The Urban Forest of Mebane, NC

An Analysis of Tree Benefits for Stormwater Management

September 15, 2018

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September 15, 2018

Green Infrastructure Center

Photo Cover Credit: Photo by City of Mebane. Photo of sculpture Winged by Mike Roig

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Table of Contents

Project Overview

This project mapped the urban forest of the City of Mebane, North Carolina and evaluated the role that tree canopy plays in intercepting and taking up stormwater and reducing water pollutants, such as nitrogen, phosphorus and sediment.

The City of Mebane can use the results to:

- Evaluate how to integrate trees into the city stormwater management program
- Understand how the urban forest benefits Mebane
- Learn why the city should continue to undertake tree planting and management

Why Map Urban Canopy?

Trees are declining throughout the southern United States. Causes for this decline arise from multiple sources including land conversion for development, storm damages, hurricanes such as Florence, and lack of tree replacement as older trees die. Many localities have not evaluated their current tree canopy, which makes it difficult to track trends, assess losses or set goals to retain or restore canopy. Mebane now has baseline data to monitor canopy protection progress, measures of the stormwater and water quality benefits of its urban forest, and can prioritize restoration of canopy where it is most needed.

Trees are the city's 'green infrastructure.' Just as we manage our grey infrastructure (roads, sidewalks, bridges and pipes), we also need to manage our 'green infrastructure' (trees and other vegetation). The city's green infrastructure provides many values that are needed for a vibrant, safe and healthful city. Trees add to the city's historic character, and they enhance its livability by filtering storm water and reducing runoff, cleaning the air, providing oxygen, shading, and natural beauty and enhanced property values. As the City of Mebane grows, it should continue to manage and expand the urban forest to maintain a livable city that meets its goal to be 'positively charming.'

Project Funders and Partners

The North Carolina Forest Service (NCFS) provided funds for the City of Mebane to evaluate how its trees can be utilized to meet goals for stormwater management. The project was conducted by the nonprofit Green Infrastructure Center Inc. (GIC) in partnership with the NCFS and the City of Mebane. The GIC created the data and analysis for the project. The project utilized GIC's mapping and its tree stormwater calculator tool, the Trees2OffsetH20. The project began in April 2018 and concluded in September, 2018.

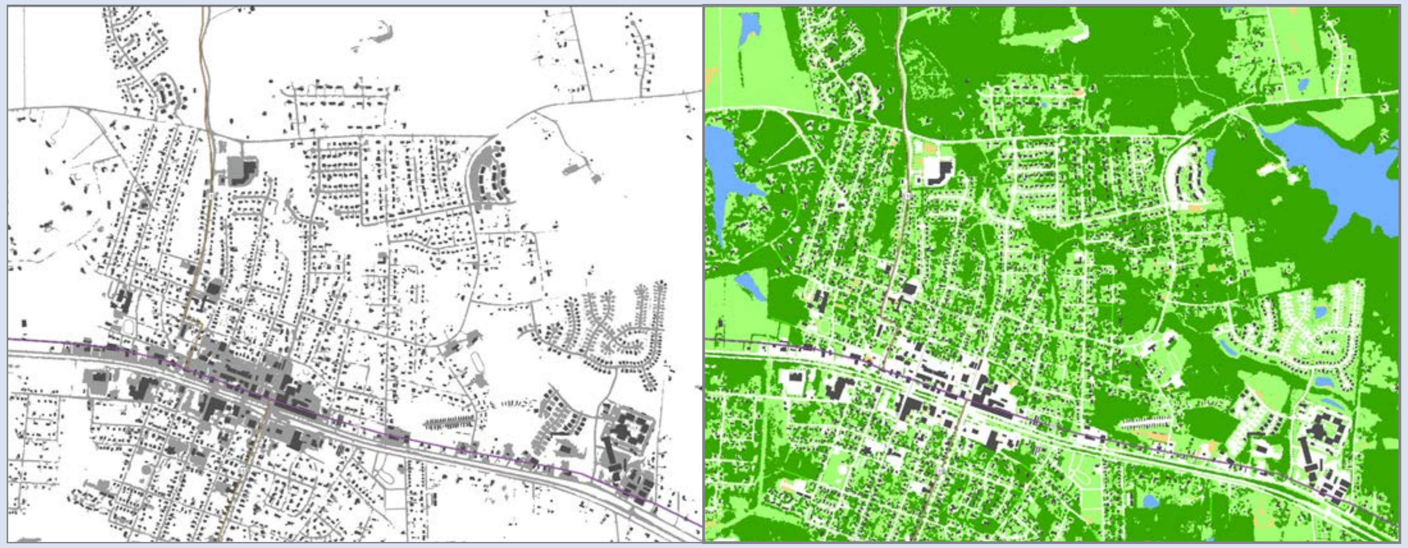


Image at left shows Mebane's gray infrastructure including buildings and roads. Classified high-resolution satellite imagery (right) adds Mebane's green infrastructure data layer (trees and other vegetation). The green infrastructure provides cleaner air, water, energy savings and beauty.

Outcomes

Mebane currently has very good canopy coverage at 38.7 percent. As the city grows and develops, it will be important to maintain existing coverage and to plant replacement trees before older trees die or are removed.

This report describes the city's current canopy coverage, the method used to map the canopy, an analysis of the canopy's stormwater uptake and an analysis for where the city can plant more trees to expand the urban forest where it is lacking. More specifically, these products were created:

- Analysis of the current extent of the urban forest through high resolution tree canopy mapping,
- Possible Planting Area analysis to determine where additional trees could be planted, and
- A calculation for stormwater uptake and pollution removal by the city's tree canopy.

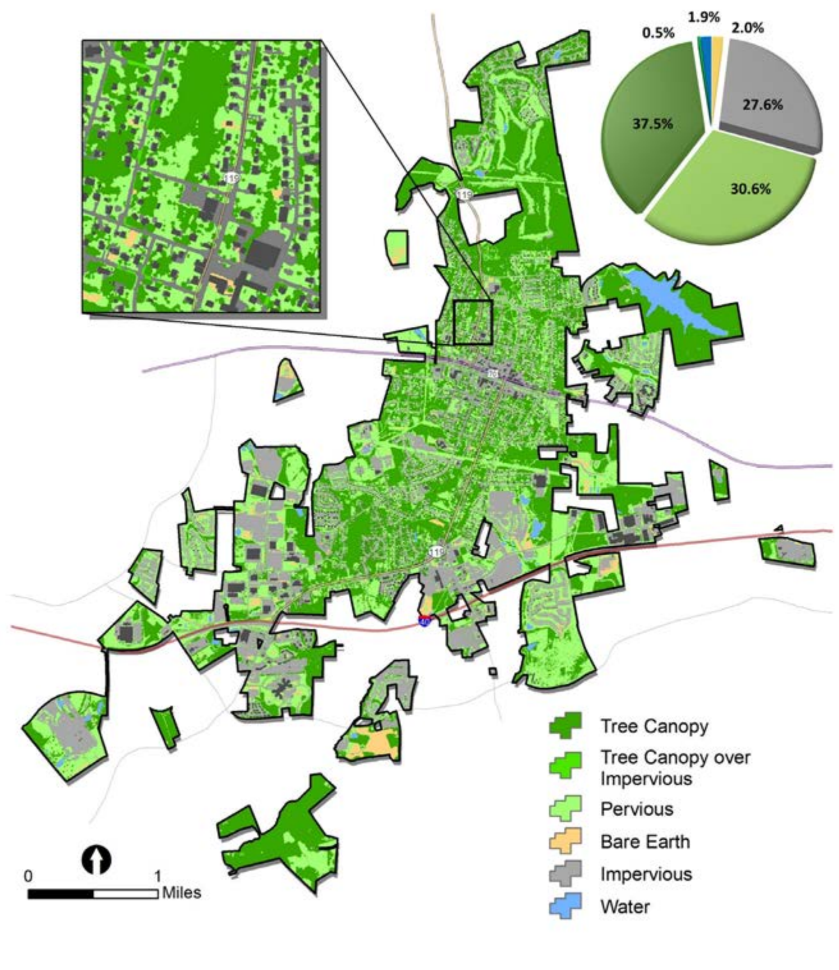
A next step for the city is to review its relevant city codes and ordinances using GIC's policy analysis tool and to create an urban forest management plan to better care for and replant the city's canopy.

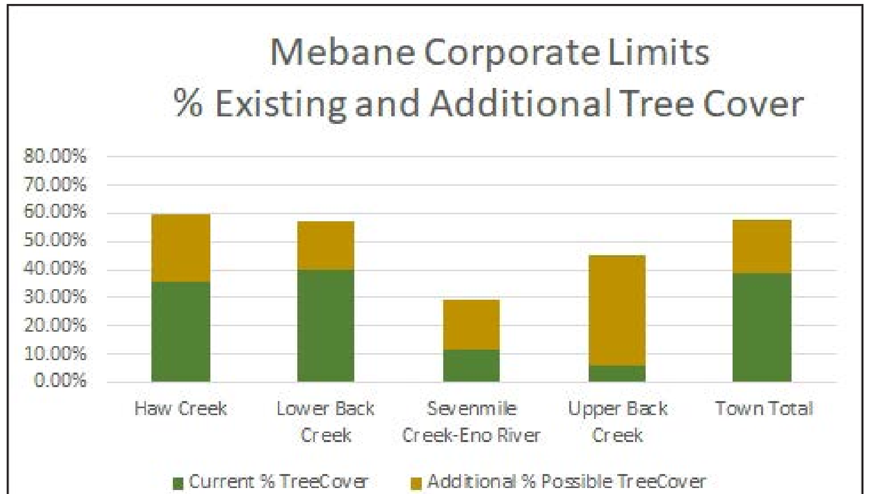
The purpose of this report is not to seek a limit on the city's growth, but to help the city better utilize its tree canopy to manage its stormwater.

Additional benefits of improved canopy include:

- fostering a healthful and vibrant community,
- cleaner air,
- aesthetic values,
- reduced heating and cooling costs,
- decreased urban heat island effects,
- increased wildlife habitat;
- fostering walkability and multimodal transportation; and,
- increased revenue from tourism and retail sales.

Total Area	Tree Canopy (acres)	Tree Canopy %	Impervious (acres)	Impervious %	Grass/Open Space (acres)	Grass/Open Space %	Water (acres)	Water %
6250	2375	38.0%	1723	27.6%	1910	30.6%	118	1.9%





Mebane still has room to plant additional trees. More trees equate to better air quality, shade and energy savings, more stormwater uptake and improved water quality too!

Changing Landscapes

Historic Land Cover in Mebane

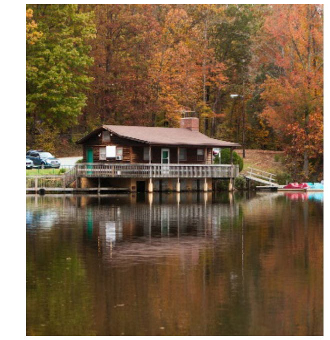
Mebane traces its origins to the establishment of the city's first post office in 1809. It is named after Brigadier General Alexander Mebane, militia member and Congressman in the 1790's. In 1881, the town was formally incorporated as Mebanesville and then in 1987, the name changed to the City of Mebane.

The arrival of the railroad in 1855 spurred further development and 1881 marked tremendous growth with establishment of the White Furniture Company. It once relied on the surrounding forests to support furniture making, a key industry for the town. White's Furniture factory was one of the most advanced furniture factories in the country using electric-powered machinery. It has been converted into 156-loft style apartments. Other significant industries were the Mebane Bedding Company (now Kingsdown) in 1904 and the Ridgeville Telephone Company (now MebTel Communications) in 1907. Mebane's location near Research Triangle Park is also a driver that spurs growth of the city.

Mebane's Geography

At 673 foot elevation, Mebane sits at a high point in the region. Situated within the Piedmont Ecoregion of North Carolina which trends northeast/southwest, it is characterized by gently rolling, well-rounded hills and long, low ridges with a few hundred feet of elevation difference between hills and valleys. The Piedmont supports early succession and scrub-shrub habitat with low, woody vegetation and herbaceous plants and dense understory vegetation.

Mebane's underlying geology is the Carolina Slate Belt characterized in Denison Olmsted's Report on the Geology of North Carolina as a region of pre-Cambrian age, low-grade metamorphosed volcanic rock characterized by slate cleavages, crossing the state in a southwest to northeast direction. Once part of an arc of volcanic areas, the erupted material and lava flows have settled within the area. Later tectonic movements led to consolidation, metamorphism, and erosion resulting in the gentle hills found today.



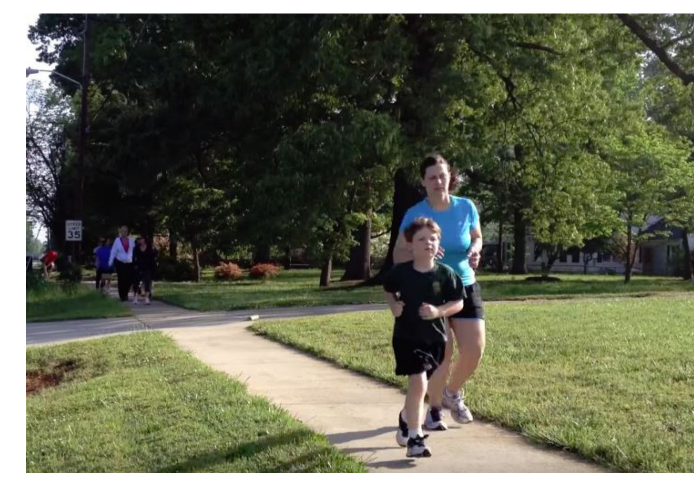
Lake Michael

Mebane's Green Future

Mebane is developing in ways that support a quality lifestyle. Although a small city, Mebane has grown 60 percent since the year 2000. Rapid growth and resultant demands for housing, commercial, business, industrial uses and transportation can put strains on both the city's grey and green infrastructure.

The city's 230 acres of city parks, including Lake Michael support the city's livability. The lake supports a healthy catfish and bass fishery with a record 19¾ lb. catfish caught in 1985 and bass up to 12 pounds. Mebane also has a strong focus on outdoor fitness. Mebane's On the Move program, focuses on getting citizens to exercise outdoors and this translates to the need for sidewalks, shade and safety. City Councilor Patty Phillips noted "It's going to be an economic incentive for businesses to relocate to our community if we have a healthy environment for people to live in and raise their children in." This is one way Mebane fulfills its motto of 'Positively Charming'!

Mebane Positively Charming



The city welcomes walkers and runners with the "Mebane on the Move" Program.

Urban Forests Provide Many Benefits

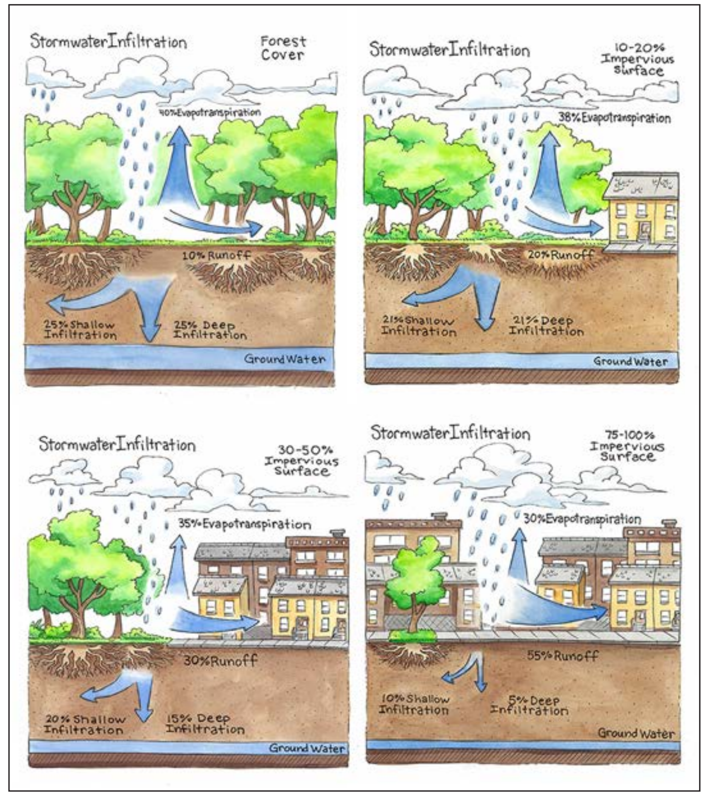
How Trees Help Cities Manage Stormwater

Trees protect cities from problems associated with stormwater runoff. However, as forested land is converted to impervious surfaces, runoff increases. This increase in stormwater causes temperature spikes in receiving streams, increased potential for pollution of surface and ground waters and greater potential for flooding. According to the U.S. Environmental Protection Agency (EPA), excessive stormwater runoff accounts for more than half of the pollution in the nation's surface waters and causes increased flooding and property damages, as well as public safety hazards from standing water. The EPA recommends a number of ways to use trees to manage stormwater in the book Stormwater to Street Trees.

Assessment and inventory of trees is key to ensuring a healthy forest.

Urban forests also buffer polluted runoff that can affect surface waters. As tree cover is lost and impervious areas expand, excessive urban runoff results in pollutants such as oil, metals, lawn chemicals (e.g., fertilizer and herbicides), pet waste and other contaminants reaching surface waters. High stormwater flows result in channel and bank scouring, releasing sediments that smother aquatic life and reduce stream depth and clog ditches, leading to yet more bank scouring and flooding, as channel capacity is lost.

Estimates from a Dayton, Ohio study found a 7 percent reduction in stormwater runoff due to existing tree canopy coverage and a potential increase to 12 percent runoff reduction as a result of a modest increase in tree canopy coverage (Dwyer et al 1992). According to Penn State Extension, during a one-inch rainfall event, one acre of forest will release 750 gallons of runoff, while a parking lot will release 27,000 gallons! This could mean an impact of millions of gallons during a major precipitation event. While stormwater ponds and other management features are designed to attenuate these events, they cannot



Runoff increases as land is developed. Data Source: U.S. EPA

fully replicate the pre-development hydrologic regime. In addition, parts of the city are older and may lack stormwater management practices that are required for new developments.

Since trees filter stormwater and reduce overall flows, planting or conserving trees is a natural way to mitigate stormwater. Each tree plays an important role in stormwater management. Based on the GIC's review of multiple studies of canopy rainfall interception, a typical street tree's crown can intercept between 760 gallons to 3000 gallons per tree per year, depending on the species and age. If a community were to plant an additional 5,000 such trees, the total reduced runoff per year could amount to millions of gallons. This means reduced flooding in neighborhoods and reduced stress on waste water treatment plants as well as less runoff into the city's streams and lake.

Excess impervious areas cause hot temperatures and runoff. Some older paved areas predate regulations requiring stormwater management. This parking lot can be retrofitted to add more trees

Additional Tree Benefits

Trees Provide Buffers Against Storms

Another compelling fiscal reason for planning to conserve trees and forests as a part of a green infrastructure strategy is minimizing the impacts and costs of natural disasters. By retaining trees and forests, it is possible to provide a buffer – a wind break – against storms.

Trees Help Achieve Regulatory Requirements

Trees also help meet the requirements of the Clean Water Act. The Clean Water Act requires North Carolina to have standards for water quality. When waters are impaired they may require establishment of a Total Maximum Daily Load (TMDL) standard and a clean-up plan to meet water quality standards. Since a forested landscape produces higher water quality by cleaning stormwater runoff (Booth et al 2002), increasing forest cover results in less pollutants reaching the city's surface and ground waters. Forest cover also reduces the cost of drinking water treatment. The American Water Works Association found that a 10 percent increase in forest cover reduced chemical and treatment costs for drinking water by 20 percent (Ernst et al. 2004).

Trees Cool Cities and Clean the Air

During long hot summers, more shade is always appreciated. Tree cover shades streets, sidewalks, parking lots, and homes, making southern urban locations cooler, and more pleasant for walking or biking. Multiple studies have found significant cooling (2-7 degrees) and energy savings from having shade trees in cities (McPherson et al 1997, Hashed et al 2001). In addition, trees absorb volatile organic compounds and particulate matter from the air, improving air quality, and thereby reducing asthma rates. Shaded pavement also has a longer lifespan so maintenance costs associated with roadways and sidewalks are less (McPherson and Muchnick 2005).

Trees Improve Cognitive Function

Children who suffer from Attention Deficit Hyperactivity Disorder (ADHD) benefit from living near forests and other natural areas. One study showed that children who moved closer to green areas have the highest level of improved cognitive function after the move, regardless of level of affluence (Wells 2000). Thus, communities with greener landscapes benefit children and reduce ADHD symptoms.

Well treed areas encourage people to walk and bike.

Trees Improve Walkability

Trees also cause people to walk more and walk farther. This is because when trees are not present, distances are perceived to be longer and destinations farther away, making people less inclined to walk than if streets and walkways are well treed (Tilt, Unfried and Roca 2007).

Trees Increase Property Values and Sales

Developments that include green space or natural areas in their plans sell homes faster and for higher profits than those that take the more traditional approach of building over an entire area without providing for community green space (Benedict and McMahon 2006).
A study by the National Association of Realtors found that 57 percent of voters surveyed were more likely to purchase a home near green space and 50 percent were more willing to pay 10 percent more for a home located near a park or other protected area. A similar study found that homes adjacent to a greenbelt in Boulder, Colorado were valued 32 percent higher than those 3,200 feet away (Correll et al. 1978).

More trees could be planted on Jackson Street for shade and beauty.

Young Tree in Mebane

Urban Forests Are Declining

Trees are declining throughout the southern United States. Causes for this decline arise from multiple sources including land conversion for development, storm damages, hurricanes such as Florence, and lack of tree replacement as older trees die. Many localities have not evaluated their current tree canopy, which makes it difficult to track trends, assess losses or set goals to retain or restore canopy. Mebane now has baseline data to monitor canopy protection progress, measures of the stormwater and water quality benefits of its urban forest, and can prioritize restoration of canopy where it is most needed.

As areas develop, natural land cover changes to urban land cover and forested land cover decreases. Today, municipalities are losing their trees at an alarming rate, estimated at four million trees annually nationwide (Nowak 2010). This is due, in large part, to population growth. This growth has brought with it pressures for land conversion to accommodate both commercial and residential development. Cities are also losing older, established trees from the cumulative impacts of land development, storms, diseases, old age and other factors (Nowak and Greenfield 2012). With a canopy of 38.7 percent, Mebane has room to improve.

> “23 percent more area downtown could possibly be planted.”

It is not just development and storms that contribute to tree loss. Millions of trees are also lost as they reach the end of their life cycle through natural causes. For every 100 street trees planted, only 50 will survive 13-20 years (Roman et al 2014). Even in older developed areas with a well-established tree canopy, redevelopment projects may remove trees. Choosing the wrong tree for a site or climate, planting it incorrectly, or caring for it poorly can all lead to tree canopy loss. It is also important to realize that an older, well-treed neighborhood of today may not have good coverage in the future unless young trees – the next generation – are planted

As the city continues to grow, it may experience losses in the future unless planting and urban forest care are better funded. As older trees die (or before they die), younger trees need to be planted to restore the older canopy. For example, canopy coverage in the central business district is only 24 percent. However, based on an analysis of existing open space, 23 percent more area downtown could possibly be planted.

Method Overview: Land Cover, Possible Planting Area, Possible Canopy Area Analysis

The best land cover for taking up stormwater is the urban forest. In order to model scenarios for future tree canopy and water uptake, a highly detailed land cover analysis and an estimation of potential future planting areas was developed (see Appendix A for details). The new land cover analyses can be used for other purposes such as analyzing urban cooling or walkability, street tree plantings, or to inform area plans or the comprehensive plan.

This project applies a different method for land cover mapping. Since urban trees vary in their ability to intercept stormwater based on their setting, a detailed land cover analysis was created to calculate how much water is taken up by the city’s trees in various scenarios. This new approach distinguishes whether the trees are within a forest, a lawn setting, a forested wetland or over pavement, such as streets or sidewalks. The amount and type of open space under and around the tree and the condition of surface soils affect the infiltration of water.

Method

Satellite imagery was used to classify the types of land cover in Mebane. The land cover map depicts those areas with vegetative cover that allow for the uptake of water and those that are impervious and more likely to have stormwater runoff. The land cover data were created using 2016 leaf-on imagery from the National Agriculture Imagery Program (NAIP) distributed by the USDA Farm Service Agency. Ancillary data for roads (from Mebane government), the Cooperative Land Cover (CLC) Map (North Carolina Natural Areas Inventory), and hydrology (from National Wetlands Inventory and National Hydrography Dataset) were used to determine:

1) Tree cover over impervious surfaces, which otherwise could not be seen due to these features being covered by tree canopy; and

2) Wetland not distinguishable using spectral/feature-based image classification tools.

3) Forested open space was identified as areas of compact, continuous tree canopy greater than one acre, not intersected by buildings or paved surfaces.

The final classification of land cover consists of nine classes (types of land cover).

NAIP Image 2016

Potential Planting Area (PPA)

Possible Planting Areas

In urban areas, tree canopy should be assessed and realistic goals established to maintain or expand it. The stormwater calculator tool developed by GIC has a cell to add trees. The calculator tool uses real analysis for how many more trees could be planted. To find this number, we need to know how many new trees might be fitted into an urban landscape. A Possible Planting Area (PPA) map estimates areas that may be feasible to plant trees. A PPA map helps communities set realistic goals for what they could plant. The Potential Planting Area (PPA) is created by selecting the land cover features that have space available for planting trees. Of the nine land cover classes, only pervious, turf, and bare earth were considered for PPA.

Next, these eligible planting areas are limited based on their proximity to features that might either interfere with a tree’s natural growth (such as buildings) or places a tree might affect the feature itself such as power lines, sidewalks or roads. Playing fields, cemeteries and other known land uses that would not be appropriate for tree cover are also avoided. However, there may be some existing land uses (e.g., golf courses or ball fields that are expected to remain in recreational use, etc.) that are unlikely to be used for tree planting areas but that were not excluded from the PPA. In addition, the analysis did not take into account proposed future developments (e.g., planned developments) that would not likely be fully planted with trees. Therefore, the resulting PPAs represent the maximum potential places trees can be planted and grow to full size.

Possible Planting Spots

The Potential Planting Spots (PPS) are created from the PPA. The PPA is run through a GIS model that selects those spots where a tree can be planted depending on the size of trees desired. For this analysis, expected sizes of both 20 ft. and 40 ft. diameter of individual mature tree canopy were used with priority given to 40 ft. diameter trees (larger trees have more benefits). It is expected that 30 percent overlap will occur as these trees reach maturity. The result demonstrates a scenario where, if planted today, once the trees are mature, their full canopy will cover the potential planting area and overlap adjacent features, such as roads and sidewalks.

Potential Planting Spots (PPS)

Tree over street

Trees over forest

Tree over lawn

Tree over parking lot

Potential Canopy Area (PCA)

Potential Canopy Area

The Potential Canopy Area (PCA) is created from the PPS. Once the possible planting spots are selected, a buffer around each point that represents a tree's mature canopy is created. For this analysis, that buffer radius is either 10 ft. or 20 ft., which result in either a 20 ft. or 40 ft. diameter canopy for each tree. These individual tree canopies are then dissolved together to form the potential overall canopy area.

Percent Street Trees is calculated using the Land Cover Tree Canopy and road centerlines, which are buffered to 50 ft. from each road segment's centerline. The percent value represented is the percentage of tree cover within that 50 ft. buffer.

Maps and Findings

Areas for Analysis

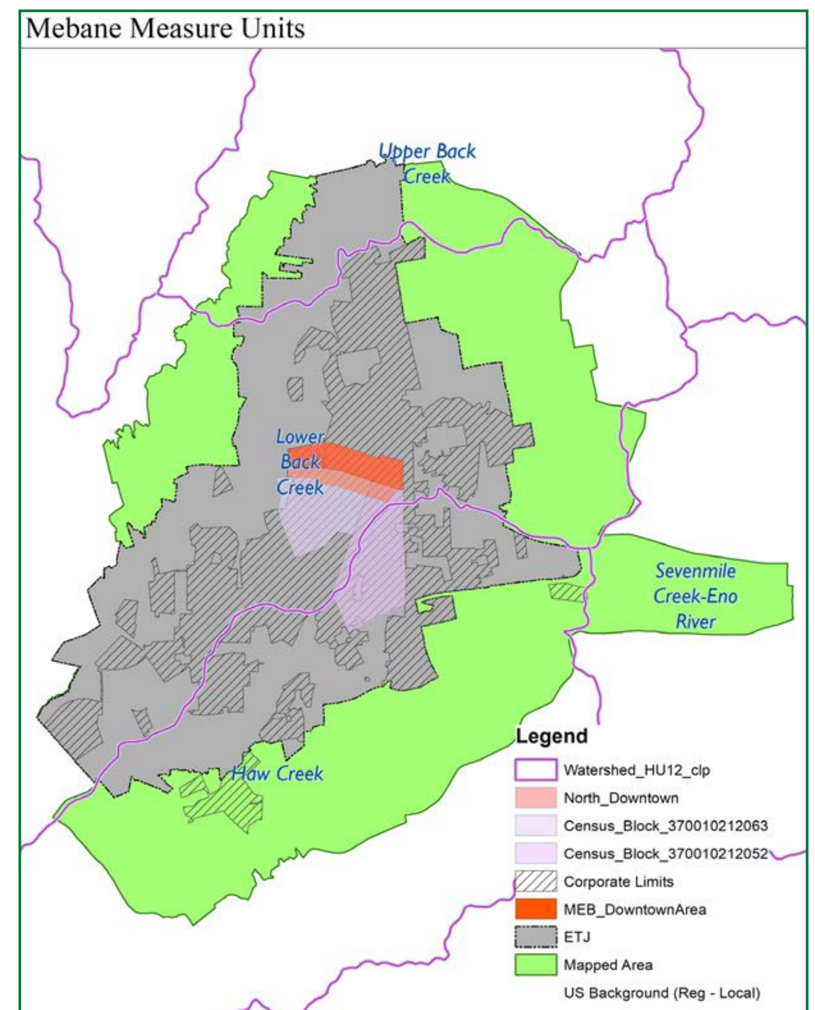
The tree canopy map can be used to evaluate future progress in tree preservation and planting. An ArcGIS geodatabase with all GIS shape files produced during the study was provided to the city.

These canopy breakdowns are as follows. Citywide forest cover is 38.7 percent.

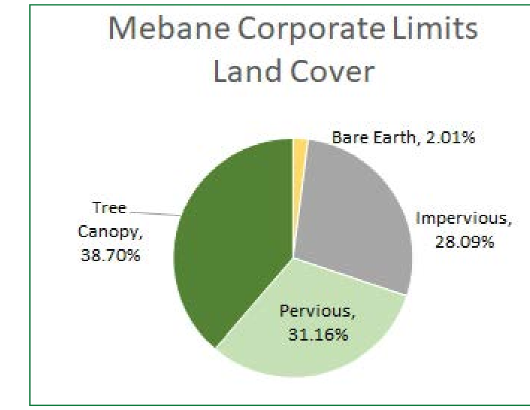
In addition the city requested statistics for canopy by the following areas:

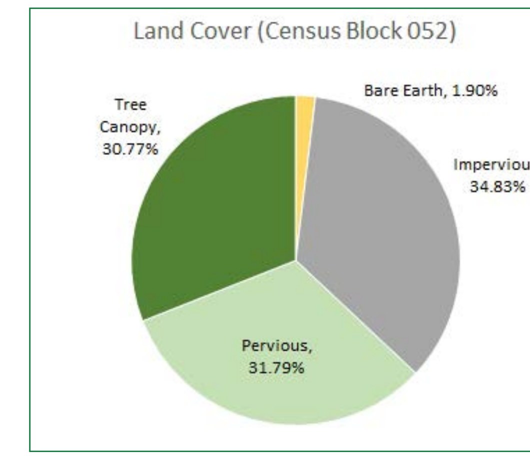
- census block (370010212052) - South Mebane (economically complex)
- census block (370010212063) - includes WERA neighborhood (minority community)
- historical downtown (north of railroad track)

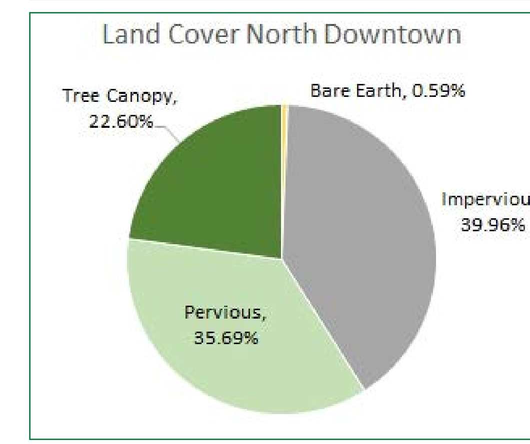
These smaller areas were not analyzed by stormwater runoff individually because the Trees2OffsetH$_2$0 model is based on drainage by watershed as the unit of analysis. However, the canopy data and the possible planting area map can inform tree planting decisions to meet many goals such as walkability, energy savings or economic revitalization.

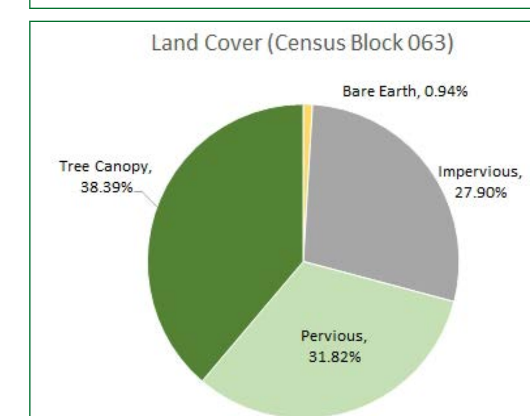


Above is the map showing the areas for tree canopy analysis.
Citywide forest cover is 38.7 percent.









Mebane: Fast Facts & Key Stats

- Counties: Alamance and Orange
- 2016 Census Population Estimate: 13,592 people

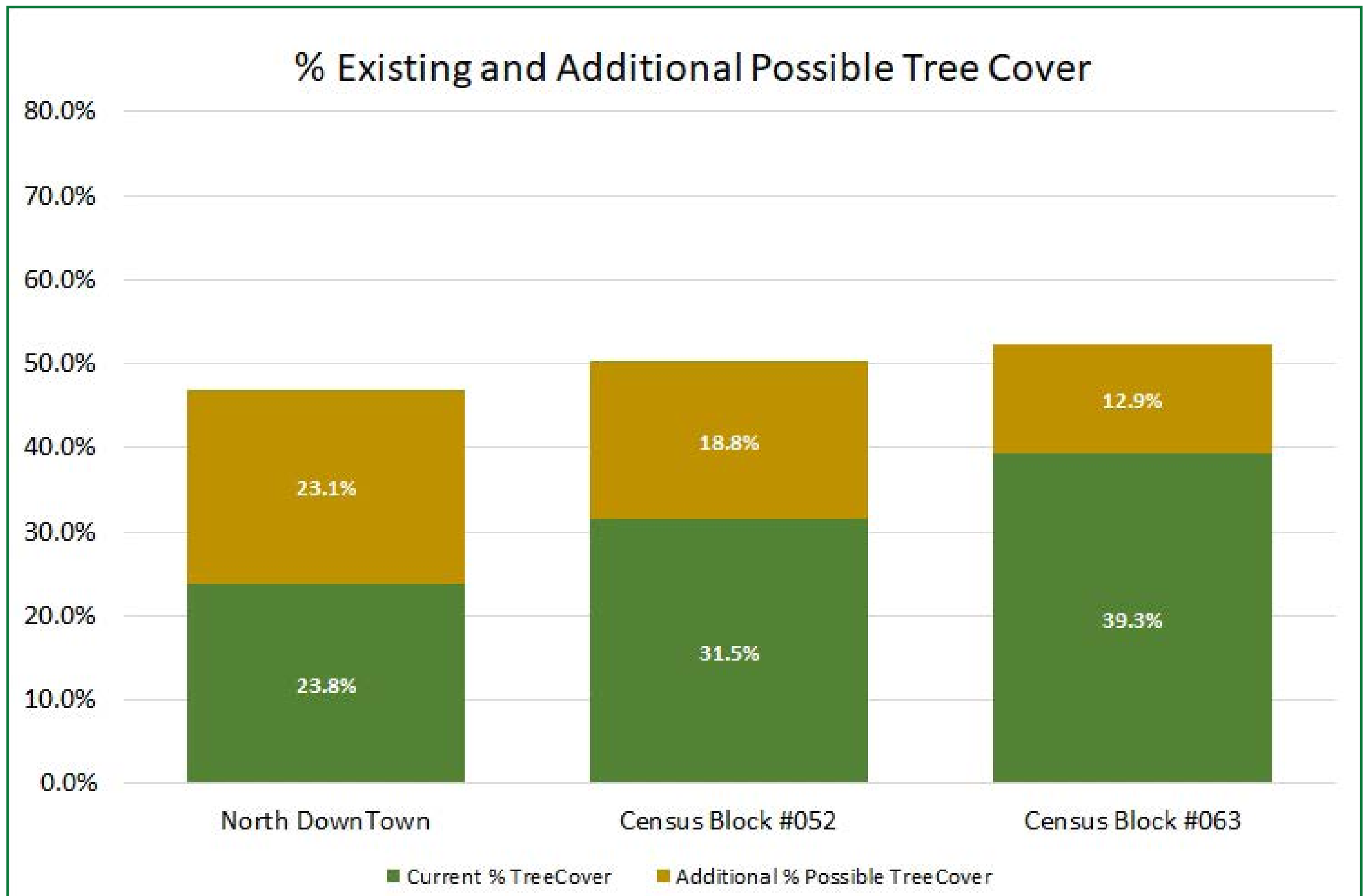
City Area:

- Total area: 9.7 sq. mi.
- Land: 49.51 sq. mi.

Natural Resources:

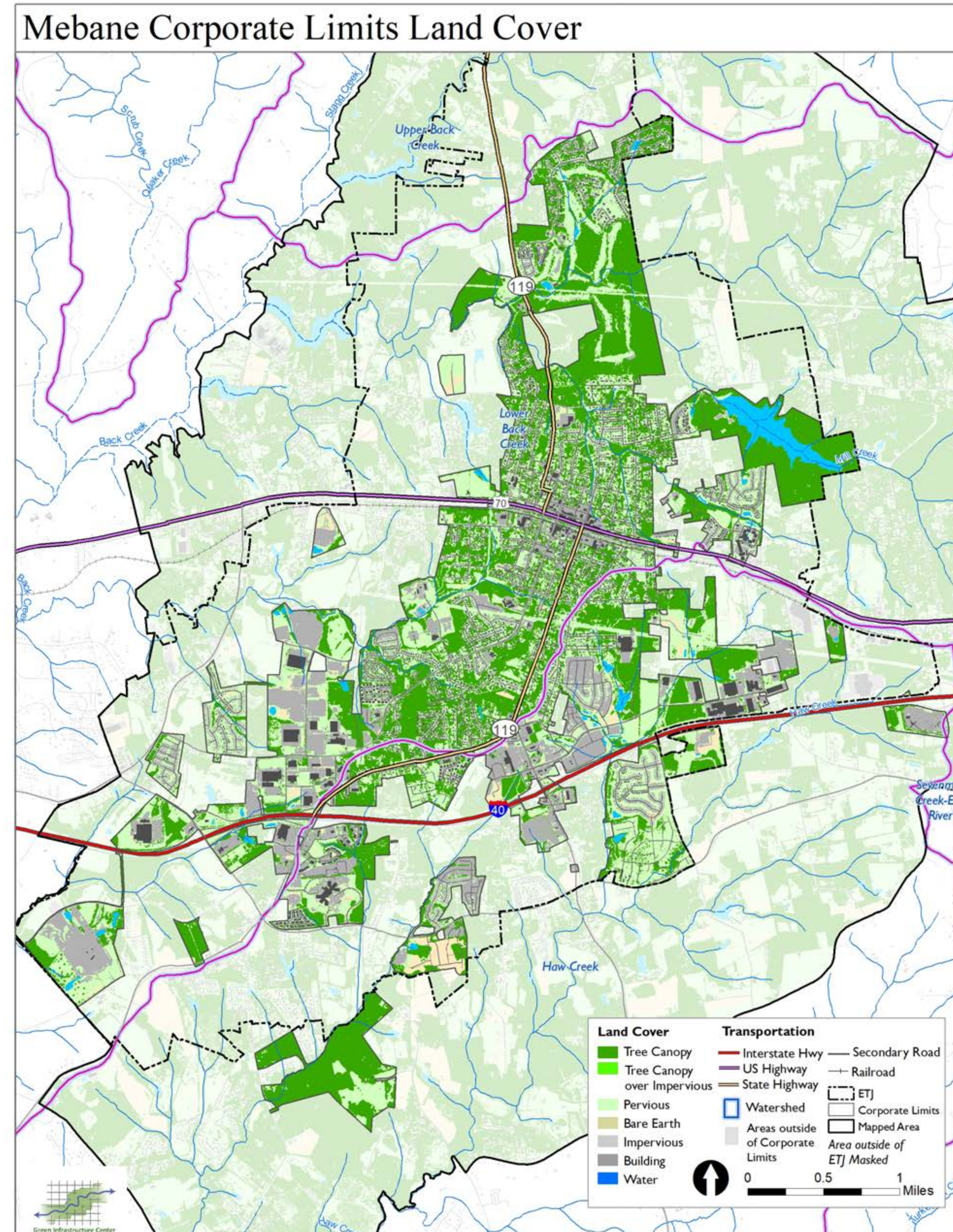
- Miles of Stream: 21 miles
- Acres of Lakes :118
  <Graham Mebane Lake outside the city is 685 acres>
- Tree Canopy: 2,344 acres

One mature tree can absorb thousands of gallons of water per year.



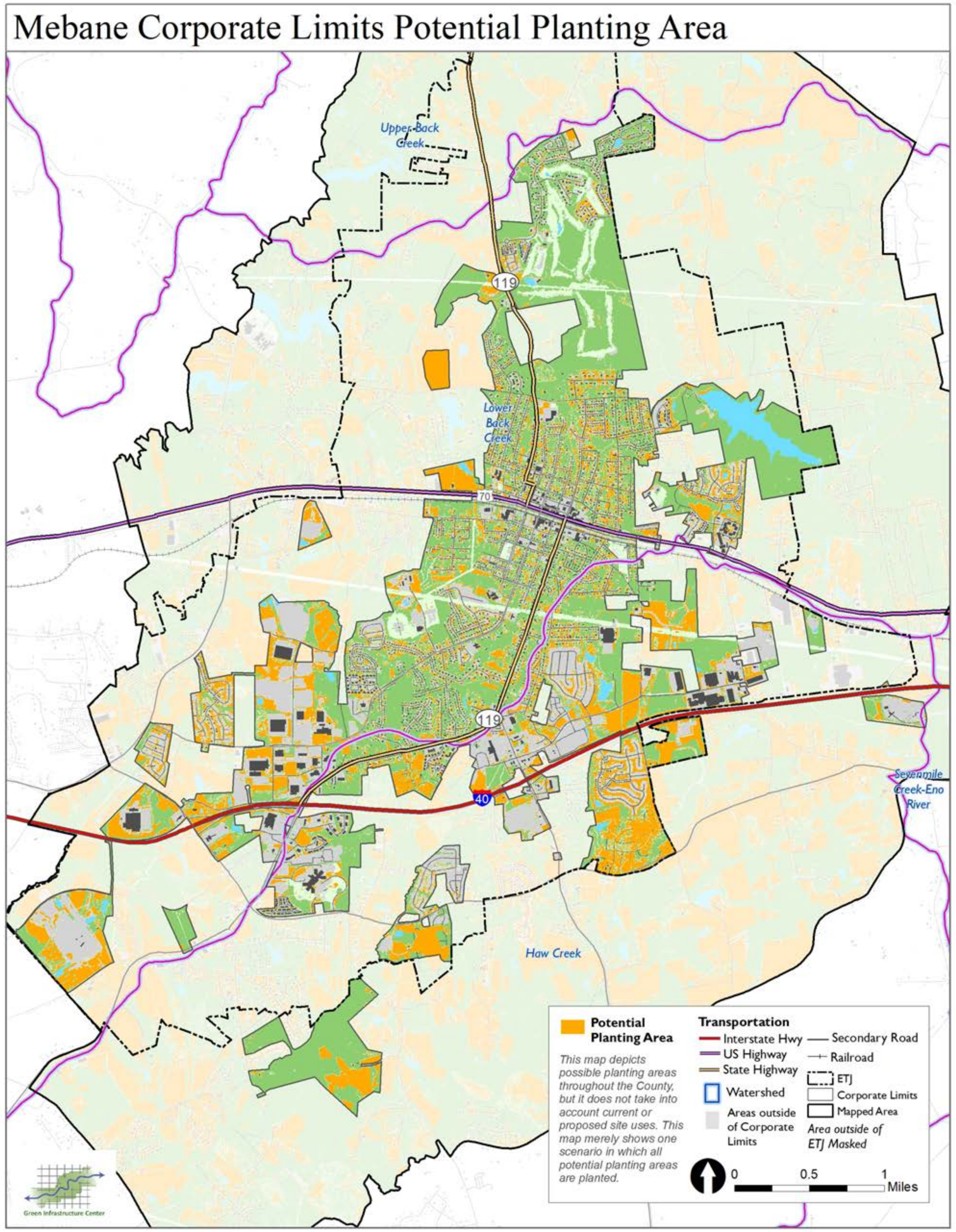
Existing and potential canopy by North Downtown and Census Blocks 052 and 063

Map of City Land Cover and Tree Canopy



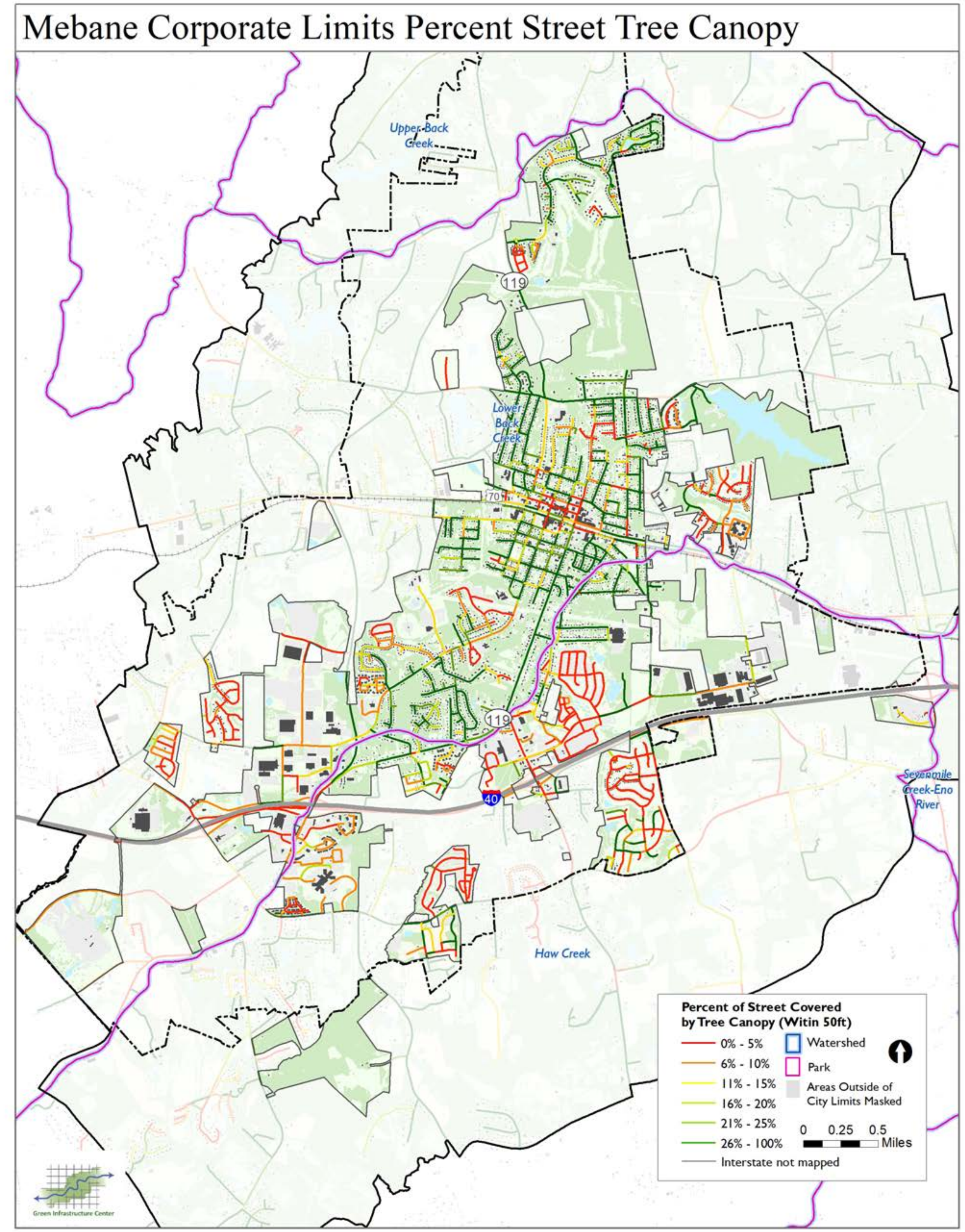
This map shows the tree canopy of the city, which covers 38.7 percent of the area.

Map of Possible Planting Areas



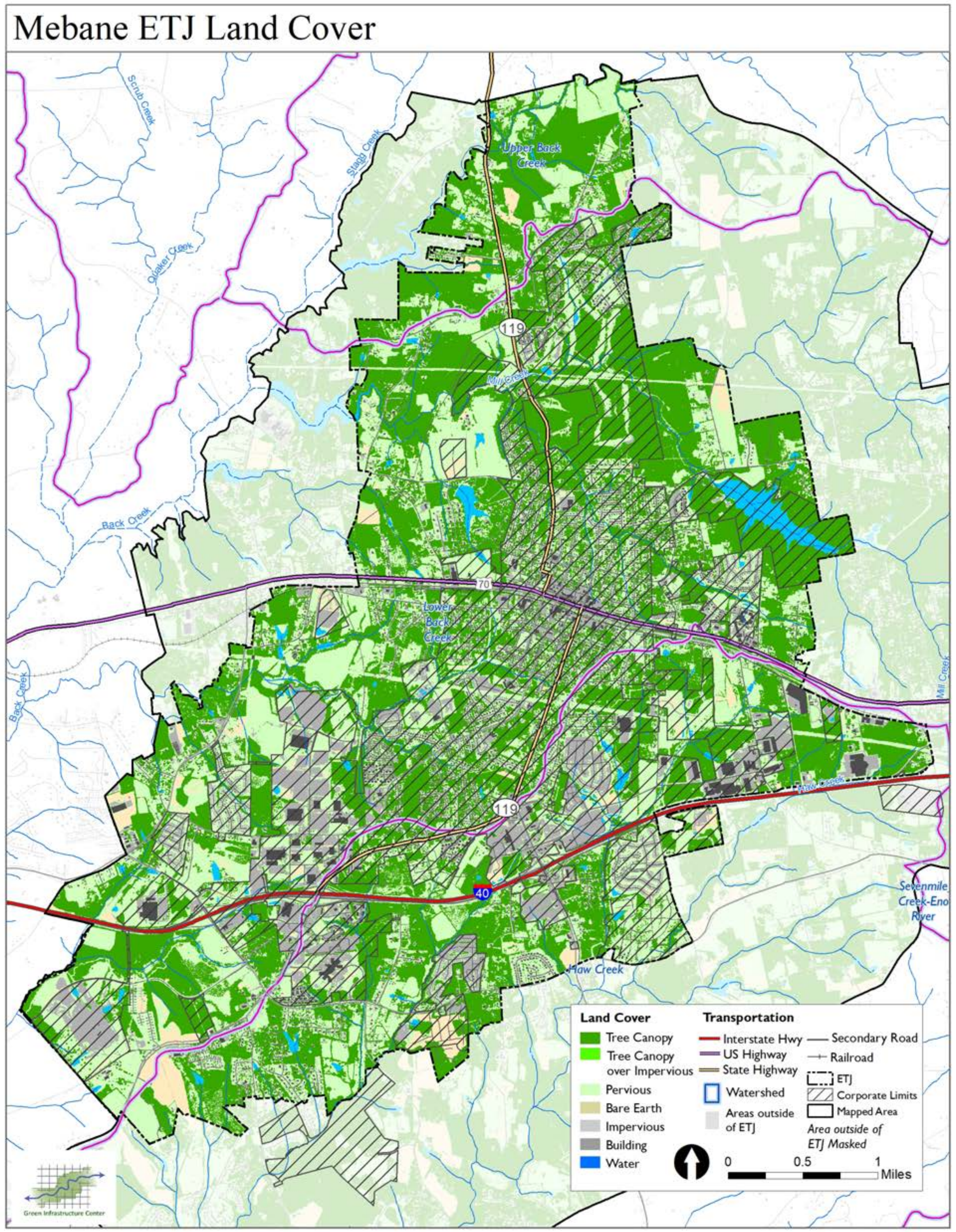
Potential Planting Area (PPA) shown in orange depicts areas where it may be possible to plant trees.
All sites would need to be confirmed in the field and may be on private or public lands.

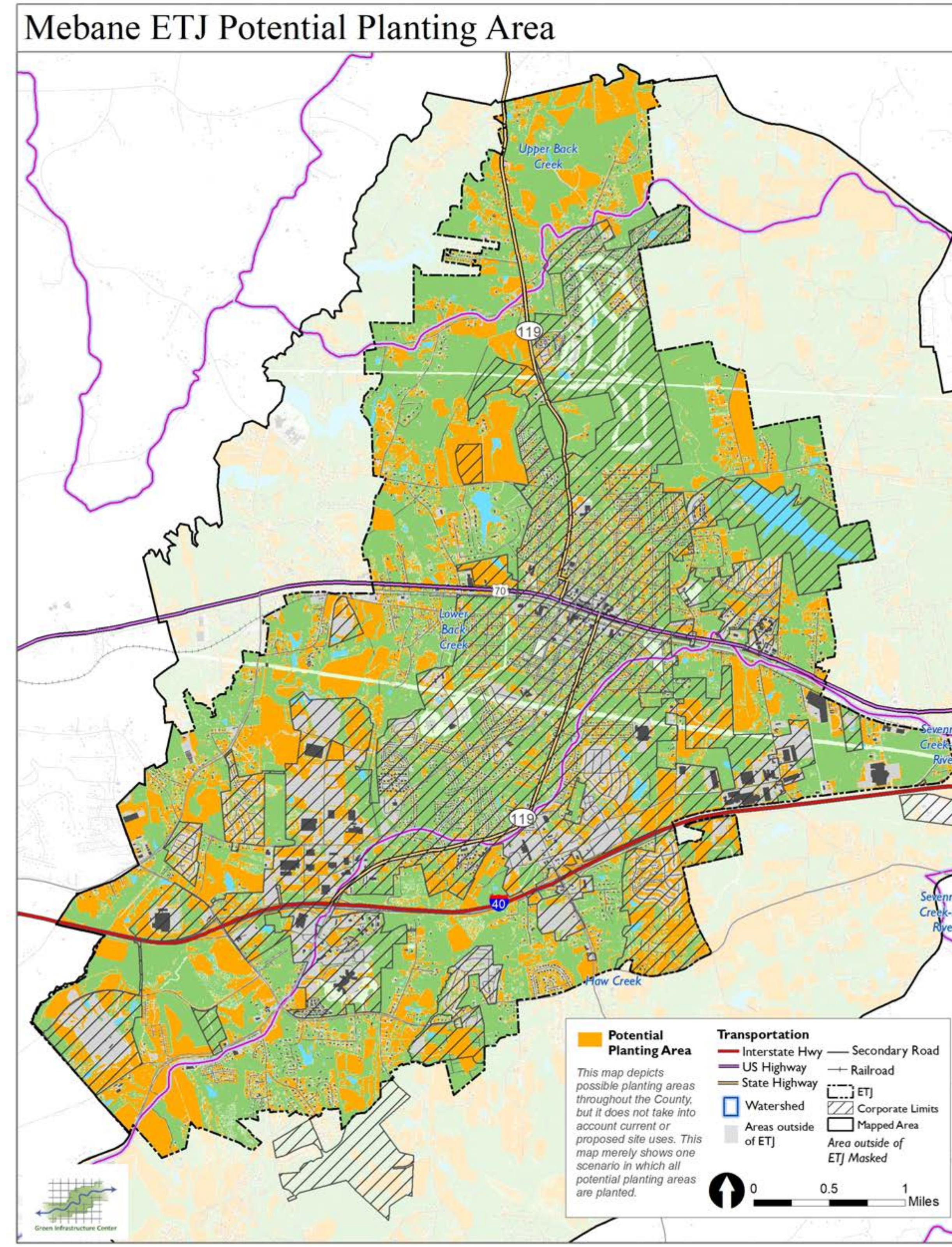
Map of Street Tree Coverage



The street trees map shows which streets have the most canopy (dark green) and which have the least (red).
Streets lacking good coverage can be targeted for planting to facilitate uses, such as safe routes to school or beautifying a shopping district.

Maps for the Extra Territorial Jurisdiction



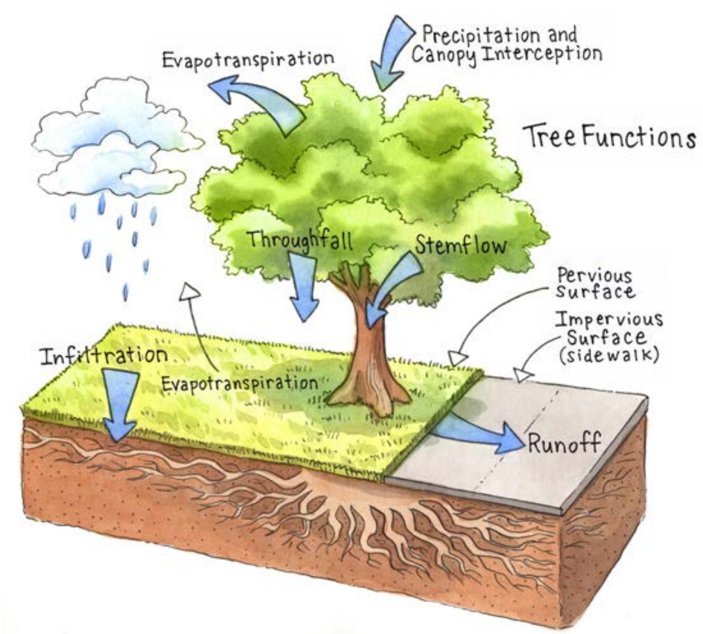


These maps show the canopy for the Extra Territorial Jurisdiction (ETJ). This analysis includes areas not currently occupied by the city, but which may be annexed in the future and are used for planning purposes.

Calculating Stormwater Interception by the Urban Forest

Calculating Stormwater Interception by the Urban Forest

The GIC evaluated stormwater runoff and uptake by the city's tree canopy using the GIC's Trees2OH20. Stormwater Calculator Tool. Trees intercept, take up and slow the rate of stormwater runoff. Canopy interception varies from 100 percent at the beginning of a rainfall event to about three percent at the maximum rain intensity. Trees take up more water early on during storm events and less water as storm events proceed and the ground becomes saturated (Xiao et al. 2000). Many forestry scientists, as well as civil engineers, have recognized that trees have important stormwater benefits (Kuehler 2017, 2016). See diagram of tree water flow below.



The stormwater runoff model provides estimates of the capture of precipitation by tree canopies and the resulting reductions in runoff yield. It takes into account the interaction of land cover and soil hydrologic conditions. It can also be used to run 'what-if' scenarios, specifically losses of tree canopy from development and increases in tree canopy from tree planting programs.

Method to Determine Water Interception, Uptake and Infiltration

Cities usually use TR-55 curve numbers developed by the Natural Resources Conservation Service (NRCS) to generate expected runoff amounts. The city could choose to use the modified TR55 curve numbers (CN) provided by GIC which include a factor for canopy interception. The city can also use the stormwater calculator tool for setting goals at the watershed scale for planting trees and for evaluating consequences of tree loss as it pertains to stormwater runoff.

The trees and stormwater calculator tool uses modified TR-55 curve numbers to calculate stormwater uptake for different land covers, since they are widely recognized and understood by stormwater engineers. Curve numbers produced by this study can be utilized in the city's modeling and design reviews. The spreadsheet calculator tool provided makes it very easy for the city to change the curve numbers if they so choose. What is new about the calculator tool is that the curve numbers relate to the real land cover conditions in which the trees are found. A canopy interception factor is added to account for the role trees play in interception of rainfall based on location and planting condition (e.g. trees over pavement versus trees over a lawn or in a forest).

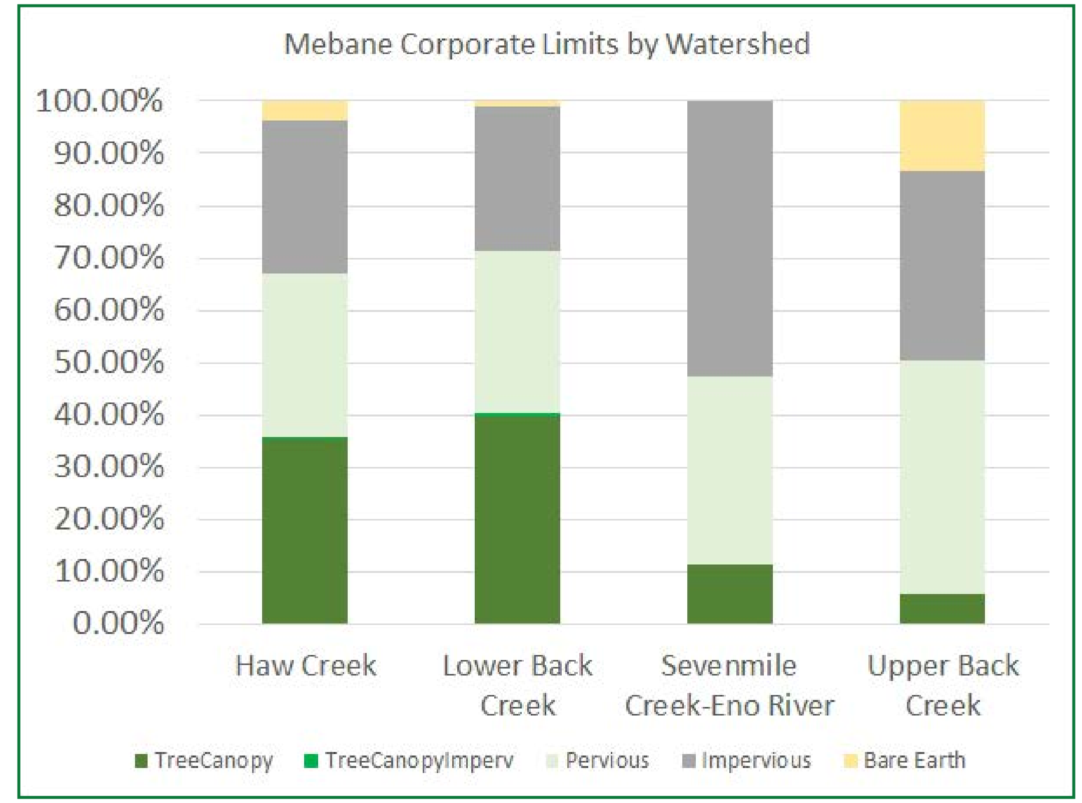
Tree canopy reduces the proportion of precipitation that becomes stream and surface flow, also known as water yield. A study by Hynicka and Divers (2016) modified the water yield equation of the NRCS model by adding a canopy interception term (Ci) to account for the role that canopy plays in capturing stormwater, resulting in:

$$R = \frac{(P - C_i - I_a)^2}{(P - C_i - I_a) + S}$$

Where R is runoff, P is precipitation, Ia is the initial abstraction, which is the fraction of the storm depth after which runoff begins, and S is the potential maximum retention after runoff begins for the subject land cover (S = 1000/CN – 10).

Major factors determining CN are:

- The hydrologic soil group (defined by surface infiltration rates and transmission rates of water through the soil profile, when thoroughly wetted)
- Land cover types
- Hydrologic condition – density of vegetative cover, surface texture, seasonal variations
- Treatment – design or management practices that affect runoff

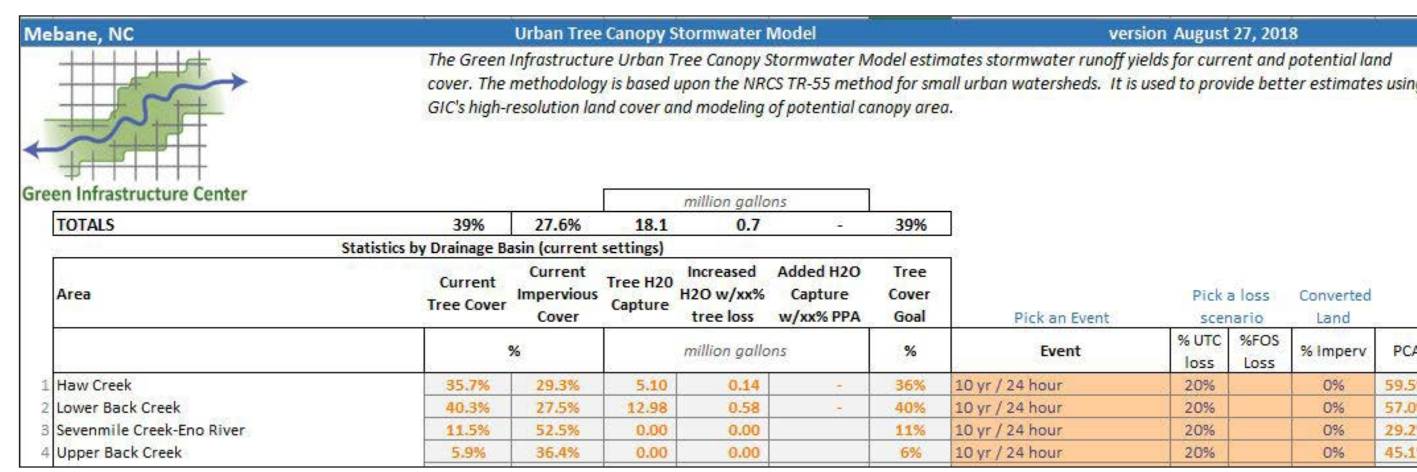


Percent Tree Cover and Possible Planting Area by Watershed

The modeling tool allows the city to add trees or reduce trees and determine the effects for stormwater capture or runoff. A key finding from this work is that removal of mature trees and existing forests generate the greatest impacts for stormwater runoff. As more land is developed, the city should seek to maximize tree conservation for maintenance of surface water quality and groundwater recharge. This will also benefit the city's quality of life by fostering clean air, walkability, and attractive residential and commercial districts.

In the graphic of the calculator tool, the model is used to estimate a hypothetical 20 percent loss of tree canopy for Mebane, and how much additional water might runoff during a 10-year storm event. This would result in an additional 6.3 million gallons of stormwater runoff (more than 9.5 Olympic swimming pools of water!). If planting efforts were to plant to half the available area for each watershed, the model shows a decrease in stormwater runoff (or increase in capture) of 3.9 million gallons during a 10 year storm. The model is a tool for seeing the results or adding or losing tree canopy.

This new approach allows for more detailed assessments of stormwater uptake based on the landscape conditions of the city's forests. It distinguishes whether the trees are within a forest, a lawn setting, a forested wetland or over pavement, such as streets or sidewalks because the conditions in which the tree is living affect the amount of water the tree can intercept. The analysis can be used to create plans for where adding trees or better protecting them can reduce stormwater runoff impacts and improve water quality.



Mebane, NC — Urban Tree Canopy Stormwater Model — version August 27, 2018

The Green Infrastructure Urban Tree Canopy Stormwater Model estimates stormwater runoff yields for current and potential land cover. The methodology is based upon the NRCS TR-55 method for small urban watersheds. It is used to provide better estimates using GIC's high-resolution land cover and modeling of potential canopy area.

Green Infrastructure Center

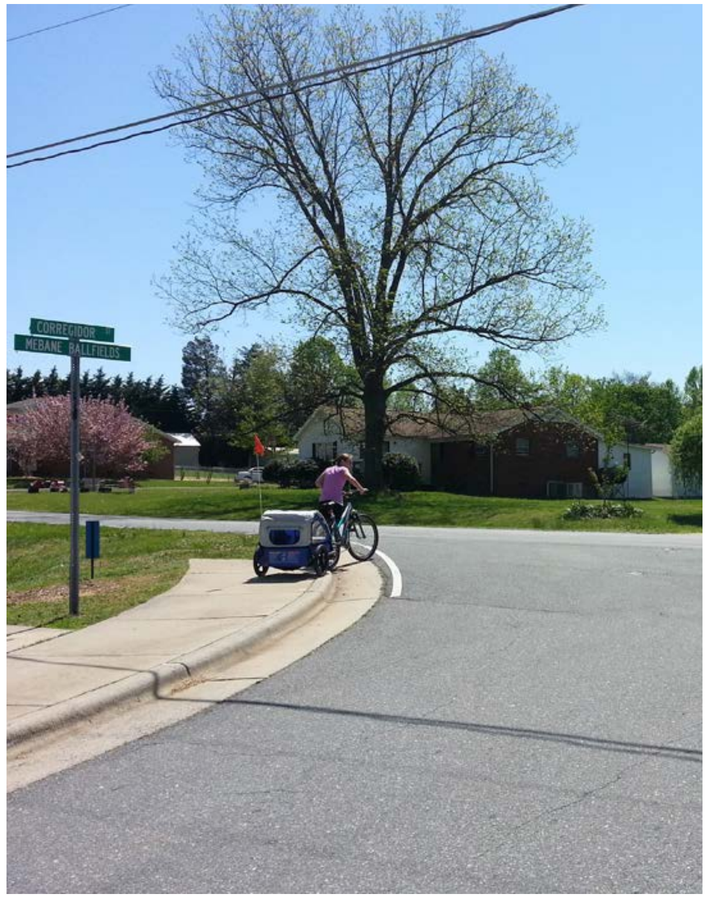
				million gallons			
TOTALS	39%	27.6%	18.1	0.7	-	39%

Statistics by Drainage Basin (current settings)

	Area	Current Tree Cover	Current Impervious Cover	Tree H2O Capture	Increased H2O w/xx% tree loss	Added H2O Capture w/xx% PPA	Tree Cover Goal	Pick an Event	Pick a loss scenario		Converted Land	
		%		million gallons			%	Event	% UTC loss	%FOS Loss	% Imperv	PCA
1	Haw Creek	35.7%	29.3%	5.10	0.14	-	36%	10 yr / 24 hour	20%		0%	59.5%
2	Lower Back Creek	40.3%	27.5%	12.98	0.58	-	40%	10 yr / 24 hour	20%		0%	57.0%
3	Sevenmile Creek-Eno River	11.5%	52.5%	0.00	0.00		11%	10 yr / 24 hour	20%		0%	29.2%
4	Upper Back Creek	5.9%	36.4%	0.00	0.00		6%	10 yr / 24 hour	20%		0%	45.1%

The calculator tool developed for this project allows the city to see the water uptake by existing canopy and model impacts from changes, whether positive (adding trees) or negative (removing trees).

Recommendations – Next Steps

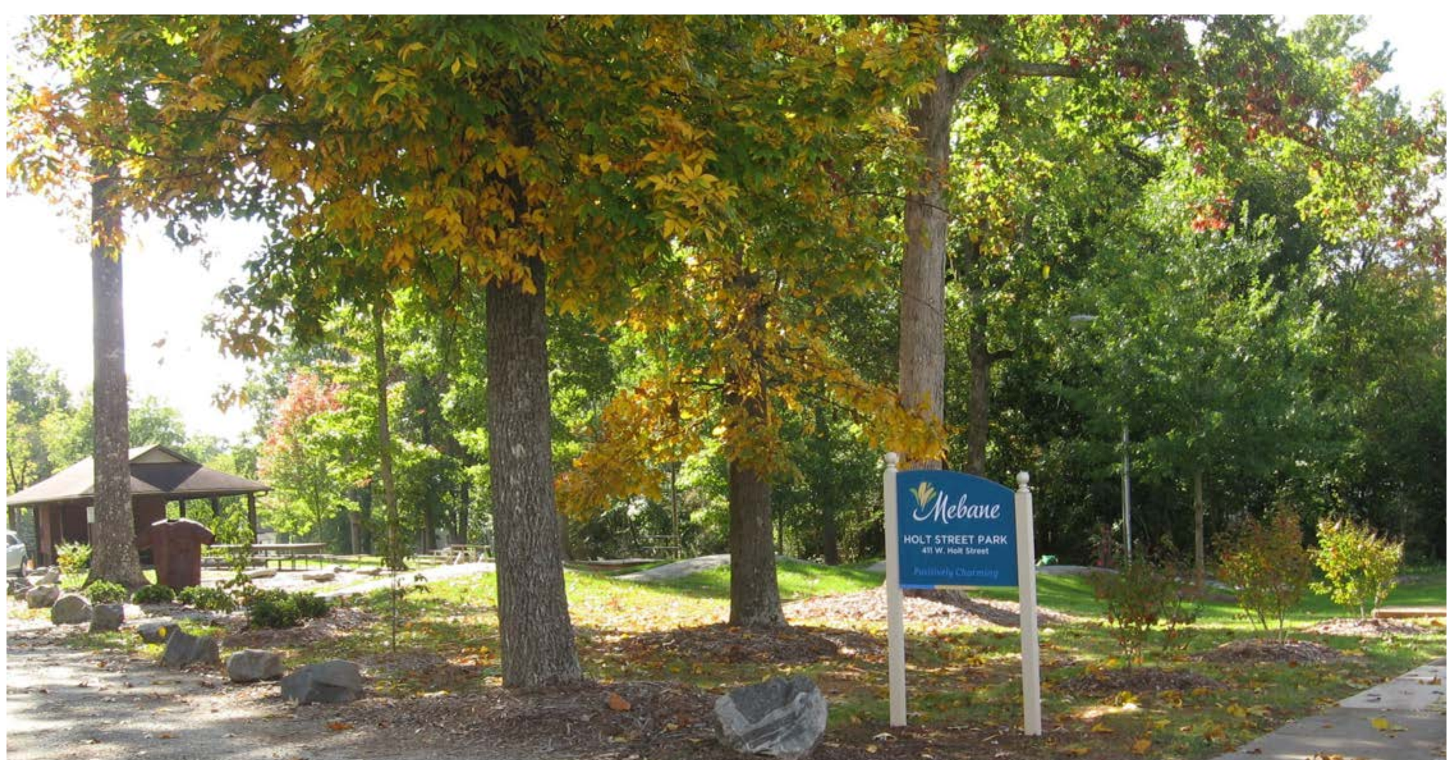


1 The city should consider opportunities to increase the protections for, and size of, the forest in Mebane. As noted earlier, the city has room to expand its canopy, especially for those areas where it is far lower than the city-wide average of 38.7 percent. The city can use the GIC's stormwater uptake calculator to determine the benefits of maintaining or increasing tree canopy goals. The calculator provided to Mebane allows the city to determine the stormwater benefits or detriments (changes in runoff) from adding or losing trees and calculate the pollution loading reductions for nitrogen and phosphorus, and sediment.

2 It is also recommended that Mebane undertake a codes and ordinance evaluation using the GIC's Trees2OH20 Policy Analysis tool to identify all the ways in which the city can reduce impervious areas and improve tree canopy.

3 The city should also consider becoming a Tree City USA to allow it to benefit from the advice and grant opportunities available through the national Arbor Day Foundation. To become a 'Tree City" with the Arbor Day Foundation requires that the city spend adequate funds per capita on tree care, have a tree ordinance, and practice tree management.

4 Additionally the city can work with developers to shrink the development footprint to minimize impervious surface. Holding a pre-development conference, with all key staff in attendance, allows all parties to explore ideas for tree conservation before extensive funds are spent on land planning.



5 The city should consider developing an Urban Forest Management Plan to guide the conservation and management of the city's trees. As part or urban forest management the city should develop a forestry emergency response plan. The city does not have a plan for replacing trees lost to natural disasters such as hurricanes or other storms. This means that canopy will decrease over time. Given the many benefits that trees provide (increased groundwater infiltration, soil stability, and reduced runoff and flooding, shade and better air quality), the city should plan for funding and replacement tree plantings following natural disasters.

6 Lastly, it is recommended that the city conduct a land cover assessment every four years to determine and allow for comparison of tree canopy coverage change over time. Keeping tree canopy coverages at levels that promote public health, walkability, and groundwater recharge for watershed health is vital for livability and meeting state water quality standards. Regular updates to land cover maps allow for this analysis and planning to take place and identify and address negative trends.

These and other practices, implemented to provide long term care, protection and best planting practices for the urban forest, will help ensure that investments in city trees will pay dividends for reducing stormwater runoff as well as clean air and water, lower energy bills, higher property values and natural beauty long into the future.

Springtime in Mebane

Appendixes

Appendix A: Land Cover Analysis Methods

This section provides technical documentation for the methodology used to classify land cover and create Potential Planting Area scenarios for the city.

Land cover classifications are an affordable method for using aerial or satellite images to obtain information about large geographic areas. Algorithms are trained to recognize various types of land cover based on color and shape. In this process, the pixels in the raw image are converted to one of several types of pre-selected land cover types. In this way, the raw data (i.e. the images) are turned into information about land cover types of interest, e.g. what is pavement, what is vegetation. This land cover information can be used to gain knowledge about certain issues; for example: What is the tree canopy percentage in a specific neighborhood?

Landcover Classification

NAIP 2016 Leaf-on imagery (4 band, 1-meter resolution) was used for the Landcover classification. The full set of NAIP data was acquired through the Earth Resources Observation and Science (EROS) Center of the U.S. Geological Survey. Additional inputs included in classification were LiDAR from various acquisition dates ranging from 2007 to 2017. The most current data were used where available.

Pre-processing

The NAIP image tiles were first re-projected into the coordinate system used by:

NAD_1983_StatePlane_North_Carolina_FIPS_3200_Feet
WKID: 2264 Authority: EPSG

Projection: Lambert_Conformal_Conic
False_Easting: 2000000.002616666
False_Northing: 0.0
Central_Meridian: -79.0
Standard_Parallel_1: 34.33333333333334
Standard_Parallel_2: 36.16666666666666
Latitude_Of_Origin: 33.75
Linear Unit: Foot_US (0.3048006096012192)

Geographic Coordinate System: GCS_North_American_1983
Angular Unit: Degree (0.0174532925199433)
Prime Meridian: Greenwich (0.0)
Datum: D_North_American_1983
  Spheroid: GRS_1980
    Semimajor Axis: 6378137.0
    Semiminor Axis: 6356752.314140356
    Inverse Flattening: 298.257222101

Supervised Classification

The imagery was classified using an object based supervised classification approach. The ArcGIS extension Feature Analyst was used to perform the primary classification with a "bull's eye" object recognition configuration was used to identify features based on their surrounding features. Feature Analyst software is an automated feature extraction extension that enables the GIS analyst to rapidly and accurately collect vector feature data from high-resolution satellite and aerial imagery. Feature Analyst uses a model-based approach for extracting features based on their shape and spectral signature.

For better distinction between classes, an NDVI image was created using Raster Calculator used instead of ArcGIS' Imagery Analyst menu for consistency. The NDVI image along with the source NAIP bands (primarily 4, 1 and 2) were used to identify various features where they visually matched the imagery most accurately.

Post-processing

The raw classifications from Feature Analyst then went through a series of post-processing operations. First, LiDAR data was used to verify and revised tree canopy; if an area was classified as Tree Cover but less than 6 feet off the ground then it was changed to Pervious. Conversely if an area was classified as pervious but more than 6 feet off ground then classified as tree canopy. Planimetric data were also used at this point to improve the classification. Roads, sidewalks, and trails were "burned in" to the raw classification (converted vector data to raster data, which then replaced the values in the raw classification). The "tree canopy" class was not affected by the burn-in process, however, because tree canopy can overhang streets. These data layers were also used to make logic-based assumptions to improve the accuracy of the classification. For example, if a pixel was classified as "tree canopy," but that pixel overlaps with the roads layer, then it was converted to Tree Cover over Impervious.

Accuracy Assessment

To assess the land cover classification a confirmation process was performed. To do this we vectorize the Landcover dataset and then buffer-in each polygon 10 feet. This eliminates the possibility that randomly generated confirmation point will fall on the boundary between two features. Next we generated about 150 random points in the map extent and visually tested what each point is. This process can be performed multiple times between iterations if necessary until accuracy is acceptable.

Some manual editing of the data was necessary because there was confusion on features such as sandy bare ground which reflects very similar light spectrums to some pavement types and also waterbodies were confused initially with darker pavement.

NAIP Image 2016

Potential Planting Area (PPA)

Potential Planting Spots (PPS)

Potential Canopy Area (PCA)

Potential Planting Area Dataset

The Potential Planting Area dataset has three components. These three data layers are created using the landcover layer and relevant data in order to exclude unsuitable tree planting locations or where it would interfere with existing infrastructure.

1. Potential Planting Area (PPA)
2. Potential Planting Spots (PPS)
3. Potential Canopy Area (PCA)

The Potential Planting Area (PPA) is created by selecting the land cover features that have space available for planting trees, then eliminating areas that would interfere with existing infrastructure.

Initial Inclusion selected from GIC created land cover:

- Pervious surfaces
- Bare Earth

Exclusion Features:

- Excluded land cover features (10 foot buffer)
  - — Existing tree cover
  - — Water
  - — Wetlands
  - — Imperious surfaces

Ball Fields (i.e.: Baseball, Soccer, Football) where visually identifiable f rom NAIP imagery.

Potential Planting Spots

The Potential Planting Spots (PPS) are created from the PPA. The potential planting areas (PPA) is run through a GIS model that selects spots a tree can be planted depending on the size tree's that are desired. The tree planting scenario was based on a 20 ft. and 40 ft. mature tree canopy with a 30% overlap.

Potential Canopy Area

The Potential Canopy Area (PCA) is created from the PPS. Once the possible planting spots are given a buffer around each point that represents a tree's mature canopy is created. For this analysis they are given a buffer radius of 10 or 20 ft. that results in 20 and 40 ft. tree canopy. This represents the trees full canopy spread at maturity.

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