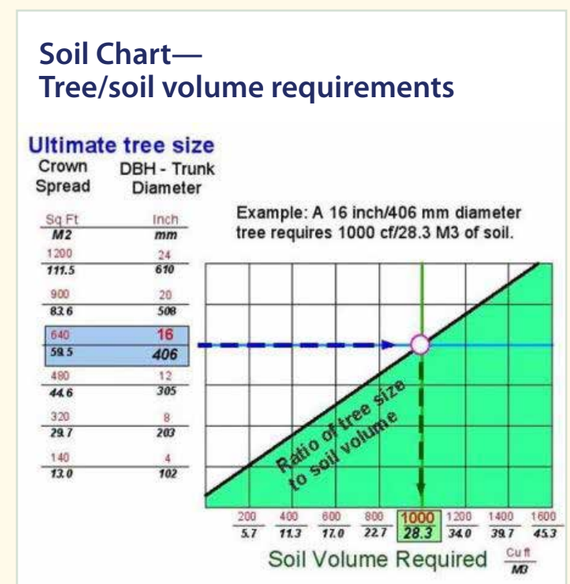
The following are recommended tree care standards, soil volumes and types.

- Install street trees of a 1-2 inch caliper. Vary trees for diversity, with at least 3-4 distinct canopy trees per block. Use appropriate native species as much as possible. Note that not all native species make good street trees. For example, Red Maple (*Acer rubrum*) does not work well near sidewalks or driveways because its roots grow close to the surface and can cause those surfaces to buckle; they are also sensitive to heat and will suffer trunk cracking when planted in paved areas. Choose street trees that do well surrounded by pavement and have limbs that grow upward in a v-shape as much as possible.

Street trees are essential for densly developed areas.

- Use a soil volume chart when designing planting boxes. Mature trees need at least 1500 ft². Install gator bags for the first 1-2 years of planting and hire regular watering staff for the spring, summer and fall (based on temperatures). Prune only in the dormant season and ensure it is done by licensed arborists. Never allow tree topping. Dead or diseased trees should be removed within two weeks to prevent harm to neighboring trees or the spread of diseases and pests. Street trees should be inspected annually and any risky conditions should be attended to within weeks, depending on the severity of risk (following ISA standards for Tree Risk Assessment).

For more see https://www.isa-arbor.com/certification/becomeQualified/becomeQualified



Case 2: North Carolina, Little White Oak Mountain, Polk County

LIttle White Oak Mountain in winter.

The Little White Oak Mountain site is a 35 acre tract that is part of Polk County and the Town of Columbus, NC. Polk County has a total land area of 239 square miles, making it one of North Carolina's smallest counties. The Town of Columbus, which only has just over 1000 inhabitants, annexed portions of this land several years ago. The surrounding landscape includes rural land and homes on large lots. Other small towns nearby include Tryon, Saluda and Lake Lure.

Steep slopes and ridges with numerous streams are common in the mountainous areas of the county , which rise to over 1,200 feet in places. Those areas below 1,200 feet typically feature the rolling hills and broader rivers seen throughout the Piedmont. The area has a rich history and is included in North Carolina's cultural heritage region for crafts and music.

Polk County is part of the middle to southern Blue Ridge Mountains, which the National Academy of Sciences has identified as the top priority nationwide for biodiversity conservation https://www.pnas.org/content/112/16/5081. At least thirty-four distinct natural community types are found within Polk County, demonstrating the incredible biodiversity supported by the county's rich landscape. In North Carolina, endangered, threatened, and special concern species

The parcel proposed to be sold for development is already highly disturbed.

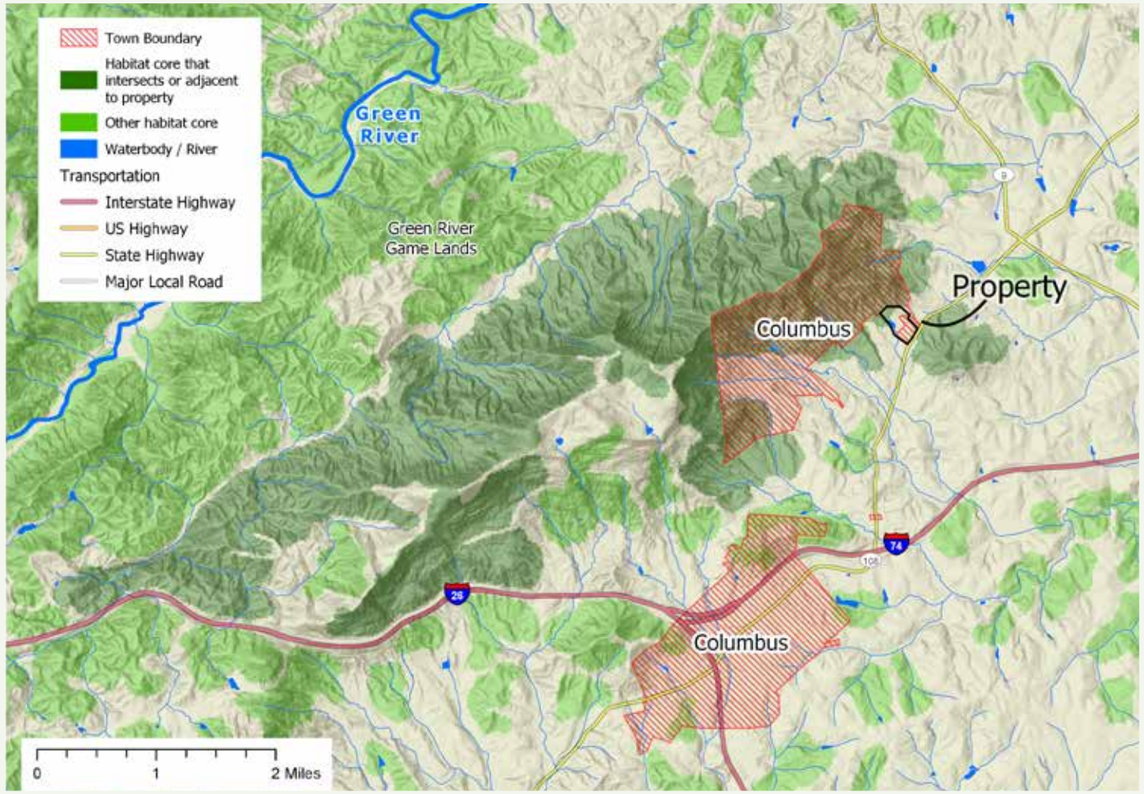
"The county supports 127 rare and watch-list plant species, of which, 45 have state status as threatened, endangered or vulnerable, and 13 are also federally listed."

have legally protected status, maintained through the North Carolina Plant Conservation Program (NCPCP).

The county supports 127 rare and watch-list plant species, of which, 45 have state status as threatened, endangered or vulnerable, and 13 are also federally listed. The surrounding Green River Game lands are just north and west of the site. These game lands are a state-owned tract of 14,331 acres set aside for wildlife conservation and management and they provide abundant outdoor recreation opportunities. In this landscape, especially, development should be done in such a way as to avoid harming these sensitive species.

For more about the site and region see:
https://conservingcarolina.org/polk-county-inventory/

The pond provides a peaceful setting for future residents.



CASE STUDY

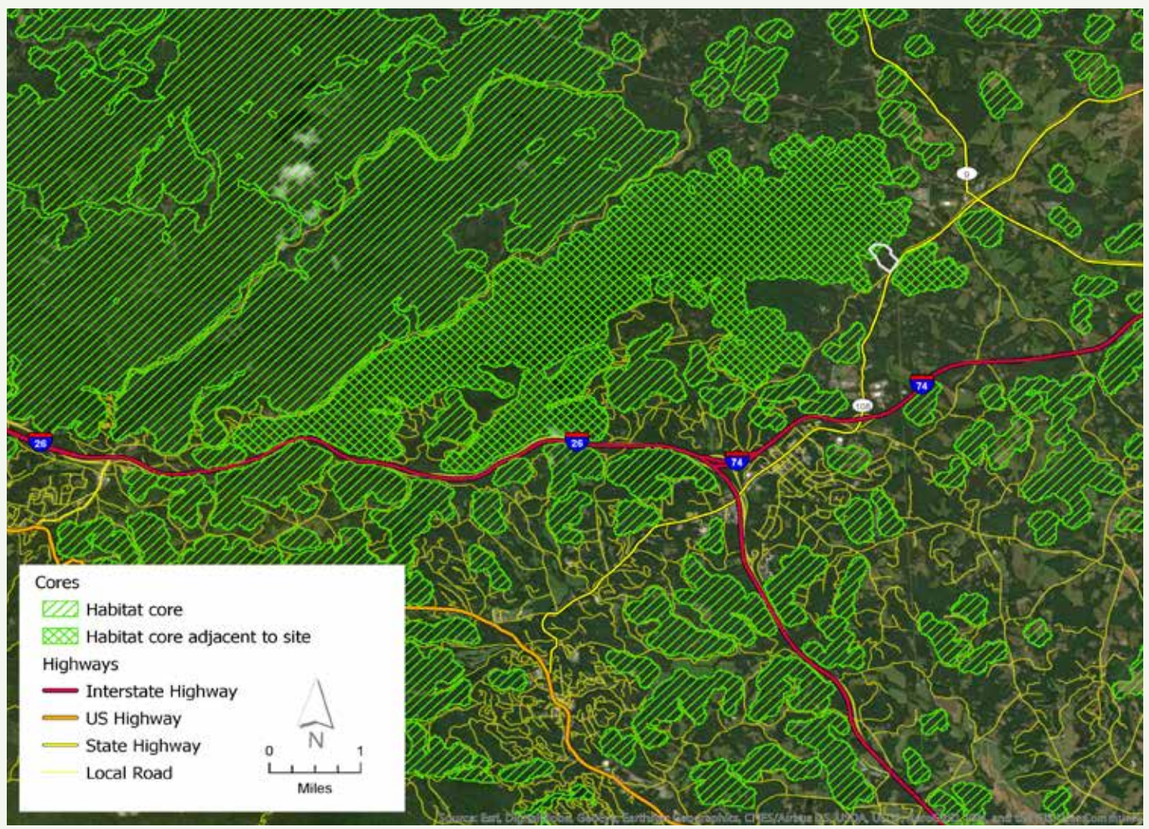
Site Development History

The area of Little White Oak Mountain was originally slated to have 687 homes on a 1,068-acre parcel on the south side of the mountain. Similar to the Long Branch site case study, this development was the victim of the mid-2000s recession and did not come to pass. However, in the fall of 2016, a land trust, Conserving Carolina, purchased the property for $2.375 million, in order to protect it from inappropriate development. In the fall of 2018 they transferred 600 acres to the North Carolina Wildlife Resources Commission to expand the Green River Game Lands, and donated 300 acres to Polk County for a local park, which protects 123 miles of streams and will feature a 10-mile multiuse trail system.

The 900 acres of new public land donated by Conserving Carolina now extends from the ridgeline of Little White Oak Mountain down to Polk County Middle School and the Polk County Recreation Complex near Highway 108, where it links to the Green River Game Lands. The newly protected land in the Green River watershed supports many endangered species, such as the white irisette, an endangered wildflower.

Mature hardwoods dominate the top, which joins the large habitat core of Little White Oak Mountain.

The Little White Oak Mountain site was largely protected by Conserving Carolina but they proposed to divide off the lower section and allow it to be developed, since it was already highly disturbed. This lower area of the parcel adjoins Route 108, had been previously logged and already supported multiple homes.



Regional Habitat Cores

Although the site adjoins a large natural area it is highly disturbed.

See the land cover map showing locations of houses and house ruins on page 60.

Conserving Carolina plans to divide the lower parcel of just over 30 acres and transfer it to the Housing Assistance Corporation (HAC) to build affordable housing. This new partnership with the HAC is part of Conserving Carolina's commitment to ensure that placing lands in conservation does not limit the supply of affordable housing. They recognize that conservation easements can sometimes cause nearby land values to escalate.

"900 acres of land is now available for conservation and public enjoyment."

One driver for house prices increasing in the area is the new Tryon Equestrian Center – a $100 million dollar horse center and resort – which may cause income disparities to increase since the center is luring many more wealthy horse patrons to build second and retirement homes in the area. It is also a source of new jobs. The development may provide an option for affordable worker housing as it is just 20 minutes from the equestrian center at Tryon.

CONSERVING CAROLINA
is a land trust serving part of Western North Carolina and the Landrum area of South Carolina. Conserving Carolina is dedicated to protecting and stewarding land and water resources vital to natural heritage and quality of life and to fostering appreciation and understanding of the natural world.
https://conservingcarolina.org/

CASE STUDY

Clearing with views of Little White Oak Mountain

The GIC choose this site as it presented an opportunity to link the developed landscape to a vast conservation area while providing residents the opportunity to live in a healthful, clean and safe environment, enjoying amenities that are not often available to people in affordable housing developments.

The site proposed for development is 35 acres and lies between the reserve and Route 108. As a steeply sloped site, it presents several challenges for development, as well as distinct needs for conservation of sensitive landscape features. However, the steepness of the site also provides for scenic vistas and striking views of natural features. The impressive 2,343-foot summit of Little White Oak mountain is visible from the center of the site.

EARLY SETTLEMENTS

Native Americans inhabited the region of North Carolina that is now Polk County for at least 11,000 years. In 1765, Governor William Tryon came to the area to broker a peace agreement with the Cherokee people following conflicts of the French and Indian War. They signed a treaty on what is now called Treaty Rock on White Oak Mountain. They established a boundary line from Virginia to Greenville SC to separate Indians from settlers.

By 1838, after repeated violations of the treaty by settlers, the Cherokee were rounded up and marched on the Trail of Tears to Oklahoma, resulting in 4,000 deaths along the way, while other Cherokee who avoided capture retreated to Western NC. Several articles reference Native American artifacts across White Oak and Little White Oak Mountain.

Developing a New Conservation Design

Similar to the Long Branch site, the first step for the Green Design Team (see box) was to determine important environmental features of the area considered for development, including forested cores and connecting corridors, surface waters (ponds, streams), elevations and other features. The GIC modeled the habitat cores for the larger conserved landscape to show how to the site contributed to the reserve areas upslope. The map on page 60 shows the habitat cores modeled for the site.

The next step was to develop criteria for the conservation development. The Green Design Team's field staff walked the site with staff from Conserving Carolina. Areas at the uppermost reaches were the least disturbed and formed part of a larger habitat core complex (see map of regional cores). The GIC also met with the staff from the affordable housing buyer Housing Assistance Corporation (HAC) to discuss their need to realize enough units of affordable homes to meet their available funds and housing goals.

Since this site abuts the protected lands purchased by Conserving Carolina, it was important that the site have an adequate buffer between the developed landscape and the reserve. In addition, the upslope areas were very steep, with loose material from the parent bedrock deposited on lower levels of the site. There were several existing roads into the site, but they were too steep for a housing development and had bad erosion problems because of how they had been laid out by prior owners.

The Green DesignTeam ponders how to fit in lots while protecting corridors for wildlife.

GIC's Green Design Team

- **Karen Firehock,** natural resource scientist and planner
- **Chris Lepetiuk,** natural resource scientist and arborist
- **Stuart Sheppard,** GIS analyst and modeler
- **Reed Muehlman,** planner and architect
- **Tim Miller,** civil engineer

Bufflehead duck in the pond at Little White Oak Mountain.

Design criteria were developed to promote forest health, water quality, landscape connectivity and access to natural landscapes for resident enjoyment. These design principles were based on the design team's expertise, as well as established standards for conservation of wildlife, birds, amphibians and water quality and quantity. These principles were tested against the site to determine what sort of conserved landscape pattern would emerge.

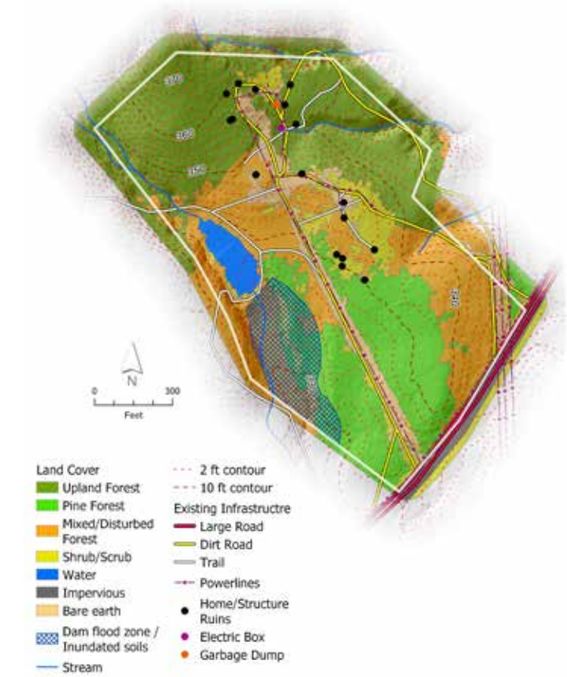
NC Natural Heritage Survey, June 2008.

Areas that were spared from timber removal are in good condition and will be included within the Nationally Significant White Oak Mountain/Tryon Peak Significant Natural Heritage Area, an area known to support an outstanding cluster of rare species and community occurrences typical of rich foothill environments. The eastern slopes of the White Oak Mountains have numerous rock outcrops embedded within forest coves that contain wet seeps and small springs. Rare and watch-list species are clustered around these features.

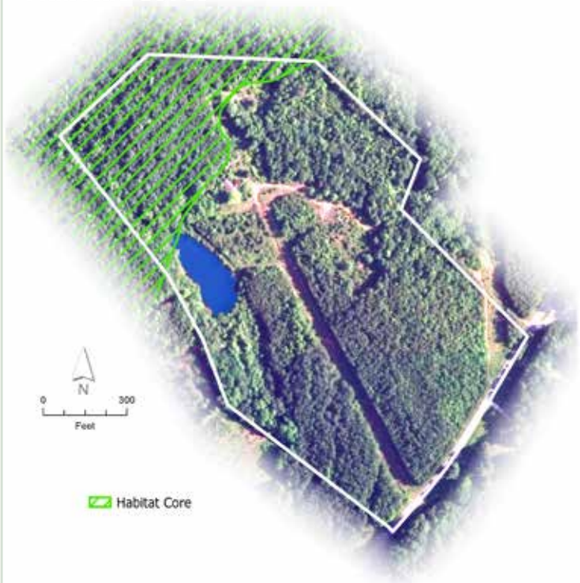
Landscape design principles for Little White Oak Mountain

- Preserve at least 50 percent of the natural landscape, especially those lands containing habitat cores.
- Identify and protect key habitat cores and corridors. While some encroachment will be needed, do not break connectivity though the site.
- Ensure wildlife corridors connect all the way through the site from top to bottom to maintain larger regional connectivity into and out of the site.
- Maintain a 100-foot wooded buffer around the pond and stream. Avoid encroachment into areas shown as possible drainages and do not dam or impact headwaters and springs.
- Consider the present and future context of the setting in site design with respect to adjacent land uses. Maintain a buffer between the site and the upslope conservation area. Maintain a 100-foot buffer for development along the road and abutting property owners on the western and southern edges of the site.
- Identify and maintain key viewsheds from site to the mountain (but do not cut trees to create views).
- Avoid disturbance of steep slopes and poorly drained soils.
- Minimize site clearing and grading to avoid erosion and topsoil loss.
- Avoid the flood hazard area below the dam, to protect public safety.
- Account for and treat both volume and velocity of stormwater management on site and use low-impact development principles wherever possible, rather than curbs and gutters.
- Adhere to Fire Safe principles to minimize fire risk throughout the development.

Land Cover



Habitat Cores



Site assessment

The next step was to assess the site's condition. This required creating a base map of the site's assets (intact forests, soil types, streams, lakes and wetlands, known amenities and other unique features). The second step was to map limiting factors, such as areas that could not be built upon (e.g. steep slopes, highly erodible or wet soils). See the Data chart in the Resources Section for a list of data obtained for the site. As with Long Branch, the GIC used Land Image Analyst (LIA) to create a land cover map using the LIA software and to derive habitat cores as described below.

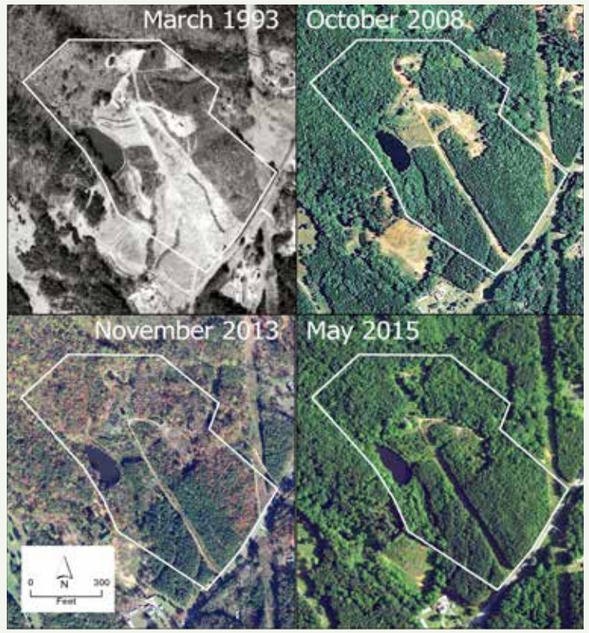
Habitat cores

Habitat cores were mapped using the GIC's model. As the site is so disturbed, only the northwest portion of the site – about 6.5 acres – was in relatively good condition with mature canopy and had a high conservation value (see text box on page 59). Although that area was not large enough to be a core by itself, it was part of a much larger 6,357-acre core. This demonstrated the importance of not only viewing a site as to the area within the legal boundary zone, but understanding it as part of a much larger ecosystem.

See prior description of the site's biological diversity in the introduction.

Staff from the Green Team conducted several site visits to understand the site and to ground-truth the modeled land cover data. The landscape was found to be very disturbed from past developments. Many structures had been demolished and some areas of the site had been used as a dump site for household refuse, such as tires, strollers and bottles.

Field staff from Conserving Carolina and GIC make observations about the landscape.



From 1993 to 2015, the site had changed from logging activity and housing developments.

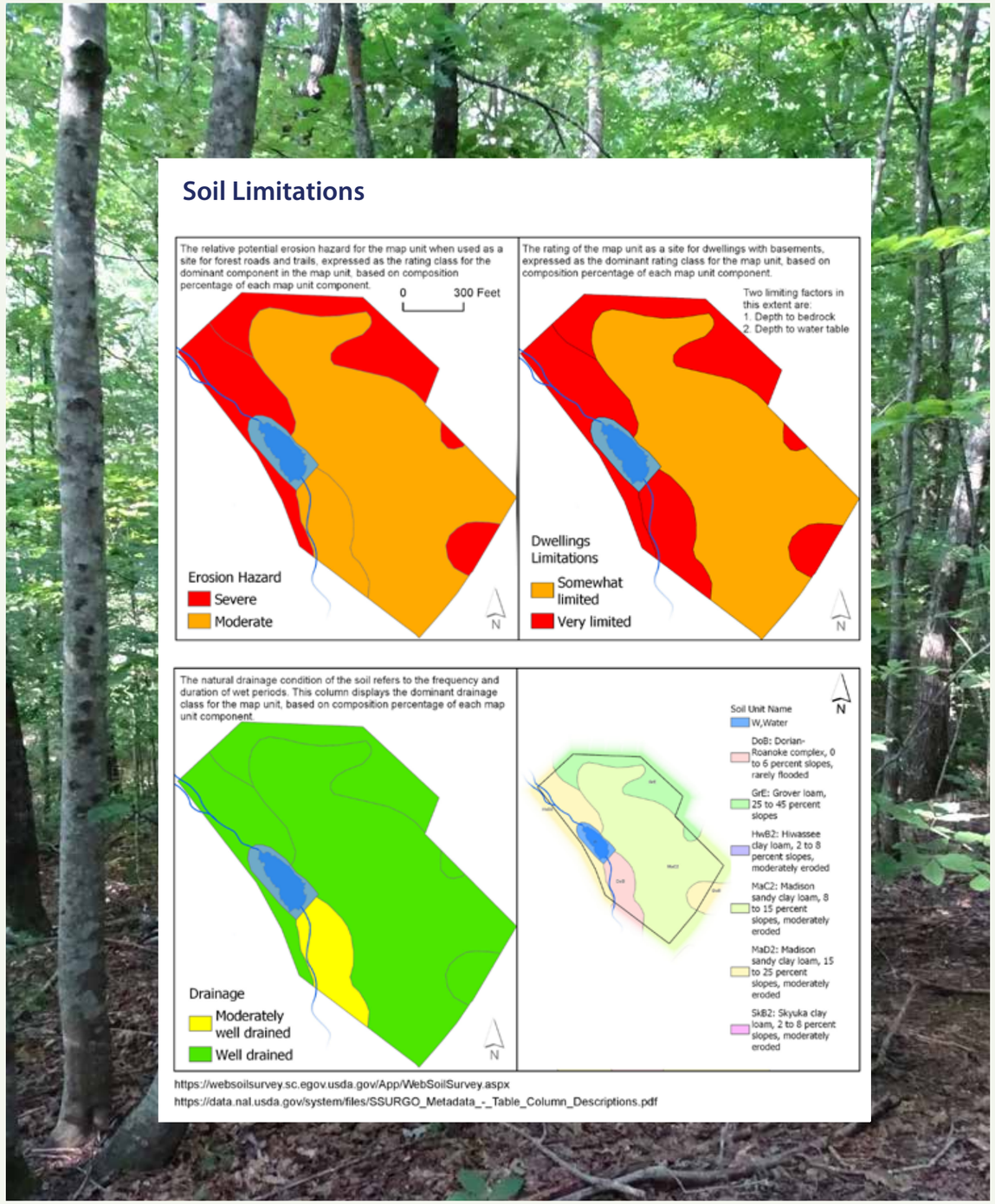
A review of aerial photography also showed how the site had changed over time. It had clearly been logged, developed for housing, and accessed for hunting and fishing. Past logging areas were found to be overcrowded with pines growing too close together, creating a potential fire hazard.

Despite these disturbances, the site had many beautiful amenities, such as a pond, views of White Oak Mountain, adjacency to thousands of acres of habitat cores, and large mature trees in the uplands and along slopes near the pond.

Ruins of a demolished structure with the mountain peak in the background.

Previously cleared land at the top of the LIttle White Oak Mountain site.

Many unmapped streams are found at Little White Oak Mountain.



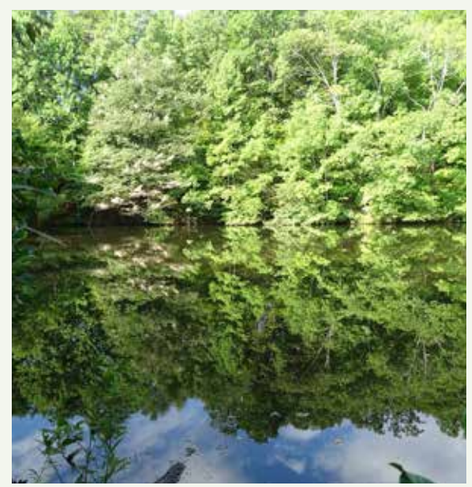
Site limitations

Due to the mountainous topography, steep slopes present the greatest limitations to development, both for roads and septic fields. Well fields are not a consideration as this site's drinking water will be serviced by the water authority (pending additional funding from grants or other sources to link to the site and fund hook-up fees). The maps show the various limitations by type: erosion hazards, depth to bedrock and water, ease of drainage, and soil type.

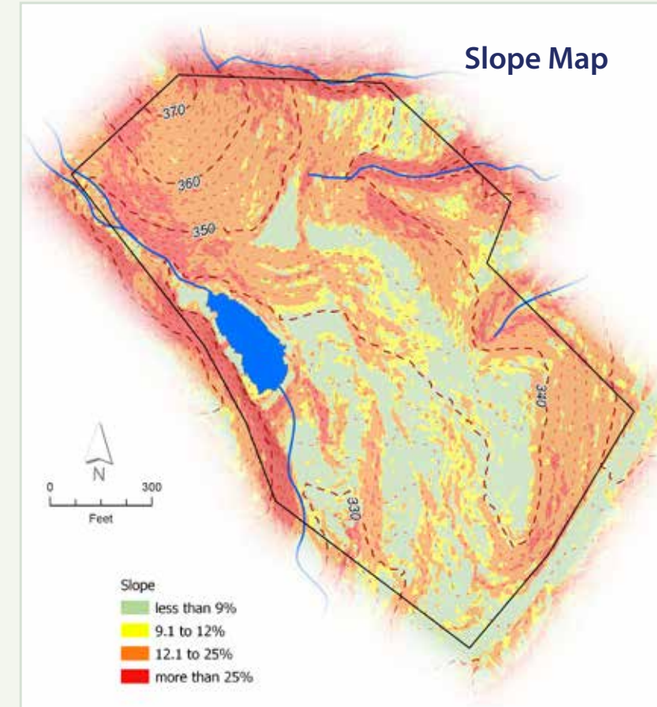
A pond on the site is approximately an acre, depending on seasonal water depth. It was created by past land owners who dammed a stream. Too small to be regulated, the earthen dam and pond are not subject to the state's safety rules. However, the area below the dam has become very wet over time, likely due to seepage from under the dam. Staff observed multiple indications of wetland formation and the soil data also showed poorly drained soils.

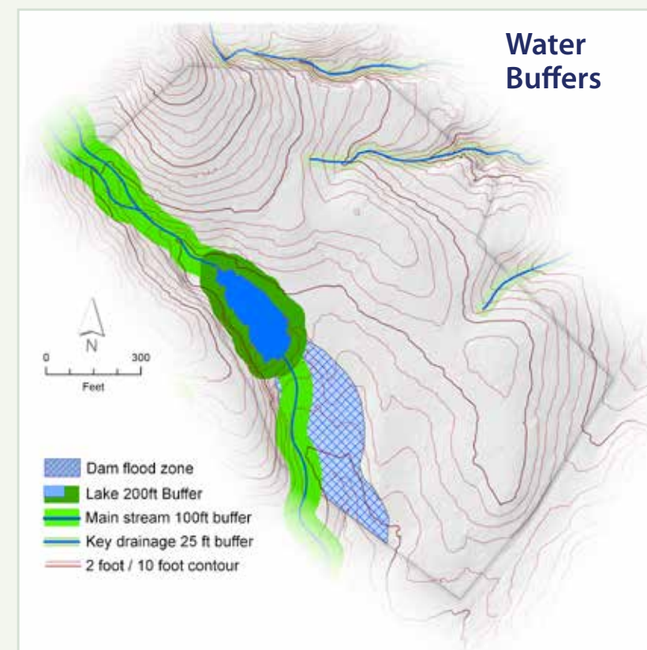
Thus, although the dam was not large, no buildings could be allowed below the pond, because of the potential of failure and prohibitions against building in wetlands and poorly drained soils. Although the original sketches done for the site by prior designers placed housing below the dam and over existing drainages, these were not feasible and had to be abandoned.

Protecting the buffers around the pond and streams (see prior list of Landscape Design principles) was another development limitation imposed by the GIC's design. A buffer of 200 feet was proposed around the pond.



The .75 acre pond offers serene vistas.



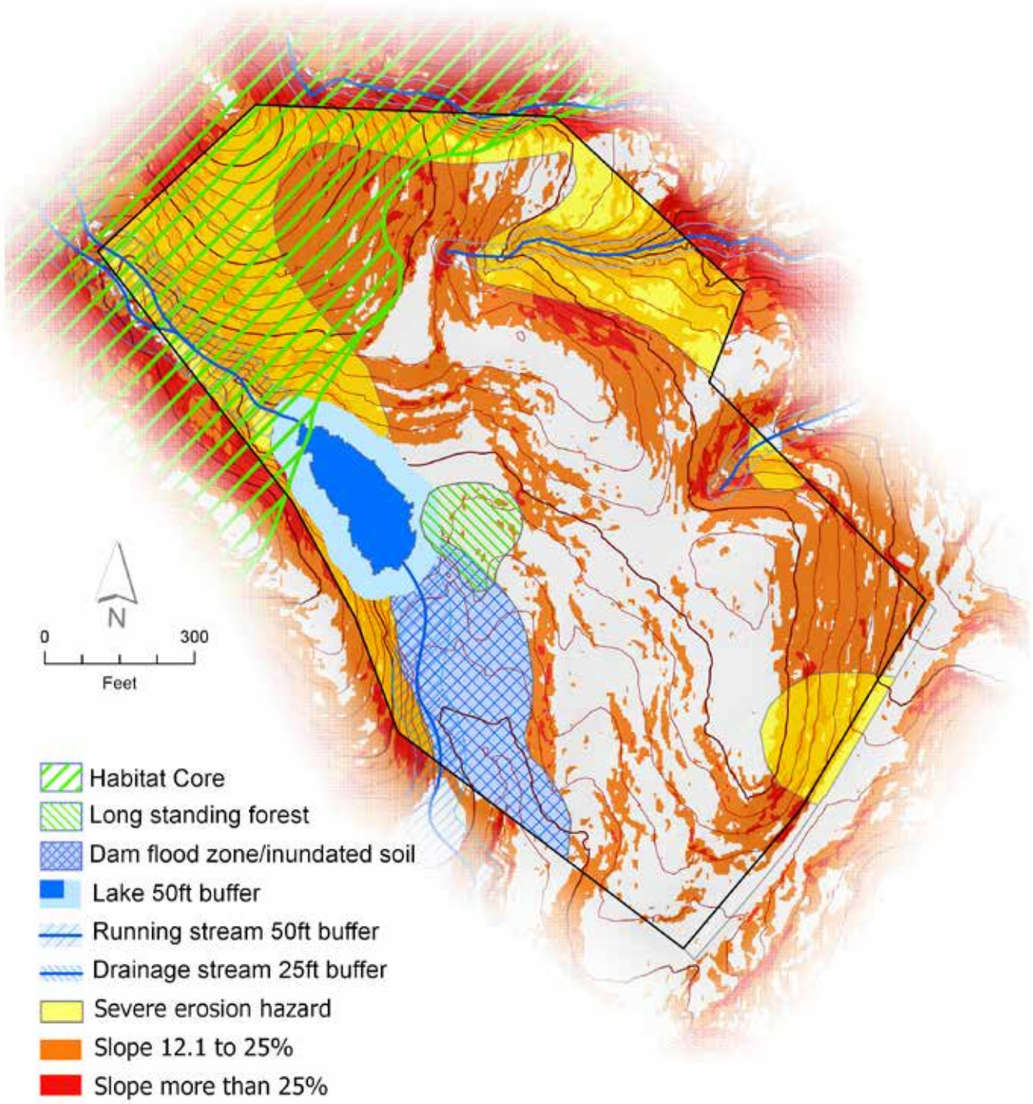


CASE STUDY

Putting all the constraints together provided the following overlay of what to avoid. This map combines all the factors listed under constraints.

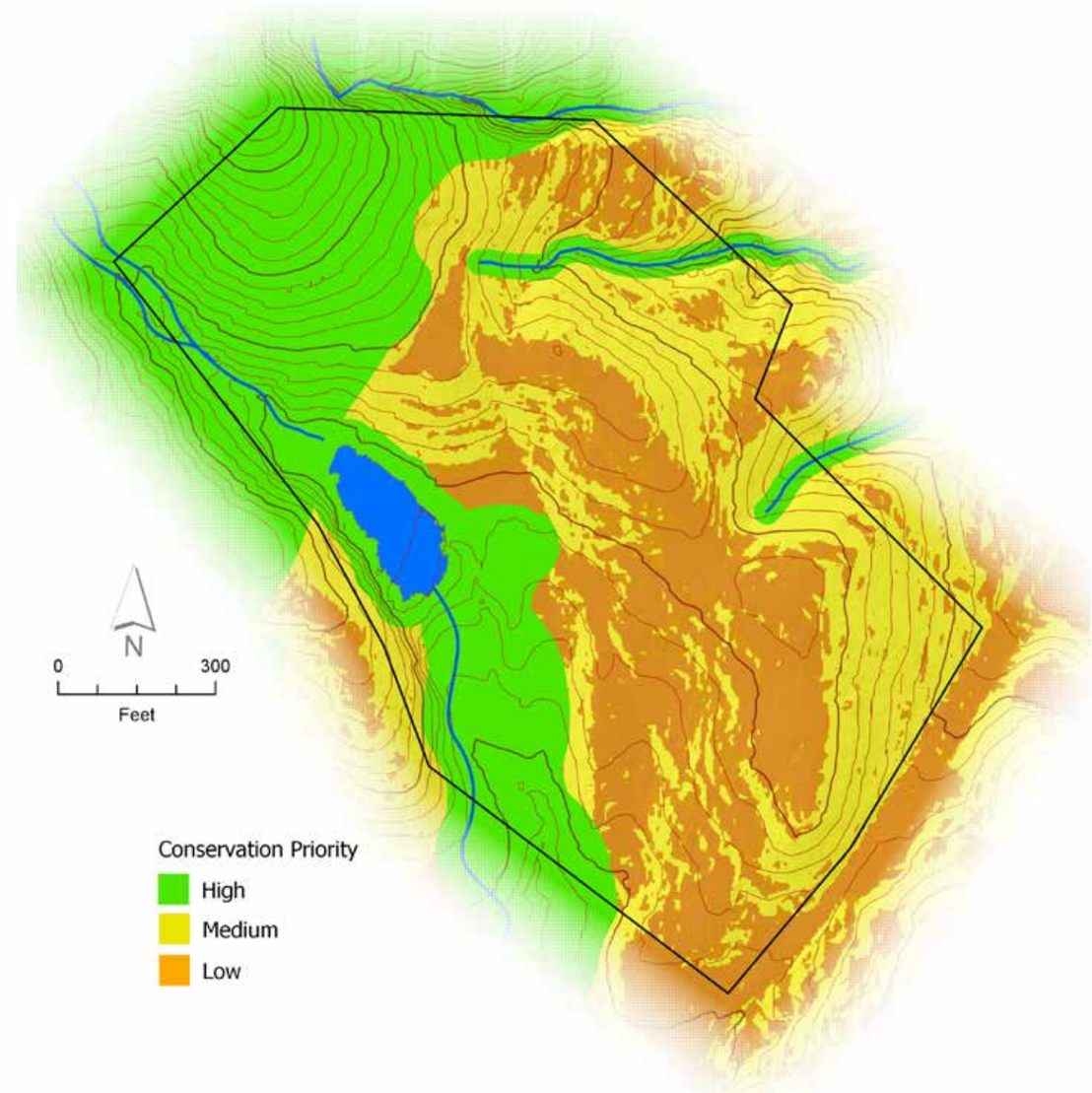
Next, all the conservation priorities (cores + streams + lake, etc.) were added together to see what should be protected.

Constraints Map



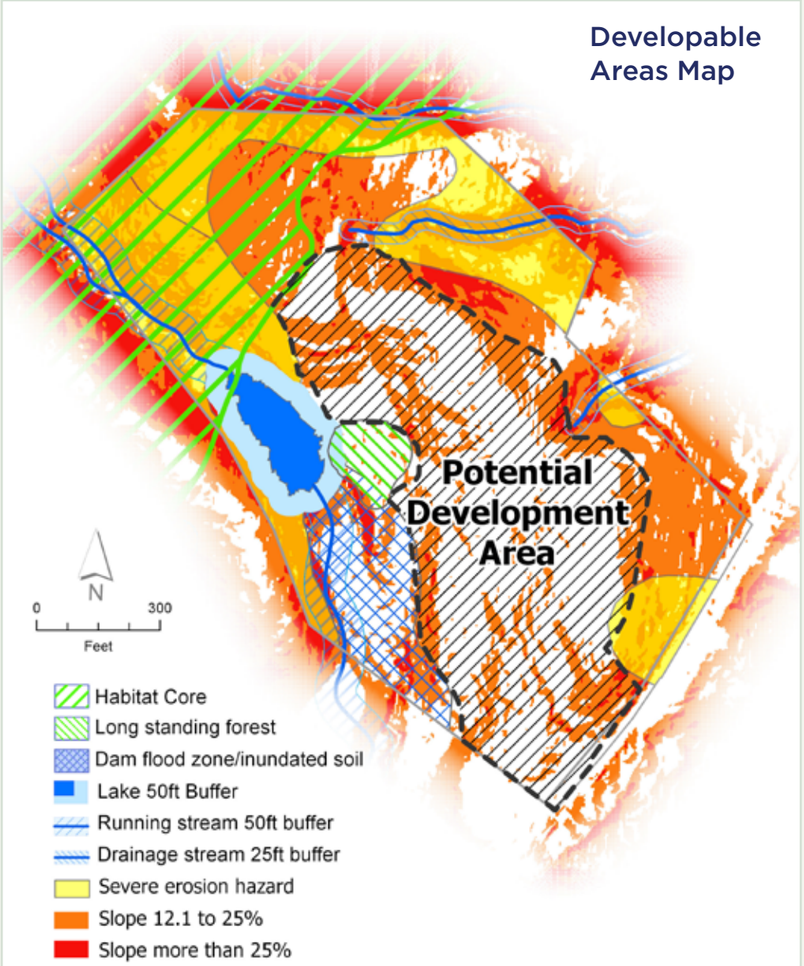
Conservation Priority Map

Combining the Constraints Map (areas limited to development) with the Conservation Priority Map (what not to develop) results in the Developable Areas Map.



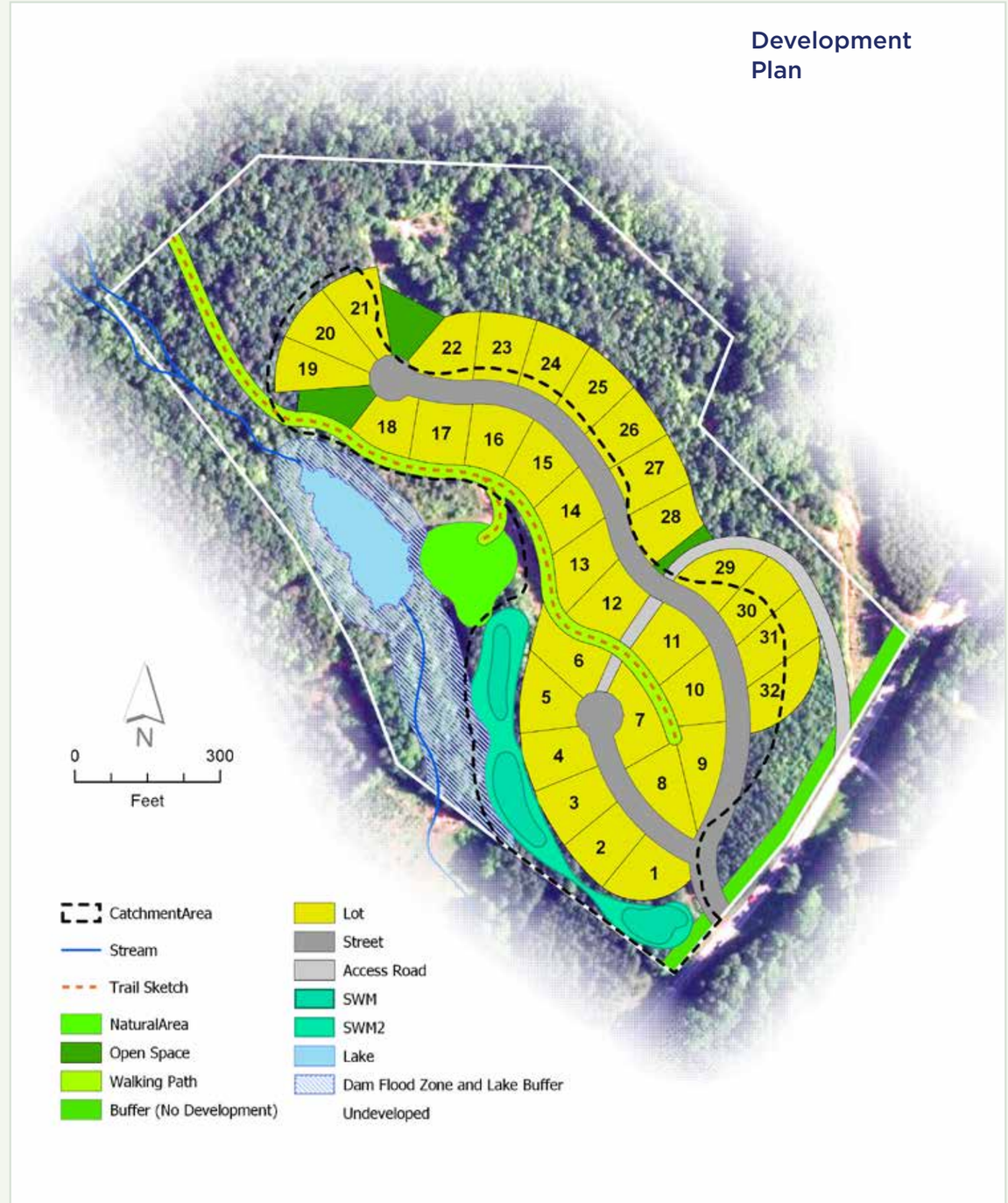
Site Statistics (derived from data and GIC's proposed plan)

- Total area of the site: **35 acres.**
- **32 single family units** in total.
- Water: **0.77 acres** (pond).
- Miles (or feet) of proposed trails: **1/3 mile** to join larger trail network on preserved upslope land.
- Acres developed (all developed surfaces including parcels, roads and stormwater pond areas, but not pocket parks, trails or green spaces): **15 acres.**
- Acres Undeveloped (all areas outside the development bubble plus any open spaces left in parks and trails): **20 acres.**



The HAC's original goal was to have approximately 35 homes on the site. They were not interested in townhomes, nor multi-family units. In addition, the lack of access to public sewer constrained the ability to have smaller lots. 6.5 acres were designated as habitat cores, of which 0.8 were removed for development. The remaining core habitat was assessed at 4.9 acres.

The following is the resultant development scheme. It meets the earlier stated principles while avoiding the site's constraints and resulted in developing 15 acres (just over half of the original area). This was acceptable to the landowner in exchange for preserving the health of the pond, as well as meeting the limitations of minimum lot size required for septic systems, the avoidance of steep slopes and buffering the surrounding recreation area. Since the lots were not completely cleared for construction, adding in the forest cover remaining on the lots left a forest cover for the entire development of 65 percent.



This rustic trail, likely an old road, leads up the mountain and can connect to the future trail network.

Recreation

The nearby County Recreation Complex offers trailheads for public access to the proposed 10-mile trail network. These trails are intended for walking or mountain biking and will be less technical than those at nearby Green River Game Lands. The GIC suggested a route from the development along a former road bed that could be used to access the public trail system in the future.

This development also used cul-de-sac designs, which were necessitated to avoid stream crossings, steep slopes and wetlands – which are very impactful to hydrologic function and water quality. However, the secondary access road was designed to be a bike and pedestrian connection between the two roads and to offer an exit in case the main entrance was blocked. Trails lead out of the site and are intended to connect to the recreation area above.

Stormwater

As this site is now (late 2019) at the conceptual design stage, a full stormwater management plan has not been completed. However, stormwater ponds have been proposed for the lower portions of the development to capture the runoff volume and allow for settling of sediment prior to discharge to the stream. As this is a small development for affordable housing, the goal is to keep maintenance as simple as possible and to reduce the costs of stormwater management. Also, as this is a rural area, availability of maintenance of low-impact development BMPs, such as permeable pavement (which requires cleaning with a vacuum truck twice a year) and bioswales (which require attention to plant health, monitoring drainage and plant survival) are not likely.

"As this is a small development for affordable housing, the goal is to keep maintenance as simple as possible and to reduce the costs of stormwater management."

The need to manage stormwater runoff can be reduced in the residential area by limiting pavement around the home and capturing water on site. Residents can apply rain barrels to their homes to reduce runoff and minimize the use of potable water. There are also ways to reduce stormwater runoff from walkways and pathways to the home while keeping costs low. The image below shows alternative designs that allow water to infiltrate the ground and lessen costs of treating pavement runoff around the home. This development is also protecting 50 percent of the forested area outside of the development lots and at least 50 percent of the trees on the individual lots, to produce an estimated overall forest cover of 65 percent.

Sidewalks can also be permeable.

Tree care and conservation

As there are many large trees on this landscape, those selected to remain should be protected with construction fencing and signage. For example, a cluster of larger trees near the pond was flagged for conservation. An additional tree survey should be conducted prior to development to identify and flag those large, healthy trees that would remain on the site. Lots should also not be cleared of trees, but should remain to the back of each lot to buffer the open space, provide shade for the homes and protect the habitat of the site. When the detailed site plan is created, it should specify the distance to each home from large trees, in order to abide by the principles for fire wise safety.

At Little White Oak Mountain, the overarching goal was to avoid removing trees and minimize clearing and grading. This resulted in far less of a developed area that needed stormwater management, since only non-forested areas required treatment. The stormwater ponds were intended to mitigate excess volume generated, but if allowances for narrower roads were allowed, it would be possible to minimize the area needing to be treated, since less pavement equals less runoff.

As a small-scale, rural subdivision, the development is not intended to have sidewalks. Although some stormwater drainage could be treated through bioswales along roadways, it was not known if the HOA for this small development would have the ability to maintain them.

As a rural subdivision that was intended to remain forested, street trees were not proposed. However, trees that overhang roads should be evaluated annually to ensure they are in good condition and not at risk of falling. Similarly, trees near homes should be evaluated to ensure they are properly cared for and not at risk of impacting a home.

Homes should practice fire wise principles to the degree practicable. It is also possible that strategic fire breaks could be placed in the area. These are strips of land where vegetation is kept low to break the spread of wildfires. The existing power line to the east partially serves as a firebreak, but a few more may be needed. The site developer should work with county foresters to design a Firewise® safety plan for the subdivision once the final site plan has been determined. Note that the new conceptual design includes a fire emergency road.

Little White Oak Mountain will provide affordable homes in a nature setting with ample opportunities to recreate. This partnership between GIC, Conserving Carolina, the Housing Assistance Corporation and the NC Forest Service represents is a unique collaboration to design a forest friendly and sustainable housing development that will support both wildlife and people for many generations to come. Hopefully, this can be a model for future partnerships between land trusts, green designers and affordable housing providers.

5 MARKETING AND MANAGING A CONSERVATION DESIGN

Marketing a conservation subdivision will require extra effort to showcase how the development is different than the usual developments. A true conservation subdivision conserves at least half of the landscape in a natural state. The difficulty is that there are many developments that are not truly conservation-designed landscapes. They may promote pollinators in backyards or have more street trees, and perhaps a trail, but their overall landscape is mostly developed, fragmented and highly manicured. For example, while a golf course may be open space, it is not wildlife habitat, although there are designs for courses that are more environmentally friendly. Today, many golf courses are being turned into wildlife areas. [12]

See the Resources Section for more on designing courses that are wildlife friendly. Also see the bibliography for a critical look at whether and how golf courses support wildlife in the southern Appalachian Mountains (Mackey et al 2014).

"The National Association of Home Builders has found that cluster developments cost an average of 34% less to develop."

5.1 Financing Conservation Design— Arguments For Bankers and Investors

There are many examples of successful conservation subdivisions. The Ponds at Woodward is an example of a conventional development turning to conservation, and realizing a greater return on investment (see box next page).

As described earlier, the GIC worked with a developer in Richmond, Virginia, to conserve 30+ acres of mature woodland, while shrinking the development footprint in half and even realizing four more homes than the original development plan.

While developments that have less roads, have less stormwater to treat, and need less facilities cost less, they also save significant up-front development costs. There are also arguments to be made for selling units that promise green spaces and associated benefits of clean air, clean water, natural beauty and access to recreation at one's doorstep.

The building industry has taken note. Professional Builder, a design and trade firm, notes that conservation developments are more attractive to today's buyer. They cite a 2010 survey of home buyers by Robert Charles Lesser & Co., which found that only half of respondents living in a typical suburban community would choose that type of neighborhood in the future. Nineteen percent said they would buy a detached home in a nature-preserve and (conservation) community. Nineteen percent wanted a cottage or patio home and 45 percent wanted a duplex or triplex in a nature-preserve community (for more see https://www.probuilder.com/back-land-trends-conservation-communities)

One perceived barrier to a conservation subdivision is the perception that such developments cost more, but this has not been shown to be true. However, one greater cost can be a lengthier process to obtain approval for rezoning. According to a study by NC State University, about 51 North Carolina counties have adopted enabling ordinances. Encouraging local governments to adopt a cluster/conservation subdivision ordinance can help speed up the process and reduce costs.

In reality, time delays can be costly for developers, especially if they have outstanding loans for land purchases. Where conservation subdivisions really help realize savings is in faster rates of sales. Homes in conservation subdivisions sell faster, sell for more, and can save on construction costs when compared to similar homes (Bowman, Thompson, and Colletti, 2009). This means that, even if a conservation subdivision cost more in the time it took to get approved, the rates of home sales and higher prices may more than make up for the slowness of government processes.

12 https://www.audubon.org/magazine/september-october-2013/bye-bye-golf-courses-hello-nature

Bundoran Farms is a different kind of conservation subdivision focusing primarily on pastureland conservation and views of agrarian lifestyles.

Developing homes in clustered patterns costs less than conventional development designs. There are savings in stormwater management (less piping distance and less volume to treat). The National Association of Home Builders has found that cluster developments cost an average of 34 percent less to develop (Thomas 1991). This is because less land needs to be cleared, resulting in less time in staff and equipment costs and less landfill and disposal fees. Grading costs are also less, since they reduce the area of disturbance and costs of removing material. Disturbing a smaller area and building in a more environmentally-sensitive pattern can also reduce the need for permits to pipe streams or fill wetlands.

Finally, many subdivisions that include amenities such as golf courses have found that they can save money by simply providing a park or community green rather than a golf course. Less than a third of residents in golf course communities actually play golf. Surveys of these residents have shown that access to open space or vistas is what they wanted. Maintaining a natural park with some trails saves hundreds of thousands of dollars in avoided costs of clearing, grading and sodding a course and tens of thousands of dollars a year in course maintenance. Instead of a golf clubhouse, add a nature center. If there are commercial areas, the greens can be used instead for a true outdoor 'beer garden' or country pub that offers views of the countryside.

PONDS AT WOODWARD

The Ponds at Woodward is an example of a conventional development turning to conservation that realized a greater return on investment. A 120-acre site was eligible to build two acre lots or to apply the Planned Residential Development (PRD) option under which four times as many dwellings could be built. The two elderly brothers who owned the farm property received an offer of $800,000 to build a 230-unit PRD. Unsatisfied with this option, the brothers marketed the property, seeking a buyer who would preserve the landscape. Developers engaged in a small bidding war over this property, resulting in multiple offers, the highest at about $1.3 million or 62 percent more than the original offer.

The Harlan Corporation of Bryn Mawr was selected. George Harlan, a highly respected local developer, was so attracted to the beauty of the working farmland that he planted 5,000 apple trees. He partnered with the Brandywine Conservancy to create a development plan featuring 70 percent open space. There are now 56 homes on the 120 acre property.

As a result of this collaborative relationship, two-thirds of the property has been permanently protected, including ten acres of mature woodlands and a working orchard (producing apples and peaches) encompassing more than 50 acres. Moreover, the family's economic return was substantially increased over any conventional alternative. For more see: http://www.pondsofwoodward.com/public/folders

5.2 Marketing Conservation Development For Buyers

In the box on the facing page are samples of marketing language used to hook potential conservation-minded buyers.

Serenbe just outside of Atlanta is perhaps one of the more famous conservation developments. Although not a standard conservation development – it does not conserve 50 percent of natural lands – it has done a great job of marketing the healthful lifestyle elements to a range of conservation-interested buyers. These are two examples of the marketing slogans and sales pitches it has used in the past:

Many of these communities are found at a state-by-state searchable website https://www.privatecommunities.com/

What do all of these places have in common? A review of many conservation developments marketing materials show that they promise the following benefits:

- **Wellness**: Stress-free living, a clean environment, access to nature and beauty, meditation in quiet spaces, freedom from the distractions of urban living, a getaway, a permanent vacation, exercise of all kinds (climbing walking, jogging, equestrian, swimming), spiritual renewal, healthful living, etc.
- **Community**: Neighborliness, private but accessible, walkable, gathering places, friendships, inter-generational places and spaces, quietude, slower pace, safety, free-roaming children.
- **Environment**: Protection of open spaces, wild places and wilderness, birds and bird song, flowing streams and clear lakes, cliffs and unique geologies, accessible wildness, pollinators, wildlife, local food, connectivity and resiliency.

These sites use illustrative descriptors such as: "deep gorges and broad valleys;" "mountain bogs and granitic rock domes;" "tranquil creeks and plunging waterfalls;" "teeming marshes, post-card perfect sunsets, misty mornings;" "star-lit skies for gazing and wonder;" "vibrant living, outdoor playground, tranquil wonderland, nature at your doorstep."

In terms of design, many emphasize locally sourced or natural materials, such as limestone fireplaces, slate floors and timber trusses and beams. They also offer EarthCraft® or LEED® standards for energy efficient and green buildings that blend into the landscape, minimizing footprints, with wrap-around porches offering vast vistas, secluded backyard gardens, or lake views. Some also emphasize low maintenance, as several focus on smaller yards with the expectation that food gardens are available at community plots, while natural areas provide 1,000 acre 'back yards' for health, fun and adventure.

Although one might think these are all high-end developments without options for young families or retirees with limited means, many emphasize multiple options for affordability. In fact, successful developments offer options that are multi-generational and appeal to many types of people, ethnic diversities and income levels. This allows these neighborhoods to be more resilient. When kids leave home for college, parents may choose to live in a smaller home down the street instead of having to move away when they downsize. Similarly, young families can grow without having to find a new neighborhood.

Some developers struggle with selling small lots as often people ask how much land they are getting. According to Randall Arendt, developers who market conservation developments successfully include the access to open spaces in their marketing materials. For example, they tout access to 80 acres of pristine nature reserves steps from the front door, or adjacencies to preservation tracts promising peace and natural vistas that will last forever. Those lots that adjoin the preservation areas can be priced higher than those on the next block over. However, running a trail behind homes that are not adjacent can provide another type of amenity to increase home prices, even on smaller lots. In these ways, both profitability and housing affordability can still be maintained. As noted above, multi-scale houses of varying prices makes for a more sustainable neighborhood.

A new trend is the use of native materials found on site. If the landscape is forested to begin with, some trees will need to be removed to make way for the development – hopefully selectively so that trees are incorporated into the development – and they can be recycled and used in the development as live-edge kitchen counters, ceiling beams, fireplace mantels, porches, and items of furniture such as bedsteads, cabinets and shelves. This will require someone to harvest

"Simple bridges can be used to cross creeks."

Marketing language appealing to conservation-minded buyers

SERENBE, GEORGIA

offers that residents can find a more healthful life. https://serenbe.com/

"Rediscover Living — Serenbe is a wellness community connected to nature on the edge of Atlanta. A neighborhood full of fresh food, fresh air and focused on wellbeing. This community is set among acres of preserved forests and meadows with miles of nature trails that connect homes and restaurants with arts and businesses. Serenbe's architectural planning sets a new standard for community living. They offer a 25-acre community farm, walking trails and other amenities."

THE GALISTEO BASIN PRESERVE, NEW MEXICO

promises personal wellness. https://www.galisteobasinpreserve.com/

"A Place of Renewal — The Galisteo Basin Preserve is a conservation-based community development located 14 miles south of Santa Fé, New Mexico. Embracing nearly 10,000 acres of sculpted arroyos, craggy sandstone formations and vast savannah grasslands, the preserve is place of refuge and sustenance for wildlife and people."

DANIEL ISLAND, SOUTH CAROLINA

one of many coastal communities, speaks to outdoor enthusiasts. https://danielisland.com/

"With hundreds of acres of parks and greenspace and more than 25 miles of trails to explore, Daniel Island is a haven for outdoor enthusiasts. In fact, parks are such an important part of living here that each neighborhood has its own. The island's parks attract families, friends and neighbors for picnics, relaxation, exercise and play, with swimming pools, picnic tables, playing fields, gardens, gazebos and more. Trails wind through maritime forest, along marsh and the water's edge and through neighborhoods and the island's downtown, offering scenic views and a safe and convenient environment for runners, walkers and cyclists."

CHINQUAPIN, NORTH CAROLINA

appeals to those wanting to escape from the bustle and stress of city life. http://chinquapinnc.com/

"It begins with a yearning to escape. To leave the stress. The job. The traffic. The busy-ness. You want a place that takes you away. Where you can free your mind, unplug, and reconnect. With family. With friends. With yourself. Chinquapin gives you what you've been missing. A pristine mountain preserve that's just three miles from downtown Cashiers, North Carolina."

"Developers who market conservation developments successfully include the access to open spaces in their marketing materials. For example, they tout access to 80 acres of pristine nature reserves steps from the front door, or adjacencies to preservation tracts promising peace and natural vistas that will last forever."

those trees on site, saw the trees and season the wood in a dry kiln, in order to have them ready for use. However, live edge tables, stone walls and other features allow for custom touches that are evocative of the local landscape and showcase a developer's commitment to reuse native materials.

As noted earlier, a key amenity for a conservation development is to have a nature center on site. To ensure its longevity, the center should be staffed by a local non-profit (or consider forming one to serve the development). A building should be provided which has space for exhibits and educational activities, such as small lab, classroom or gathering space, so that the center can function for education. It can be partially or fully supported by HOA dues.

If staffed with knowledgeable conservation professionals, an on-site nature center can function as a local advice center on habitat conservation, management needs and education for new residents. If run as a day-camp, it can provide an amenity for residents' children. If it has a pleasant garden attached, it could serve for weddings and receptions.

If the open space of the development is placed under conservation easement, a local land trust can be the holder or co-holder of the easement and HOA fees can be used to support needed upkeep, such as the removal of invasive species, repair of docks or boat ramps, clearance of trees after storms, trail maintenance, and inspection of trees near recreation areas to ensure they remain in good condition. Such services are best conducted by an on-site conservation group rather than contracting to outside sources, which may be unfamiliar with the site or may hire unskilled laborers. Most successful conservation developments mention the importance of having a conservation or nature center on site for upkeep of the wildlands and the harmonious use of the landscape by residents and visitors.

"A key amenity for a conservation development is to have a nature center on site. If staffed with knowledgeable conservation professionals, an on-site nature center can function as a local advice center on habitat conservation, management needs and education for new residents."

5.3 Ensuring Good Stewardship and Management

An on-site firm is ideal to ensure good stewardship of the landscape. Forestry agencies should also be consulted for assistance in creating forest management and fire safety plans, as described below.

Conservation subdivision management

Forest management: A forest management plan is recommended for conservation subdivisions in forested areas of the Carolinas. Such a plan can ensure that key goals are met, such as promoting wildlife health, protecting water quality, creating selective harvest plans to remove trees in the path of development that have commercial value, and reducing fire risk. For example, both sites studied for this guide have places where trees should be strategically thinned to encourage better growth of surrounding trees or that could benefit from prescribed burns.

Fire safety

There are two aspects of fire safety to consider: the minimization of fire risk through forest management methods, such as thinning or prescribed burns to reduce excess fuel loads; and fire safety for the residents, which may mean adding emergency exits, widening driveways and access roads to homes, underbrush clearance initiatives, the placement of fire suppressant equipment, and designing lots such that individual homes are less exposed to the risk of fire, known as being 'Firewise®'.

Limiting thick vegetation within 30 feet of a home is one Firewise® principle. In some denser developments, especially those in cluster subdivisions, Firewise® principles that require spacing houses father apart cannot be met, so the designer needs to consider the fire risk of the area and other fire risk factors when designing lot sizes, house locations and landscaping standards.

For more on this, see the Resources Section of this guide for fire safety planning and design resources.

In conservation subdivisions, which will have more natural landscaping, HOAs may want to consider additional fire safety rules concerning burning trash or leaves, the locations of outdoor fire pits and grills, banning more flammable grass species, such as ornamental pampas grass or trees such as Eastern red cedar or eucalyptus, and shrubs such as juniper or wax myrtle. In general, avoid species with resins, oils or waxy composition.

For more about highly flammable plants, as well as those that have some fire resistance, see https://www.state.sc.us/forest/scplants.pdf.

Rural communities in or near forests should also consider home evacuation training such as "Ready, Set Go®", which prepares residents in fire-prone areas to evacuate safely and rapidly.

Prescribed burns are an important management tool to reduce excess fuel buildup while fostering new understory growth. Image Credit: NC Forest Service

FIREWISE® BUILDING DESIGN

Roofs: Class A, B or C rated, such as metal or clay, cement or slate tiles.

Exterior Walls: Cement, stone or brick.

Glass: Double paned or tempered.

Eves, Fascias, Soffits, Vents: boxed or enclosed with screens.

Decks: Consider terraces instead, otherwise see this report for decking materials: https://ucanr.edu/sites/postfire/files/247804.pdf

"Limiting thick vegetation within 30 feet of a home is one *Firewise®* principle."

"Another benefit of natural landscaping is that it tends to be heartier than non-native plants. Native plants are better adapted to the local climate and its inherent variability."

Communities located near national forests may also qualify for free assistance through the USDA Forest Service's Community Protection Grant Program, which assists communities surrounding national forestland with Community Wildfire Protection Plans (CWPPs)

The NC Forest Service and the SC Forestry Commission are also available to assist local emergency management and fire departments with development of Community Wildfire Protection Plans (CWPPs). These fire management plans evaluate wildfire hazards and provide preparedness, mitigation and prevention recommendations at the fire district level. See the Resources Section for program links.

There may also be limits on bringing in purchased firewood, as this can introduce new pests into the subdivision.

While these extra rules may seem unusual, they are very necessary for conscientious residents who live within the 'wildland urban interface.' For information about fire safety and planning, example fire-safe subdivision rues and home fire-safety resources, see Section 6: Resources.

The native fringe tree is a hardy choice that grows well in the Carolinas.

Native club moss growing on the forest floor in South Carolina at Long Branch.

Backyards and common spaces

In addition to those areas to be managed as wildlands or protected lands within the conservation subdivision, residents and businesses should also have a hand in contributing to a healthful landscape. In addition to being fire safe, they should plant their yards with species that support songbirds and pollinators. Section 6. Resources lists several sources, such as "Bringing Nature Home," which provide a wealth of information on what to plant to attract and support wildlife.

Another benefit of natural landscaping is that it tends to be heartier than non-native plants. Native plants are better adapted to the local climate and its inherent variability. They are also naturally more resistant to pests. HOAs or developers should consider limiting garden plants to native species only. However, if that is considered too restrictive, a list of allowed "non-native, non-invasive" plants, shrubs and trees could be developed, so that if non-native vegetation is used, at least it will not escape the backyard and invade the surrounding area.

Mowing of open spaces should be kept to a minimum. It should be done only to provide places for walking, to protect buildings for fire safety and to avoid the common problems of chiggers and ticks where people are walking. However, keeping areas "natural" does not mean that they do not need to be managed. Invasive species such as English ivy or trees such as ailanthus (tree of heaven) can sprout up, just as cattails can overtake a wetland. This does not necessarily require more maintenance – just different maintenance.

KEEP SKIES DARK!

According to the International Dark Skies Association "Glare from artificial lights can also impact wetland habitats that are home to amphibians such as frogs and toads, whose nighttime croaking is part of the breeding ritual. Artificial lights disrupt this nocturnal activity, interfering with reproduction."

To minimize the harmful effects of light pollution, lighting should:

- Only be on when needed.
- Only light the area that needs it.
- Be no brighter than necessary.
- Minimize blue light emissions.
- Be fully shielded (pointing downward).

Instead of using large riding mowers, developments may need more crew devoted to controlling invasive species.

If an open landscape, such as a meadow, is desired, this may require periodic burns every few years just to maintain native and fire-adapted species, as well as to remove young trees that will pop up on their own in unmowed areas. This may require hiring a professional company to do this work since there will be safety and liability concerns with any open flames.

Composting is another factor to consider since residents who choose a conservation subdivision may be more likely to want a composting pile. If composting is desired for kitchen food wastes, it is recommended that they be handled in a closed container protected against animals since open compost piles can attract bears, raccoons and deer into yards where they are unwelcome. Open areas for yard compost are okay, but residents should be instructed not to use the nearby woods as dumping places for yard wastes. Communities can also consider creating a local space to accept community compost and handle this at one location, allowing residents to come pick up composted soil once it has been processed —
by nature!

Finally, residents should be prohibited from feeding wild animals. Bird feeders are fine, but they may also attract bears, raccoons and other critters that may come into conflict with people. If natural areas have been well-conserved, bird life should be abundant without having to offer food at backyard feeders.

Lighting

Even if the locality does not have a "dark skies" ordinance, a conservation subdivision should adopt its own rules restricting harmful lighting. Dark skies rules prevent projection of light upwards or laterally in order to avoid interference with night-time species. Day and night cycles are how animals and plants know when to sleep, forage, hunt, breed or avoid predation. People have disrupted these cycles with nighttime lighting. For nocturnal animals, light pollution turns night into day.

A conservation subdivision should adopt lighting standards to ensure downcast lighting that also have "full cutoff" when not in use. Playing fields, community pools and other public spaces should not be lit when not in use. If security is a concern, motion detection lights can be used. The International Dark Skies Association has many recommendations for how to choose the right types of lights, as well as what rules to consider. See the text box above and the Resources Section for more.

"Day and night cycles are how animals and plants know when to sleep, forage, hunt, breed or avoid predation. People have disrupted these cycles with nighttime lighting."

5.5 Conclusion

Conservation subdivisions are not an alternative to conservation. They have been shown to conserve 50 to 70 percent of a site and thus support a wealth of ecosystem services. However, there are cautions to this approach (see text box).

Many conservation subdivisions do not preserve connectivity throughout their site. Many are still designed with an island mentality and protect chunks of isolated lands throughout the development that are disconnected internally and externally. These types of developments also multiply edge habitats, which allow invasives to penetrate the forest, along with domestic predators (house cats and dogs) and nest parasitizers, such as the brown headed cowbird. In summary, the rules (box at right) should be applied to judge whether or not a conservation subdivision has truly achieved its conservation moniker.

Why We Need To Design Differently

"Rampant low-density residential development is taking a critical toll on biological diversity and ecosystem services.

We now have the opportunity to counter this crisis head on by linking development design to conservation.

There are two big challenges to making conservation development an ecologically and economically successful alternative to conventional development:

(1) Conservation developments will not achieve conservation goals unless they are designed specifically to protect and restore biodiversity and ecosystem services. Simply increasing housing density and setting aside land may be insufficient. Instead, conservation developments must occur in the context of regional planning, and their design and management must be informed by property-level ecological resource assessments.

(2) Institutional change necessary to enable conservation development will not occur until stakeholders recognize the full value of this approach." (Pejchar et al, 2007).

A land trust may also hold a conservation easement on the conserved lands, thus allowing a tax break for the property. Legal protections must be in place to ensure the landscape is not developed in the future. At the very least, open space must be deeded as undeveloped. Ideally, a conservation subdivision will partner with local conservation groups, land trusts and others to share in the management of conservation spaces. See the resources section for additional design guidance and technical support for designing landscapes in harmony with nature.

This guide has been supported by the U.S. Forest Service and the state forestry agencies of North and South Carolina. These agencies recognize that the future of the forests of the South will depend upon a new range of development practices. This guide supports many past notions of conservation design, but places greater emphasis on ensuring that ecological values are supported. People need to live on the land. The question is whether we will do so in way that adds value and supports the natural systems we depend on.

We end with a quote by Gifford Pinchot:

"Without natural resources, life itself is impossible. From birth to death, natural resources, transformed for human use, feed, clothe, shelter and transport us. Upon them we depend for every material necessity, comfort, convenience and protection in our lives. Without abundant resources, prosperity is out of reach. Unless we practice conservation, those who come after us will have to pay the price of misery, degradation and failure for the progress and prosperity of our day."

– Gifford Pinchot, First Chief of the U.S. Forest Service

"Conservation developments will not achieve conservation goals unless they are designed specifically to protect and restore biodiversity and ecosystem services."

Sprawl Versus Compact Green Designs

In each of the examples below, a designer can keep the landscape connected or develop in a pattern that disconnects habitat.

EXISTING:
A parcel surrounded by residential development supports a riparian wildlife corridor and habitat core.

SPRAWL DESIGN:
Lots cover the entire parcel and trapped green space in the middle is now disconnected from the rest of the habitat core. Land is cleared down to the river for views and one lot impacts the wetland.

CONSERVATION DESIGN:
The riparian corridor is maintained through the site, fifty percent of land is kept in conservation, the wetlands are protected, and a trail provides access to the natural area.

EXISTING:
A parcel with a small farm surrounded by residential development supports a riparian wildlife corridor.

SPRAWL DESIGN:
Lots cover the entire parcel and large areas of mowed lawn and a garden provide open space for views. The stream corridor is broken by a road and some lots are cleared down to the river for views, while one lot impacts the wetland.

CONSERVATION DESIGN:
The riparian corridor is kept through the site, fifty percent of land is maintained in conservation, and a trail provides access to the natural area with wooden footbridges to cross the creek. A community garden is located close to residents. Lots remain mostly forested.

To Be a True Conservation Subdivision, a Development Plan Must:

- Be an appropriate place to develop – not a greenfield located far from daily needs, such as workplaces, schools and shopping.
- Conserve at least 50 percent of the land in a natural (non-manicured) state that is connected throughout the development and outside the parcel boundaries.
- Begin by evaluation of the most important ecological features, which are identified and placed 'off limits' to building.
- Minimize the amount of pavement throughout and consider the use of alternative drainage strategies for stormwater, such as low-impact development designs.
- Establish standards for avoidance of undue environmental harms and stressors – buffer lakes and rivers by at least 100 to 300 feet and smaller streams and springs by 50 to 100 feet. Avoid crossing waterways or piping streams as much as possible. Consider foot bridges and other ways to connect neighborhoods. For example, a gridded street network may not respect existing topography and drainages.
- Provide access for people to enjoy nature, but do so by minimizing footprints of recreational facilities and trails. Avoid sensitive areas such as headwaters, wetlands, springs, diurnal pools and breeding places. Use elevated boardwalks, viewing platforms, rustic trails, etc., but do not remove mature trees simply to enhance views.
- Create landscaping standards for public spaces that disallow invasive non-native species, and promote planting and care for native species. Avoid large expanses of lawns unless they are for a dedicated purpose, such as a farmer's market or festival space.
- Maintain natural areas through on-going maintenance to maintain native species. Woodlands or prairies that are prevented from burning naturally may require prescribed burning. Wetlands and other spaces may require removal of invasive species.
- Keep lawn areas to a minimum and ensure lots are not oversized. Larger lots of 3 acres or more may require two-thirds of the land to remain in a natural state.
- Allow for tree removal only through a legal permit, and require arborist certification concerning the tree's condition.
- Identify the entity to take over on-going care and management of all natural areas, ideally through funded partnerships with a local conservation group or land trust.
- Provide a process to educate current and new residents about how to care for the natural landscape, including rules to manage their own yards in ways that are harmonious for the conservation of indigenous species.
- Adopt safety principles, such as Firewise Design®, to ensure that development patterns and yards do not increase fire risks.
- Adopt rules to live in harmony with nature, such as dark skies and noise ordinances to avoid disturbing wildlife – and neighbors!

6. RESOURCES

This section provides references for statistics cited in this guide, sources of technical support for trails or other public amenities, and data sources for conservation planning, low-impact stormwater strategies and designing yards to support wildlife. Although not an exhaustive list, it offers key links for further information.

6.1 Data for Planning

States offer a wealth of free data to use for planning.

Map viewer for South Carolina data available here:

https://scdnr.maps.arcgis.com/apps/MapSeries/index.html?appid=b7fe877738e3447085976d3acfa3c8d1

Conservation Priorities:

The state of South Carolina has a land conservation bank and has mapped top priorities for conservation here: https://sccbank.sc.gov/statewide-conservation-map

Maps and data for North Carolina available here:

https://www.nconemap.gov/

Case study data:

The chart on the next page depicts the data obtained for analysis of the two case study sites featured in this guide. All these data are publicly available.

6.2 Funding and Technical Support Opportunities

Technical support and funding for healthy forests and habitats

States also offer programs and funding support for forest conservation and planting. The following are links to the North Carolina and South Carolina programs, however, all states offer assistance for urban and community forestry. These sites also provide technical direction for tree care, tree selection and maintenance. Each forestry region also has regional and county foresters available to work with landowners. Below are the several key links, but each agency has many more resources on their websites (as do other states):

North Carolina state resources:

- **North Carolina Urban and Community Forestry Grant Program**: https://www.ncforestservice.gov/Urban/urban_grant_program.htm
- **North Carolina Forest Service resources for forest management:** https://www.ncforestservice.gov/Managing_your_forest/managing_your_forest.htm
- **North Carolina Forest Service guidance for protecting trees during construction**: https://www.ncforestservice.gov/Urban/protecting_trees_during_construction.htm
- **Maintaining a Healthy Forest:** This manual provides basic information about threats to forest health, guidance in diagnosing tree disorders, and pest management recommendations. https://www.ncforestservice.gov/forest_health/forest_health_handbook.htm

South Carolina state resources:

- **South Carolina Urban and Community Forestry**: https://www.state.sc.us/forest/urban.htm
- **South Carolina guidance for protecting trees during construction, selecting and planting trees**: https://www.state.sc.us/forest/urbantcm.htm
- **South Carolina Green Infrastructure Guide**: http://trees.sc.gov/gic-sc15.pdf

Data Used for Planning Conservation Subdivisions in This Guide

Data	Description	Source	Link (where available)
Forest Habitat Cores	• Regional dataset from the GIC Model edited by Esri for distribution with the Green Infrastructure Planning dataset. • Local Scale Habitat Cores from the GIC using data produced from the latest available satellite imagery.	• Esri – Environmental Systems Research Institute • GIC – Green Infrastructure Center. Contact GIC for SC cores, or use the Esri data.	• The model can be downloaded from Esri: https://www.arcgis.com/home/item.html?id=d653270fb24847deaf65892f1b3c4b6e
Long Standing Forest	• Data shows where forest persists throughout time in archived Google satellite imagery (1990-2018)	• Google Earth Imagery	https://www.google.com/earth/
Dam Flood Zone	• Both sites have a dammed stream/river. Below the dam is a hazard zone delineating area that would be affected by a breach. If dam size and holding pond are greater than certain criteria, the flood zone is documented by the state agency.	• NC: Coincides with Moderately well drained soils. – See Soils data below. • SC: DHEC Department of Health and Environmental Control uses the Inundation model DSS-Wise Lite.	• Flood zone for NC Site from unknown source. No official records found. • If there is a dam on a property in, contact the DHEC for the modeled flood zone: https://www.scdhec.gov/
Slope	• Slope is an important restriction when considering building site, type of construction and layout. • Different states have various rules for those slopes upon which roads can be built, and other restrictions regarding building on slopes.	• NC provides complete LiDAR Point Cloud datasets, available from the state government. • SC: Digital Elevation Model is available for the county scale from the SC Department of Natural Resources.	• NC: https://www.nconemap.gov/datasets/digital-elevation-model-20-grid-cells • SC: http://www.dnr.sc.gov/gis.html
Soils	• Soils data will determine area suitability for development based on a wide range or criteria including: inundation, drainage capabilities, erosion hazards, depth to water table, and depth to bedrock.	• The USDA Natural Resources Conservation Service produces the SSURGO (Soil Survey Geographic Database), a comprehensive dataset that includes many attributes useful for assessing an area's building suitability.	• Dataset can be downloaded from the NRCS website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053627 • Web mapping and data exploration tool is available via the Web Soil Survey (WSS) page: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm • General sources: https://websoilsurvey.nrcs.usda.gov/app/
Roads/ Transportation	• Roads and trails are an important part of the picture, both inside the site and for assessing the sites' suitability regionally.	• Roads can usually be downloaded from a county's spatial data page but scale might not be reliable within the site. • Satellite imagery and data from the client were used to map the trails and existing road network within the site.	• SC: Greenville county GIS website https://www.gcgis.org/ • NC: Polk County GIS Website http://www.polknc.org/quick_links/gomaps_gis/index.php#.XZJHFkJ7Ijl
Parcel/Ownership boundaries	• Property boundaries are important, not only for the project site, but also for looking at regional context and which nearby land use practices might affect or be affected by activities on the project site.	• County websites usually have parcel boundaries available.	

Fire planning and fire safety

- ***Safer From the Start, A Guide to Firewise®-Friendly Communities***: https://www.nfpa.org/-/media/Files/Training/certification/CWMS/SaferFromtheStart.ashx?la=en
- **How to redesign communities for fire safety**: https://fireadapted.org/
- **Ready-Set-Go Program**: http://www.wildlandfirersg.org
- **Benefits of Prescribed Burning slide show**: http://www.dnr.sc.gov/burningbenefits/index.html

NC Firewise® resources: https://www.ncforestservice.gov/fire_control/fc_wui.htm

- **Home design for fire safety**: https://www.ncfirewise.org/pdf/home_assessment.pdf
- **Landscaping for fire safety**: https://www.ncfirewise.org/pdf/firewise_landscaping.pdf
- **Community wildfire protection plans**: https://www.ncforestservice.gov/fire_control/fc_wui.htm

SC Firewise® resources: http://www.state.sc.us/forest/firewise.htm

- **Example fire safety plan for a subdivision**: http://www.state.sc.us/forest/hunterspt.pdf
- **Plant flammability list**: https://www.state.sc.us/forest/scplants.pdf

Community forest management:

- **Tools to plan for community forests**: https://www.vibrantcitieslab.com/toolkit/
- **Utilizing Trees for Stormwater Management**: http://www.gicinc.org/trees_stormwater.htm
- **Southern Woodland Owners and Conservation Agreements**: **A Guide for Land Trusts and Resource Professionals:** explains how to establish conservation plans with private forest owners: https://www.treefarmsystem.org/stuff/contentmgr/files/1/e87c10ae501b96584727faebed3bac5f/misc/southern_woodland_owners_and_conservation_agreements.pdf
- **Guide to Preserving Trees in Development Projects**: https://extension.psu.edu/a-guide-to-preserving-trees-in-development-projects

Conservation subdivision design

- **Green Growth Toolbox/Handbook** North Carolina's Wildlife Resources Commission offers the Green Growth Toolbox with resources for planners, designers, developers, local governments and citizens. The handbook is available here: https://www.ncwildlife.org/Conserving/Programs/Green-Growth-Toolbox/Download-Handbook
- **The Conservation Subdivision Design Handbook for North Carolina** (examples and guidance): https://www.ncufc.org/uploads/Conservation_subdivision.pdf
- **The Green Infrastructure Center** has resources, case studies and books on its website. Learn more about habitat conservation and planning here: http://www.gicinc.org

Trail planning

Although the developer of a site can install trails, boat ramps, etc., there are opportunities for technical and funding assistance, especially if these site amenities will be open to the public. To obtain outside funding, there must be a derived public benefit. Some conservation submissions also establish a public nature center that educates residents about how to live in harmony with a natural landscape.

- **American Trails** offers the opportunity to apply for assistance for planning and building trails: https://www.americantrails.org/resources/planning-design
  They also have a library of technical support https://www.americantrails.org/resource-library
- **National Park Service** offers technical support for community trail planning: https://www.nps.gov/orgs/rtca/index.htm

Backyards and open space plantings

- ***Bringing Nature Home*** is both a book and a website that provides a wealth of resources for how to plant species to attract pollinators. http://www.bringingnaturehome.net/
- ***The Living Landscape: Designing for Beauty and Biodiversity in the Home Garden*** is another book that residents and designers can use to plan for connectivity and natural health. It is available from most book sellers.
- **North Carolina Native Plant Society**: https://www.ncwildflower.org/native_plants/recommendations
- **NC Go Native** website for landscaping urban areas: https://projects.ncsu.edu/goingnative/
- **South Carolina Native Plant Society**: https://scnps.org/
- **North Carolina Audubon Society**: Bird Friendly Native Plants: https://nc.audubon.org/conservation/bird-friendly-communities/bird-friendly-native-plants
- **South Carolina Audubon Society**: Bird Friendly Native Plants: https://sc.audubon.org/conservation/plants-birds-bf

Environmentally sensitive golf course design

- ***Wildlife Links: Improving Golf's Environmental Game***, by the U.S. Golf Association https://www.usga.org/content/dam/usga/pdf/Water Resource Center/usga-wildlifelinks.pdf

Dark skies and lighting standards:

- **International Dark Skies Association**: https://www.darksky.org/our-work/lighting/lighting-for-citizens/led-guide/
- **Update on states with regulations**: http://www.ncsl.org/research/environment-and-natural-resources/states-shut-out-light-pollution.aspx

Low-impact development (best management practices for stormwater)

For detailed LID techniques, see these free resources and also the book by Huber listed in the References section:

- N.**C. State University *Low Impact Development Guidebook* and training** http://www.onsiteconsortium.org/npsdeal/NC_LID_Guidebook.pdf
- ***Low Impact Development for the North Carolina Coast***: http://www.nccoast.org/uploads/documents/guides/LIDNC.pdf
- ***Low Impact Development in Coastal South Carolina: A planning and design guide***: http://www.northinlet.sc.edu/lid/
- **U.S. Environmental Protection Agency Resources for LID**: https://www.epa.gov/nps/urban-runoff-low-impact-development

6.3 References

Arendt, Randall G. *Conservation design for subdivisions: A practical guide to creating open space networks*. Island Press, 2012.

Arendt, R. G. (2013). *Growing greener: Putting conservation into local plans and ordinances*. Island Press. http://www.heat-mi.org/files/randallarendt.pdf

Benedict, Mark A., and Edward T. McMahon. *Green infrastructure: linking landscapes and communities*. Island press, 2012.

Bowman, Troy, Jan Thompson, and Joe Colletti. "Valuation of open space and conservation features in residential subdivisions." *Journal of Environmental Management* 90, no. 1 (2009): 321-330.

Colcombe, S., and A.F. Kramer. 2003. Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science* 14, 2: 125-130.

Crompton, J., Love, L. and Moore, T. 1997. "An Empirical Study of the Role of Recreation, Parks and Open Space in Companies (re) Location Decisions." *Journal of Parks and Recreation Administration* 15(1), 1997: 38-58.

Darke, Rick, and Douglas W. Tallamy. *The living landscape: Designing for beauty and biodiversity in the home garden*. Timber Press, 2014.

Firehock, Karen. *Strategic green infrastructure planning: a multi-scale approach*. Island Press, 2015.

Firehock, Karen and Richard Walker, *Green Infrastructure: map and plan the natural world with GIS*. Esri Press, 2019.

Hanula, J. L., Horn, S., & O'Brien, J. J. (2015). Have changing forests conditions contributed to pollinator decline in the southeastern United States? *Forest Ecology and Management*, 348, 142-152.

Huber, Jeffrey. "Low Impact Development: a design manual for urban areas." *Arkansas: Fayetteville* (2010).

Louv, Richard. *Last child in the woods: Saving our children from nature-deficit disorder*. Algonquin books, 2008.

Mackey M.J., Connette G.M., Peterman W.E. & Semlitsch R.D. (2014). Do golf courses reduce the ecological value of headwater streams for salamanders in the southern Appalachian Mountains?, *Landscape and Urban Planning*, 125 17-27. DOI: 10.1016/j.landurbplan.2014.01.013 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.713.7864&rep=rep1&type=pdf

Pejchar, Liba, Peter M. Morgan, Margaret R. Caldwell, Carl Palmer, and Gretchen C. Daily. "Evaluating the potential for conservation development: biophysical, economic, and institutional perspectives." *Conservation Biology* 21, no. 1 (2007): 69-78. http://www.centerforoceansolutions.org/sites/default/files/publications/Pejchar et al 2007.pdf

Thomas, H. L. 1991. The economic benefits of land conservation. Technical memo of the Dutchess County Planning Department, Dutchess County, New York.

Tilt, Jenna H., Thomas M. Unfried, and Belen Roca. "Using objective and subjective measures of neighborhood greenness and accessible destinations for understanding walking trips and BMI in Seattle, Washington." *American Journal of Health Promotion* 21, no. 4_suppl (2007): 371-379.

Wolf, K. L. 2007 (August). City Trees and Property Values. *Arborist News* 16, 4: 34-36.

We dedicate this guide to Tony Harper who owned the Long Branch Lake property featured in this guide. Tony's vision is shared throughout this work. As he said to us more than once, "People build on places and destroy the very things they loved — the clean water, the views and the nature. I don't want to build like that. I want the water to stay clean and the wildlife to still be here when we are done." We thus, dedicate this guide to Tony's legacy and hope that his vision for Long Branch will be realized.

Antony 'Tony' Caldwell Harper

January 5, 1936 - September 23, 2019