

Conservation Planning Guide: Bolin Creek Natural Area

June 2021



Friends of Bolin Creek

Protecting our Bolin Creek Watershed

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Executive Summary

Bolin Creek and its surrounding forest is a highly-valued community resource which provides recreational opportunities, increases economic value, presents research opportunities, and hosts a vibrant flora and fauna that depend on the health of a stream under increasing duress. The creek itself is part of the network of streams feeding Jordan Lake, a drinking-water supply for many towns and cities in the Triangle area of North Carolina.

In recent decades, Bolin Creek has unfortunately witnessed a deterioration in stream quality, aquatic ecosystem health, and wildlife habitats on the land surrounding the creek. As Chapel Hill and Carrboro continue to urbanize, it is essential to continue to monitor the impact that construction and development are imposing on the ecological health of the Bolin Creek Natural Area and its watershed.

The Bolin Creek Natural Area includes 325 acres owned by the University of North Carolina;¹ the 27 acre Adams Preserve, owned by the Town of Carrboro; and 77 acres, privately owned by P.H. Craig for a total of 429 acres. It is rare to find such contiguous tracts of undeveloped land in an urbanized area, and numerous scientific studies have identified this area as ecologically sensitive and in need of conservation.

[Friends of Bolin Creek](#) (FOBC) is a local 501(c)(3) environmental organization founded in 2003 to protect the Bolin Creek watershed and its surrounding natural areas through community education and action. FOBC is dedicated to conserving this area for future generations by spearheading the creation of a coordinated conservation management plan. Preserving Bolin Creek is critical for addressing climate change, protecting water quality, providing for stormwater management, and maintaining wildlife habitat integrity.

It will take more active state and local management , along with non-profit and volunteer efforts, to address the many threats to this watershed and reverse the present trend of degradation. Today, these threats include stormwater runoff, pollution, sediment from poor construction practices, poor trail maintenance, and continuing urbanization, including the prospect of paving in the stream's riparian zone. Climate change only exacerbates these issues, making responsible management of Bolin Creek essential to the environmental health of our community.

¹ The University of North Carolina owns nearly 1,000 acres of land in this area including the former airport. This study focuses only on the 325 acres described here.

Through encouraging collaboration across public and private institutions and identifying specific goals and strategies, this document lays the groundwork for substantive action to improve the ecological health of our treasured community resource, leading to cleaner water and air, while supporting healthful recreational and educational opportunities for the community.

Our long-term goal is to protect the natural resources of the Bolin Creek Natural Area through coordinated conservation management. By doing so we will:

- Preserve the health of the forest and its botanical and wildlife assets;
- Support the implementation of the Town of Carrboro's Community Climate Action Plan by increasing carbon sequestration and stream health;²
- Honor the value that our citizenry places on conserving our forests, as witnessed by the many thousands of recreational hours that the public enjoys within this natural area every year;
- Build on the extraordinary work accomplished by former town elected leaders and the University of North Carolina administrators to conserve significant portions of the Bolin Creek Natural Area. (See 4.5.)

This Guide provides practical implementation steps to achieve our goal through the coordinated creation and implementation of a land use management plan:

- Form a Bolin Creek Natural Area Planning Committee to coordinate planning for the Bolin Creek Natural Area as a protected reserve for wildlife, recreation and future conservation.
- Invite Carrboro, UNC and all landowners to commit to a coordinated management plan that will protect Bolin Creek's riparian corridor and implement portions of [Carrboro's Community Climate Action Plan](#).
- Meet on site with landowners to identify areas in need of immediate attention.
- Raise funds to pay for the preparation of a land use management plan.
- Contribute to enhanced communication and vigilance of utility maintenance activities, particularly with the upcoming replacement of the OWASA sewer line.
- Encourage elected officials to support recommendations from past initiatives.

² The Carrboro Community Action Plan features several specific recommendations in line with FOBC's suggestions. See Part IV for more detail.

Purpose and Intended Use of this Document

The Conservation Planning Guide for the Bolin Creek Natural Area is a stewardship resource created by Friends of Bolin Creek 501(c)(3).

Bolin Creek Natural Area

The Bolin Creek Natural Area features land divided among multiple landowners and managers, making responsible conservation practices utterly reliant on cooperation and communication. Friends of Bolin Creek aims to facilitate this coordination by consolidating available research and historical information about land management in this document. By identifying the resources of the 429 acres of Bolin Forest, this guide intends to stimulate and inspire government and conservation leaders to work toward the permanent conservation of Bolin Forest and restore the area to a continuous, thriving urban forest.

Community Resource

Perhaps most essentially, this document serves as a community resource to anyone who wishes to know more about the Bolin Creek Watershed and how to protect it from further damage. Local governments will utilize this resource as they continue their efforts to repair Bolin Creek and its tributaries. This watershed has been studied extensively from the formative [2003 Assessment Report: Biological Impairment in the Little Creek Watershed](#) to the [2012 Bolin Creek Watershed Situation Assessment](#). A full list of studies can be found [here](#). Brought together in one place, *Conservation Planning Guide: Bolin Creek Natural Area* pairs a description of local history, politics, and applicable laws and ordinances relevant to the health and management of Bolin Creek with the data and knowledge from a number of state and EPA funded studies of this valued resource.

Friends of Bolin Creek

Friends of Bolin Creek will reach out to each Bolin Forest landowner with this report, working toward a collaborative management plan that benefits the entire forest. The information and general strategies in this document will provide a foundation for a holistic action plan for the preservation of Bolin Forest, so that it may remain a healthy natural resource for our community.

Friends of Bolin Creek

Friends of Bolin Creek (FOBC)³ is a local 501(c)(3) environmental organization that was founded in 2003 to protect the Bolin Creek watershed and its surrounding natural areas through community education and action. Our work aims to enhance quality of life for all the residents of Chapel Hill and Carrboro by addressing water quality issues, encouraging environmental stewardship, and nurturing an appreciation of our rich Piedmont natural resources. Our community projects include developing water quality curriculum for 8th grade middle schools, organizing nature educational walks, and conducting workshops on climate change, stream bank mitigation, urban stream health, and rain gardens. For a more thorough list of FOBC activities and projects, please see [Appendix II](#).

The mission of Friends of Bolin Creek is to nurture Bolin Creek Forest as a healthy living forest that harbors natural aquatic and terrestrial communities, coexisting next to the growing urban population of Carrboro and Chapel Hill. In our desired future, the 429 acres of the Bolin Creek Natural Area are managed holistically to protect water quality and environmental integrity, while continuing as a recreation mecca and an educational resource.

In June of 2018, FOBC convened a Bolin Forest Advisory Committee to discuss the outline and purpose of this conservation planning document.

The committee members include:

- i. Michael Paul, FOBC, Stream Ecologist
- ii. Robert Crook, FOBC, Forester
- iii. John Morris, FOBC, Water resources
- iv. Betsy Kempter, FOBC, Education and Outreach Specialist
- v. Dick Ludington, FOBC, Conservation Foundation
- vi. Julie McClintock, FOBC, President

In addition to the committee reviewers, we made the final draft available for comment to these additional people and organizations:

- Dave Stancil and Christian Hirni, Orange County, Lands Legacy Program
- Anna Wu and Sally Hoyt, UNC Facilities

³ (Employer Identification Number 37-1451471, NC ID: 0655089)

- Allison Weakley and Ernest Odei-Larbi, Chapel Hill Stormwater Management Division
- Randy Dodd, Stormwater Services, Town of Carrboro
- Laura Janeway and Trish MacGuire, Planning staff, Town of Carrboro
- Dave Andrews, Town of Carrboro Town Manager and Planning staff
- Emily Sutton, Haw River Assembly
- Randee Haven O'Donnell, Science Educator
- Debbie Bolas, Friends of Bolin Creek
- Linda Haac, Friends of Bolin Creek
- Meg Malloy, Conservationist, Bolin Forest Homeowners Association

This document was completed with the guidance of this committee as a stewardship resource for Friends of Bolin Creek, the landowners, and community members and leaders who value Bolin Creek and its forest.

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Acronyms

BCMP: Bolin Creek Conceptual Master Plan

CN: Carolina North

DEQ, also NCDEQ: North Carolina Department of Environmental Quality

DWQ, also NCDWQ: North Carolina Division of Water Quality

EPA: Environmental Protection Agency

FOBC: Friends of Bolin Creek

NCBG: North Carolina Botanical Garden

NC-GAP: North Carolina Gap Analysis Project

NHP, also NCNHP: North Carolina National Heritage Program

OWASA: Orange Water and Sewer Authority

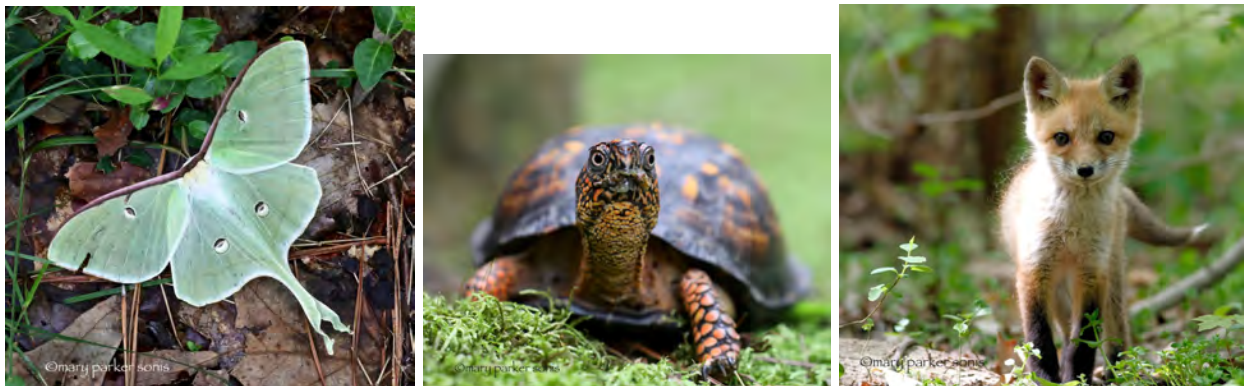
UNC, also UNC-CH: University of North Carolina (at Chapel Hill)

Part I Introduction

1.1 A Unique Community Resource

The towns of Chapel Hill and Carrboro make up more than half the population of Orange County, with approximately 80,000 people between them, according to the *NC Department of Commerce 2020 estimation*.⁴ With a mix of permanent residents and university students, this area boasts a deep-rooted cultural community, established school systems, and engaged residents who value environmental protection and outdoor recreation.

Nestled between these two towns and among schools and residential neighborhoods is a 429-acre forested greenspace that locals call Bolin Creek Forest. If you spend any time in Bolin Creek Forest, you will admire the beautiful mature hardwood trees on the banks of Bolin Creek. You will pass through a diverse, naturally evolving forest that includes centuries-old trees alongside new growth. If you stay long enough, you may even spot a box turtle crossing the trail, a great blue heron wading in the creek, or hear a pileated woodpecker tapping in the tall trees, foraging for its meal.



Left to right: Luna Moth, Eastern Box Turtle, Juvenile Red Fox, all spotted in Bolin Creek Forest.

[Photos by Mary Sonis.](#)

This large urban forest provides ecological, recreational, educational, and economic benefits to our community. Bolin Creek Forest is unusual for its proximity to growing urban development in Chapel Hill and Carrboro. As urbanization intensifies, the forests and creeks of the Bolin Creek Natural Area are becoming increasingly valuable to the environmental and recreational health of these communities.

⁴ North Carolina Department of Commerce, November 2020. [Labor & Economic Analysis](#).

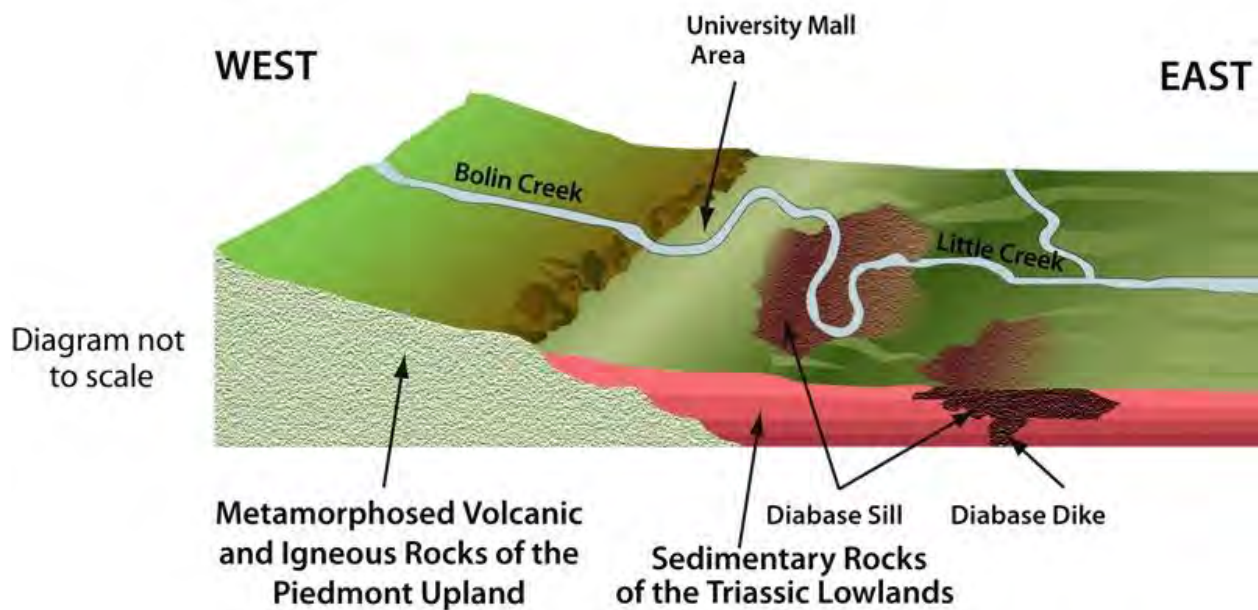
Although this resource is treasured by the urban community because of its proximity and special character, studies show that very proximity to past and ongoing urban development has brought undesirable consequences. We will be addressing those threats to the health of the watershed in [Part III](#) of this document.

The goal of this document is to provide conservation advocates, climate activists, town and local officials, and the forest property owners (UNC, Adams Preserve, P.H. Craig) with a basic framework for coordinated action. It is through joint collaborative action that conservation can be most effectively planned and managed.

1.2 Overview of Bolin Creek Natural Area

The Bolin Creek Natural Area is characterized by a rich but threatened diversity of flora and fauna, a varied topography and a diverse geology. The stretch of Bolin Creek owned by UNC, which extends from Homestead Road to the P.H. Craig property, is characterized by a wide floodplain that fills during some storm events. Beaver activity in the area further broadens the path of stormwater. Traveling southward through the P.H. Craig property, the floodplain gradually narrows and the east side of Bolin Creek is laced with many walking trails. On the steeper west side of Bolin Creek, homes alongside Bolin Forest are perched on the bank above the creek. Traveling still further south along the creek, the railway tracks presses in on the east side, narrowing the walking area next to the creek before finally crossing Bolin Creek on a high railroad trestle. At this point, still walking south along the creek, one enters a spectacular narrow old geologic feature that borders the Adams Preserve, characterized by metamorphosed volcanic and igneous rock outcroppings. An old iron mine is found just below the Ironwood neighborhood on the east bank. A geologist has noted that much more weathering has occurred on the west side of the creek due to the more open gentle slopes.

The geology of the entire course of Bolin Creek is captured in this illustration.



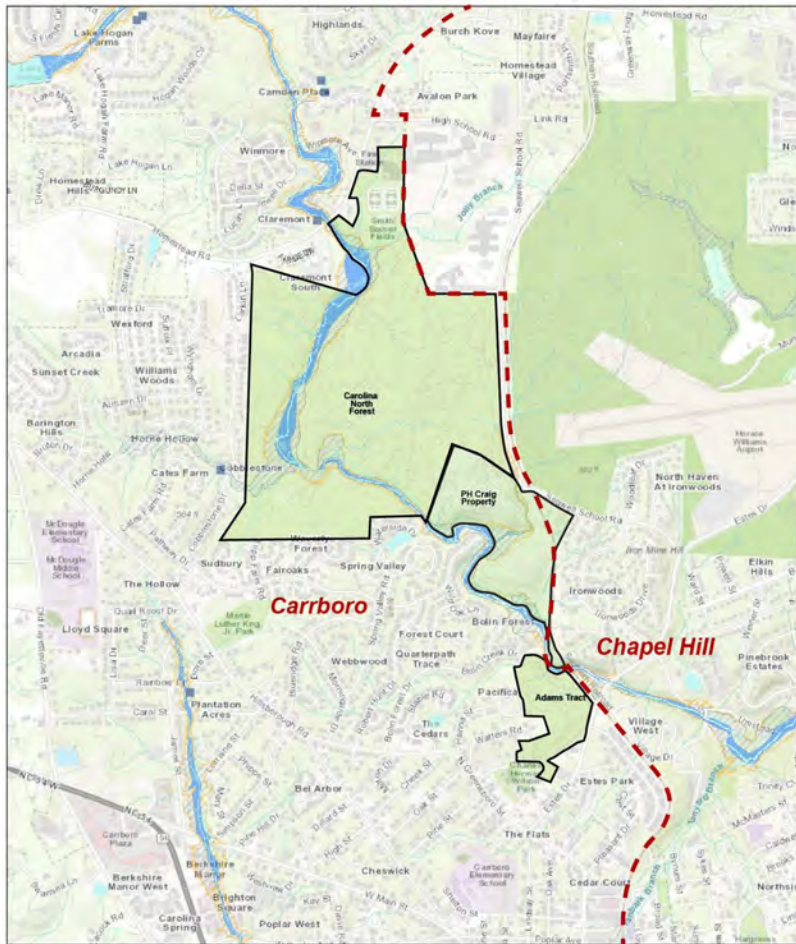
[Figure A](#). Bolin Creek Area Geological Model.

1.2.1 Defining Bolin Creek Natural Area

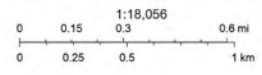
In this document, *Bolin Creek Natural Area* refers to the area of land bordered by Seawell School Road to the east, Homestead Road to the north, Estes Drive Extension to the south, and Greensboro Road and the Bolin Forest neighborhoods to the west. This area consists primarily of three adjacent parcels of land: the 27-acre Adams Preserve in the south, owned by the town of Carrboro and Orange County; the 325-acres of the Carolina North Forest to the north, owned by the University of North Carolina (UNC); and the 77-acre privately owned P.H. Craig Property, wedged between these parcels.⁵ Additionally, the Bolin Creek Natural Area includes small acreages of common land held by the residential homeowner associations of Ironwoods, Spring Valley, Bolin Forest, Cates Farm, Pacifica, and Claremont neighborhoods. For a map of the major owners of the natural area and its boundaries, see Figure B below.

⁵ The overall Bolin Creek watershed also includes about 30 acres of land to the east of the railroad track along Seawall School Road, but this document focuses on the land west of this road.

Bolin Creek Conservation Map



- November 24, 2018
- Elevation Certificates
 - Base Flood Elevation
 - Streams
 - Wetlands
 - Lakes, Ponds, and Creeks
 - Floodplain
 - 0.2 pct annual chance (500-yr)
 - 1 pct annual chance (100-yr)
 - Floodway
 - 1 pct annual chance future conditions
 - Jurisdictions
 - Jurisdictional Boundary



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, Geobase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, © OpenStreetMap contributors, and the GIS User

Figure B. Bolin Creek Natural Area.

General project area map that includes the three main parcels of land but does not include the part of Carolina Forest east of Seawell School Road, nor land owned by Bolin Creek neighborhood associations.

1.2.2 Conservation Status

Of the three main tracts of land in the Bolin Creek Natural Area, two are publicly owned, one by the town of Carrboro, and one by the University of North Carolina (UNC). The public owners of these tracts have established a precedent for forest conservation on both sides of the privately held P.H. Craig tract.

The Adams Preserve, acquired by Carrboro in 2004, is currently conserved and managed by Orange County under the terms of the funding agency, the [North Carolina Clean Water Management Trust Fund](#) (recently renamed the North Carolina Land and Water Fund). These conservation funds are designed to protect and preserve NC waterways and their environs. Accepting these funds requires certain management practices, such as limiting vehicle use on the trails.

Management of the UNC Carolina North property is subject to a contract between the Town of Chapel Hill and UNC known as the Carolina North Development Agreement, signed in 2009. The same year, Biohabitats, a firm specializing in ecological preservation and restoration, identified five areas for ecological preservation and restoration within the UNC-owned land of Bolin Creek Watershed on the west side of Seawell School road. These areas are administered by the Triangle Land Conservancy under the terms of the development agreement. A few years later, UNC developed a [Land Stewardship Policy](#), which outlined the university's commitment to conservation and opened up future research possibilities for the forest.⁶

The privately owned P.H. Craig tract has been managed as a tree farm by its owner, P.H. Craig, for the past 50 years. When the owner announced a tree harvest of 40 acres in 2018, the Carrboro Town Council (formerly Town of Carrboro Board of Aldermen) explored with the owner and conservation organizations the prospect of the Town of Carrboro acquiring this tract for conservation and paying the owner not to harvest. This offer was rejected and the timber was harvested.

1.3 Reasons to Conserve At-Risk Portions of the Bolin Creek Natural Area

⁶ "As part of the 2009 Development Agreement with the Town of Chapel Hill, the University agreed to place 258 acres of the tract into CAs (Conservation Areas) under perpetual conservation, 53 acres of the tract into the 100 Year Limited Development Area under conservation until 2109, and 408 acres of the tract into the 50 Year Limited Development Areas under conservation until 2059," [Land Stewardship Policy](#), 4.

The North Carolina Natural Heritage Program declared this 425-acre Bolin Creek Natural Area, owned by UNC, P.H. Craig and Carrboro, of great historical and cultural significance and worthy of preservation.⁷ Additionally, the NC Gap Analysis Project identified much of the Bolin Creek riparian corridor as a priority wildlife habitat.⁸

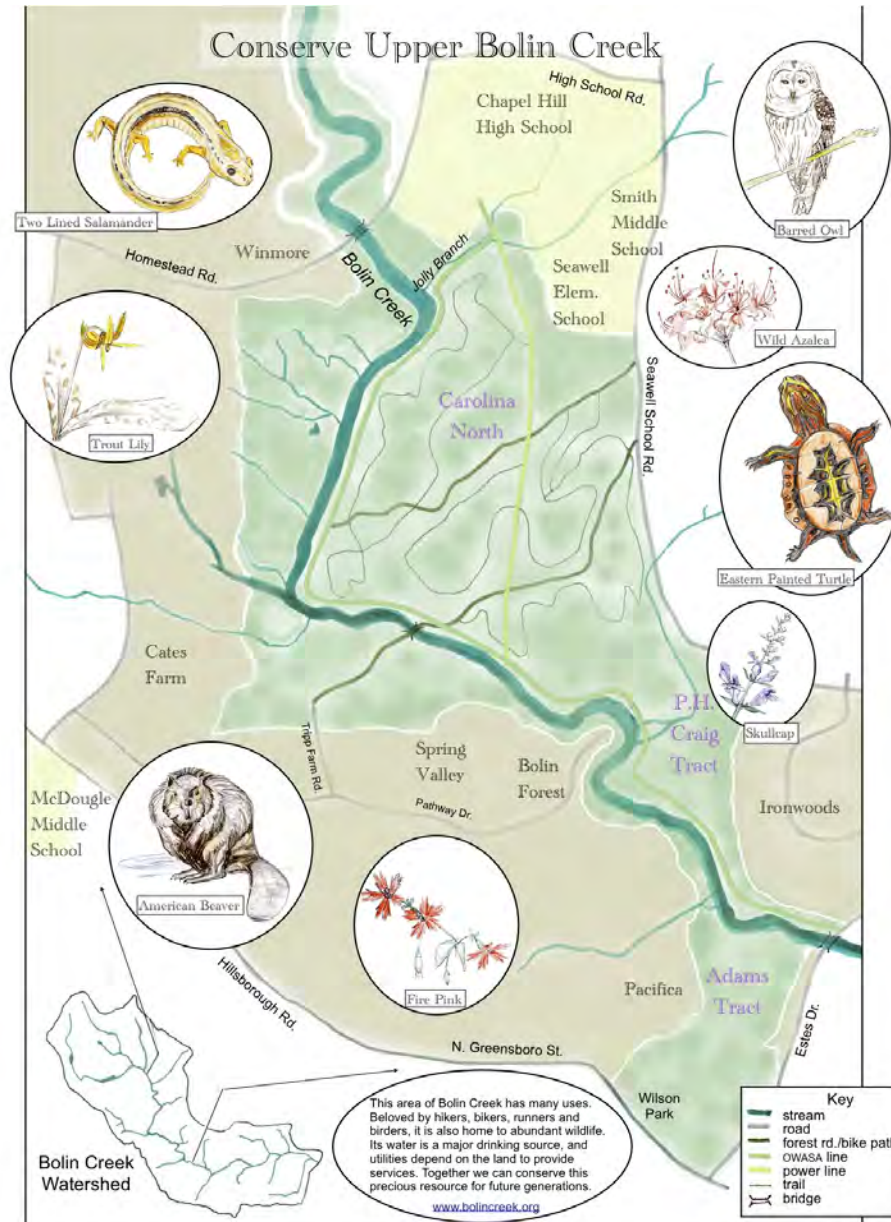


Figure C. Artist's Map of Upper Bolin Creek by Geneva Green

⁷ Orange County Environment and Resource Conservation Department and N.C. Natural Heritage Program, [Inventory of Natural Areas and Wildlife Habitats for Orange County](#), North Carolina, 2003.

⁸ North Carolina State University, [North Carolina Gap Analysis Project](#). Last updated November 2019.

1.3.1 Wealth of Botanical and Animal Assets

Threatened Species

The Bolin Creek Natural Area riparian corridor preserves water quality for Bolin Creek and downstream waters, acts as critical habitat for many species, and provides movement corridors for wildlife.⁹ Many animal species rely on the contiguous forest and stable riverbanks to maintain their fragile habitats. There are a number of endangered and threatened animal species in Orange County. Specifically, Bolin Creek hosts a salamander species, the four-toed salamander, known only rarely in the American Southeast and nowhere else in the world.¹⁰

The Bolin Creek area had been used by UNC zoologists for years as a salamander research site, especially a large deep pool located along a tributary... [this] site along Bolin Creek where the salamander was previously known to occur was, in fact, destroyed in 1987 by the construction of a sewer line.¹¹

Pockets of salamander habitat remain. Increased conservation efforts can allow for the preservation of such species by protecting their habitat.



Left: Spotted Salamander lays eggs. Right: Four-toed Salamander. Both species are native to Bolin Creek and threatened by habitat degradation.

[Photos by Mary Sonis.](#)

⁹ The “riparian corridor” refers to the plant and animal habitat along the river bank. These corridors contain a vegetation and root system that naturally mitigates flood damage and prevents bank erosion.

¹⁰ [Inventory of Natural Areas and Wildlife Habitats for Orange County](#), 2003.

¹¹ [Inventory of Natural Areas and Wildlife Habitats for Orange County](#), 2003. 38, 26.

Bird Migration

Birds of all kinds, but particularly migrating species, rely on the vegetation covering the riparian corridor and the food sources along and in the creek. When migrating birds stop along their journey, they must increase their body weight by a third. They rest and eat in the lush safety of Bolin Creek Forest before continuing on their long journeys. Migrating warblers are a particular group of species that can be spotted in the fall and spring of each year. Bolin Creek Forest is additionally both home to and a migration point for the Wood Thrush, a species of special concern due to its precipitous decline in the past few years.



Migratory Birds in Bolin Creek Forest. From left to right: Canada Warbler, Swainson's Thrush, Magnolia Warbler.

[Photos by Mary Sonis.](#)

Forest Canopy

Mature hardwoods stands, rare in urban areas, provide increasingly scarce sites for migratory birds and other locally rare species.¹² The Inventory of Significant Natural Areas and Wildlife Habitats mentions that at least a dozen species of neotropical migrant birds and red-shouldered hawks breed here.¹³ Bolin Creek and the tree canopy provide an essential migratory stop for warblers in the spring and the fall, while also reducing greenhouse gases by storing carbon, improving fish habitat, and keeping streams cooler in the summer. The forest within the Bolin Creek Natural Area hosts a diverse mixture of pine, beech, oak, hickory, poplar, and sourwood trees, as well as the uncommon umbrella magnolia tree. In spring, wildflowers bloom alongside hardwood trees. The

¹² For an in-depth description of forest types as this document defines them, see the [NHP Plant Communities Classification](#).

¹³ [Inventory of Significant Natural Areas and Wildlife Habitats](#), 37.

diversity of soil types and moisture levels allows for an abundance of trees and plants throughout the various forest canopy layers of the Bolin Creek Forest.

For a more complete account of the area's natural communities, see [Appendix V](#).

1.3.2 Water Quality and Stream Health

Riparian forests protect water quality, play a significant role in stabilizing stream banks, mitigate the impact of flood and storm waters, and provide shade and organic matter (e.g., wood and leaves) that provide habitats for macroinvertebrates.¹⁴ These environmental functions not only improve wildlife habitat for aquatic and terrestrial organisms, but also have a positive impact on drinking water quality.

Bolin Creek feeds into Little Creek, which in turn flows into Jordan Lake, a drinking water supply for almost a half million people living in Research Triangle towns. This [Haw River Watershed map](#) illustrates the network of streams flowing into Jordan Lake. Jordan Lake is a man-made federal reservoir filled in 1982, authorized by Congress for flood control, improving downstream water quality, meeting water supply needs, and providing for recreation and fish and wildlife habitat. Jordan Lake is now a drinking water supply for a number of growing towns and cities, including eventually the Orange Water and Sewer Authority (OWASA). Jordan Lake is important as a drinking water source in the ever-more-crowded Triangle region, as the area lacks significant groundwater aquifers. OWASA, Chapel Hill and Carrboro's water and sewer utility, has an allocation of five million gallons a day from Jordan Lake (not yet utilized). OWASA is currently evaluating long-range alternatives, including how this allocation would fit into the utility's overall water supply plan.¹⁵

Bolin Creek is one of the partially impaired streams leading into Jordan Lake. A stream is classified as impaired when significant degradation has interfered with the water body's designated use (such as aquatic life propagation or water supply).¹⁶ Impairment results

¹⁴ Benthic macroinvertebrates (small aquatic animals and the aquatic larval stages of insects) are useful indicators of water quality because they can be found in all but the most severely polluted or disturbed habitats and because they have a wide range of pollution tolerances amongst various species. We can measure water pollution by analyzing the type and number of various macroinvertebrate communities present in a given stream or river.

¹⁵ OWASA owns land on the Western shore of Jordan Lake for a future water intake, which is being planned by a partnership of the regional utilities.. More information is available in the [Western Intake Partnership Project Overview](#).

¹⁶ The water quality data assessment process for this classification, known as the "Integrated Report," is outlined on the [North Carolina Department of Environmental Quality website](#).

from stressors on the natural environment, often in the form of pollution or habitat degradation, which disrupt and destroy the natural ecological diversity of the stream. [North Carolina's 303\(d\) list](#) first classified Bolin Creek as biologically impaired in 2005 due to the absence of aquatic organisms expected for healthy streams in this region. The impaired section of Bolin Creek begins in the urbanized portions of Chapel Hill and Carrboro (where Bolin and Booker Creeks join Little Creek) and has been steadily moving upstream.¹⁷ The forest surrounding Bolin Creek functions as a filter for pollutants and sediment, increasing both water quality within the creek and drinking water quality in Jordan Lake.¹⁸ As a natural filter and wildlife habitat, the preservation of the forest is inextricably linked to the quality of water flowing through Bolin Creek and into downstream waters. We must protect the forest to help ensure the health of our drinking water supply and the preservation of aquatic habitats.

¹⁷ "In the middle Bolin Creek subwatersheds... urbanization increases and the stream receives stormwater runoff from much of downtown Chapel Hill. A gradual downstream decline of the conditions of various watershed indicators is evident. The riparian area is compromised by a sewer line easement and various encroachments." (For more information, see Morgan-Little Creek LWP Targeting of Management Report).

¹⁸ Calder, Ian, et al. "[Towards a new understanding of forests and water.](#)" *Unasylva* 229. vol. 58, 2007.

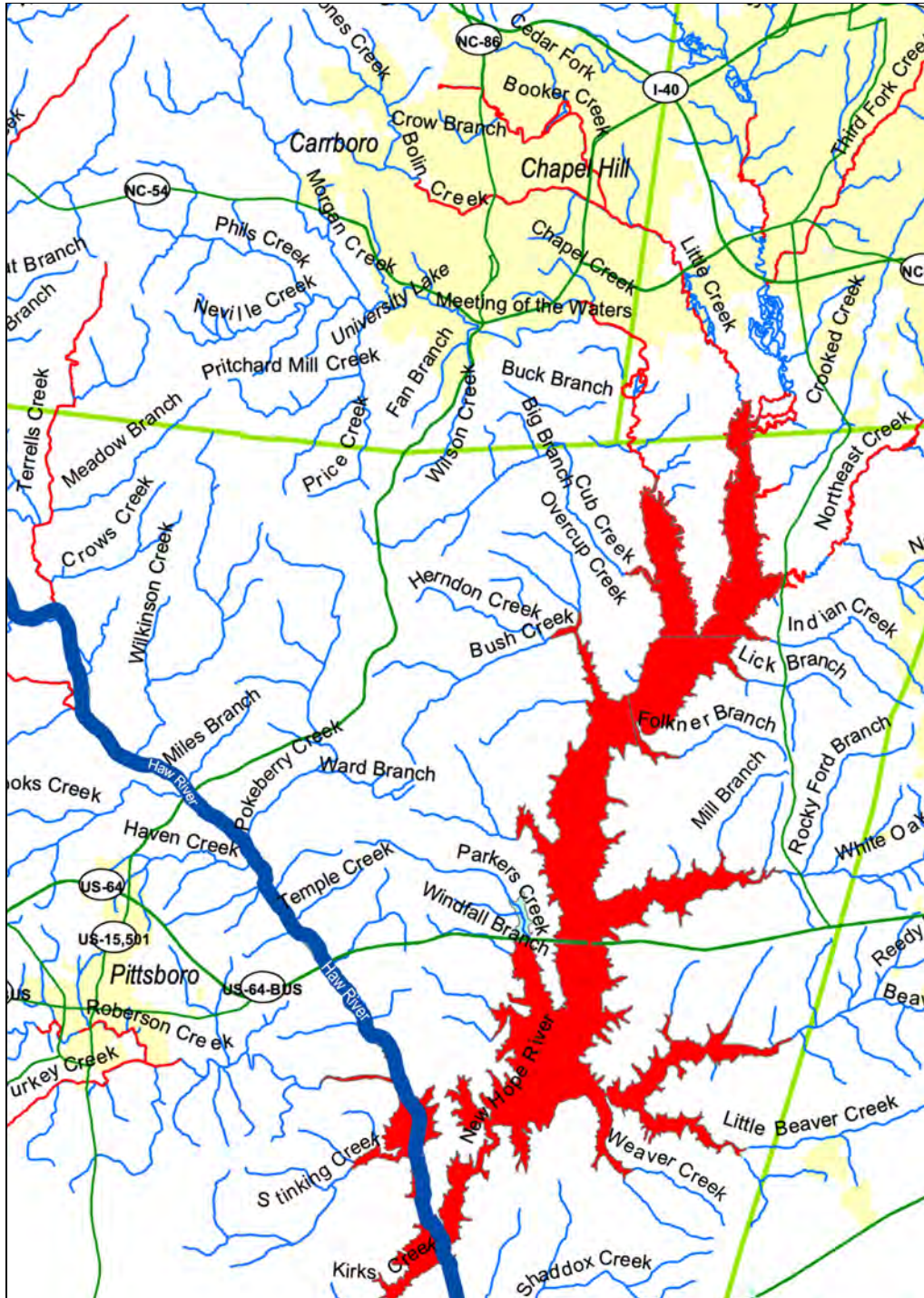


Figure D. [Haw River Assembly Watershed Map](#). Streams in red are on the 2016 EPA 303(d) impaired waterways list. Bolin Creek, partially red, is in the top center of the image.

According to the latest 303(d) report (2018), Bolin Creek remains impaired for biological integrity from the reach beginning just downstream from Pathway Drive to its confluence with Booker Creek. Friends of Bolin Creek worked proactively with the Chapel Hill and Carrboro school administration to build in measures to mitigate stormwater for the Chapel Hill High School renovation. However, during construction, these stormwater management measures were insufficient to stop sediment from the school from entering Bolin Creek during several storm events.

It is not yet known how the extensive renovations of Chapel Hill High School and the new road crossing of Jolly Branch, a tributary to Bolin Creek, will affect the long-term health of Bolin Creek.

1.3.3 Risks of Paved Surfaces to Water Quality

A healthy riparian area is one that remains in its original and natural condition as much as possible. Piedmont streams support a variety of trees, vegetation, and wildlife. The tree canopy reduces water temperatures, while tree root systems retain riverbanks and prevent erosion. Paving and urbanization degrade and dismantle these natural systems. The link between urbanization and stream impairment is undeniable:

As urbanization occurs, threats to watershed functions can include: increased stormwater discharges directly to streams, in terms of both volume and velocity; increased overland flow of stormwater; increased pollutant loading in stormwater due to build-up and wash-off, illicit connections, and dumping into storm sewers; increased stream temperature due to lack of shading and heated stormwater runoff from ponds and impervious areas; reduced groundwater recharge and baseflow due to increased imperviousness; and decreased number and diversity of plants and animals due to the lack—or poor quality—of habitat.¹⁹

The Morgan and Little Creek Management Report (2004) called for protective measures to prevent further stream impairment. Today, urbanization continues to encroach on the Bolin Creek Watershed. Protection of the riparian zone is integral to the future health of the stream, its wildlife, and the quality of our drinking water.

The University of North Carolina [Report on Jordan Lake](#) (2019) reported similar findings about the environmental impacts of urbanization. “Lands urbanized before 1980 are hot spots for diffuse nutrient export. They release about double the TN

¹⁹ [Morgan and Little Creek Management Report](#).

[total nitrogen] and TP [total phosphorus] of agricultural and post-1980 urban lands (per unit area).” Additionally, “Undeveloped lands export about an order of magnitude (10x) less TN and TP than agricultural and urban lands (per unit area). Thus, development of natural lands will substantially increase nutrient loading to Jordan Lake.”²⁰ One of the most effective ways to prevent this nutrient loading and runoff pollution is by limiting impervious surface coverage in the Bolin Creek Natural Area.

In 2010, the Cantena Group, Inc. documented the harmful aspects of the proposed paving of a trail along Bolin Creek in a review of [Carrboro’s Conceptual Master Plan for Greenways](#).

*These grading activities would inevitably result in the loss of riparian trees and vegetation and cause root damage that could result in unstable stream banks. Unstable banks would in turn result in more riparian tree loss and further destabilize stream conditions. The loss of mature riparian trees would increase light penetration and raise stream temperatures which results in increased algal growth and decreased dissolved oxygen levels, all of which are detrimental to water quality and aquatic life.... Another factor not fully considered is that the paved corridor could exacerbate erosion during heavy rainfall or high flow events through higher velocity hydraulic turbulence resulting from flows off the edges of the paved surfaces. Without the integration of well designed storm water attenuation structures into the design, which are not properly addressed, the paved greenway could increase erosion in numerous areas along the proposed corridor.*²¹

In 2010, Friends of Bolin Creek representatives and Carrboro Planners met with the NC Department of Environment and Natural Resources Buffer Coordinator and learned about the risks of paving next to waterways.²² The Coordinator discouraged paved trails close to streams because they result in the loss of streambank trees, which stabilize stream banks. She described several cases in which paved paths intended to shore up stream banks did the opposite, requiring extensive repairs. In the case of Bolin Creek, the Coordinator feared the proposed 10-foot wide cement path, plus a cleared area on each side adjacent to Bolin Creek, would remove tree roots and increase the velocity of stream flow during storms, undermining the pavement and increasing streambank erosion.

²⁰ The University of North Carolina and NC Policy Collaboratory. “Jordan Lake Study: Final Report to the North Carolina General Assembly, December 2019,” 7.

²¹ [Bolin Creek Greenway Conceptual Master Plan Goals Consistency Review](#), 3.

²² The Department of Environmental and Natural Resources is now named North Carolina Department of Environmental Quality.

Further, the North Carolina Department of Environmental Quality (DEQ) Buffer Coordinator explained that Jordan Lake Buffer rules only allow the construction of a paved greenway when there is “no practical alternative.”²³

*Uses designated as allowable may proceed provided that there are no practical alternatives to the requested use pursuant to Section 9.(A) of this Section. This includes construction, monitoring, and maintenance activities. These uses require written authorization from the [Municipality/County].*²⁴

Friends of Bolin Creek cited several anticipated alternatives, including the UNC commitment to build a bike path along Sewell School Road as a practical alternative. The transportation funding for the facility depended on UNC proceeding with campus construction. When the NC General Assembly delayed funding, UNC Administrators acknowledged the promised improvements could not be implemented. As a consequence, the towns of Chapel Hill and Carrboro in 2017-18 took the initiative, and their boards put the bike facility along Seawell School Road on the Metropolitan Planning Organization funding priority list. We concluded that since a practical alternative can be built, it would rule out approving a paved greenway within the Jordan Lake Buffer. In addition, there is a network of north-south unpaved trails on the east side of Seawell School Road on the Carolina North property.

According to the NC Department of Environmental Quality, paving along waterways is not an acceptable solution for protecting streams or preventing erosion along stream banks. In a [2011 article](#) in the *Carrboro Citizen*, John Morris, former Director of the North Carolina Division of Water Resources, wrote,

*Putting a paved greenway on the Bolin Creek sewer easement, which is largely within 30 feet of the creek, would tear up tree roots and remove trees that are holding the creek banks in place and providing shade for the stream...What some paving advocates are missing is that the paved greenways that we are familiar with along Bolin Creek, Booker Creek and Morgan Creek in Chapel Hill are built away from the creeks, leaving a wide, protective buffer in all but a few spots.*²⁵

²³ Both Carrboro and Chapel Hill Ordinances adopted the model Jordan Lake Buffer Rules that specify that a wide paved greenway is considered an “allowable” use. However, it is only permitted if it is determined there is “no practical alternative”

²⁴ “[[Local Model](#)] Riparian Buffer Protection Ordinance [for North Carolina],” 21.

²⁵ Morris, John. [The Carrboro Citizen](#), November 3, 2011.

The original section of the Chapel Hill Greenway that runs between the Community Center and MLK Jr. Boulevard was built in a wide floodplain and stays at least 50 feet away from Bolin Creek, except for one creek crossing. This is not true for the section of paved greenway between Umstead Park and MLK Jr Blvd, which required challenging engineering to fit pavement to DOT standards between a steep hillside and Bolin Creek. At many points, the greenway is just a few feet from the edge of Bolin Creek. Before 2000, and before the Jordan Lake Buffer Rules were in place, the Chapel Hill Town Council made a policy choice to place the value of connecting the downtown Northside neighborhood to an existing bikeway over the value of protecting ecology and stream health.²⁶ The area's steep topography forced the construction of a high retaining wall to hold the bank. Both the wall and the stream banks require on-going repair.²⁷ Because so much of the riparian area is now hardscaped and is no longer pervious, stormwater moves faster in the channel, scouring out stream banks and moving very large boulders downstream after each large storm event. It is not uncommon to see contract workers for the Town doing repair work for days after a major storm.²⁸ The trees along the stream banks that are now hemmed in by pavement on both sides are slowly dying. Chapel Hill's experience is instructive to other towns who want to build paved trail connections close to creeks with difficult topography.

A common misconception in the discussion of the pros and cons of paved paths is that the unpaved side path along the creek is a significant source of sediment for Bolin Creek in the Bolin Creek Natural Area. John Morris writes,

*I have walked the trail after heavy rains and observed that the OWASA easement is only a very minor and localized source of sediment to the creek. There are simple and inexpensive solutions to these small problem areas. The thorough studies of Bolin Creek by the N.C. Ecosystem Enhancement Program and the N.C. Division of Water Quality make clear that the significant threat to Bolin Creek is from land development and stormwater runoff from the developed and developing parts of the whole watershed, not from the forested area and not from the OWASA easement.*²⁹

²⁶ On the north side of Bolin Creek along Umstead, a wide sidewalk runs the full distance between Umstead and MLK that could have been widened and avoided disturbance on the south side altogether. At FOBC's urging, OWASA had agreed before the project began to put the sewer replacement line underneath Umstead Drive.

²⁷ FOBC has not been able to find out the accumulated costs of maintaining a paved greenway so near a creek.

²⁸ There are an estimated tens of thousand of dollars spent each year on greenway repair.

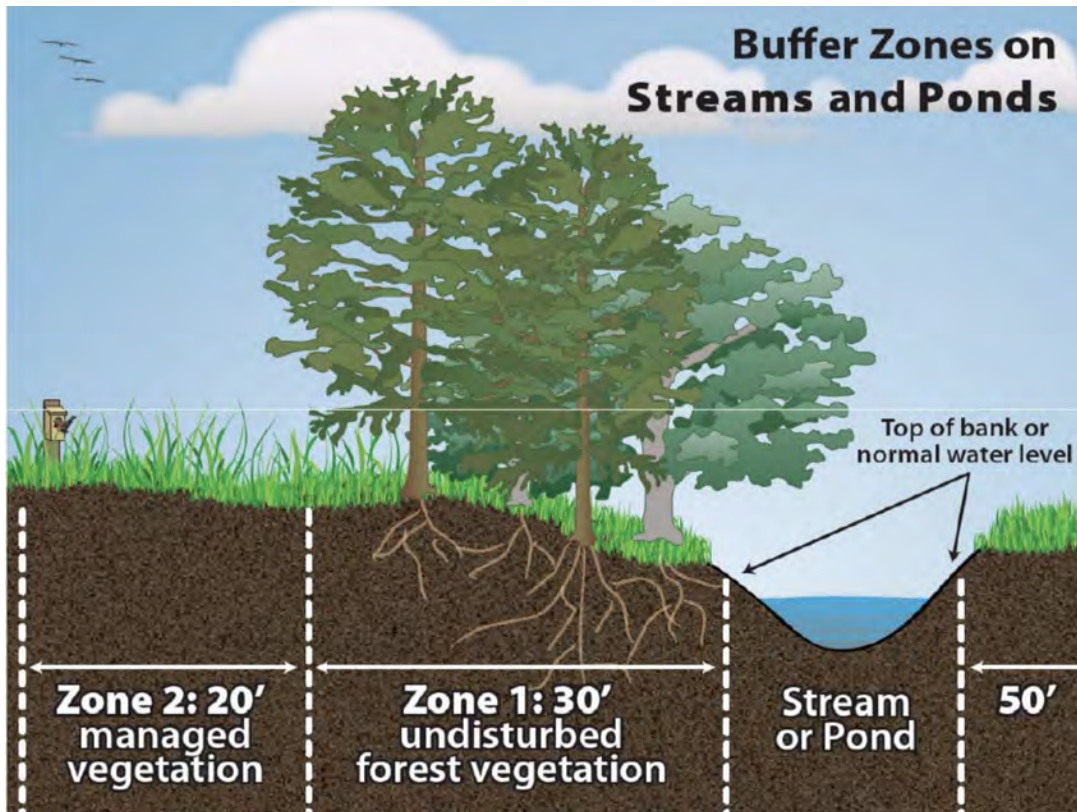
²⁹ John Morris, [Carrboro Citizen](#).

1.3.4 Complying with State Water Quality Rules

In 2009, the State of North Carolina adopted the Jordan Lake Nutrient Management Strategy, commonly known as the [Jordan Lake Buffer Rules](#). DEQ led a six-year initial effort to protect riparian areas along water bodies throughout the Jordan Lake watershed by negotiating these rules with all stakeholders. The Jordan Lake watershed includes the three tributary subwatersheds known as the Upper New Hope, the Lower New Hope, and the Haw River arms of the Jordan Reservoir. The Jordan Lake Buffer rules are designed to protect the many feeder streams that feed into the Jordan Lake Watershed, including Bolin Creek (See Fig. D) by reducing pollution from wastewater discharges, stormwater runoff, agriculture and fertilizer application in both new and existing development within the Jordan Lake watershed.

All waterways in [Carrboro and] Chapel Hill and its planning jurisdiction[s] flow into the Upper New Hope Arm of Jordan Lake. This area of the lake experiences frequent algal blooms due to overloads of nitrogen and phosphorus. The algal blooms can cause taste and odor problems in drinking water, kill or stress aquatic life, and can release toxins into the water. Riparian buffers are important in providing vegetation to filter stormwater runoff and to stabilize streambanks. They reduce erosion and sedimentation and the corresponding pollutants that flow into streams and the lake.³⁰

³⁰ Town of Chapel Hill, "[Jordan Lake Rules](#)."



Jordan Lake Rules Buffer Zones Illustration.³¹

Jordan Lake Buffer Rules include riparian buffer rules and stormwater rules for new and existing development.³² The NC General Assembly delayed the implementation of the Jordan Lake stormwater rules that would require all the municipalities in the Jordan Lake watershed to retrofit existing development to reduce nutrient loading from stormwater. The delay came about because local officials from the towns of Burlington and Greensboro strongly objected to the new nutrient management requirements, in part because the North Carolina Home Builders complained that

³¹ From “[Jordan Watershed Riparian Buffer Protection Ordinance Information Session](#),” December 2010.

³² Implementation of existing stormwater rules has been phased - Stage 1 requires local governments to submit an annual nutrient management strategy report. Stage 2 implementation depends on ongoing monitoring. From the rule (15A NCAC 02B .0266): "The Division shall defer development and implementation of Stage 2 programs required in a subwatershed by this Item if it determines that additional reductions in nutrient loading from existing development in that subwatershed will not be necessary to achieve nutrient-related water quality standards. In making this determination, the Division shall consider the anticipated effect of measures implemented or scheduled to be implemented to reduce nutrient loading from sources in the subwatershed other than existing development." For more info on Jordan rules implementation, see

<https://deq.nc.gov/about/divisions/water-resources/water-planning/nonpoint-source-planning/jordan-lake-nutrient-0#existing-development-stormwater>

Local jurisdictions are required to implement state and local laws and FOBC as a volunteer organization wants to assist in any way we can to help local jurisdictions meet these rules, and exceed them if possible.

1.3.5 Supporting Research Findings and Restoration Projects

Morgan-Little Creek LWP Targeting of Management Report Establishes Baseline Environmental Conditions

The 2004 Morgan-Little Creek LWP Targeting of Management Report by Tetra Tech, Inc. and Soil & Environmental Consultants, Inc. specifically recommended this section of the Upper Bolin Creek Watershed for conservation and preservation, as it hosts a rich ecosystem increasingly threatened by growing urbanization.³³ The map below illustrates how experts support the significance of and give high priority to conservation of this portion of the Bolin Creek watershed (in purple).

³³ Tetra Tech, Inc. and Soil & Environmental Consultants, Inc, "[Morgan-Little Creek LWP Targeting of Management Report](#)." North Carolina Ecosystem Enhancement Program, September 2004.

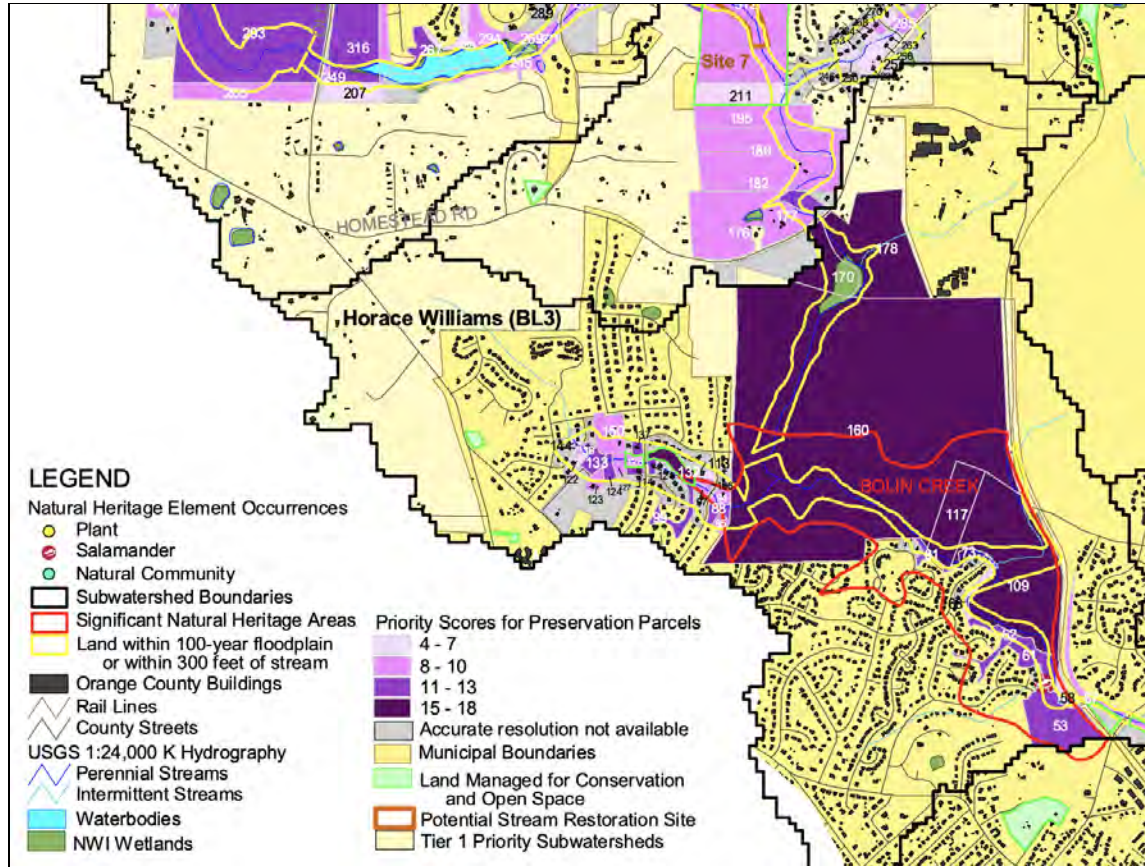


Figure E. Parcel-Level Analysis of Preservation Potential. From Morgan Creek Local Watershed Plan Targeting of Management Report, 4-7.

This state-sponsored study identified urbanization as “the biggest overall threat to watershed functions,” evidenced by the steady spread of stream impairment from the urbanized lower reaches of the creek to the less-developed upper reaches of the creek. It will take local action to mitigate the current damage to the natural area and prevent further water quality and habitat degradation from spreading.

FOBC Report Advocates for Conservation

In 2004, Friends of Bolin Creek wrote a report making the case for conservation of Bolin Creek Natural Area.³⁴ This report provided the foundation for an appeal for conservation to the Carrboro Town Council in 2004.³⁵ On October 4, 2005, the Town Council unanimously adopted [a resolution](#) that deemed the Bolin Creek Natural Area to be

³⁴ Friends of Bolin Creek, “[The Future of the Upper Bolin Creek Corridor](#).” May 2004.

³⁵ A similar case was made to the University of North Carolina in the negotiations that led up to the Carolina North Development Agreement in 2009.

worthy of conservation, acknowledging its rich natural resources and natural significance. The resolution had no regulatory effect.

Carrboro and Chapel Hill Advance Joint Bolin Creek Restoration Plan

When Friends of Bolin Creek achieved 501c(3) status, it provided both Carrboro and Chapel Hill a needed community partner organization to apply for 319 grants. In 2012, both towns jointly initiated a [Bolin Creek Restoration Plan](#) for the purpose of removing Bolin Creek from EPA's list of impaired waterways. It identified a list of restoration projects to halt and reverse the impacts of urbanization on the critical riparian natural areas within the Bolin Creek watershed.

Towns Apply for and Receive Additional Grants

Both Chapel Hill and Carrboro have received a number of EPA and State-funded grants. Friends of Bolin Creek served as a partner in these grant requests. Those [reports](#) funded by grants include:

- [Bolin Creek: Geomorphic Assessment](#) (2007).³⁶ Carrboro received a Clean Water Management Trust Fund grant in 2006/2007, in cooperation with Chapel Hill, and contracted EarthTech to perform a study of Bolin Creek. This study identified and ranked locations contributing to poor geomorphic conditions (i.e. sites of erosion and/or bank instability).
- [Bolin Creek: Tanyard Branch Study](#) (2011).³⁷ This study helped the towns of Chapel Hill and Carrboro to determine how best to manage stormwater in this area and how to approach future stream restoration projects.

In 2012, the Towns obtained a grant to contract the Watershed Education for Communities and Officials (WECO) at North Carolina State University to study the watershed and the area of our study known as the Bolin Forest Natural Area. Given the community controversy caused by Carrboro's consideration of a paved path next to Bolin Creek, this initiative was well timed. The final report was the [Bolin Creek Situation Assessment](#) (2012).³⁸ Through a number of interviews, this document sought to describe and document the interests of assorted watershed stakeholders and organizations,

³⁶ EarthTech Inc., Carrboro, N.C., "[Bolin Creek Watershed Geomorphic Analysis and Potential Site Identification for Stormwater Structures and Retrofit](#)." November 2007.

³⁷ Tilinghast, Erica. "[Stormwater Control Measure Discharge Standards to Improve Stream Geomorphic Stability](#)." North Carolina State University Libraries, 2011.

³⁸ Watershed Education for Communities and Officials, NC Cooperative Extension, North Carolina State University. "[Bolin Creek Watershed Situation Assessment](#)." February, 2012.

engage stakeholders in Bolin Creek restoration, and determine how stakeholders could participate in restoration efforts.

Carrboro also received two separate 319 grants in 2008 and 2009 to pursue restoration projects, culminating in these final reports:

- [Dry Gulch Final Report](#). This report summarizes the restoration of Dry Gulch stream in 2012 using natural stream channel design and construction methods.
- [McDougle Final Report](#) (2012). A 1,280-square foot bioretention area, an overflow device, and a cistern were installed at the McDougle Middle School in 2010 to illustrate stormwater runoff management practices. FOBC used this project as a hands-on educational project for the students.³⁹
- [Pacifica Final Report](#) (2012). This study measured pollutants in stormwater runoff in relation to residential development over a six-year period in the Piedmont region of North Carolina.

A few regional studies have also been conducted about the Jordan Lake watershed and the relationship between local pollutants and general water quality.

- [Jordan Lake One Water](#). This exciting initiative begun in 2017 involves hundreds of regional partners who have undertaken an holistic approach to planning water resources and wastewater management together.
- [The University of North Carolina Jordan Lake Study](#) (2019). The General Assembly commissioned UNC to provide actionable information for decision-makers for the most effective approaches to sustain nutrient management and water quality in Jordan Lake.

The Bolin Creek watershed is one of the most studied watersheds in the state. A complete list of those studies is found [here](#).

1.3.6 Community Benefits

Urban forests and greenspaces increase the qualitative value of living in nearby communities by making them more enjoyable and desirable places to live, work, and raise families. Greenspaces such as the Bolin Creek Natural Area assume even greater community value when they are located near our rapidly urbanizing towns, providing an accessible pocket of undeveloped natural land for urban dwellers to enjoy. Wooded trails

³⁹ A video about the McDougle rain garden project can be found [here](#).

like those in the Bolin Creek Natural Area support active lifestyles for community members, which in turn makes our community mentally and physically healthier. A 2016 study by the Nature Conservancy explains:

*One study found that residents living in areas with more green space were more than three times as likely to be physically active, and approximately 40% less likely to be overweight or obese, as those living in areas with low levels of green space.*⁴⁰

Along with the benefits to adult and elderly populations, access to undeveloped natural land is important for future generations. The preservation of natural areas provides educational and developmental opportunities for children.

*Growing evidence shows nearby nature provides tremendous benefits to children in cities, and is an essential element of child development... Nearby nature provides a variety of educational benefits, having positive effects on attentional capacity, impulse control, and overall cognitive development.*⁴¹

Conserving the Bolin Creek Natural Area is not only environmentally responsible; it brings proven benefits to our community members. Since the covid-19 pandemic, we have witnessed a renewed interest in discovering the natural world, as our forests, streams, and trails have proven physical and psychological benefits to the community. Access to the natural world ensures both healthier and happier citizens and an outdoor classroom for younger generations.

1.3.7 Community Involvement and Support

A Well-Loved Resource

The forested area within the Bolin Creek Natural Area is filled with recreational trails that allow opportunities for hiking, biking, running, bird watching, and various other activities. The trails in the forest serve as training grounds for Chapel Hill High School's cross country team as well as a communal meeting place for running and mountain biking groups, walking groups, and nature enthusiasts.

⁴⁰ House, E. et al., The Nature Conservancy, Washington State Chapter, 2016. "[Outside our Doors: the benefits of cities where people and nature thrive.](#)" 11.

⁴¹ The Nature Conservancy, Washington State Chapter, 2016. "[Outside our Doors.](#)" 14-15.

The recreational trails within the forest are heavily used, indicated by trail conditions and [Strava global heat maps](#), such as the one provided below in Figure D. The opportunities for outdoor recreation provides physical, psychological and healing benefits to our community. In 2020, perhaps due to the COVID-19 pandemic, we've seen higher than usual use of our natural areas.

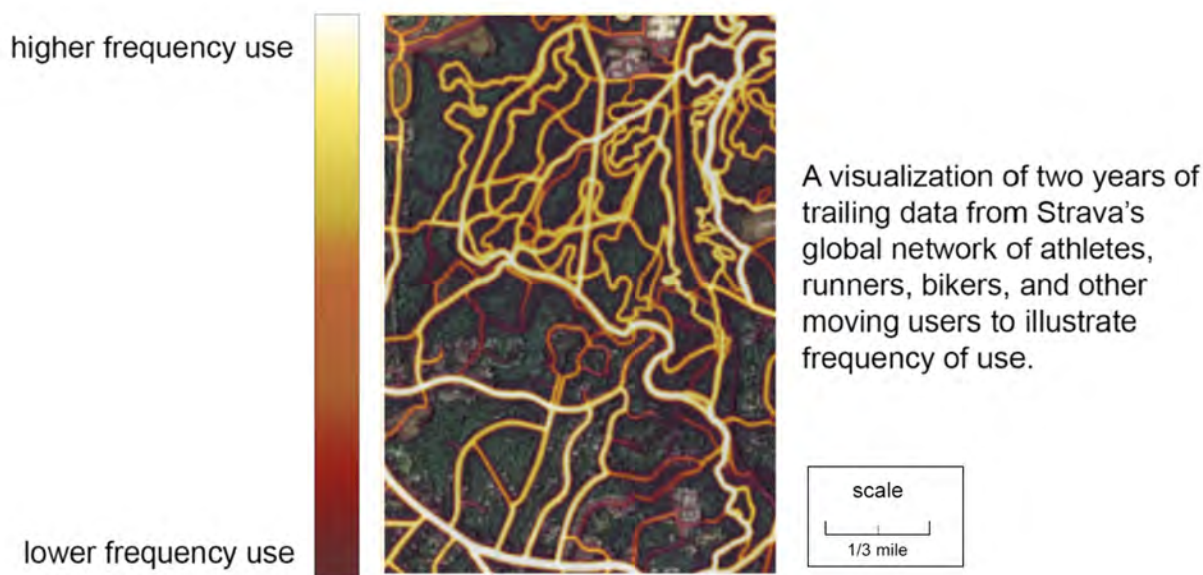


Figure F. Strava Global Heat Map: Bolin Creek Forest.

Demonstrable Support for Conservation

Beyond enjoying the many trails in the Bolin Creek Natural Area, local citizens continually demonstrate their commitment to the forest's conservation. [A FOBC petition](#) opposing the paving near the creek gathered nearly 1500 signatures. Carrboro and Chapel Hill residents have repeatedly voiced their support for the conservation of local forests in public meetings and petitions. Community members have been eager to attend training sessions about how to slow stormwater by building rain gardens and learning how to stabilize creek banks in sessions co-hosted by Friends of Bolin Creek with the NC State Extension Division. In recent years, public support for conservation played out during the 2018 tree harvest of the P.H. Craig property. In June 2018, several hundred community members gathered at Smith Middle School to hear conservation experts and local officials (including Mayor Pam Hemminger and Mayor Lydia Lavelle) respond to

P.H. Craig's announcement that he planned to harvest the timber on his property.⁴² Although Mr. Craig went through with the timber harvest, community members voiced their concerns so strongly that local leaders worked with conservation groups, such as the Triangle Land Conservancy, to find ways to conserve the future integrity of the forest.

Citizens have been quick to push for local government support for conservation in other ways, too. Public support was instrumental in Chapel Hill and [UNC's 2009 decision](#) to conserve hundreds of acres of forest by concentrating the planned new Carolina North campus development on the old airport runway, instead of expanding the new campus into the forest. In the same year, the Carrboro Town Council employed Greenways, Inc. to author a report with recommendations to start a system of greenways. The consultant's report, the [Bolin Creek Greenway Conceptual Plan](#), presented options for a number of possible greenways for the Bolin Creek Natural Area. Thanks in large part to public encouragement and a petition from 1400 citizens, the Carrboro Town Council decided not to approve the option to build a paved path along Bolin Creek in 2009, which would have bisected the forest and harmed water quality. However, the resolution left open the option to revisit the question.⁴³

Friends of Bolin Creek has played a vital role in engaging and educating citizens in Chapel Hill and Carrboro through advocacy and educational opportunities for residents to learn about how to protect the natural resources of the Bolin Creek Natural Area. Previous and on-going initiatives for families and children include home rain garden tutorials, wildflower walks, educational nature walks, and workshops to learn about stream restoration.⁴⁴

Charles Morris, a filmmaker and former Carrboro resident, released a documentary film in January 2017 about the controversy caused by the [Bolin Creek Greenway Conceptual Plan](#) to build a paved path along Bolin Creek. The forty-four minute film tracks the current and potential future impacts of paving this greenway, as well as documenting the overwhelming community support to preserve the forest's natural state.⁴⁵

All of the above examples demonstrate an overwhelming support for the conservation of the Bolin Creek Natural Area. Many community members enjoy the benefits of the forest

⁴² For more information, see the [FOBC coverage](#) on the 06/21/18 community meeting concerning the Craig tract.

⁴³ Resolution can be found [here](#). (Item D3 of Carrboro Board of Aldermen minutes from December 8, 2009.)

⁴⁴ For more information and examples of community outreach, visit <http://bolincreek.org/blog/education/> or see [Appendix II](#).

⁴⁵ The film, Bolin Creek Unpaved, is available at <https://bolincreekunpaved.com/>.

and trails. The recent timber harvest at the privately owned portion of the natural area served as a wake up call for community members who had assumed these woods would always be there for recreation and enjoyment. This incident also prompted cooperative action among community groups and local government leaders to find ways to protect this precious resource.



Aerial footage of Bolin Creek Natural Area from [Bolin Creek Unpaved](#).

Part II

Bolin Creek Natural Area Partners

The Bolin Creek Natural Area includes public and privately-owned properties. In order to develop restoration and conservation strategies for the Bolin Creek Natural Area, it is necessary to identify the current partners and landowners in the area. This section focuses on the current land use within the Bolin Creek Natural Area, and the ownership history of the largest properties, and relevant existing land management agreements. While we limit our discussion to the three largest properties owned by the Town of Carrboro, P.H. Craig and the University, there are several small tracts in the riparian portions of the Bolin Creek Natural Area owned by homeowner organizations who will want to participate in a collaborative Management Plan. Friends of Bolin Creek, as a 501(c)(3) non-profit organization, will play an advocacy role in this partnership.

Friends of Bolin Creek as a Partner

Since its inception in 2003, Friends of Bolin Creek has been a stakeholder in the future health of the Bolin Creek Natural Area. Although the organization does not own land in this watershed, its persistent advocacy for creek health and forest conservation spurred early North Carolina state studies of the area, which led to many Carrboro and Chapel Hill restoration projects funded by EPA and the state of North Carolina.⁴⁶ FOBC intends to continue to play an advocacy and facilitative role on behalf of the health of Bolin Creek by supporting and encouraging the Bolin Creek Natural Area land owners in their coordinated management and conservation efforts.

2.1 Natural and Jurisdictional Features

The individual parcels and natural features that make up the undeveloped portions of the Bolin Creek Natural Area are described below.

Total Land in the Bolin Creek Natural Area: 325 acres owned by the University of North Carolina, 27 acres in the Adams Preserve owned by Carrboro, and 77 acres in the privately owned P.H. Craig Property, with a total of 429 acres.⁴⁷

⁴⁶ A complete list of these studies can be found [here](#).

⁴⁷ The Craig property is in Carrboro's planning jurisdiction but not yet within the Town limits.

Bolin Creek: Bolin Creek, part of the Cape Fear River Basin, runs north-south through the study area. About 11 miles in length, Bolin Creek starts in rural Orange County off of Old Route 86 and flows southeast into Carrboro and Chapel Hill. In Chapel Hill, it joins Booker Creek east of South Estes Dr. to form Little Creek, which flows into Jordan Lake, a drinking water reservoir for Chatham County and parts of Durham, Orange, and Wake Counties. The section of the creek within the bounds of the Natural Area is about three miles long.

OWASA easement: A sewer corridor, about 30 ft. in width, runs parallel to Bolin Creek through all three properties. The utility corridor, maintained by OWASA, has numerous sewer access points throughout. A trail along the corridor connects with various other trails in Carolina North, the P.H. Craig property, and the Adams Preserve, as well as neighboring subdivisions. This stream-side trail is the most used trail within Bolin Creek Forest.

Orange County Joint Planning Land Use Plan: While this document was adopted over three decades ago, it has remained the basis for land use planning in Orange County and the cities of Chapel Hill and Carrboro. The passage of this plan in 1986 expanded Carrboro's jurisdictional boundaries into the Bolin Creek Natural Area and specified that Carrboro could expand urban services into the upper Bolin Creek watershed.⁴⁸ As a consequence, since 1986 Carrboro has slowly added many new neighborhoods: the Claremont, Lake Hogan Farms, and Ballentine developments have provided new homes for Carrboro residents, but not without causing added stressors to the health of Bolin Creek.

Norfolk Southern Railroad

A spur of the Norfolk Southern Railroad runs parallel to Seawell School Road and at one point comes within 60 feet of Bolin Creek on the P.H. Craig property. Further south it crosses Bolin Creek on a very high trestle above the Adams Preserve.

The only purpose of the rail line is to deliver coal to UNC's fluid bed boiler plant that heats UNC buildings. The 2019 Bike Plan Steering Committee and the consulting firm of Alta both suggested the Norfolk-Southern rail line could ultimately be converted to a trail when UNC ceases using coal in its power plant and the rail line is no longer needed.

⁴⁸ This action was taken to compensate Carrboro for downzoning around University Lake, at that time OWASA's only water supply reservoir.

2.2 Jurisdictional Boundaries

The three contiguous parcels of wooded land in our study are located in Orange County, North Carolina, to the west of Seawell School Road. This portion of the watershed falls under Carrboro planning jurisdiction, excluding a small portion of the P.H. Craig property in Chapel Hill's jurisdiction. A map of the forest can be found in [Figure A](#).

2.2.1 Adams Preserve

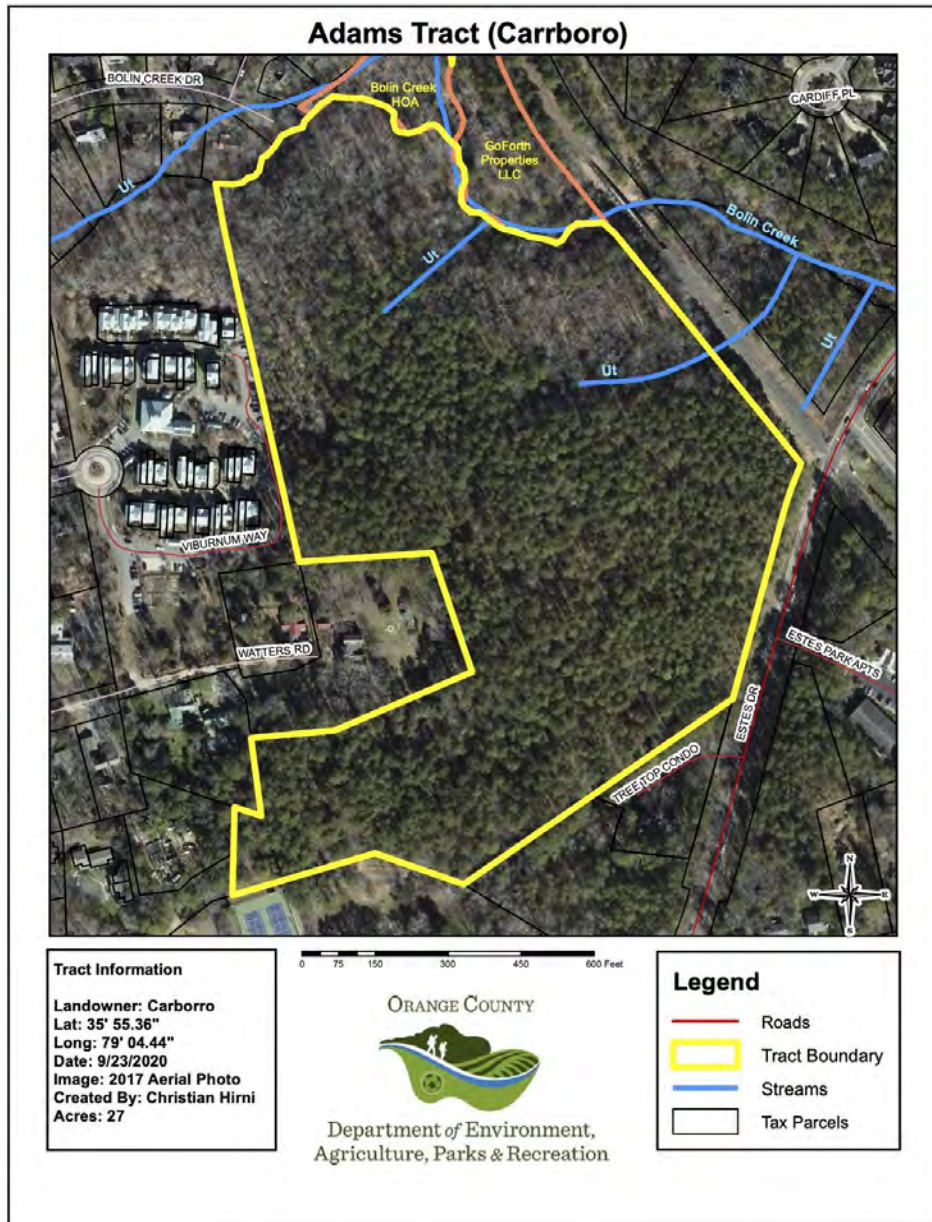


Figure G. Adams Tract, Courtesy of Orange County Land Legacy Program.

The Town of Carrboro owns and administers, along with Orange County, the 28-acre Adams Preserve, the southernmost parcel of the Bolin Creek Natural Area, extending as far south as Carrboro's Wilson Park. It is bordered by Wilson Park and Estes Drive Extension to the south; the Norfolk Southern rail line to the east; Pacifica, a residential neighborhood, to the west; and Bolin Creek to the north.

The property connects to the privately owned P.H. Craig Property via the OWASA easement that runs along Bolin Creek. The easement connecting the two properties is flanked by two small properties along Bolin Creek owned by adjacent residential neighborhoods: Ironwoods to the east and Bolin Forest to the west. Currently, the Adams Tract has an OWASA easement with a sewer line running through the land close to the creek.

Dry Gulch, a major tributary of Bolin Creek, runs along the northern edge of the property from Pacifica and the Bolin Forest neighborhood into Bolin Creek. Wilson Park, a recreational area owned by the Town of Carrboro located off North Greensboro Street at the southern end of the tract, provides an excellent access point to the interconnected trails of the Bolin Creek Natural Area.

The current trail system extends from Wilson Park in the south, northward to join the OWASA easement and Bolin Creek on the northern edge of the property. [The Adams Preserve](#) offers a web of natural surface trails that can be entered from the north side of Wilson Park. Three different trails lead to a main trail that runs along the west side of Bolin Creek. Carrboro built a paved bike path connecting Estes Drive with the Adams Preserve and Wilson Park in order to make a safe connection for cyclists. A wide variety of native trees are [labeled](#) along the trail.

2.2.2 P.H. Craig Property

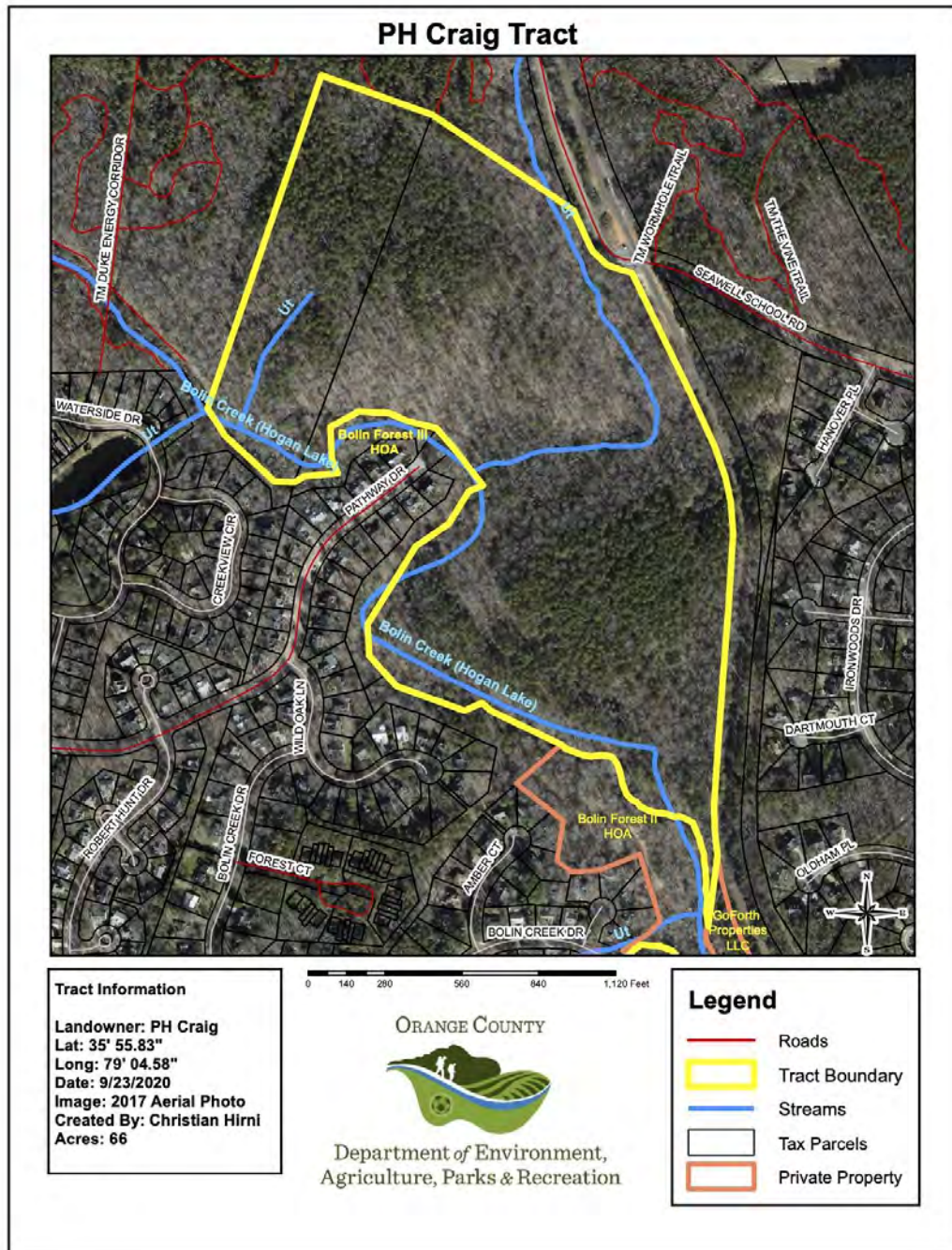


Figure H. P.H. Craig Property.

The Craig Property lies northwest of the Adams Tract and southeast of Carolina North Forest, connecting two parts of Bolin Creek Forest that are already largely conserved. The Craig Tract neighbors three residential neighborhoods: Ironwoods (Chapel Hill) in

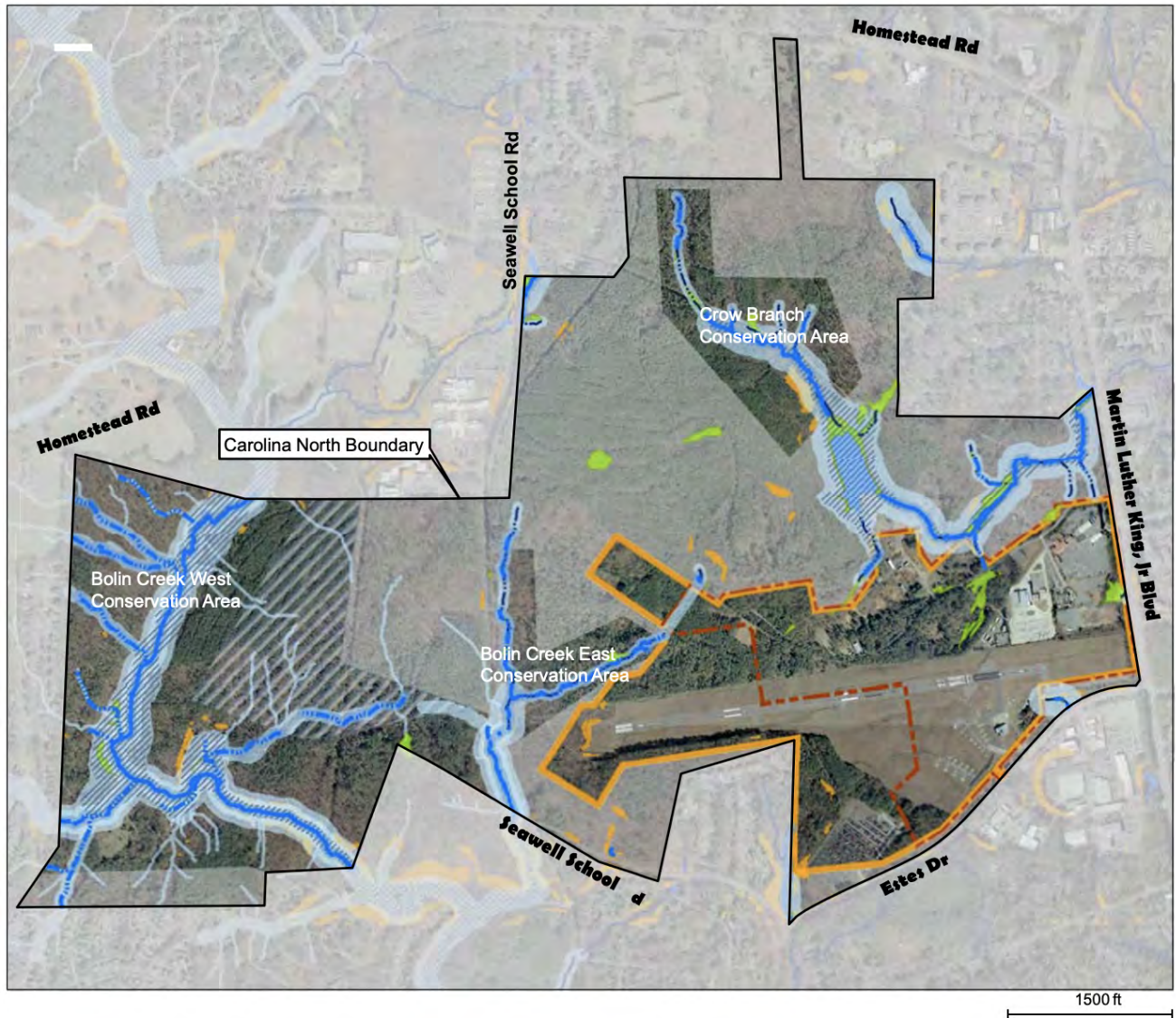
the south and Bolin Forest and Spring Valley (in Carrboro) in the west. Bolin Creek runs along the western edge of the Craig property. The Norfolk Southern rail line runs through the eastern side of the Craig Tract. This rail line is the boundary between Carrboro and Chapel Hill.

Two significant tributaries of Bolin Creek transverse the property: Craig's Branch, named for the landowner, and an unnamed tributary further south. There are approximately eleven other streams on the property: one perennial, one intermittent, and nine ephemeral, according to [Chapel Hill GIS Interactive Maps](#). The 2011 [Carolina North Proposed Conservation Area Description](#) records a wetland within the property, on the border with Carolina North.⁴⁹ Other wetlands may exist on the property, but inconsistent surveying of this area has yielded incomplete data.

Similar to the other properties, the P.H. Craig Tract is home to a series of trails that connect to the forest-wide trail network found on adjacent parcels. The informal single-track trails (trails sufficiently wide for one person or one bicycle) on the property were likely developed gradually from foot traffic, as the forest here is well-loved. While trails on this property are less trafficked than those on the Carolina North property, a [Strava map](#) reveals the intense recreational use these trails do receive.

⁴⁹ Biohabitats, Inc. "Carolina North Proposed Conservation Area Description"

2.2.3 Carolina North Forest



[Figure 1](#). UNC-Owned Forest. Bolin Creek Conservation Area pictured on the left branch of land, a portion of the Bolin Creek Natural Area. Horace Williams airfield outlined in orange.

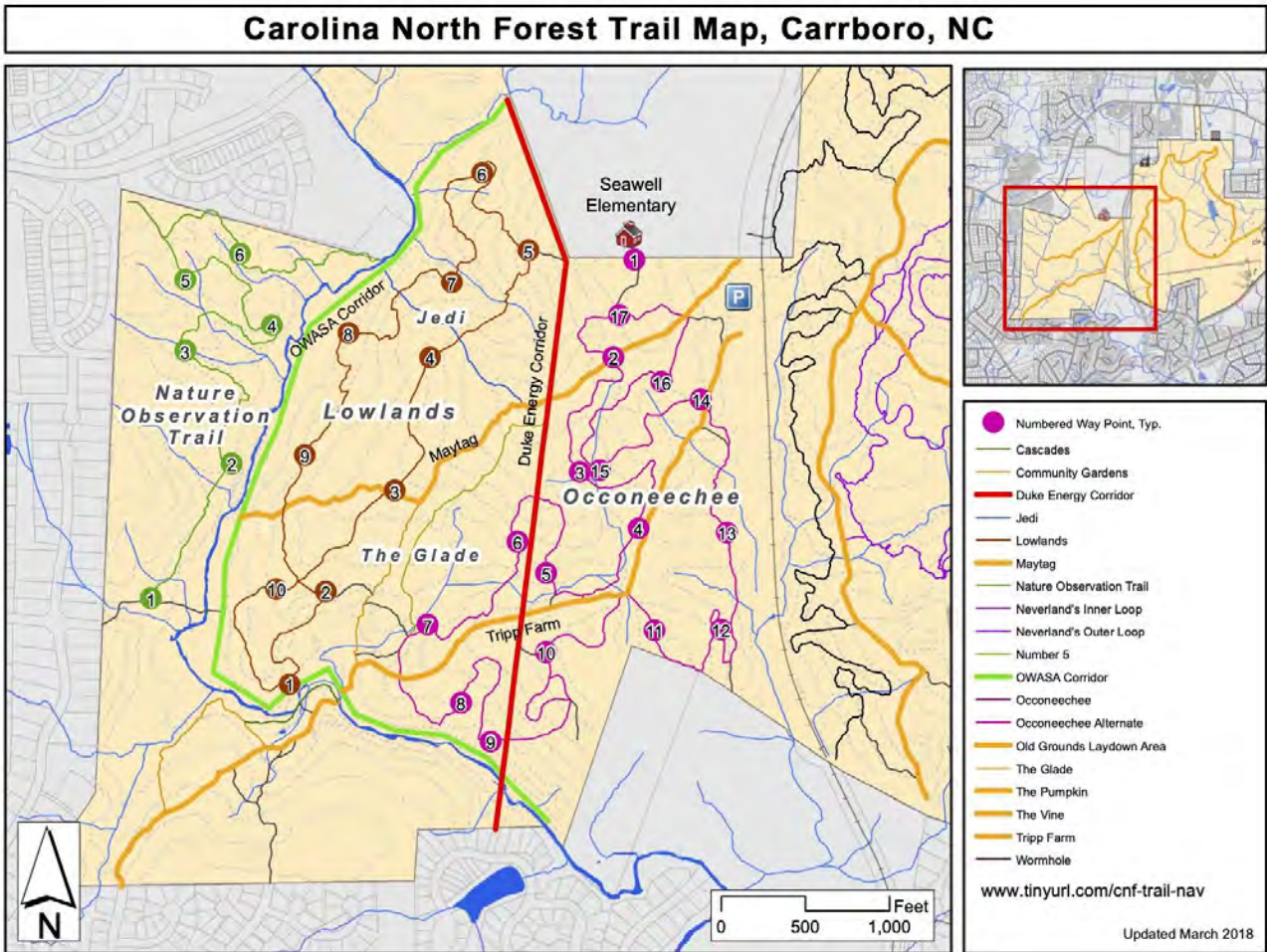


Figure J. Zoomed-in image of [UNC-Owned Forest](#) West of Seawell School Road.

A 325-acre section of the Carolina North Forest, west of Seawell School Road and north of the Craig Tract, makes up the largest forested tract in the Bolin Creek Natural Area. It is part of the 1000 acre tract that Horace Williams gave to UNC. This document will refer only to the western segment of Carolina Forest immediately surrounding Bolin Creek. UNC refers to this area as Carolina North-west (CN-west) and FOBC refers to it as a portion of the Bolin Creek Natural Area. Residential developments and three separate Chapel Hill - Carrboro public schools surround the property to the north and west. Two utility corridors run through the property: the OWASA utility easement and a Duke Energy easement that runs north-south through the middle of the property. In addition, there is a gravel service road that runs east-west.

Bolin Creek flows through the western side of the property, with extensive riparian forest on either side of the creek. Many tributaries to Bolin Creek are located on this property:

approximately eight intermittent, ten ephemeral, and two perennial streams, including Hogan's Creek, a major tributary of Bolin Creek. Carolina North also contains three small palustrine, (non-tidal) forested wetlands, plus one that borders the Craig tract.⁵⁰

Numerous single-track, multi-use, and several informal trails run through the property.⁵¹ All the trails receive moderate to heavy use from bikers, runners, and walkers. [More trail maps](#) for this property can be obtained via UNC Facilities Services. The most prominent trails include the OWASA easement along the creek and the Duke Energy Power easement (50 ft. wide). These trails run north-south through the western side of Carolina North Forest.

2.3 Past and Present Land Management

This section summarizes current and past ownership of the three major land segments included in the Bolin Creek Natural Area and gives more information on their current management.

2.3.1 Adams Preserve

This 30-acre parcel of land, formerly used for pasture and farmland, including an old homestead, was acquired by UNC Botany Professor J. Edison Adams in 1950.⁵² The homestead is now privately owned, while the remaining 28 acres were purchased by the Town of Carrboro and the Orange County Lands Legacy Program in 2004 with funds from the Clean Water Management Trust Fund.⁵³

By the terms of the purchase agreement, Carrboro Public Works developed a maintenance plan for the property, and is required to coordinate management with the Orange County Lands Legacy Program. Also, under the terms of the Clean Water Trust Fund, that partially funded the purchase, bicycling is not permitted in the riparian areas, although bikers have used the area in the past. FOBC wants to work with the Town of Carrboro to develop appropriate signage to meet the restrictions of the Clean Water Management Trust Fund.

⁵⁰ Biohabitats Inc. for University of North Carolina at Chapel Hill Facilities Planning Department, "[Carolina North Proposed Conservation Area Descriptions](#)", 2011.

⁵¹ Informal trails are unpaved, natural surface paths suitable for hiking, walking, and single-track bicycle use.

⁵² Professor Adams acquired the homestead known as the Weaver House and worked to restore it. After Edison Adams' son, John, inherited the property, it was divided into a 28-acre and a two-acre parcel with the homestead in 2004.

⁵³ For a more extensive history of this property and the other sections of Bolin Forest, visit <http://bolincreek.org/blog/education/history/>.

The [Town of Carrboro Three-Year Management Plan](#) for the Adams Preserve was approved by the Carrboro Board of Alderman in June 2006.

2.3.2 P.H. Craig Property

The privately owned 77-acre Craig Tract is central to the goal of preserving a large contiguous forest bordering Bolin Creek. This parcel, north-east of the Adams Tract, has been owned by P.H. Craig since 1965.

Over the years of his ownership, Mr. Craig has not prevented hikers or birders from walking the many trails on this 77-acre tract and enjoying its natural beauty. In portions of Bolin Creek Forest, mountain biking has become increasingly popular and has resulted in some trail damage. During the early 2000's, the land became a popular place for erecting jumps for off road bicyclists. Friends of Bolin Creek worked with P.H. Craig to coordinate with volunteers and dismantle the jumps, while encouraging the sport in other places where it would cause less disruption. In 2020, Triangle Land Conservancy's acquisition of a nearby park, known as [Brumley Forest](#), provides extensive mountain biking opportunities.

At various times over the last 20 years, Mr. Craig has signaled a willingness to sell his land for the purpose of conserving this property for public ownership. In 2015, Mr Craig received the Long Leaf Pine award from the Governor as recognition for preserving his property for nearly 50 years. Shortly thereafter, he declined a third offer from Friends of Bolin Creek and other conservation organizations to consider a permanent conservation agreement.

P.H. Craig registered his property as a tree farm in 1991. An Orange County forester with the NC Division of Forest Resources has prepared several management plans for him. Here is a timeline of land management on this tract.

1965	Craig buys land along Bolin Creek and an old homesite with a partner.
1977	Land was transferred from his partner to Mr. Craig in November 1977. ⁵⁴
1991	Both parcels are approved for forestry present-use valuation for the 1991 tax year.
2003	Initial Forest Management Plan submitted to Orange County Tax Office.
2015	Craig honored with Order of the Long Leaf Pine Award for conservation efforts.
Dec. 2017	NC Forest Service Sends New Forest Management Plan to P.H. Craig.
May 2018	Carrboro Town Manager Dave Andrews and Planning Director Trish McGuire meet with PH and his associates to discuss his plans for timber harvesting.
June 2018	Towns of Chapel Hill and Carrboro respectively receive and approve a request for a timber harvesting permit on P.H. Craig's property in each town. About 35 acres in the Carrboro jurisdiction were timbered. Four acres of the 77-acre property are in Chapel Hill.

2.3.3 Carolina North Forest

[Horace Williams](#) donated the whole of the UNC property in the Bolin Creek Natural Area, in addition to another 675 acres east of Seawell School Road.⁵⁵ UNC has been and continues to be a collaborative and environmentally-conscious owner of this tract of

⁵⁴ PIN 9779634975, per Deed Book 282 page 635, for \$20,000.

⁵⁵ Horace Williams, a former UNC student, joined the UNC faculty in the late 1880s. After studying at Harvard and in Germany, he bought the property, then farmland, around 1905. When he died in 1940, he gifted nearly 1000 acres of this land outside of town to the University of North Carolina in trust, the income to be used for fellowships in philosophy. He died at age eighty-two and was buried in the Old Chapel Hill Cemetery. Before UNC signed off on the Carolina North Agreement, University of North Carolina settled the terms of his will with the Department of Philosophy.

forested land. UNC put forward this stewardship goal in their 2015 [Carolina North Land Stewardship Policy](#):

The University is committed to responsibly stewarding the open spaces and natural areas within the Conservation Areas and Limited Development Areas (subject to the 100 year and 50 year periods) of the CN property. The University will protect and preserve the physical and biological integrity of the environment, maximize ecosystem services inherent in those areas, and provide opportunities for education, research, and recreation.⁵⁶

One of the major achievements of the Town-Gown negotiations leading up to the signing of the Carolina North Development Agreement was the agreement to cluster the new planned UNC innovations campus on the old airport strip, rather than expand its future development into the 1,000 acres of Bolin Creek Forest owned by the University of North Carolina. Top concerns of the Town of Chapel Hill leadership were environmental damage and traffic impacts. These agreements, memorialized in the Carolina North Development Agreement, laid the groundwork for conservation of the forest.

As former Chapel Hill Mayor Kevin Foy said, “The Carolina North plan incorporated protection for land around Bolin Creek because both the town and the university recognized the importance of land conservation to the integrity of the forest.” Unfortunately, UNC has been unable to implement the plan for the new campus due to lack of state funding.

Following the Carolina North Agreement, a specific nature trail was designated for walkers and birders, and closed for more active recreation. Its prescribed use has been allowed to lapse over the last few years. As a consequence, the Long Horned Owl no longer nests near there because runners and bicyclists are now permitted to frequent the trail.

The UNC Carolina North Forest is managed and operated under the supervision of the UNC-CH Grounds Director. A forest manager oversees the entire 1000-acre UNC tract. Because of the sizable acreage and largely undisturbed forest, including the 325 acres west of Seawell School Road, wildlife abounds in this amazing landscape.

The UNC Forest Manager maintains an [active trail management plan](#). The primary goal of this trail management effort is to “facilitate the recreational and leisure experience by

⁵⁶ The University of North Carolina at Chapel Hill and Biohabitats Inc, Feb 2015. [Carolina North Land Stewardship Policy](#), 7.

maintaining and enhancing the existing trails within the Carolina North Forest. By employing sustainable planning and practices to preserve and rehabilitate the trail network, trail resources will continue to be available for current and future users.” UNC says its trail maintenance practices protect the environment, do not contribute to the degradation of natural systems, meet users’ needs, and require minimal long-term maintenance.⁵⁷ Communications occur between the Carolina North Forest Managers and forest users on a daily basis, in person and through posted signs and information kiosks. UNC erected a wooden bridge over Bolin Creek around 2009, connecting the trail networks on both sides of Bolin Creek.

2.4 Conservation Status

2.4.1 Adams Preserve

The Adams Preserve was purchased in 2004 with the help of North Carolina’s Clean Water Management Trust Fund and the Orange County Land Legacy Program. The land’s status as a Conservation Easement excludes activities such as development and logging and requires environmental and sustainability practices to be regulated by Orange County. The town of Carrboro created an official three-year Management Plan in 2006 calling for restoration of the Bolin Creek easement and improvement of the existing trail system.⁵⁸

Although the 2006 Management Plan suggested future projects, there have been no updates, and the plan could use one. Formerly suggested projects in the Plan include the construction of a bridge over Bolin Creek, a FEMA Floodplain modification study, the removal of invasive species, and various other small-scale actions, like the installation of park benches, interpretation signs, and additional small trails.

Friends of Bolin Creek is interested in helping to address several trail maintenance needs identified by the Town of Carrboro Public Works and the Orange County representative in the Lands Legacy Program. On a recent site visit to the Adams Preserve, representatives from Carrboro and Orange County checked out the condition of the trails and agreed to creating two new trail alignments that would cause less erosion. FOBC will coordinate with the Lands Legacy Program and Carrboro Public Works to convert two trails running up and down the hillside to create small sections of trails that run across the hillside with switchbacks. Both tasks could be easily performed

⁵⁷ From University of North Carolina, “[Trail Management](#).”

⁵⁸ Town of Carrboro, “[Adams Tract -- 3 Year Management Plan](#),” June 2006.

by volunteers with supervision from Carrboro Public Works and the Lands Legacy Program.

2.4.2 P.H. Craig Property

A privately owned section of Bolin Creek Forest, the P.H. Craig property's registration as a tree farm did not disrupt the balanced ecosystem of the contiguous forest of the Bolin Creek Natural Area until the owner decided to timber it.⁵⁹ Even though the tract was not cleared until recently, the property has been registered as a tree farm since 1991.⁶⁰

As far back as 2004, FOBC began an initiative to purchase and conserve the P.H. Craig property in order to create one contiguous natural area. Past accomplishments bode well for a future vision of public ownership for the Bolin Creek Natural Areas. The acquisition of the Adams Preserve and the conservation of key parts of UNC's Carolina Forest provide the impetus to bring all of this portion of Bolin Creek Forest into the 425-acre forested public domain.

In August 2017, a North Carolina Orange County Forester provided a new harvest plan for Craig's property. The plan recommended clear-cutting pine-dominated hardwood stands on the property over a three-year period and replanting with a monoculture stand of loblolly pines for future timber production.⁶¹ Timber cutting began in October 2018 and ended in December 2018.

The timber harvesting on the P.H. Craig tract ignited community action.⁶² When the plan was announced in 2018, several hundred people met with conservation experts and the Mayors of Chapel Hill and Carrboro to discuss the harvest plan. The Carrboro Town Council responded to the Mayors' leadership and embraced an effort to stop the tree harvest and conserve the land in 2019.

⁵⁹ The first of these timber plans was prepared by the Forest Service in August 1990; subsequent plans were prepared in December 2003 and in June 2009. Aerial imaging from 1988 indicates that a section of the Craig tract was historically a cultivated pine plantation. However, recent decades have seen the land return to a mature mixed hardwood/pine forest. This tract remained minimally disturbed until October 2018. Before then, there had been no tree removal or major disturbances on the property during his ownership, except within the OWASA easement.

⁶⁰ Rules under the Department of Agriculture promote tree farming, and the registration allows the owner to pay very low taxes in exchange for following a state approved management plan.

⁶¹ North Carolina Department of Agriculture and Consumer Services, [P.H. Craig Property Harvest Plan](#), December 2017.

⁶² Up to that time, many community members who regularly hiked the trails were surprised to discover that this land was privately owned and registered as a tree farm.

Despite this leadership and strong public support for conserving this beautiful forest, Craig has refused multiple offers to purchase the property. Carrboro's offer demonstrates the weight of public interest in forest conservation and the important role this forest has played in our community for decades. Even now, despite the tree clearing, the Town of Carrboro and its Mayor have maintained an interest in acquiring the privately held land. This experience has built a base of community support for conservation.⁶³

Carrboro Mayor Lydia Lavelle worked to negotiate a different outcome for the property and stated,

"Once we heard of Mr. Craig's plans, our Town Council asked that I meet with him to find a resolution that did not include logging this property. I worked toward this end diligently over the past several months, but ultimately he decided to exercise his right to log on his property. I know the members of the Town Council are all disappointed with this outcome."

Mayor Hemminger of Chapel Hill said,

"We are all saddened at this outcome for this beautiful tract of woods near Bolin Creek. We value our trees and all that comes with protecting our canopy, our wildlife, our clean air, our water quality or just being in the woods. As our community continues to grow, it is even more important to protect our green environment for our own healthy future. Thank you for all you and the Friends of Bolin Creek have done to keep us all aware of how important our forests are to our own health and sense of community."

2.4.3 Carolina North Forest

Prior to the 1980s, sections of what the University now designates as Carolina North were cleared for logging and agricultural use. Since 1980, tree removal has been limited to trail development and maintenance. In the early 2000s, UNC's interest grew in preparing a long term development and conservation plan for this land. In 2007, UNC's [Ecological Assessment Report: Carolina North](#) identified areas of high quality and ecological significance for permanent preservation. The Council of State of North Carolina approved maintaining these areas in a permanent conservation easement monitored by the Triangle Land Conservancy. Given the location of these designated

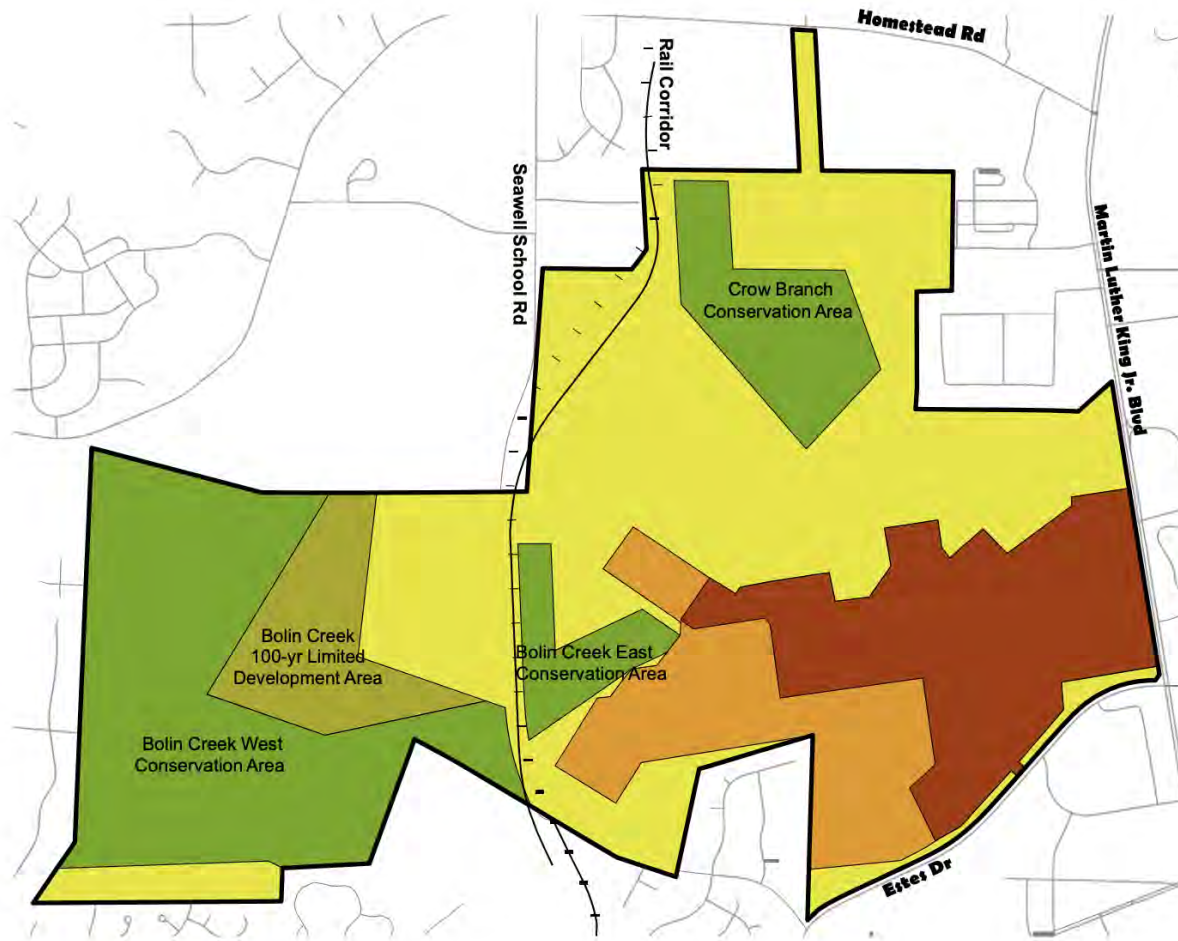
⁶³ If the land were to be acquired by a conservation trust, it could be converted to a North Carolina Piedmont Prairie or grassland. These ecosystems were common in the area prior to the arrival of Europeans and sequestered large amounts of carbon belowground, despite not being forested. It is worth noting this area can benefit the environment either as a forest or a prairie, as long as it remains undeveloped.

conservation areas, along with state and local rules protecting waterways, most of the 325 acres owned by UNC west of Seawell School Road will not be developed for the foreseeable future. Chapel Hill and UNC incorporated these conservation easements into the [Carolina North Development Agreement](#), signed by Chapel Hill and UNC in 2009, applying to approximately 183 acres of Carolina North. The agreement requires that the land “retains the applicable land and water areas predominantly in their natural, scenic or open condition,” and limits the uses of the conservation areas to recreation, trail maintenance, education, and research. This protected portion of the forest is located on the property’s west side, including the riparian corridor along the creek and the southern edge of the property extending to the railroad tracks. A proposal to slightly alter boundaries of these zones was approved by the parties to the agreement in 2012.⁶⁴

As stated previously, the [Carolina North Land Stewardship Policy](#) outlines the intended use and various conservation classifications of this large tract of land. The University’s stated stewardship vision is to “protect and preserve the physical and biological integrity of the environment, maximize ecosystem services inherent in those areas, and provide opportunities for education, research, and recreation.”⁶⁵ The figure below outlines the three categories of conservation (development areas, limited development areas, and conservation areas). The development areas, shown here in red, are located atop the historical footprint of the Horace Williams airport.

⁶⁴ University of North Carolina at Chapel Hill Facilities Planning Department, “[Carolina North Development Agreement Annual Report 2012-2013](#).”

⁶⁵ [Carolina North Land Stewardship Policy](#), 7.



Type of Area	Description	Area (ac)
	Carolina North Property	947
	Development Area (20-year)	Approved for development by DA 133
	Development Area (50-year)	Currently a Limited Development Area; Planned for development between 2029-2059 95 (95+133 = 228)
	Limited Development Area (50-year)	No development before 2059 per DA 408
	Limited Development Area (100-year)	No development before 2109 per DA 53
	Conservation Areas	Perpetual restrictive covenants apply 258

Figure K. Carolina North Area Types Specified in Development Agreement, from [Land Stewardship Policy](#), 26.

Limited Development or 100-year Limited Development classifications prohibit development that “involves the construction or use of a building” prior to the years 2059 and 2109, respectively. However, the development agreement still allows for the

construction of roads, utility lines, greenways, and various other non-building construction projects within the limited development areas. UNC will continue to play a leadership role in providing an environmentally conscious approach to the ecological health of the stream and forest.

Part III Threats to Bolin Creek

This section examines various natural and manmade stressors on Bolin Creek and analyzes their current and potential future impacts on the Bolin Creek Natural Area.

The [2018 NC DWQ 303\(d\) list](#) identified a lower stretch of Bolin Creek as impaired, an area that has been impaired since 2006. The impaired segment of the creek extends downstream from Pathway Drive, a street within the Bolin Forest Neighborhood (adjacent to the P.H. Craig property) to the confluence with Little Creek.

3.1 Urban Development

Bolin Creek and Bolin Forest's location amidst an urban landscape has resulted in stressors on the natural areas of the watershed. Stormwater run-off from rooftops, streets, fertilized lawn and gardens, and sediment from land disturbance contribute to this impairment. Today, residential neighborhoods make up the majority of the developed area surrounding the upper watershed of Bolin Creek.⁶⁶ Many of these neighborhoods were built closer to the creek than would be required by current stormwater rules.

The headwaters of Bolin Creek are located in the Orange County rural buffer on the historic Earnhardt Farm, where rural density protects water quality. More stressors have resulted from Carrboro building out its transition zone area with the Hogan Farms and Claremont developments. Not surprisingly, the most polluted and at-risk segments of Bolin Creek have been those in closest proximity to these more urbanized areas. This "pattern of degradation ... indicates that urbanization is the biggest overall threat to watershed functions."⁶⁷ A great deal of the land zoned for urban development is already built out, but Chapel Hill and Carrboro planners and elected officials will need to proceed carefully to ensure that development of the last remaining tracts does not deposit additional sediment and pollutants into Bolin Creek or its tributaries.

⁶⁶ "Landscape manipulations by humans have had a tremendous impact on the natural communities of this area. The cutting of much of the eastern deciduous forest and draining of wetlands removed an unknown number of plant species from local areas... The Carolina parakeet, passenger pigeon, and ivory-billed woodpecker are now extinct... Extirpation, or local extinction, of large carnivores removed the gray wolf, mountain lion, and black bear from this area. Larger game species such as the woodland bison and elk are no longer found here, though white-tailed deer, wild turkey and beaver, once extirpated, have now been re-introduced." *2004 NHP survey*, 20.

⁶⁷ Tetra Tech, Inc. and Soil & Environmental Consultants, Inc., "[Morgan-Little Creek LWP Targeting of Management Report](#)." North Carolina Ecosystem Enhancement Program, September 2004. 1,4.

3.1.1 Impervious Surface Cover

One major reason that urbanization threatens watershed functions is that urban development brings an increase in impervious surface cover. Impervious surfaces -- such as paved roads, roofs, and compacted soils -- are incapable of water absorption, instead directing runoff to stormwater drains.⁶⁸ Stormwater runoff from these impervious urban areas increases the magnitude of peak water flows after rains, causing erosion, sedimentation, and physical degradation of the stream channel and its habitats.⁶⁹

Greater impervious surface coverage in a stream ecosystem means greater detriment to water quality. A 2012 analysis of the entire Bolin Creek watershed found impervious surfaces covered about 16 percent of the watershed area.⁷⁰ This percentage has only increased since 2012 as numerous new subdivisions have been built in the northern part of the Bolin Creek watershed, covering millions of square feet in impervious surfaces.⁷¹ Within the Bolin Creek Natural Area portion of the watershed, deteriorating stream health is directly proportional to the increase in impervious surface coverage around and upstream of this segment of the creek.⁷²

The rapid increase of impervious surfaces and the subsequent increase in peak stormwater volume has changed not only the shape and flow of Bolin Creek, but also the aquatic biological communities it supports. The 2003 Little Creek Watershed Assessment Report additionally emphasized that higher flow rates and scouring flushes away organic material and contributes to stream bank erosion.⁷³

3.1.2 Stormwater

The term stormwater refers to the higher flows from impervious and other surfaces into streams. If stormwater is not properly managed, the resulting high flows can damage our water quality, creek beds, and the ecological health of adjacent riparian land, as is the case with the threatened health of Bolin Creek.

⁶⁸ "Effects associated with increased impervious area include: increased stream temperature; increased stormwater volume and flooding; declines in infiltration and [stream] baseflow; increased bank erosion and habitat degradation; and increased pollutant loading." [Little Creek Watershed Assessment Report](#), 14.

⁶⁹ Hession, W. C., et al. "[Ecological benefits of riparian reforestation in urban watersheds: study design and preliminary results.](#)" *Environmental Monitoring and Assessment* 63.1 (2000): 211-222.

⁷⁰ Chapel Hill and Carrboro, N.C. "[Bolin Creek Watershed Restoration Plan.](#)" 2012.

⁷¹ Orange County North Carolina [GIS Data](#) site.

⁷² The 2004 [Morgan Creek LWP Targeting Management Report](#) found that the Bolin Creek Natural Area had an elevated risk of soil and stream bank erosion with increased development.

⁷³ North Carolina Department of Environment and Natural Resources Division of Water Quality Planning Branch, "[Assessment Report: Biological Impairment in the Little Creek Watershed.](#)" June 2003.

Flowing across urban impervious surfaces, stormwater collects pollutants such as fertilizers, pet waste, motor vehicle waste, litter, and sediment from the landscape. This pollution can be directly channeled into Bolin Creek and its tributaries by stormwater sewers and outfalls, although in the case of the older Bolin Creek Forest neighborhoods without storm sewers, water flows off these surfaces in sheets and enters Bolin Creek and its tributaries at many different points. Pollutants degrade water quality, as measured in benthic monitoring, where the number and variety of benthic macroinvertebrate communities are evaluated.⁷⁴ Benthic monitoring of Bolin Creek and other local streams used to be routinely conducted at a state level, until funding cuts in the 2000s. Since then, this monitoring has been conducted at a local level by professional benthic biologists following the state's same rigorous procedures.

Additionally, the excess of nutrients in the stormwater causes eutrophication, or an overproduction of algae. According to a 2018 study, "Jordan Lake has been consistently rated as eutrophic or hyper-eutrophic, and nutrient input from urban (26%) and agricultural (16%) land uses upstream serves as important stimulant for phytoplankton (microscopic algae) growth."⁷⁵ This is particularly true of the north-west quadrant, where urban run-off and discharges from OWASA and Durham's wastewater plants enter the lake.

Poor stormwater management is a threat to biodiversity in the entire interconnected and interdependent terrestrial-aquatic Bolin Creek ecosystem. Continued urban development in Carrboro and Chapel Hill has caused major stream impairment from pre- and post-construction runoff, polluted stormwater runoff, increased stream temperatures, and degraded wildlife habitats.⁷⁶ Multiple studies and records by local citizens have documented the changing health of Bolin Creek over time. The impairment of water quality in Bolin Creek and its aquatic life has a large-scale impact on the health and natural sustainability of the forest ecosystem and the larger geographic area, as well as

⁷⁴ NC Department of Environment & Natural Resources Division of Water Quality Planning Section, "[Cape Fear River Basinwide Water Quality Plan](#)," October 2005.

⁷⁵ Wiltsie, Daniel et al. "[Algal Blooms and Cyanotoxins in Jordan Lake, North Carolina](#)," *Toxins* vol. 10, 2 92. 24 Feb. 2018.

⁷⁶ [Morgan Creek LWP Targeting of Management Report](#), 3-1.

There are many known methods to manage and curb stormwater runoff and pollution (permeable paving, rain gardens, and green roofs for example), but there is often insufficient landowner interest and available resources to enact these projects.

a negative economic impact on the communities that must treat the resulting polluted drinking water.⁷⁷

Moreover, stormwater can be a threat when public sewers are not properly sized to needed capacity. In sudden rainstorms, neighbors report that sewer overflows are not uncommon in Bolin Creek Forest, when sewage flow rates exceed the capacity of the sewer pipe along the easement. When Claremont and neighborhoods north of Bolin Creek Forest were built out, larger sewer mains were installed to take into account expected future development. However, the larger sewer main is presently connected to the smaller capacity sewer located in Bolin Creek Forest installed in the 1980s. According to OWASA's capital improvement plan, the utility will begin correcting this situation in 2024.

3.1.3 Stormwater Management Changes and Construction Practices

In the 1980s and 1990s, many new neighborhoods -- for example, the Bolin Forest neighborhood -- were built closer to Bolin Creek than would be permitted today in 2020. Since that time, both Carrboro and Chapel Hill have instituted ordinances that require protection of riparian buffers and help control the volume of stormwater run-off. The NC General Assembly instituted new water quality rules in the 1990's for all North Carolina cities and towns. All these changes helped to mitigate pollution from the runoff from rooftops, streets, lawns, and construction activities.

But these policies have not stopped all the polluting effects of urban development that have increased impervious surfaces upstream of the Bolin Creek Natural Area. Climate change is causing more frequent and severe storm events that may require ordinances to be updated. In addition, rules governing construction practices are not as demanding as those for completed projects causing the number one pollutant - sediment - to enter Bolin Creek after storm events. Adding to these challenges, the Orange County Erosion Control Division bears the enforcement responsibility for overseeing stormwater management during the construction phase of projects in Orange County, except for state owned property where projects are monitored by an inadequately funded state staff. Inadequate funding for inspectors at the town, county and state levels is a significant detriment to stormwater management.

⁷⁷ The impairment of water quality entering Jordan Lake makes finished water more expensive to treat. Pollution prevention reduces utility costs bringing an economic benefit as well as a healthier ecosystem to our urban streams..

Chapel Hill adopted a Resource Conservation District (RCD) overlay zone in 1985 for the purpose of protecting water quality and stream habitat.⁷⁸ However, many exceptions to this zoning policy have been granted over the years, blunting its effectiveness. Chapel Hill is now looking at improving its stormwater review process.

Despite reasonably good pre- and post-construction ordinances in Carrboro and Chapel Hill, occasional incidents cause pollution in Bolin Creek. The Chapel Hill High School renovation, for example, caused significant structural damage to Jolly Branch, a small tributary of Bolin Creek. The main entrance to the school now crosses Jolly Branch with a major driveway entrance, requiring the removal of trees and a reconfiguration of creek banks. Temporary sediment ponds and silt fencing were installed, but did not prevent sediment from Jolly Branch flowing into the main branch of Bolin Creek.

Strengthened ordinances have slowed water quality deterioration in Bolin Creek and its tributaries, However the continuing impacts of urbanization and climate change conditions call for vigilance and more action.

Chapel Hill and Carrboro Form Stormwater Utilities

In 2001, the Chapel Hill Town Council approved forming a stormwater utility supported by a special stormwater tax that accompanies the local property tax bill. This tax billing began in 2004. The Town Stormwater staff has grown to seven staff members. The tax money collected is put into an enterprise fund that enables the Town to hire staff and experts to take preventative measures, address day-to-day stormwater problems, gather data from sub-watershed studies to ascertain the effectiveness of stormwater facilities, and plan for future needs. However, identified needs for stormwater management improvement projects have far exceeded available town resources. The Town of Carrboro followed suit in 2018, forming a stormwater utility of its own.⁷⁹

3.1.4 Pollution Sources

Pollution sources can be diffuse, coming from multiple locations as in the case of stormwater runoff, which travels along many streets, roofs, sidewalks, and parking lots before entering the creek. In other cases, pollution comes from a single identifiable

⁷⁸ Significant improvements to the RCD Ordinance were made in 2003, including the expansion of buffer widths required for new development, but exemptions for existing development remain.

⁷⁹ Read more about the Town of Carrboro stormwater utility on the "[Stormwater](#)" page of the Carrboro town website.

source like a stormwater outflow or an underground storage tank. Cities need resources and staff who are able to manage both types of pollution sources in order to effectively protect water quality and stream health. In one instance, an abandoned fuel storage tank leaked into Bolin Creek during a storm event.⁸⁰ At the time, Carrboro had insufficient staff to address the issue in a timely manner, resulting in fuel from the tank running into Bolin Creek. This issue provided an impetus for Carrboro to establish a larger utilities staff that would better equip the town to manage such problems in the future.

Both Carrboro and Chapel Hill regulate pollution through an illicit discharge program. The Town of Carrboro’s [Illicit Discharge Detection and Elimination Program](#) lists many potential pollution sources and outlines the town’s method of addressing illicit discharge when it occurs. “The purpose of Carrboro’s IDDE program is to find, fix and prevent illicit discharges,” which most commonly occur from the following sites.⁸¹

Table 1 Site Activities in Carrboro with the Highest Potential to Produce Illicit Discharges

Residential	
Car Washing	Swimming Pool Discharges
Driveway Cleaning	Dumping/Spills
Septic System Maintenance	Lawn/Landscape Watering
Commercial/Institutional/Municipal	Commercial
Car Washes	Laundry/Dry Cleaning
Gas Stations/Auto Repair Shops	Nurseries and Garden Centers
Oil Change Shops	Restaurants
Building Maintenance (power washing)	Dumping/Spills
Landscaping/Grounds Care (irrigation)	Municipal Fleet Storage Areas
Public Works Yard	Outdoor Fluid Storage
Parking Lot Maintenance (power washing)	Road Maintenance (Town and State)
Vehicle Fueling	Vehicle Maintenance/Repair
Vehicle Washing	Washdown of greasy equipment and grease traps
Printing	Loading and unloading area washdowns
Outdoor material storage (fluids)	Underground storage tanks (fuel)

“Site Activities in Carrboro with the Highest Potential to Produce Illicit Discharges.” From Carrboro Illicit Discharge Detection and Elimination Program.

Sewage system leaks of various types are also a pollution source. OWASA is responsible for the maintenance of our sanitary sewer system. Carrboro’s Stormwater program only gets involved when there is a leak into the stormwater system. There are a

⁸⁰ State Emergency Medical Services officials were alerted along with FOBC and town staff. State personnel were able to track the oil leak from the spill into the creek back up to an abandoned tank in an older Carrboro home located on Greensboro Street.

⁸¹ Town of Carrboro, [“Illicit Discharge Detection and Elimination Program.”](#) August 2020. 8.

limited number of alternative septic systems in Carrboro/Chapel Hill that the Orange County Health Department regulates.⁸²

3.2 Utility Easements

The OWASA sanitary sewer, a Duke Power corridor, and multiple UNC service roads all intersect and cut through Bolin Creek Forest. These service roads and corridors have heavy foot and bike traffic, connecting in multiple places to a vast network of trails. These service roads are also utilized by maintenance vehicles, emergency response vehicles, and UNC facilities vehicles. The level of foot and service vehicle traffic has led to weathered roads with large ruts and holes that flood during storm events. Inundated roads are prone to widening, as vehicles and foot traffic avoid flooded locations, creating trail braids and widening the informal path. Within these utility easements, the forest has been cleared and replaced with either limited vegetation or gravel for maintenance or access repair. Erosion in this area (particularly behind Chapel Hill High, Smith Middle, and Seawell Elementary Schools) has been exacerbated by steep slopes and regrading with lightweight Chapel Hill gravel, which washes away into Jolly Branch. Utility easements and service roads reduce wildlife habitat and create opportunities for invasive plant species to grow.

3.2.1 Orange Water and Sewer Authority (OWASA)

The OWASA sewer easement has been specifically mentioned as a concern in multiple watershed assessments. This easement, which follows along the creek in and upstream of Bolin Creek Forest, has replaced many riparian trees with a travel way for maintenance, in some cases within the 50-ft riparian buffer zone. [The Bolin Creek Watershed Situation Assessment](#) recommends a 100-ft riparian buffer to protect biological stream health. Deep-rooted vegetation in the riparian buffer helps stabilize the streambank. Areas that lack such root systems are far more susceptible to destructive bank erosion.

The sewer system crosses the creek twice within the Carolina North portion of Bolin Creek Forest, and numerous times upstream. At these sites, there is evidence of stress on the stream channels. In addition, OWASA maintenance vehicles cross the stream in these locations, causing soil compaction on the streambank and contributing to erosion and destabilization.⁸³ OWASA has added riprap (large rocks piled in a stable way to

⁸² More information about these septic systems can be found on the [Orange County Health Department website](#).

⁸³ Chapel Hill and Carrboro, N.C. "[Bolin Creek Watershed Restoration Plan](#)." 2012.

prevent erosion) at these low-water crossings to mitigate erosive stress on the creek, but their mitigation effectiveness is variable. There is evidence from visual observations that the hardscape material has made erosion worse in some locations where the banks are particularly steep. The location of the OWASA corridor so close to the creek also introduces a threat of pollution from sewer leaks. Since such pipe leaks would degrade the aquatic ecosystem and threaten water quality, OWASA works to prevent them. Presently the section of sewer main through the Bolin Creek Natural Area is undersized.

OWASA intends to replace approximately 4,000 feet of the existing 15-inch sewer pipe with a 24-inch sewer pipe from Pathway Drive to Estes Drive Extension. According to Mary Darr, OWASA Chief of Operations, plans call for replacing 1,200 feet of the line in 2024 and the balance in 2042. The new interceptor will provide additional capacity and will correct existing surcharge conditions and overflows in the current sewer main.”

As this project takes place within the Bolin Creek Natural Area, it raises concerns over how the construction will impact the riparian zone, water quality, and recreational use. OWASA has not reacted to a recommendation in Carrboro’s [Bolin Creek Conceptual Master Plan](#) that recommends the replacement line be constructed at least 50 feet from the creek to maintain long-term stream health. Ordinarily a minimum 50 foot setback is recommended to protect stream health. However, because of the steep banks south of Pathway Drive, moving the line would likely result in immense short-term damage to presently undisturbed steep areas of the forest and lead to a more expensive installation. Further study of the best location for the replacement line is needed before construction commences. Engineering for the first section of the OWASA replacement line will begin in 2022.

3.2.2 Power Easement

The other easement of concern is the power line behind Seawell Elementary and Smith Middle School, which has created heavy erosion and siltation in the creek. When silt or other sediment enters the creek, it degrades the habitat of aquatic organisms, many of which are sensitive to fine sediment increases. Studies have shown that fine sediment accumulation can cause a loss of abundance and diversity in macroinvertebrate communities.⁸⁴

⁸⁴ Harrison, E. T., Norris, R. H., & Wilkinson, S. N, “[The impact of fine sediment accumulation on benthic macroinvertebrates: implications for river management.](#)” Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference (pp. 139-144). Charles Sturt University: Thurgoona, New South Wales, 2007.

3.2.3 Service Roads

The service roads in the Carolina North forest are gravel surfaced roads. UNC Forest staff perform minor repairs. Major repairs, including re-grading and resurfacing, are accomplished through contracted services. The existing service roads are shown in Figure B.

Within the Conservation Areas, the Carolina North Development Agreement allows maintenance of existing service roads but prohibits relocation or widening of existing service roads, as well as creation of new service roads. In the Limited Development Areas and Development Areas, activities beyond maintenance of the existing service roads are subject to the applicable sections of the Development Agreement.

3.3 Potential Greenway Construction Next to Creeks

3.3.1 Paving Controversy History

The Department of Transportation (DOT) is likely to be the funding agency for constructing greenways in North Carolina. Under DOT's definition, a greenway trail is a 10-ft wide multi-use graded paved roadway with a base of asphalt or concrete, along with an aggregate shoulder of at least 2-ft on each side. Such a path requires exemptions from two different sets of protective rules: the Jordan Lake Buffer Rules, which protect a 50-ft of vegetated buffer along Bolin Creek and its tributaries, and the North Carolina Department of Environmental Quality (NCDEQ) rules, which protect Bolin Creek and the wetlands in the proposed paving site. Greenways are a permitted use within the 50-ft buffer under the Jordan Lake Buffer Rules, but only if the DEQ determines there is no practical alternative.⁸⁵

In 2009, the Carrboro Town Council commissioned the firm Greenways Incorporated to develop the *Bolin Creek Greenway: Conceptual Master Plan*. The concept plan recommended options for the construction of a number of paved greenways.⁸⁶ FOBC, along with other concerned citizens, strongly opposed the recommendation to construct a 12-ft wide paved path along the creek, running for several miles between Homestead

⁸⁵ “[Local Model] Riparian Buffer Protection Ordinance [for North Carolina],” 21.

⁸⁶ See: [Board of Alderman Review of the Bolin Creek Conceptual Master Plan](#), December 8, 2009. Also see: [Executive Summary of Bolin Creek Conceptual Master Plan](#), 2009. The [misleading language](#) of this plan alleged a stated purpose to improve water quality and provide wildlife habitat in Bolin Creek by creating a paved pathway. In reality, impervious surface coverage within natural areas has a proven, direct connection to habitat degradation and negatively impacts water quality.

Road and Estes Drive Extension. The Carrboro Town Council reviewed the plan recommendations in December 2009 and adopted several of the recommendations for paved greenways, tabling the construction of the creekside greenway (detailed in phases 3 and 4 of the plan). The two routes approved and subsequently constructed were phase 1A (entrance into Wilson Park from Estes Drive Extension) and 1B (the paved greenway joining Claremont and Chapel Hill High School). The December 2009 Board of Aldermen [resolution](#) also recommended that the staff develop a process for the public to discuss the controversial route at a future date.⁸⁷

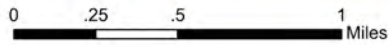
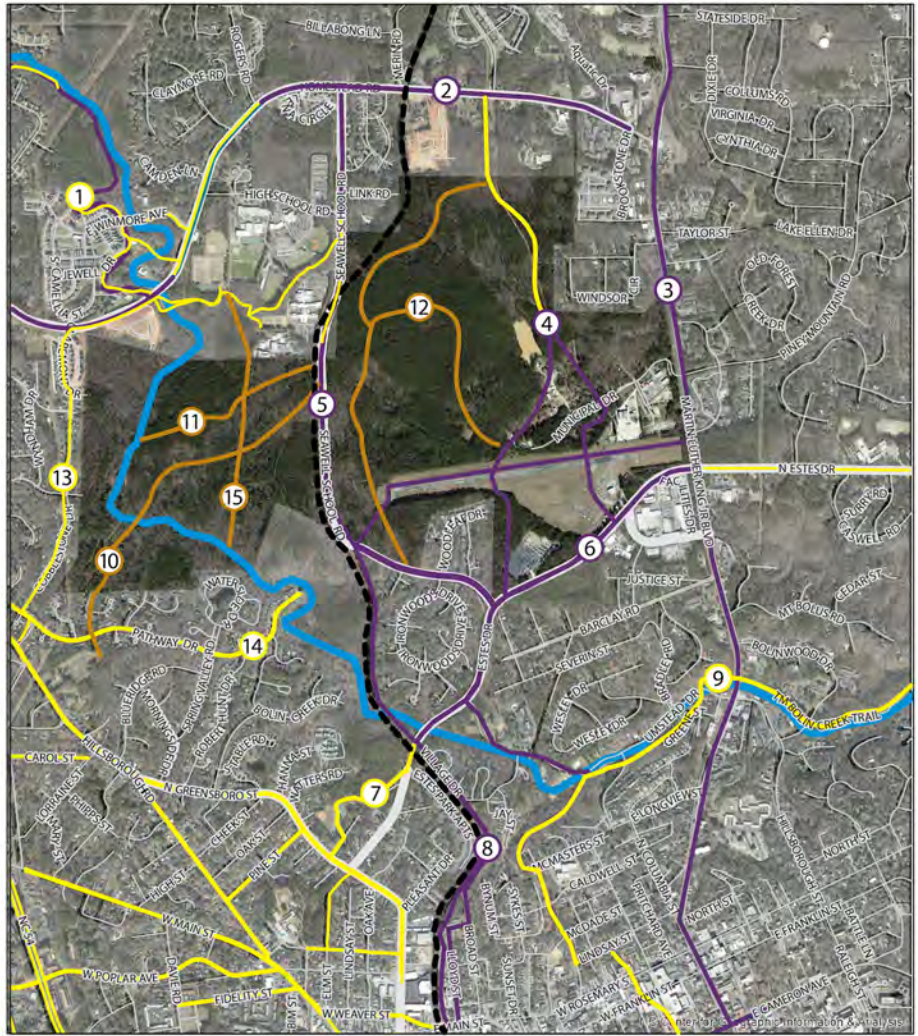
In 2010, the Carrboro Town Council directed the Carrboro Greenways Commission to review the greenway options. Following a year of monthly meetings when this topic dominated each Greenways Commission meeting, the Greenways Commission concluded that there was no need for a paved greenway next to Bolin Creek, given the many alternative bikeways, and passed a resolution stating that conclusion.⁸⁸

Also in 2010, Friends of Bolin Creek launched a transportation study of area bike routes and published a map of routes illustrating the existing and planned network of bike routes surrounding Carolina North and the Bolin Creek Natural Area.⁸⁹ Given the large number of bike routes shown on this map, it is difficult to make any case for why an additional impervious surface in the form of a paved creek-side path would be of benefit. Further, since state policy requires that greenways be kept out of stream buffers unless no practical alternative exists, the map demonstrates several practical alternatives to any proposed construction along the creek.

⁸⁷ Item D3 of [Carrboro Board of Aldermen minutes](#) from December 8, 2009

⁸⁸ Carrboro Board of Aldermen [Resolution](#). December 8, 2009. 10-11.

⁸⁹ Friends of Bolin Creek, "[Bicycle Routes Near Carolina North and Upper Bolin Creek](#)," August 2010. Map has since been updated. See Figure L.



Legend

- Existing Bikeways
- Proposed Bikeways
- Streets
- Natural Surface Trail
- - - Railroad Tracks

Key to Planned Bikeways

- 1 Homestead-Chapel Hill High School Multi-Use Path
- 2 Homestead Road Bike & Pedestrian Enhancements
- 3 MLK Boulevard Jr. Bikepaths
- 4 Carolina North Bicycle Connector
- 5 Seawell School Road Bikelines or Multi-Use Path
- 6 Estes Drive Bikelines and Multi-Use Path
- 7 Wilson Park Bikeway/Greenway
- 8 Campus-to-Campus Bicycle Connector
- 9 Bolin Creek/Tanyard Branch Paved Trails
- 10 Carolina North Tripp Farm Road Connector
- 11 Seawell School Road to Bolin Creek Northern Route
- 12 Pumpkin Loop, Off-Road Carolina North Unpaved Trails
- 13 Cobblestone Bike Boulevard Northbound
- 14 Multiple Bike Boulevard Routes
- 15 Powerline Trail

March 2019

Figure L. Bike Trails in Bolin Creek Natural Area.

A combined Carrboro Town Manager and Mayor initiative began in 2018 to find common ground among the various interests on the paving issue. Representatives included FOBC, the Bike Coalition, the Carrboro Town Council, and the Mayor. While this effort did not immediately succeed, in 2019 the Carrboro Town Council initiated a Bike Plan Steering Committee for the purpose of identifying priorities for future new routes to update the Carrboro Bike Plan. The Bike Plan Steering Committee represented all stakeholder constituencies and in its final report identified priority projects. A paved creekside path was not among the final recommendations.

UNC has not taken a position on the controversial proposal to pave along Bolin Creek. In an April 11, 2012 letter to FOBC, Gordon Merklein, UNC Executive Director of Real Estate Development, made a commitment that if UNC were to be asked to formally review such a request, the public would be consulted before the University would respond.⁹⁰ UNC has the final jurisdiction over developments within its land, but the University made clear its intention to take full community input into account if any new proposal is made in the future.

The 2010 Carrboro Greenways Commission thoroughly explored all greenway options for a year of meetings attended by many members of the public. The Greenways Commission concluded in a formal resolution that there was no need to further explore or the option of a bike trail next to the creek unless circumstances were to change. More recently, the 2019 Bike Plan Steering Committee set new priorities for bikeways and greenways.

Finally, a paved greenway next to Bolin Creek would harm water quality and damage the riparian tree canopy. Impervious surface coverage in such close proximity to the creek poses a major threat to stream health and additionally conflicts with state ordinances, as discussed earlier.

3.3.2 Effects of Paving on the Environment

In 2010, Save Bolin Creek commissioned the Catena Group Inc. to conduct an assessment of the [Bolin Creek Greenway Conceptual Master Plan](#) of the greenway plan to determine if the project was consistent with its stated purposes and assess the impact of a paved trail. The examination focused especially on the issues of jurisdiction, along with the effects on water and wildlife.

⁹⁰ For the original correspondence, please see [Appendix X](#).

The resulting [Bolin Creek Greenway Conceptual Master Plan Goals Consistency Review](#) concluded that the proposed project did not serve the stated purpose of improving water quality and would further impair the creek and its tributaries. As discussed in [3.1.1](#), the introduction of impervious surfaces into riparian zones reduces their essential filtering function, damaging stream health. Constructing new impervious surfaces in an already urban watershed would reduce infiltration of precipitation and increase sheet flow, stream flashiness, and flow velocities.

Another potential danger of the proposed paved trails, according to the Catena Group, would be increased erosion. The Catena Group's report notes that such construction in Bolin Creek Forest would require excavation and grading into stream valley slopes, rock outcroppings, and bedrock, which currently have low erodibility. Excavation of these features would result in unstable stream banks. Loss of trees within the riparian zone would also increase light penetration, resulting in elevated stream temperatures, increased algal populations, and decreased dissolved oxygen.⁹¹ In addition to the impacts on water quality described above, the loss of riparian forest would degrade habitat for aquatic wildlife in Bolin Creek and its tributaries.⁹² It is axiomatic in stream ecology that riparian forests are integral to a well-functioning stream community, which depends on both the water quality benefits noted above, as well as the organic matter from riparian trees, which constitutes the majority of organic matter supporting the stream food web.

The Catena Group report also noted Bolin Creek Forest currently supports rare natural communities considering its urban surroundings. Construction of the proposed project would threaten the value of the current wildlife habitat in Bolin Creek Forest. Trail construction would degrade or eliminate wetland seeps and floodplain pools that provide breeding habitat for amphibians.⁹³ Additionally, according to the Catena Group's review, the clearing of trees and vegetation would provide the opportunity for invasive plants to grow, minimizing plant biodiversity.

3.4 Inadequate Trail Maintenance

The many human users of the Bolin Creek Natural Area depend on trails that can protect water quality while being safe for walking and running. A complex network of trails

⁹¹ Hession, W. C., et al. "[Ecological benefits of riparian reforestation in urban watersheds: study design and preliminary results.](#)" *Environmental Monitoring and Assessment* 63.1 (2000): 211-222.

⁹² Catena Group, Inc. "[Bolin Creek Greenway Conceptual Master Plan Goals Consistency Review](#)," April 2010.

⁹³ Wetland seeps are defined by their unique proximity to this slow-moving groundwater. Seeps usually occupy small areas on sloping hillsides leading down to a floodplain.

weaves through this area, making the natural landscape accessible to pedestrians and bikers. Hikers and mountain bikers frequent both central, wide trails and informal single-track trails that weave through the forest. Recurrent use in what used to be pure forest has additionally created informal trails and increased trail braiding. Strava heat maps ([Figure E.](#)) and other surveys have established these trails are heavily used, and the pandemic in 2020-21 has only increased recreational use in the area.

Unlike paved paths, natural area trails allow water to filtrate into groundwater, but without proper maintenance they can erode. Conditions of the creek trails can vary; trails are often muddy after a storm event, and heavy foot and bike traffic can dislodge sediment. Trail maintenance is necessary to properly control stormwater and erosion and allow for the safe, continued use by the many people who hike and run through the Bolin Creek Natural Area.

There are several specific problem areas that need attention. Regular use of non-maintained trails has caused rutting and widening of trails, compacting soil and altering its physical and biological composition, sometimes causing the ground to become as impervious as a paved surface. There are several trail crossing points on Bolin Creek and its tributaries that show evidence of soil erosion and consequent siltation (silt or clay pollution) into the creek, but these are correctable. Proper trail maintenance and plantings in the riparian corridor can minimize this harmful erosion and protect stream health, whereas paving these heavily used paths would only exacerbate present issues.

A Management Plan would provide a number of recommendations to ameliorate stormwater management. These recommendations could include slowing stormwater by diverting it through level spreaders, or installing boulders, water bars and smaller diameter gravel in certain areas. A plan formulated by landscape engineers would also provide reconstructed wetlands and even pools in some areas to support salamander habitats. Finally, engineered recommendations in a Maintenance Plan would create a network of alternate woodland paths that would allow recreational users to skirt problem areas, similar to what Battle Park has designed and built to deal with problem areas.

The University of North Carolina maintains the trails on their own property and recognizes the damage some trails have had on the ecological integrity of the area.⁹⁴ In the [Carolina North Stewardship Policy](#), UNC describes their responsibility as follows:

⁹⁴ Trail maintenance is performed as described on the CN Forest website under Trail Management at: <http://carolinanorthforest.unc.edu/TrailManagement>.

*In addition to trail maintenance, site maintenance in the CN Forest includes the installation and maintenance of site furniture including benches, trash and recycling receptacles, dog waste containers, information kiosks, signs and gates. Minor repairs and maintenance are performed by the CN Forest Staff. Major repairs and improvements are performed by contract service providers. The singletrack trail system at CN has been created over time by the local community. **Trail layout and alignment has focused on the user experience at the expense of ecosystem services.** CN's Office of Forest Management maintains the existing trail network, improves and relocates alignments when necessary, and creates new trails as appropriate... Single-track trails are subject to closure⁹⁵ when conditions are too wet and trail use will cause degradation of the trails, erosion and sedimentation, and degradation of water quality, etc. Forest Management will close the single-track trails until such time as conditions are dry enough to return them to use.⁹⁶*

UNC recognizes that effective trail maintenance has historically taken a backseat to user accessibility and experience, to the detriment of the ecosystem. With proper trail design and maintenance, ecological health and user enjoyment can coexist. Although UNC's Stewardship Plan does not contain specific management strategies and actions, it provides a framework for their development. Presently, an on-site urban forester and University stormwater staff are available to address problems as they arise, and while helpful, these staff are an insufficient replacement for a coordinated management plan.

It is noted here that some unmet maintenance needs on the UNC property, such as invasive plant control, stream cleanups and native plantings, are implementation steps outlined in Carrboro's Community Action Plan, suggesting the value of a coordinated management plan.

For UNC's Carolina Forest, the Urban Forester posts trail conditions online to discourage use immediately after a storm event. Even so, there are problem areas that need consistent attention. Heavy equipment from UNC or OWASA traversing the creekside path near the UNC bridge has caused ruts within the riparian area. OWASA or UNC have placed large rocks in the muddy areas in an attempt to curb erosion, but the practice has not been entirely effective. Recreational users find the large rocks dangerous and have taken to going around the area, causing the path to widen further.

⁹⁵ During the periods when the single track trails are closed, the service roads and utility corridors are still open for recreational use.

⁹⁶ Biohabitats Inc. and University of North Carolina, 2015. "Carolina North Land Stewardship Policy," 15. (Emphasis our own).

There are scores of well-loved and well-used trails on this UNC property. Due to the challenge of overseeing a large forest, the University has recruited volunteers to help maintain bike trails, foot bridges and exercise stations. Due to the large numbers of visitors, UNC policies require that dogs be leashed. Occasionally walkers have been knocked down or bitten by dogs not under proper control. A coordinated Management Plan could ensure a consistent policy across the Bolin Creek Natural Areas so that users would have common expectations for the rules of the forest.

For the Adams Preserve, the Town of Carrboro Public Works Department has official responsibility for maintaining the trails in the Adams Preserve as set out in the 2006 Management Plan in coordination with the Lands Legacy Program in Orange County.⁹⁷ Recently, Friends of Bolin Creek coordinated with the Town of Carrboro and the Orange County Lands Legacy Director to identify several problem areas needing trail maintenance. In two cases (one below Pacifica and the other on the main trail down to the creek), steep up and down trails were causing erosion problems. Each problem area could be easily solved by volunteers with appropriate supervision creating switchbacks across the hillside and closing trails that cause erosion.

The trails on PH Craig tract hold many of the same challenges. An inspection of the property in 2018 showed no erosion entering the riparian area from the side trails joining the riparian area. However, one vertical trail from the top of the ridge to the creek has become so deeply incised it is not comfortable to walk safely and should be permanently blocked from usage. Mountain bikers over time have eroded the trail to turn the trail into a ravine. With the property owner's permission the top of the trail could be blocked with tree limbs. A large log at the bottom already diverts sediment into the woods, away from the creek.

3.5 Invasive and Native Pest Species

Invasive species are exotic species of plants, animals, or pathogens that aggressively reproduce and outcompete native species. In Bolin Forest, common invasive plant species include Elaeagnus, Japanese Stiltgrass, Japanese Honeysuckle, Kudzu, and Chinese Privet can take over and prevent native trees from seeding in and growing, especially in riparian areas where there is abundant moisture. Invasive species like these alter soil composition, threaten native plants, and reduce biodiversity. Lower biodiversity, in turn, negatively impacts creek health. The spread of invasive species in the riparian

⁹⁷ Town of Carrboro, "[Adams Tract -- 3 Year Management Plan](#)," June 2006.

zone, particularly along the OWASA corridor, can lead to decreased tree cover. along the creek, increasing soil erodibility and degrading habitat for aquatic invertebrates that require leaf litter.⁹⁸



Invasive Species Left to Right: Elaeagnus, Japanese Stiltgrass, Japanese Honeysuckle, Chinese Privet.

Although invasive fauna occurrences in Bolin Creek Forest are less recorded, Gypsy Moths, Emerald Ash Borers, Fire Ants, and other invasive insects have been reported in Orange County and may exploit Bolin Creek Forest unless properly managed. Many of these species are destructive to native plants.⁹⁹ For more details and a complete list of invasive species, the USDA early detection distribution map of invasive and exotic species can be found on the [EDDMapS website](#).¹⁰⁰

In addition to invasive plant species, Bolin Creek Forest is threatened by native pest species such as the Southern Pine Beetle. While the southern pine beetle has not currently been recorded in Bolin Creek Forest, future timber harvesting and loblolly pine plantings could increase the likelihood for infestation if not properly managed. Effective management would include proper spacing of trees, monitoring for southern pine beetles, and thinning of aging or dying trees.¹⁰¹

In 2014-15, a partnership between six neighborhoods (three phases of Bolin Forest, Quarterpath Trace, Forest Court, and The Cedars) and the Town of Carrboro

⁹⁸ NC State University, "[Invasive, Exotic Plants of the Southeast](#)."

Prince, Ann, "[Invasive Species of the Piedmont: Shrubs, Trees, and Vines--- How You Can Help!](#)" Eno River Association, 2016.

⁹⁹ The Gypsy Moth, for instance, attacks northern Red Oak, Chestnut Oak, and White Oak trees [39].

¹⁰⁰ University of Georgia Center for Invasive Species and Ecosystem Health, "[Status of Invasives: North Carolina](#)," eddmaps.org.

¹⁰¹ John Nowak, Christopher Asaro, Kier Klepzig, and Ronald Billings, "[The Southern Pine Beetle Prevention Initiative: Working for Healthier Forests](#)." *Journal of Forestry*, vol. 106, Issue 5. July 2008, 261–267.

collaborated to address invasive plant problems and to promote healthy native trees. Invasives were addressed at four levels:

1. At the entrance to Bolin Forest, a significant wisteria invasion had killed dozens of trees and bushes in the green buffer zone between land owned by two HOAs. The grant supported two environmental consultants to treat the wisteria and plant cover crops, then work with volunteers over four workdays to remove dead trees and bushes and to purchase, plant, and mulch 100 native trees. Following the initial project, volunteers have continued to water, mulch, and implement deer protection to support healthy growth of young trees.
2. An awareness and action workday held across these neighborhoods helped citizens to identify and manage Japanese stilt grass. The environmental consultants shared management strategies, and then multiple teams spread out to remove stilt grass in common areas and private yards. Print and electronic materials were shared through the HOAs to support ongoing stilt grass control.
3. Consultants from Green Roots Environmental Design developed an [urban forestry stewardship plan](#) and posted it on the Town of Carrboro website.
4. A community-wide forum was held with 75 attendees at the Carrboro Century Center to share the above urban forest stewardship plan, and to discuss how these neighborhoods were addressing invasives and planting trees as a model for other neighborhoods.

This initiative is an encouraging example of how Town authorities, state resources and neighborhoods can work together toward better health for our creeks and forests.

3.6 Clear Cutting

In 2018, 40 acres of the 77-acre property owned by P.H. Craig was clear cut with the intent of planting a monoculture loblolly pine stand in accordance with the [Timber Harvest Plan](#). Future timbering of this private land in other locations is possible and cannot be prevented without land acquisition.

When mature forests are clear cut, biomass is removed and soils are disturbed, releasing excess carbon back into the atmosphere. Evidence suggests that soils store twice as much carbon as the trees themselves. Disturbed forest soils can continue to lose carbon from decaying organic material even after seedlings are planted. Even though the young trees are sequestering atmospheric carbon, the rate of soil decay

caused by clear cutting gives off carbon at a higher rate than the young trees can absorb. According to the Center for Biological Diversity,

Undisturbed forests are crucial for a healthy climate, continuously taking carbon dioxide from the atmosphere and storing it in trees, shrubs and soil. But logging can transform a swath of forest from a carbon 'sink' into a carbon source, not only destroying CO₂-absorbing trees but emitting tons of new greenhouse gases in the process.¹⁰²

Before the P.H. Craig forest harvest occurred in June 2018, Friends of Bolin Creek sought expert advice from Professor Douglass Frederick about the condition of the forest. He advised the Carrboro Town Council and Mayor [in a letter](#) that the stand that was to be harvested was in excellent health and could grow in a healthy fashion for another eighty years.¹⁰³

The outpouring of community interest and concern about the tree harvest brought about a consequential step toward jump-starting efforts by Carrboro and Chapel Hill leaders to work with conservation groups to seek land acquisition as a long-term solution.

Other than this clear-cut segment, Bolin Creek Forest is a healthy contiguous forest with a diversity of plant species, structure, and age. Large, diverse forests are more naturally protected against invasive species, disease, intense storms, and other natural disturbances compared to forests with lower biodiversity and more uniform structure and age. Unfortunately, the Craig Forest Management Plan recommended the clear-cut areas be converted to a monoculture of loblolly pine trees, which would lessen forest diversity, leading to the spread of invasive species.¹⁰⁴ Proper management of this stand will be necessary to ensure that it remains a healthy, productive, early successional forest.¹⁰⁵

Clear cutting and potential future development of roads and/or buildings will result in habitat loss and fragmentation. This urban forest is unique in that it has so far escaped fragmentation. Fragmentation of forests into smaller parcels reduces wildlife habitat for

¹⁰² Center for Biological Diversity, "[Clearcutting and Climate Change](#)."

¹⁰³ The original letter is included in [Appendix VIII](#).

¹⁰⁴ For example, invasive species like Japanese Stiltgrass are known to exploit disturbed areas of bare soil, like those left behind in the clearcutting process. A loblolly plantation on this site would decrease biodiversity compared to the natural mixed pine and hardwood present before the clearcutting.

¹⁰⁵ Early successional forest stand refers to the young, regenerating (or planted) stand following clearcutting. Early successional is an ecological term referring to the process (succession) of young trees and plants growing back on a site after disturbance (in this case, clearcutting). A "late successional" stand would be an older mature forest, similar to what was clearcut.

species that require large contiguous forests for a home range, or breeding preferences, and increases the introduction and propagation of nonnative species. For more information on forest fragmentation and its impact on natural communities, see [Appendix V: Bolin Forest Natural Resource Analysis](#).

3.7 Risk of Potential Future Development

Both the Adams Tract and Carolina North Forest are currently protected from development by their respective conservation easements and management plans. Although the limited development areas within the Carolina North Forest portion could potentially see development after 2059 and 2109, it is unlikely for several factors: (1) the placement of the conservation easements on the most sensitive and significant tracts; (2) the availability of land in the vicinity of the old airport runways; and (3) the Carolina North Agreement that gives UNC a ready permit to develop the airport area. Development in the privately owned P.H. Craig Property is a more present risk. Over the years, FOBC has worked with local conservation groups to try to bring the Craig property into the public domain, but so far these efforts have not been successful. Development in upland portions of the property would greatly compromise the contiguity and value of Bolin Creek Forest because of its strategic location between the Adams Preserve and Carolina North forests.

The threat of future development is not limited to the forest itself. Bolin Creek already suffers from stressors associated with urbanization south of Estes Drive extension and north of Homestead Drive. Friends of Bolin Creek can play an advocacy role by identifying the few remaining undeveloped parcels upstream of Homestead Road and to ensure that town leaders protect the upstream portions of Bolin Creek and its tributaries.

3.8 Climate Change

Within the current context of global climate change, forests play an increasingly necessary role as carbon sinks, or reservoirs of atmospheric carbon dioxide. Forests absorb and store carbon dioxide, filter pollutants, and even cool the air by absorbing heat and providing shade.¹⁰⁶ This cooling effect is especially important in urban areas where forests are uncommon and impervious surfaces comprise much of the landscape. Urban zones act as heat islands, with higher air and surface temperatures than surrounding

¹⁰⁶ Stephenson, Nathan L., et al. "[Rate of tree carbon accumulation increases continuously with tree size.](#)" *Nature* 507, 2014. 90.

forested or rural areas.¹⁰⁷ Forests in the southeastern United States can continue to provide a sink of atmospheric carbon dioxide. As the climate crisis worsens, it will be imperative to protect these natural carbon sinks in the face of development pressures and urbanization.¹⁰⁸

The towns of Carrboro and Chapel Hill are located in ecosystems that are and will continue to be affected by a warming planet. Climate change is likely to increase the frequency and intensity of storms and droughts in the area, exacerbating the stress on urban waterways. Although we can expect climate change to worsen conditions generally in the area, the Bolin Creek Natural Area still offers an opportunity to mitigate local conditions. The most obvious advantage of a wooded natural area is the reduction of CO₂ emissions through carbon sequestration in soils and in the plant biomass of trees.

The Bolin Creek Natural Area also presents an opportunity to improve ecosystem health and resilience by providing a tree canopy that shades creeks, thus fostering macroinvertebrate life. Healthy waterways encourage a richer wildlife and native plant variety. A healthy forest, and in particular a riparian forest like that within the Bolin Creek Natural Area, is essential to the health of downstream waterways. Carrboro has adopted a [Community Climate Action Plan](#), which is consistent with and supported by many of the recommended actions in this plan.

¹⁰⁷ Tyrväinen, Liisa, et al. "[Benefits and Uses of Urban Forests and Trees](#)." Urban Forests and Trees, 2005. 81-114.

¹⁰⁸ These ecosystems not only store macronutrients in their biomass, but also stabilize and build soils with rich microbiological processes that recycle nutrients, protecting creeks from being overloaded and overfertilized by sediment and nutrients. Climate change risks increased water temperature, which can make creeks less suitable habitats for aquatic species. Riparian forests shade creeks and help regulate their water temperature, allowing for important microclimates to flourish in creeks and creek valleys.

Part IV

Creating a Conservation Plan

In Parts I and II, we provided a review of available information on natural resources, the health of Bolin Creek, and the surrounding forest within the Bolin Creek Natural Area. In Part III we identified environmental and social trends that can be harmful to this area. Here in Part IV we provide recommendations for managing these trends to conserve and protect the Bolin Creek Natural Area going forward.

4.1 Reasons to Conserve the Bolin Creek Natural Area

Within this document, we have brought together the underlying natural, cultural, and scientific foundations for conserving the Bolin Creek Natural Area. As the global climate crisis reaches new heights of urgency, local and national leaders alike will be increasingly responsible for protecting what remaining natural areas exist. Local forests and creeks found in the Bolin Creek Natural Area provide an increasingly essential function for carbon storage, temperature regulation, and wildlife habitat preservation. Ensuring this area's conservation helps fulfill a commitment made by local governments to take action to mitigate climate change, while at the same time protecting the health and safety of our local community.

In summary, implementing a coordinated management plan in this area will:

- Preserve the natural wealth of the forest and its botanical and animal assets.
- Further climate-action plans to protect our trees to improve carbon sequestration and stream health while exceeding state and local water-quality regulations.
- Honor the value that our citizens place on conserving our forests, demonstrated by the thousands of recreational hours that the public enjoy within this natural area every year.
- Build on the extraordinary work accomplished by former town elected leaders and University of North Carolina administrators to conserve significant portions of this natural area. (See Part 4.3 of this document.)

4.2 Our Goal

Our long-term goal is to protect the natural resources of the Bolin Creek Natural Area through coordinated conservation management.

To accomplish this goal, Friends of Bolin Creek proposes a strategy to develop and implement a land use management plan that calls for coordinated actions by property owners, elected officials, recreational users, and supporters of FOBC. It will build on the legacy of civic actions taken to date (see 4.3). While each property owner can take unilateral action in their portion of the Bolin Creek Natural Area, much more can be achieved through coordinated action of property owners, town leaders and non profits. A coordinated management plan will offer benefits to the Town of Carrboro, UNC, and other property owners. As an active non-profit in the Chapel Hill and Carrboro communities, FOBC is well-positioned to organize volunteers to implement many of the steps in a jointly approved management plan for the Bolin Creek Natural Area.

4.3 Foundational steps taken by university and town leaders over the past two decades that make a joint management plan feasible:

Past conservation achievements in this area make the creation and implementation of such a joint management plan possible. It will take perseverance from all entities – OWASA, Town of Carrboro, UNC, FOBC, and additional private property owners – to develop a collaborative management plan for the Bolin Creek Natural Area, but the following efforts have laid the groundwork for a coordinated Management Plan to be achieved.

- UNC and Town of Chapel Hill’s collaborative [Carolina North Development Agreement](#),¹⁰⁹ signed in 2009, clearly states environmental goals for Bolin Creek Forest and commits to future conservation of Bolin Creek Forest;
- [UNC Carolina North Land Stewardship Policy](#)¹¹⁰ set out environmental goals for the Carolina North forest, based on an environmental assessment conducted by Biohabitats Inc.;
- Town of Carrboro’s successful 2004 acquisition of the Adams Preserve conserves 27 acres within the public domain;

¹⁰⁹ The University of North Carolina at Chapel Hill and The Town of Chapel Hill, “[Development Agreement](#).” July 1 2009.

¹¹⁰ Biohabitats Inc. and University of North Carolina, “[Carolina North Land Stewardship Policy](#),” 2015.

- NC State baseline studies have established the unique environmental value of Bolin Forest;
- Bolin Creek Restoration projects have been undertaken by Town of Carrboro and Chapel Hill;
- OWASA, the local water and sewer utility, is committed to the highest environmental practices to protect water quality;
- [2012 Bolin Creek Situation Assessment](#):¹¹¹ A state-funded assessment of steps needed to protect the Bolin Creek Natural Area has been conducted. This study was initiated by NC DENR, commissioned by the Towns of Carrboro and Chapel Hill, and contains transcripts of more than 100 interviews measuring attitudes toward watershed protection and paving. The study recommends the creation of a collaborative management plan to better protect water quality.

4.4 Battle Park as a Model

The North Carolina Botanical Garden (NCBG) and many volunteers have brought about a significant transformation of Battle Park in the last 16 years. Over a decade ago, the UNC Chancellor, Dr. James Moeser, called on the NCBG seeking assistance for the management of Battle Park, a 93-acre forest spreading from UNC's Forest Theatre downward to the Town of Chapel Hill's Battle Branch Trail (which eventually reaches the Community Center). After some deliberation, the NCBG agreed to take on responsibility for Battle Park on July 1, 2004.

UNC bequeathed to NCBG a remarkable document describing the history, geology, hydrology and soils of Battle Park. Sharing similarities in scope with the Planning Guide for the Bolin Creek Natural Area, it provided the foundational document for NCBG to develop a management plan for trail restoration with limited resources. The very first Battle Park Curator, Stephen Keith, spearheaded many projects during his tenure, but one of particular importance at the beginning was to implement a trail restoration plan that had been studied and offered by a landscape architecture firm hired by UNC.

The plan mapped out a new trail system that eliminated foot traffic in compromised riparian areas, designated new routes that would reduce erosion, and created an enjoyable walking path by building steps, landings and benches where appropriate. Keith then took on the major task of enlisting volunteers to implement the plan on weekends over the period of one year. The NCBG now holds educational programs and guided

¹¹¹ Watershed Education for Communities and Officials, NC Cooperative Extension, North Carolina State University. "[Bolin Creek Watershed Situation Assessment](#)." February, 2012.

hikes to introduce the public to this unique resource. Battle Park still relies on community involvement, and the volunteer program looks different, but is still going strong with support from both the local university and the surrounding neighborhoods to maintain this natural resource.

The Battle Park Restoration Project serves as a model for the proposed Bolin Creek Natural Area Planning Committee and the land management plan to follow. Battle Park shares many similar topographical and waterway characteristics with the Bolin Creek Natural Area. Both tracts are on portions of land owned by UNC, attract many recreational users, experience trail maintenance issues, share riparian sewer easements alongside the creek, and are located adjacent to residential developments.

The Battle Park Model is applicable to the Bolin Creek Natural Area both because of its topographical similarities and the limited resources with which its management plan was developed. With the cooperation of UNC, NCBG staff implemented extensive improvements to Battle Park’s trail system and reduced invasive species. Its landscape management plan identified the highest value improvements that would slow erosion and benefit recreational users. The plan was achieved with inspiration, limited funding and the extensive use of volunteers. Due to limited resources, a basic Land Management Plan for the Bolin Creek Natural Area could adopt a similar strategy of utilizing volunteer work and cooperating with surrounding neighborhoods.

4.5 Framework for the Bolin Creek Natural Area Management Plan



We recommend these next steps:

- 1) **Problem identification: Meet on site with landowners to identify immediate restoration areas.** FOBC will organize two separate creek walks with UNC and the Town of Carrboro, accompanied by OWASA representatives to identify problem stormwater areas and erosion sites along Bolin Creek and the sewer easement and to identify priority areas for restoration.

- a) List areas needing attention and plan for their environmentally responsible repair and maintenance by on-the-ground projects to improve water quality, protect wildlife and natural resources, and provide a better recreational user experience.
 - b) Identify sites of erosion, compaction, invasive species, and pollution from stormwater runoff and other sources.
 - i) Examples: Identify known priority restoration areas in the riparian zone where areas of the stream banks are degraded, single track trails that head down slopes instead of across them, sites where invasives such as Japanese stilt grass have taken over woodland areas, and sites where clear cutting and monoculture planting have recently compromised the biodiversity, such as of the P.H. Craig tract.
 - ii) Identify sites along the stream bank that would benefit from planting vegetation to slow stormwater flow from side paths into the creek.
- 2) **Form a Bolin Creek Natural Area Planning Committee.** The Committee's purpose is to coordinate management actions for the Bolin Creek Natural Area as a protected reserve for wildlife, recreation and ecosystem conservation. This committee will bring together representatives from both private and public landowners - UNC, the Town of Carrboro, and HOAs - as well as FOBC representatives and relevant experts. It will:
- a) Create a jointly held vision for conservation and protection of the Bolin Creek Natural Area that will increase funding opportunities. FOBC will take the initiative to raise necessary funds to develop a basic management plan.
 - i) Seek out future funding opportunities from urban forestry and riparian forest grants, government grants, and private donors;
 - ii) Ask UNC, Carrboro, HOAs, and other private parties to commit to supporting those coordinated efforts and help identify eroded areas and restoration opportunities. Landowners will have final say on planned improvements.
 - b) Establish partnerships with similar organizations (i.e. Haw River Assembly, Ellerbe Creek Watershed Association, and the NC Botanical Garden) to support management efforts.
- 3) **Develop a Bolin Creek Natural Area Management Plan.** Landowners, consultants, town leaders, and recreational users will all participate in reviewing the elements of the Management Plan, which will guide the immediate and future

steps of this natural resource. Property owners and committee members will approve the plan before work begins. The Management Plan will:

- a) Outline principles identified by UNC, the Town of Carrboro property owners and FOBC to guide decision-making.
- b) Work with partners to identify areas for restoration with priority on riparian areas. Create a geographic reference map of these sites to assist with planning restoration projects.
- c) Recommend steps to restore problem erosion or land disturbance areas.
- d) Identify and recommend programs to control and prevent invasive species.
- e) Plan for less damaging OWASA sewer easement maintenance practices.
- f) Meet with OWASA engineers to plan restoration projects when the sewer line is replaced (i.e. by restoring wetlands, creating rain gardens, installing water bars and stormwater basins).
- g) Maintain recreational infrastructure by improving trail maintenance to avoid environmental damage.
- h) Promote environmentally friendly use of trails by placing trail signs, distributing educational pamphlets, installing and maintaining pet waste receptacles, etc.
- i) Assess impacts of pedestrian and bicycling traffic on the ecosystem in key areas.¹¹²

4) Implement Plan with Volunteers

- a) Friends of Bolin Creek will work with landowners to identify priority projects and obtain advance permission for each one.
- b) Follow the Battle Park model and train crew leaders to supervise volunteers. Ultimately FOBC would hire a part time staff person to coordinate grants, survey the area, manage the inventory of its natural resources, train volunteers and implement an ecological monitoring program.
 - i) Reach out to local volunteers by engaging with student groups, local schools, and community service programs.
 - ii) Reach out to the many neighborhood HOA surrounding Bolin Creek and tap community members there to assist in the plan implementation.

¹¹² UNC is currently performing a survey of trails on their Carolina North property, monitored by Triangle Land Conservancy.

4.5.1 Long Term Strategies

Although the long range land management plan for the Bolin Creek Natural Area includes all landowners collaborating at once, alongside consultants and town leaders, we must recognize that a management plan may be implemented a step at a time as the management plan progresses. Already as of March 2021, several Bolin Forest HOAs and the Town of Carrboro have invited Friends of Bolin Creek to coordinate with them on a joint application for a 319 grant.

When we find a property unwilling to proceed with a collaborative plan, we will proceed with the available partners toward meeting our objectives. We anticipate growing good working relationships with the University of North Carolina because of their good stewardship practices of their land, the conservation measures already in place, and their willingness to make their land available for recreation while protecting the creek and wildlife.

- In later phases of land management planning, FOBC can secure grant funding which could enable activities such as the following:
 - Hiring a part- or full-time staff member to organize and train volunteers, coordinate with HOAs and the Bolin Creek Natural Area Planning Committee to arrange riparian zone restoration projects.
 - Environmental Action: Establish a Monitoring program using volunteers. Use qualified experts to teach survey and monitoring assessments. With hired staff it would be possible to identify a consistent species indicator system and implement its use for monitoring ecological health at specific locations throughout the forest.¹¹³
 - Minimize further fragmentation and degradation caused by utility easement and other infrastructure developments (e.g. OWASA sewer line, Duke power line). Planning Committee will communicate with utilities to encourage adoption of more environmentally sustainable practices.
 - Propose a tree banking program to Chapel Hill, in which the town pledges to plant a certain quantity of trees to replenish what is lost naturally and/or removed. The town of Carrboro has pledged to participate in such a program in their Community Climate Action Plan.¹¹⁴

¹¹³ See [“A Landscape Plan for Wildlife Habitat Connectivity in the Eno River and New Hope Watersheds, North Carolina.”](#) December 2019.

This report provides a wealth of material relevant to maintaining healthy forests.

¹¹⁴ Town of Carrboro, [“Community Climate Action Plan,”](#) Jan 2017. 47.

- Research wildlife management and restoration strategies with the purpose of maintaining aquatic and terrestrial animal biodiversity within Bolin Forest and Bolin Creek. Such projects may include native plantings, enhancing habitat, increasing connectivity, etc.
- Plan for long term land management by considering practices like a controlled burning of the forest, which could open microhabitats to increase biodiversity and improve wildlife habitat.
- Enroll the Bolin Creek Natural Area in a voluntary carbon credit scheme.¹¹⁵

4.6 What is the Friends of Bolin Creek Agenda moving forward?

Friends of Bolin Creek, in concert with its partners, is prepared to provide leadership to jumpstart the formation of the Management Plan through the steps we’ve identified in our proposed framework (4.5). Ongoing deliverables for FOBC and the Land Management Plan to work towards include:

- **Provide resources and leadership to implement a coordinated management plan for the Bolin Creek Natural Area.**
- **Work with partners towards complete conservation of Bolin Creek Natural Area.** Continue to urge our government leaders to acquire the last piece of private property, the P.H. Craig tract. The Town of Carrboro made serious efforts to secure this property in the summer of 2018 and at that time sought professional help from conservation groups. The Town of Carrboro should continue to be alert to potential opportunities for acquiring this last piece of privately held land within the forest boundaries.

“I believe that [private] property is best protected under a long-term conservation easement (or sale), where the tract can become part of the publicly protected land in the County to be enjoyed by the public and used for teaching, research and the long-term benefit of the community”

¹¹⁵ Carbon credits are tradeable carbon emission permits with a monetary value. In a carbon credit scheme, entities releasing carbon emissions must purchase and use these carbon credits, of which there are a finite amount, limiting the aggregate amount of carbon emissions in the area.

- Doug J. Frederick, Professor, Department of
Forestry and Environmental Resources, NC
State University

- **Conduct education and outreach with partners:** Friends of Bolin Creek has established a track record for providing quality educational events for anyone interested to learn about nature and the special Bolin Creek Natural Area. Past programs have focused on mushrooms, birds, geology and stream restoration. The annual spring wildflower walks with experts and the “Walk in the Winter Woods” with commentary and photos by locally renowned photographer Mary Sonis, are especially popular. Friends of Bolin Creek will continue educational outreach, and will play a key role in helping to implement the Maintenance Plan. FOBC will:
 - Hold watershed symposium to educate and highlight how to protect our urban waterways. See previous [2012 symposium](#) footage.
 - Support Town efforts to mitigate climate change and to improve stormwater management capabilities.
 - Work with school administrators to better address practices at Smith Middle School and CH High School that are polluting waterways, and to educate students and administrators about the impact of these practices.¹¹⁶
 - Educate citizens about proper construction practices. Haw River Assembly’s “[Muddy Water Watch](#)” Program trains continues to train citizen volunteers to work with local governments to report bad practices to local and state authorities.¹¹⁷
 - Develop curriculum around Bolin Forest and collaborate with local institutions to incorporate Bolin Forest into lesson plans. Facilitate educational uses of the forest in Chapel Hill Carrboro K-12 public schools, day-schools and nature schools, and universities. Offer options for field trips and long-term studies in the forest or creek. Train teachers to use the forest and creek to meet their curriculum needs.

- **Assemble and maintain a public database of website links and summaries of relevant scientific studies** and publications for public access.

¹¹⁶ The high school is a pollution source due to the fertilization of its athletic fields, which are close to several tributaries flowing into Bolin Creek. Smith Middle School has had contractors dump waste water directly down storm drains that flow into the creek.

¹¹⁷

- **Produce a trail brochure** of the Bolin Creek Natural Area that illustrates animal and plant habitats and the safest and best maintained trails for public use.
- **Compile an understandable, comprehensive list of relevant ordinances** and regulations for community use; provide guidance on how to handle infractions.
- **Build on Carrboro's Climate Action Plan's outreach, in particular the Green Neighbor Initiative** to educate and encourage sound environmental stewardship of Bolin Creek from creek neighborhoods.
- **Encourage towns to tighten up land use ordinances** to incentivize Low Impact Development as a way of improving stormwater management.
- **Develop a network of community volunteers** to assist with Bolin Creek Natural Area projects (restoration, invasive species removal, trail maintenance, monitoring, etc). Reach out to schools, student groups, local list-serves, community events, and other organizations to recruit volunteers.

Appendices

Appendix I. Contact Points for Each Property

Adams Preserve	Christian Hirni <i>Lands Legacy Program, Orange County</i> chirni@orangecountync.gov
	Joseph Guckavan <i>Public Works Director, Town of Carrboro</i> jguchavan@townofcarrboro.org 919-918-7427
	Randy Dodd <i>Stormwater Utility Manager, Carrboro</i> rdodd@townofcarrboro.org 919-918-7341
	Wendell Rogers <i>Facilities Administrator, Town of Carrboro</i> wrodgers@townofcarrboro.org 919-918-7371
P.H. Craig Property	Mr. P.H. Craig phc@nc.rr.com
Carolina North Forest	Anna Wu <i>Facilities Director, UNC</i> awu@facilities.unc.edu
	Greg Kopsch <i>Urban Forester, UNC</i> greg.kopsch@fac.unc.edu

Appendix II. FOBC Education and Outreach Efforts

In 2012, Friends of Bolin Creek (FOBC) took on a Water Sustainability Initiative to improve the health of the Bolin Creek watershed, strengthen local science education,

and build community engagement around local environmental health. These projects, outlined below, have allowed for a better understanding of the Bolin Creek watershed, increased community engagement, and built substantial collaborations among both local and state institutions.

McDougle Middle School Rain Garden¹¹⁸

In 2011, FOBC partnered with the Town of Carrboro, McDougle Middle School, and NC State University on an EPA 319 Grant to build a rain garden at McDougle Middle School in Carrboro. FOBC developed and implemented curriculum support for classroom engagement, and provided rain garden construction and maintenance lessons. FOBC's Education Coordinator provided assistance with water quality measurements and watershed lesson plans in and out of the classroom. A Project Wet Workshop, designed to promote high quality watershed education, was also hosted at McDougle Middle School for educators.

Chapel Hill Community High School Workshop

As part of the Watershed Sustainability Initiative in partnership with Chapel Hill Community High School (CHCH), Friends of Bolin Creek co-developed a Rain Garden Construction Workshop on the CHCH campus. This workshop supported students in watershed based volunteer projects such as the construction and maintenance of rain gardens, and provided educational tools for hands-on hydrology lessons in and out of the classroom. The Friends of Bolin Creek education specialist designed a curriculum to incorporate nearby Bolin Creek, and its abundant natural resources, into the classroom. The Strowd Roses grant provided funding to build hydrology lab stations for classroom and field use. FOBC partnered with CHHS teachers and students, the Redwoods Group, and community members to build indoor and outdoor hydrology stations, renovate the outdoor classroom, and clean up Jolly Branch, a tributary of Bolin Creek located on the high school campus. As a follow up, Friends of Bolin Creek provided in-classroom guidance for implementation of hydrology lab stations and water quality field work in Bolin Creek.

Educator Workshop

In 2011, FOBC partnered with the UNC Institute for the Environment to hold a teacher workshop at the Carolina Center for Educational Excellence entitled "Integrating Lab and

¹¹⁸ A video about this project can be found at https://www.youtube.com/watch?v=0rfHae95M0U&feature=emb_title&ab_channel=msJuliemcclintock

Field Study of our Watershed for the Classroom.” This workshop examined the Jolly Branch sub-watershed of the Bolin Creek watershed, which includes the campuses of CHHS, Smith Middle, and Seawell Elementary Schools.

“Can We Heal Our Waterways” Symposium

Together with the UNC Institute for the Environment, Friends of Bolin Creek organized a symposium on local waterways. The 2012 event, sponsored and organized by Friends of Bolin Creek partnered with the North Carolina Botanical Garden, the towns of Chapel Hill and Carboro, and other organizations, was designed to educate community members on the increasing threats local waterways face, and to promote discussion and movement toward healing them. Speakers at the event presented studies to paint a comprehensive picture on the health of piedmont streams. More information and power-point presentations can be found on the [FOBC official website](#).

Community Rain Garden Workshop

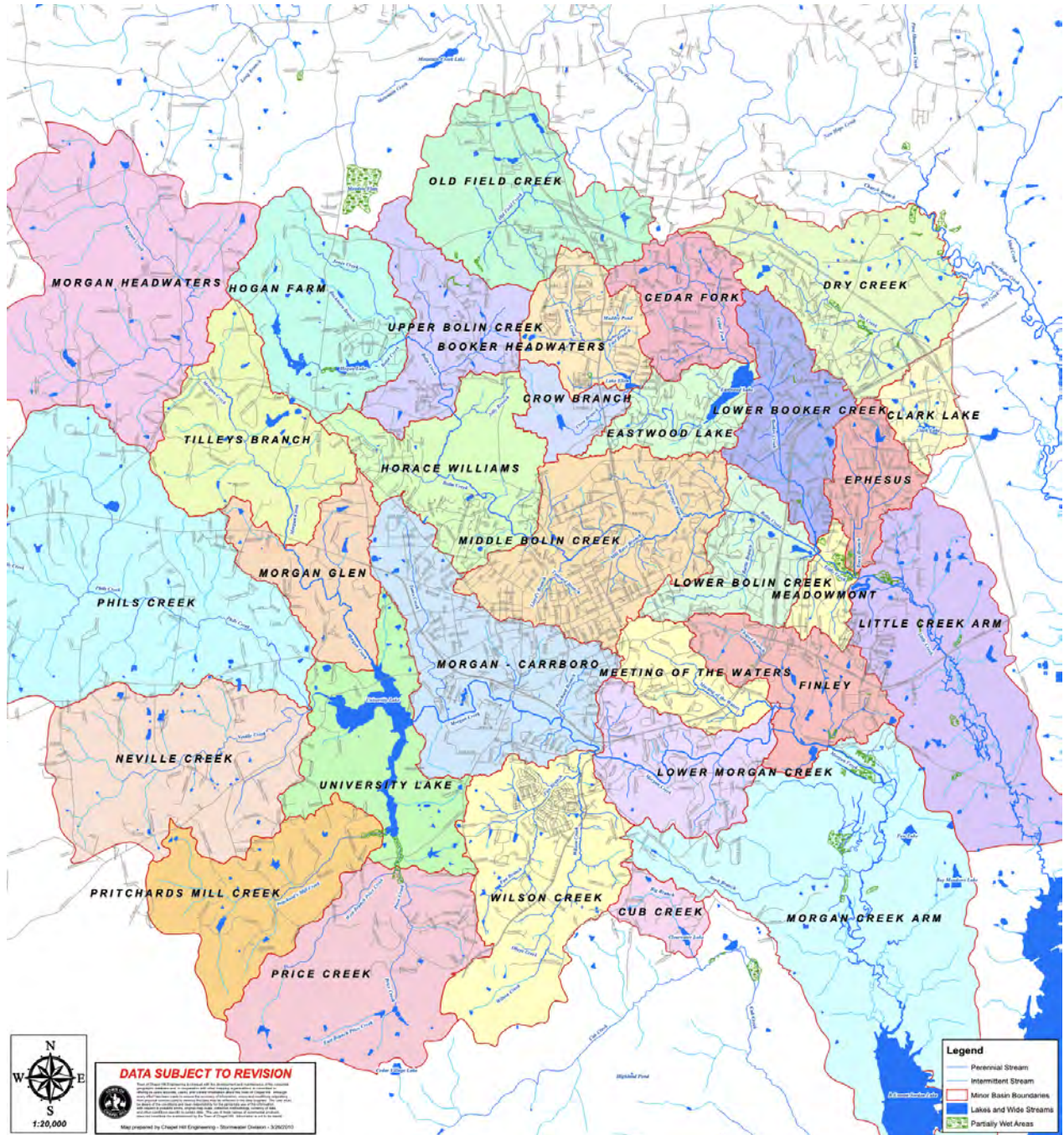
In partnership with NC State University, Friends of Bolin Creek hosted a series of community workshops designed to educate homeowners on proper construction, placement, and maintenance of rain gardens. After hosting a rain garden workshop at the High School, cosponsored by the Town of Chapel Hill, it was noted that those attending did not follow up and build rain gardens. Participants were surveyed to identify barriers. Some were concerned about finding the right place in their yard and sizing the garden properly. Others were put off by the size of the job and the type of plants to choose. We consulted with the Ellerbe Creek Watershed Association about Durham’s [Rain Catchers Program](#) to find tactics to ensure better follow through, such as providing individual counseling and offering free mulch and plants to those who committed to building a rain garden. During the subsequent workshops, presented with NC State, residents felt supported, and there was an increase in followthrough.

In 2017-18, FOBC worked with NC State and local homeowners to host two workshops in Backyard Stream Restoration. Using an exemplary home site on Bolin Creek, these workshops focused on identifying and demonstrating streambank restoration techniques homeowners could then implement on their property to protect property and improve habitat and water quality.

Battle Park Outreach

Appendix III. Watershed Ordinances

This map locates the Bolin Creek Watershed within the Cape Fear and Neuse watersheds.



<https://www.townofchapelhill.org/home/showdocument?id=12589>

Appendix IV. Bolin Creek Natural Area Wildlife Habitats

As discussed throughout this report, the unique natural landscape and living ecosystems of Bolin Forest are constantly influenced by both natural and manmade forces. This appendix presents more detailed information about terrestrial and aquatic habitats in Bolin Forest. We first provide an overview of the wildlife in this area (birds, amphibians, mammals, and reptiles, then provide a list of outside resources for readers to explore.

Terrestrial Wildlife

(Species with confirmed current presence are indicated with an asterisk* in the following sections.)

Birds

The variety of forest types within Bolin Forest provide habitat for a great diversity of bird species. Interior forest specialists, like the Wood Thrush, Cooper's Hawk, and the Worm-eating Warbler* (*Helmitheros vermivorum*), depend especially on habitats like Bolin Forest, as they can only breed in large forested regions (typically over 50 meters in width and larger than 100 acres). The large hardwood forest provides habitat for permanent residents, such as the Pileated Woodpecker* (*Hylatomus pileatus*), Barred Owl* (*Strix varia*), Red-shouldered Hawk* (*Buteo lineatus*), and Great Horned Owl* (*Bubo virginianus*). Bottomland hardwood regions are critical for other migrant breeders, such as Louisiana Waterthrush (*Parkesia motacilla*), Kentucky Warbler, and American Redstart* (*Setophaga ruticilla*). Pine-dominated sections of the forest provide habitat for species such as the Pine Warbler* (*Pine Warbler*), Brown-headed Nuthatch, and Eastern Wood-Pewee (*Contopus virens*) during the summer [16,6,8,14].

Other priority species that have been documented in the Bolin Forest include, but are not limited to, the Wood Thrush* (*Hylocichla mustelina*) and Brown-headed Nuthatch* (*Sitta pusilla*) which are both high-priority species in great decline in the Piedmont, the Hooded Warbler* (*Setophaga citrina*), the Northern Flicker* (*Colaptes auratus*), the Kentucky Warbler* (*Geothlypis formosa*), the Yellow-Billed Cuckoo* (*Coccyzus americanus*), the Cooper's Hawk (*Accipiter cooperii*), and various others. Blue Heron and Mallard Duck and Night Heron

In addition to providing a habitat for many priority species, Bolin Forest acts as a breeding or stopover site for neotropical migrant birds. These birds typically breed in summer in the U.S. and migrate south to spend winter in South and Central America. Stopover sites allow long-distance migrants to rest, forage for food, and get relief from storms, increasing their chance of survival. Research suggests these sites are specifically selected by migrant birds for their resources [40]. Bolin Forest is home to Neotropical migrant breeders such as the Worm-eating Warbler* (*Helmitheros vermivorum*), Swainson's Warbler (*Limnothlypis swainsonii*), the Hooded Warbler, the Northern Parula* (*Setophaga americana*), the Wood Thrush, and the Yellow-bellied Cuckoo, and Hummingbirds as well as many others. Riparian forests are critical for Neotropical migrants during migration periods. The *2015 NC Wildlife Action Plan* identifies the nesting bird concentrations in riparian forests as the highest in the state.

Amphibians

Low, wet areas of Bolin Creek Forest provide ideal breeding locations for amphibians. Wetlands can be found across the various tracts, and a vernal pool sits in Carolina North-west, on the eastern side of Seawell School Road. Amphibians depend on Bolin Forest's wetlands and floodplain pools for both egg deposition and larval development, while the hardwood bottomland forest regions provide quality habitat for adults looking to forage or evade predators [16].

According to the [Inventory of Natural Areas and Wildlife Habitats of Orange County](#), in 2004 Bolin Forest contained one of the nine sites in Orange County where the four-toed salamander* (*Hemidactylium scutatum*) was recorded. Number of current sites where the species is present is unknown. Although the authors speculate that the four-toed salamander population has since disappeared due to the destruction of a deep pool prior to 1998, verified individual sightings have occurred as recently as 2011, suggesting that the population still exists. Further studies are necessary to determine presence, population size, and demographics [16,6].

In addition to the state-listed four-toed salamander, other priority amphibian species found in Bolin Forest include the marbled salamander* (*Ambystoma opacum*), spotted salamander* (*Ambystoma maculatum*), northern slimy salamander (*Plethodon glutinosus sensu stricto*), and the three-lined salamander* (*Eurycea guttolineata*). Many other amphibian species live throughout the forest including: cope's gray tree frog (*Hyla chrysoscelis*), narrow mouth toad (*Gastrophryne carolinensis*), red-backed salamander (*Plethodon cinereus*), and various other relatively common species.

Mammals

Priority mammal species that likely reside in Bolin Forest include Silver-haired Bat (*Lasionycteris noctivagans*), a winter resident and migratory species, and the Eastern Mole (*Scalopus aquaticus howelli*). Many other ecologically significant mammal species can be found in Bolin Forest such as the American Mink* (*Neovison vison*), Muskrat (*Ondatra zibethicus*), and American Beaver* (*Castor canadensis*). American Beavers are a keystone species in riparian zones, and play an essential role in the health of wetlands, a critical habitat for many other species, such as amphibians. Eastern Coyote* (*Canis latrans*) are the only source of predation pressure placed on a healthy population of White-tailed deer* (*Odocoileus virginianus*) [16,14].

Reptiles

Like amphibians and small mammals, reptiles suffer greatly from habitat fragmentation. These species, unlike birds, are not able to easily move from one forest segment to the next for survival and reproduction. When roads divide usable habitat, fatalities increase and populations suffer. Fragmentation can also disturb the connectivity between aquatic and terrestrial systems, a habitat feature upon which many species rely. [14,16]

Priority reptile species in this region include, but are not limited to: Spotted Turtle (*Clemmys guttata*), Broadhead Skink (*Eumeces laticeps*), Eastern Box Turtle* (*Terrapene carolina*), Mole Kingsnake* (*Lampropeltis calligaster*) and watch-list species, Eastern Smooth Earthsnake (*Virginia valeriae valeriae*). The Slender glass lizard (*Ophisaurus attenuatus*), Scarlet Snake (*Cemophora coccinea*), and Scarlet Kingsnake (*Lampropeltis triangulum*), all state-listed rare species, were historically found in the region but current presence is unlikely.

Further Resources

Eno-New Hope Plan GIS Data

The [Eno-New Hope Plan Geographic Information System](#) data provides geographic visualizations of areas suitable for terrestrial wildlife, which also indicate landscape habitat integrity. The data focuses on the Eno River and New Hope Creek watersheds. Each area is ranked by “landscape connectivity value,” which measures how essentially certain areas contribute to a contiguous wildlife habitat area. As stated in the [Map Package Instructions and Metadata](#), “the layers are intended to be used as an aid to

conservation planning only and do not imply the existence of or use by particular wildlife species populations within a given area.”

Inventory of Natural Areas and Wildlife Habitat of Orange County

The most recent natural resource inventories of the entire Bolin Forest are from the 2004 [Inventory of Natural Areas and Wildlife Habitat of Orange County](#) conducted by the N.C. Natural Heritage Program (NHP). Though future surveys are necessary for a complete picture of current plant and wildlife populations, photographic evidence and expert eye-witness accounts have confirmed the continued existence of wildlife identified in the 2004 study.

Appendix V. Bolin Creek Natural Area Landscape and Geology

[The Geology of Bolin Creek and the Chapel Hill, North Carolina Area](#)

All of Bolin Forest and most of the Bolin Creek watershed lie on the Carolina Terrane, previously referred to as the Carolina Slate Belt. This geological region is defined by diverse, metamorphosed volcanic rock. Bolin Creek Forest’s terrain is typically gently rolling hills, upland ridges, slow moving streams and narrow floodplains. Loam and clay are the most common soil types found in the study area, often in combination with silt [1,2,4,6].

Forest Cover

Dry upland sites support species such as loblolly pine (*Pinus taeda*), post oak (*Quercus stellate*), blackjack oak (*Quercus marilandica*), pignut hickories (*Carya glabra*), and shortleaf pine (*Pinus echinata*) and Shagbark Hickory and tulip poplar. The understory includes redbud (*Cercis canadensis*), dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), and red cedar (*Juniperus virginiana*) and Fringe Tree. The herb layer is sparse in the upland regions [2,6,8].

Along lower slopes and high sections of the outer floodplain are mixed mesic hardwood sites. The canopy in these sites includes shagbark hickory (*Carya ovata*), white oak (*Quercus alba*), red maple (*Acer rebrum*), and southern red oak (*Q. falcata*) tulip poplar. Understory trees include Umbrella magnolia (*Magnolia tripetala*), a regionally rare species, and sourwood (*Oxydendrum arboretum*). Painted buckeye (*Aesculus sylvatica*) and spicebush (*Lindera benzoin*) are common in the shrub layer [2,6,8].

The canopy of Bolin Forest's lowland regions includes hardwoods like sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), beech (*Fagus grandifolius*), and American Sycamore (*Platanus occidentalis*) and Paw Paw. A few small natural depressions supporting willow oak (*Quercus phellos*) have been recorded, although a more recent survey is needed to verify these still exist. The herb layer is dense near Bolin Creek. Japanese stiltgrass (*Microstegium vimineum*) and Chinese privet (*Ligustrum sinense*), both invasive competitors of native plants, are abundant near the OWASA corridor and in the floodplain [2,6,8].

Recreational and utility use (such as the OWASA corridor) have altered the vegetation that once existed along the floodplain. Where trees are still present, they are younger and smaller in diameter. Such use has also led to bank erosion and creek incision throughout the forest [1,8]. Altered hydrology can greatly reduce connectivity between the creek and floodplain, which is an essential feature for wildlife. Heavy use of forest trails also results in lack of vegetation and compacted soils. Trail braiding (the splitting of one trail into multiple smaller trails) also occurs throughout the forest, further increasing these effects. In locations throughout Bolin Forest, trail proximity to the creek as well as disturbance to sewer line placement has resulted in soil erosion increasing sedimentation in Bolin Creek and its tributaries.

The Adams Tract is mainly mature pine-dominated mixed hardwood forest. The upland hillside descends steeply to the creek on the north side of the property where the forest is dominated by mixed hardwoods, with a small bottomland forest segment. A more detailed description of the site can be found in the Town of Carrboro's *3-Year Management Plan of the Adams Preserve*.

Prior to 2019 logging, the P.H. Craig Tract was characterized by mixed old growth hardwood and pine accompanied by handsome granite outcroppings from an earlier volcanic period. The tract contained both mature pine/hardwood forests in upland locations and mature bottomland floodplain forest near the creek. The most mature portion of the tract contained trees that are estimated to be at least 100 years old [2]. Wedged between two forested tracts already dedicated to conservation (owned by UNC and Carrboro respectively), conservation of this land would provide vast benefits for forest and stream connectivity. While logging has removed vegetation from the majority of this tract, its location favors a restoration to native piedmont forest or prairie.

The Carolina North- West property consists of bottomland hardwoods along Bolin creek, mixed pine/hardwood throughout, and dry oak-hickory forest in upland regions. The most

mature portion of all of Bolin Forest exists in the northwest corner of this property, west of Bolin creek, with trees at least 110 years old. Mixed pine/hardwoods in hillier regions along the floodplain are estimated to be at least 80 years old, and along the eastern edge of the parcel, where cultivated pines are dominant, mixed hardwoods have emerged in the understory and are entering late successional stage [3]. The classifications are based on the [Carolina North Proposed Conservation Area Descriptions Report](#).

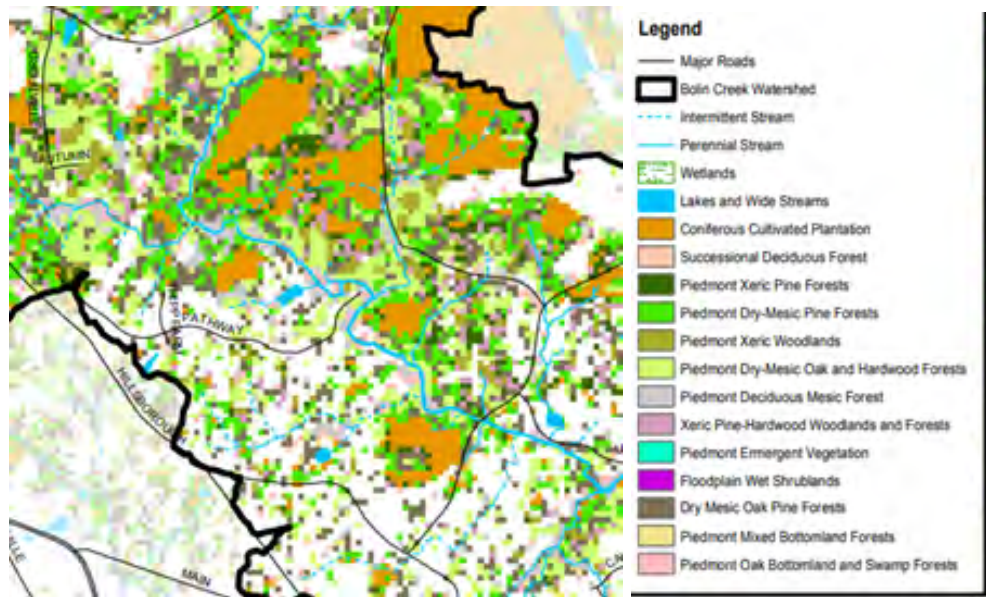


Figure: Natural Heritage Programs Historic Plant Communities classification based on 1986 aerial images.

Status

The 2005 *NC Division of Water Quality (DWQ) Cape Fear Basinwide Plan* first identified Bolin Creek as an “impaired” stream. The main basis for Bolin Creek’s classification as impaired is a series of benthic macroinvertebrate surveys conducted between 1993 and 2003 by DWQ. It is also supported by frequent annual monitoring carried out by the towns of Carrboro and Chapel Hill since 2000. These studies found the creek was biologically impaired, with a decrease in biodiversity and environmentally sensitive species with movement downstream. In addition, impairment is not a stationary problem: over time, the site of impairment moves upstream. Degradation in Bolin Creek was once only present in downstream areas of high development and, without restoration efforts,

will proceed further upstream [1,7,26]. As the DWQ uses presence and abundance of diverse aquatic organisms as an indicator of stream health, impairment status suggests an inability to support biological species as expected in a comparable, fully functional stream.

Hydrology and Fluvial Geomorphology

Bolin Creek has been studied extensively since biological impairment became evident. In 2003, as part of the NC Ecosystem Enhancement Program, DWQ completed a watershed assessment of the Little Creek watershed, including Bolin Creek. Results were published in the [“Assessment Report: Biological Impairment in the Little Creek Watershed.”](#) In 2004, as part of the Morgan Creek and Little Creek Watershed Plan, a [Morgan Creek Detailed Assessment Report](#) and subsequent *Targeting of Management Report* was published. The latter report proposed management strategies to address the targeted areas for restoration. Though none of the suggested restoration sites were within Bolin Forest, one site was upstream of Bolin Forest, within Hogan Farms Subdivision. At this site, the report recommended establishing a wider floodplain at the channel’s existing elevation in order to make the floodplain accessible. As discussed in 1.1.6, a functioning floodplain will filter pollutants in periods of high flow, stabilize the stream bed, and increase overall functionality of the stream. See the [Targeting of Management Report](#) for more details on this recommendation.

Aerial images, taken in 2003, revealed the watershed’s upper portion as nearly 50 percent forested, with low percentages of impervious surfaces and relatively low levels of riparian buffer disturbance. Analysis of more recent aerial images is lacking. Both benthic community and water quality ratings are better than those of the watershed’s lower reaches [7]. However, as several studies note, this portion of the Bolin Creek is likely the most susceptible to future development [1,3,7].

Due to the geological features of the Carolina Terrane, bedrock substrate can be found throughout the watershed. At these locations the stream banks are relatively stable and incision is not common, though where bedrock is absent, incision and consequential widening have occurred [1,4]. The lower portion of the watershed, downstream of Bolin Forest, sits on the Triassic basin, where incision, erosion, and sedimentation are common. This portion has lower quality aquatic habitat due to problems such as reduced riparian tree canopy and channel instability [1,4,7,9]. Impairment of Bolin Creek downstream of Bolin Forest further emphasizes the need for the preservation of this natural area.

In 2011, the *Carolina North Proposed Conservation Area Descriptions Report* noted that within Carolina North-West, Bolin Creek is highly incised in the upper reaches and less incised farther downstream. The intermittent tributaries have lower levels of incision and generally stable channels [1,3]. There are two points of direct stormwater runoff from Seawell School Road into two different tributaries. Recent construction at the high school entrance will also result in another source of direct stormwater runoff into Jolly Branch (a tributary of Bolin Creek).

Water Chemistry

There has been no regular monitoring of water chemistry in Bolin Creek since Chapel Hill discontinued this practice in 2010. Chapel Hill's website states that the town will conduct "occasional spot-checks of water chemistry in response to reports of dumping or spills." In 2012, the town completed [the Bolin Creek Watershed Restoration Plan \(BCWRP\)](#), which reviewed all existing studies of the watershed including water chemistry monitoring. According to the BCWRP, "analysis for status and trends in water quality conditions showed no clear trend for any constituent except for expected seasonal variations in temperature and dissolved oxygen. No clear pattern of exceedance of state standards was apparent from the available data, either." The study notes monitoring for these specific constituents as they are known to be associated with urbanization, but these standards are not necessarily the most important constituents to evaluate when determining stream health [1,2].

Jordan Lake has had consistently high nutrient levels since its creation in 1983. To address this issue, they developed the [Jordan Lake Nutrient Strategy](#). This strategy includes the creation and implementation of the Jordan Lake Rules, which were intended to improve water quality of the lake and watershed by minimizing nutrient pollution into the lake.

The 2019 [Jordan Lake Study](#), commissioned by the NC General Assembly, presents ideas on how to more equitably apportion the costs of paying for nutrient and management watershed work to meet the Jordan Lake Rules for existing development.

Appendix VI. Watershed Restoration Efforts

The towns of Chapel Hill and Carrboro received two EPA 319 Grants for water quality monitoring and restoration in the Bolin Creek watershed. Under these grants, NC State University Department of Biological & Agricultural Engineering designed and implemented stream restoration projects, water quality monitoring, and stormwater

bioretention projects, including one in Dry Gulch, a Bolin Creek tributary in the Pacifica residential neighborhood. More information on that specific project can be found in the [Dry Gulch Final Report](#).

Invasive Plant Species Control

In 2014 and 2015, 6 neighborhoods (3 phases of Bolin Forest, Quarterpath Trace, Forest Court, and The Cedars) and the Town of Carrboro collaborated to address invasive plants and to promote healthy trees. With \$10,000 in support from the NC Forest Service through an Urban and Community Forestry Grant, and a \$10,000 in-kind match from 580 hours of volunteer time from over 100 volunteers, invasives were addressed at four levels:

1. At the entrance to Bolin Forest, a significant wisteria invasion had killed dozens of trees and bushes in the green buffer zone between two HOAs. The grant supported two environmental consultants to treat the wisteria, plant cover crops, and to spend four workdays working with volunteers to remove dead trees and bushes, and to purchase, plant, and mulch one hundred native trees. Following the grant, volunteers have continued to water, mulch and implement deer protection to support healthy growth of the young trees.
2. An awareness and action workday was held across these neighborhoods to identify and manage Japanese stiltgrass. The environmental consultants shared management strategies, and multiple teams spread out to remove Japanese stiltgrass in common areas and private yards. Print and electronic materials were shared through HOAs to support ongoing stiltgrass control.
3. An [urban forestry stewardship plan](#) was developed by the consultants and is posted on the Town of Carrboro website.
4. A community-wide forum was held at the Carrboro Century Center, where 75 attendees gathered to share the urban forest stewardship plan, and to discuss how these neighborhoods addressed invasives and planted trees as a model for other neighborhoods.



Local business Townsend Bertram & Co coordinated with Friends of Bolin Creek on annual invasive plant removal events on the Adams Tract.

Table 3. Significant Animal Species of Orange County (Page 1 of 2)

Endangered:

Alasmidonta heterodon	Dwarf Wedgemussel
Alasmidonta varicosa	Brook Floater [mussel]
Fusconaia masoni	Atlantic Pigtoe [mussel]
Lampsilis cariosa	Yellow Lampmussel
Lasmigona subviridis	Green Floater [mussel]
Picoides borealis	Red-cockaded Woodpecker
Toxolasma pullus	Savannah Lilliput [mussel]

Threatened:

Haliaeetus leucocephalus	Bald Eagle
Alasmidonta undulata	Triangle Floater [mussel]
Lampsilis radiate conspicua	Carolina Fatmucket [mussel]
Strophitus undulates	Creper [mussel]

Special Concern:

Etheostoma collis	Carolina Darter
Hemidactylium scutatum	Four-toed Salamander
Necturus lewisi	Neuse River Waterdog [amphibian]
Tachopteryx thoreyi	Gray Petaltail [dragonfly]
Villosa constricta	Notched Rainbow [mussel]

Significantly Rare:

Accipiter striatus	Sharp-shinned Hawk
Ambloplites cavifrons	Roanoke Bass
Lythrurus matutinus	Pinewoods Shiner
Vireo gilvus	Warbling Vireo
Diacyclops jeanneli putei	Carolina Well Diacyclops
Cambarus davidi	Carolina Ladle Crayfish

Regionally Rare:

Acantharchus pomotis	Mud Sunfish
Allothrombium sp.	Sumo Mite
Amblyscirtes hegon	Pepper and Salt Skipper
Ameiurus brunneus	Snail Bullhead
Amia calva	Bowfin
Ammodramus savannarum	Grasshopper Sparrow
Anolis carolinensis	Green Anole
Bombycilla cedrorum	Cedar Waxwing
Buteo lineatus	Red-shouldered Hawk
Buteo platypterus	Broad-winged Hawk
Callophrys augustinus	Brown Elfin
Callophrys henrici	Henry's Elfin
Callophrys niphon	Eastern Pine Elfin
Centrarchus macropterus	Flier [fish]
Chlosyne nycteis	Silvery Checkerspot [butterfly]
Dendroica petechia	Yellow Warbler
Elaphe guttata	Corn Snake

[*Inventory of Natural Areas and Wildlife Habitat of Orange County*](#) 2004

(Table 3. Page 23)

Appendix VII: What a Healthy Urban Forest Looks Like

How do we determine when an ecosystem is healthy or when it is in need of restoration?

Like all ecosystems, at the heart of the Bolin Creek Natural Area is a complex web of interactions between biotic (non-living chemical and physical factors in the environment which affect ecosystems) and abiotic (living components of an ecosystem, like plants and animals) factors. These factors, such as soil composition, quality of the water, diversity of plants, animals, and microorganisms all play critical roles in determining forest health. Maintaining the delicate balance of these functions becomes increasingly difficult when a natural area is surrounded by growing urbanization.

Human influence on forest health is profound, which is why maintaining good health in urban forests can be a daunting task. Despite these challenges, a healthy urban forest is possible with proper management and a dedicated community. A truly healthy urban forest can meet the needs of human and natural communities simultaneously, providing a resource to local residents while sustaining the diverse interactions and functions that are unique to the natural ecosystem.

The various plant and animal species in a forest fulfill different ecological functions, so diversity is crucial. Plants with deep roots, for example, absorb water and move nutrients through the soil layers, providing nutrients to plants with more shallow roots. They also stabilize soil and prevent erosion. This is an especially important process near stream beds in riparian areas, where natural floodplains connect aquatic and terrestrial ecosystems, facilitating valuable functions such as water filtration and sediment deposit.

Even dead trees, such as snags or logs, serve a necessary purpose, providing biomass and serving as a habitat for species like owls, woodpeckers, and roosting bats. Later, decomposers in the soil like worms, beetles, and other invertebrates break down these trees and other organic matter on the forest floor, converting the matter into usable nutrients for plants and other organisms. Healthy soil is loose and porous, allowing for water infiltration and aerobic decomposition.

Because of the delicate relationship between plant and animal life, a healthy forest must also be a diverse forest. In healthy ecosystems, animals help to maintain a balanced ecosystem. Animals disperse seeds, control growth of understory shrubs and herbs through grazing, and contribute to nutrient enrichment of the soils.

Healthy forests must also be well-connected and contiguous to host sufficiently diverse and healthy wildlife. This continuity prevents wildlife death from road crossings and increases the carrying capacity of animal species. Some animals require large forests, while others prefer small forest patches, or forest edges. Some animals require vernal pools for breeding, while others dwell in rock crevices and outcroppings. A diversity of micro ecosystems allows for a greater diversity of animal species and a healthier, more resilient ecosystem.

Flooding is a common occurrence in the Southeast, and climate models predict heavier and more frequent storm events in our future. In a healthy ecosystem, rainwater falls on or is directed to permeable surfaces, where it can be filtered and stored before reentering the watershed. Stormwater and groundwater enter the stream slowly, both decreasing bank erosion and allowing for groundwater recharge to occur.

[The Town of Carrboro has adopted a Climate Action Plan.](#)

Appendix VIII: Doug Frederick Memorandum. July 23, 2018.

Memorandum

To: Mayor Lydia Lavelle and Carrboro Board of Aldermen
From: Doug Frederick, Professor of Forestry
Date: July 26, 2018
Re: PH Craig Forest

Over the past months, I have visited and explored PH Craig's property in Bolin Forest, studying the health of the forest ecosystem and the potential value of the property for both timber harvest and conservation. I have reviewed the December 2017 forest management plan submitted to Mr. Craig by the NC Forest Service and I have also, on several occasions, spoken directly with Mr. Craig's consulting forester, Mr. Bill Dryman, to better understand their rationale and details of their proposed harvest.

The following is my objective assessment of the property based on 40+ years as a working forester and university educator in the field of forestry. My bio is attached at the bottom of this document for your reference.

I would be happy to answer any follow-up questions or discuss these important issues further by phone, email or in-person meeting at your convenience.

Thanks in advance for your consideration.

Sincerely,

Douglas Frederick, PhD

Douglas Frederick, PhD

Present Status

This 77-acre tract of forested land is located along the eastern edge of Bolin Creek, wedged between the 325-acre Carolina North Forest and the 27-acre Adams Tract. The tract contains both upland and floodplain forests. There are significant areas of steep slopes with fragile soils. The adjacent tracts are conserved in some fashion. Carolina North contains conservation areas – some dedicated for 50 years and some in perpetuity by the University of North Carolina and the Town of Chapel Hill – as memorialized in the 2009 Carolina Development Agreement. Orange County and the Town of Carrboro purchased the Adams Tract in 2003 for conservation purposes.

Previous Studies

This tract has been identified as a Natural Heritage Site which means it has special ecological significance and is recognized by the State of North Carolina. A 2004 baseline study established that this tract, together with the adjacent tracts, forms an area of special significance worthy of preservation.

Forest Health

There are very few privately owned forest stands in the Triangle area that are as well developed as the Craig stand. The forest on this tract is a diverse mixture of mature upland hardwoods in very good health and growing well. It has significant ecological values (including water quality protection, wildlife habitat, biodiversity, etc) as well as long-term scientific value for teaching and research. Its location also makes it an ideal site for educational and outreach use by the Carrboro and Chapel Hill public schools and the University of North Carolina and NC State University. The forest is a prime example of a forest entering "old-growth" conditions, which makes it an invaluable "reference forest" for management and ecological studies. In addition, its location in a rapidly urbanizing landscape makes it exceptionally valuable for recreation as a mature forest 'green-space'. It also has high value for carbon sequestration due to the annual growth and large quantities of accumulated biomass. Unlike a young regenerating forest, this forest has maximum ecological diversity. It is far more valuable in its current state than it would be as a loblolly pine plantation, which is Mr. Craig's stated plan for the property after clear-cutting.

Forest Management Plan

I do not dispute that Mr. Craig has every right to clear-cut his property. As I have said before, goals and objectives are the right of the landowner and he has sought advice from professionals, so it is not solely his decision. I respect the NCFs foresters and Bill Dryman for their recommendations and advice, as well as the woods experience of PH. However, in this particular situation, I don't agree with their assessments of fire danger and liability to adjacent landowners and, the risk of insect attack in the mature pines. I suspect that the primary motivation is a desire to maximize timber profits (both short and long term) at the expense of preserving and cultivating the overall value of the land.

To me, the most compelling reason to protect and preserve this property is the ECOLOGICAL QUALITY and LOCATION of this forest.

The Craig forest sits in the middle of an urbanized landscape, and that location makes it far more valuable in its present, undisturbed, 'old growth' condition than if it were located in rural Orange County. The community is and will be able to use and enjoy this mature forest much more easily and have an opportunity to see and experience a mature Piedmont forest unlike the vast majority of forest tracts.

From my firsthand assessment, I don't believe Mr. Craig's timberland is in immediate danger of loss by insects, disease, fire or other factors and, as such, there is no critical need to clear cut harvest this stand at present.

I do acknowledge that 80-to-90-year-old pine timber poses some risks by not cutting. There is some future risk from beetles, heart and root rot etc. but minimal danger of liability from fire. Young pine stands are much more vulnerable to crown fires that could spread to adjacent communities. Mature stands of pine and hardwoods like the Craig stand will have occasional mortality but this is natural and doesn't mean the entire stand should be clear-cut out of fear of losing the entire forest.

There are several healthy stands of mature, 90+-year-old pine and hardwoods within 50 miles of the Craig tract, which stand as prime examples of stands that are preserved in their natural state with no cutting. NC State University has stands at Hill Forest, north of Durham, and Schenck Forest outside of Raleigh. Duke Forest also has stands preserved with no cutting because of their ecological, teaching and research significance. Neither Duke nor NC State have any plans to cut these forests since their value lies in their natural development, old age structure and the rich biodiversity they support. These forests are best used for research, teaching, and public enjoyment. Forests like these are notably rare, but that is all the more reason to protect them as we also strive to allow younger forests to reach a similar late successional stage. We can better manage young forests if we understand the growth patterns, structure and dynamics of mature and older growth forests such as the Craig Forest.

Umstead State Park is another excellent example of a large, protected forest (5000+ acres) with stands aged 90 to over 150 years old and still in very good condition. Individual trees die every year at Umstead as part of a natural cycle, but the forest continues to evolve with some large pines and hardwoods dying and being replaced with younger trees in openings. Species composition changes but this is the natural succession in Piedmont mixed pine / hardwood forests. There are scattered outbreaks of pine beetle attacks in Umstead Park but that does not threaten the entire forest. The same would be true on the Craig property.

I agree with Mr. Craig that "select cutting" of his tract is not a good idea at this stage of development and I am not recommending that option. I believe the choice is clear-cutting the stand or preservation.

Risks of Clearcutting

Clearcutting this property would yield significant monetary value from the pines and the white oaks, yellow poplar and other hardwoods, but there will be a high price to pay in terms of the negative ecological impacts of road building, harvesting machinery, soil erosion and degraded water quality. Further, the starkness of a stump-field in the middle of a now-contiguous forested corridor along and adjacent to Bolin Creek will be a visual scar on Bolin Forest for decades and generations to come. This corridor needs to be protected and preserved intact for the community and for future generations of students, hikers, bikers, researchers and wildlife.

In his Herald Sun editorial published on June 27,2018, Mr. Craig wrote, *"I hope I have adequately explained why I have to clear cut portions of the most beautiful tract of land in Orange County"*. The community meeting held on June 21st, 2018 at Smith Middle School showed clearly that several hundred of Mr. Craig's friends, neighbors and community leaders think there are other factors to consider in deciding the fate of these 34 acres.

Considerations for a Proposal

If an agreement can be reached with Mr. Craig to protect this property and not clear cut the 34 acres, I feel strongly that Mr. Craig and his forestry consultant should be fully compensated for current expenses, Mr. Craig's land and the timber on his tract. That is only fair.

Any viable proposal from the City(s) or County should agree to compensate Mr. Craig fully for both the value of his timber and the value of his land. Mr. Craig should also be publicly recognized for his past, present and future stewardship of the property, which could be accomplished via naming rights (The Craig Preserve), a plaque or statue, and other formal recognition.

It is unequivocally the overwhelming desire of the community, neighbors and elected officials from Carrboro and Chapel Hill for this property not to be clear cut but to be left in a natural state. The risks to the mature timber are recognized but the true value of this tract in an undisturbed condition outweighs all natural risks.

I believe the property is best protected under a long-term conservation easement, where the land can become part of the publicly protected land in the County to be enjoyed by the public and used for teaching, research and the long-term benefit of the community.

One constituency voice that might help would be a letter from the HOAs of adjoining neighborhoods stating that they respect Mr. Craig's right to cut his trees but urging him not to use a questionable threat to their neighborhoods as justification for the clearcutting. If Mr. Craig just came out and said, "I want to make money and its my land, so I am going to cut", we would have to accept his right to make that decision. However, his fire and beetle risk justifications he has stated publicly to date, in my opinion, are either overstated or, in some cases, false.

Your objective would be to ask Mr. Craig to consider not cutting his 34-acre planned harvest area before he fully weighs the consequences and the tremendous long-term value this tract will have for the communities and citizens nearby. I think this tract together with adjacent protected lands could become a jewel in the

center of an urbanizing landscape where we are losing more mature forestland each year.

The only real option we have at this point is to approach Mr. Craig with a proposal that we would like to finance the purchase of his land so that we can preserve it. That offer should be made by Mayor Lydia Lavelle and another independent party as part of the discussion.

The last example of a late successional forest that may be a useful comparison is as follows: The North Carolina Botanical Gardens in Chapel Hill has large forested areas that have been preserved and no cutting is allowed. That tract is similar to Craig's tract and has large pines and hardwoods. It is a very old and healthy forest and not in imminent danger of degrading. Trees occasionally blow over and some get beetles. There is little risk of fire either on the tract or danger to adjacent landowners. The tract has (and will) have many, large trees with new ones filling openings after wind throws. There is no immediate desire or need to do cutting in that stand. The objectives of ownership can be preservation, aesthetics and maintaining a late-successional ecosystem with all the biodiversity and carbon sequestration that goes with that objective. I recommend asking the Director of the Botanical Gardens for help in making the case that there is no "imminent danger" of preserving an old stand of trees.

My Background

I have been teaching forestry at NC State University for 41 years, where I currently hold the position of Professor of Forestry. I teach 5 undergraduate and graduate courses and work in private forestry consulting in the summer as well as during the academic year. As faculty members, we are encouraged to maintain our consulting practice since it brings practical experience directly to our students.

I have maintained my active consulting business in forestry for many years. I have worked with large and small private landowners plus I have worked for large corporations through our NC State Research Cooperatives program as well as through attorneys who represent large companies like Weyerhaeuser and International Paper Company. Work with these companies involved management strategies with natural hardwoods, natural pine and pine plantations.

I have served as Chairman of our College Forests Advisory Committee in the Department of Forestry and Natural Resources for over 25 years and in that role I have had direct impact in the management of our College Forests, which includes several thousand acres in the Piedmont and the Coastal Plain. That role is in advising our College Forests Manager on management, timber sales, reforestation and all aspects of silviculture of natural stands and plantations. My responsibilities include advising on decisions re: harvesting, replanting, burning, herbicide use and designating stands as protected natural areas for no harvesting. We have dedicated significant areas across our College Forest as 'natural areas' with no cutting planned. The Society of American Foresters has recognized our work preserving these areas for research, teaching, and use as long-term reference sites.

I also manage my own private timberland tracts. I have managed a large tract in Pennsylvania for over 50 years and have conducted 3 partial cuts in which I personally marked every tree for harvest and marketed the timber. I have gifted this tract to my two sons and they plan to continue to sustainably manage the property. We have considered managing this tract for old-growth conditions since, after three improvement cuttings, all the trees are large and in very good health.

I own and manage a mixed hardwood and pine tract in Chatham County on the Deep River. I salvage-logged this tract after Hurricane Fran with the objective of creating a mixed stand of large trees. I marked the timber and arranged for marketing it.

Appendix IX. Climate Change Resources

Carrboro Community Action Plan (include link)

Chapel Hill Draft Climate Action Plan

[Global Warming \(and its effects on stormwater\)](#), Presentation by Tom Grizzle to

Booker Creek Watershed Alliance

Appendix X. Gordon Merklein Correspondence



THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

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April 11, 2012

Julie McClintock
Friends of Bolin Creek
614 Beech Tree Court
Chapel Hill, NC 27514

Dear Ms. McClintock:

We are in receipt of your letters dated December 31, 2011 and March 12, 2012 regarding a January 6, 2011 memo drafted by individuals on the Carolina North Trails and Forest Advisory Committee.

At this time, there is no action which the University of North Carolina at Chapel Hill has taken, or has been asked to take, in regards to any type of trail along Bolin Creek as it relates to plans by the Town of Carrboro. The University will have no formal recommendation(s) regarding any type of trail along Bolin Creek until it has received an official request from the Town of Carrboro to review or approve a request for a trail on University property along Bolin Creek, should the Town of Carrboro ultimately pursue such a trail.

If the University is asked by the Town of Carrboro to respond or approve a request for a trail that impacts University property, then appropriate University staff will formally review the request and seek input from multiple sources, including the Carolina North Trails and Forest Advisory Committee, the public, and others. Given the passage of time since the January 6, 2011 memo was drafted, additional research will be required before the University could respond to any request, if one is received.

In regards to your request for the University to withdraw the above mentioned memo, the University respects the rights of the individual members of the Carolina North Trails and Advisory Committee to express their opinions. Ultimately it is up to the University, not an advisory group, to make any final decisions or recommendations regarding issues associated with Carolina North.

Regards,

Gordon Merklein
Executive Director of Real Estate Development

cc: Patricia Crawford
Bruce Runberg
Leslie Strohm
Anna Wu

Friends of Bolin Creek
614 Beechtree Court
Chapel Hill, NC 27514

Mr. Gordon Merklein
Executive Director of Real Estate
University of North Carolina
Campus Box 1000
Chapel Hill, NC 27599-1000

Dear Mr. Merklein:

Thank you for your letter of April 11, 2012, responding to the Friends of Bolin Creek letters of December 31, 2011 and March 12, 2012. We are very heartened by your assurances on our central concerns.

I do want to correct what seems to be a misinterpretation of our concerns in your last paragraph. We have no objection to the Trails and Forest Committee or any other interested individuals making recommendations to the University. What caused our concern was the distribution of the Memo in question by the University with the agenda package for the October 25, 2011 meeting of the Trails and Forest Committee, creating the impression that the University had validated the Memo and was preparing to use it as a basis for a decision. As we explained in these earlier letters, the January 6, 2011 Memo is based on assumptions unsupported by the extensive scientific information available on Bolin Creek and on a misinterpretation of state policies. This Memo is therefore not a suitable basis for University decisions.

We appreciate your assurances that if the University does decide to develop a position on this paving issue, that you will involve the public in a transparent decision process and also your indication that further research into the issue beyond the Memo will be necessary. This direction is appropriate, considering the responsibilities undertaken by the University in the development agreement and the outstanding natural values of this segment of Bolin Creek.

We look forward to continuing to work with you and other University representatives on our common concerns for managing the natural resources of Bolin Creek.

Sincerely,



Julie McClintock

cc: Patricia Crawford
Bruce Runberg
Leslie Strohm
Anna Wu